



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 [Working Professional]

Implemented from the batch admitted in Academic Year 2024-25

[Working Professional syllabus]

Signature

Signature

Signature



Signature
Dean-Academics
VJTI MUMBAI

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.




Dean-Academics
VJTI MUMBAI

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.



Dean-Academics
VJTI MUMBAI

Credit Framework for L.Y. B.Tech Civil Engineering [Working Professional] - Semester - VII

Sr.	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
								TA	MST	ESE
1	WPSE4001T	Design of Steel Structures	3	1	0	4	4	20	30	50
2	WPCE4001T	Transportation Engineering	3	1	0	4	4	20	30	50
3	WPCE4002T	Water and Wastewater Engineering	3	0	0	3	3	20	30	50
4	WPCE4301T*	Open Elective – I	3	0	0	3	3	20	30	50
5	WPCE4101T*	Program Elective – II	3	0	0	3	3	20	30	50
6	WPSE4001L	Design of Steel Structures Laboratory	0	0	2	2	1	ISCE :60		40
7	WPCE4801P	Project stage I	0	0	4	4	2	ISCE :60		40
Total			15	2	6	23	20			

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

[Signature]

[Signature]

[Signature]



Dean-Academics
VJTI MUMBAI

Credit Framework for L.Y. B.Tech Civil Engineering [Working Professional] - Semester – VIII

Sr.	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
								TA	MST	ESE
1	WPCE4003T	Construction Management	3	1	0	4	4	20	30	50
2	WPCE4004T	Construction Entrepreneurship	3	1	0	4	4	20	30	50
3	WPCE4102T*	Program Elective – III	3	0	0	3	3	20	30	50
4	WPCE4302T*	Open Elective – II	3	0	0	3	3	20	30	50
5	WPCE4003L	Construction Management and Civil Engineering Software Laboratory	0	0	2	2	1	ISCE :60		40
6	WPSE4001L	Structural Design and Structural Engineering Software Laboratory	0	0	2	2	1	ISCE :60		40
7	WPCE4802P	Project stage II	0	0	8	8	4	ISCE :60		40
Total			12	2	12	26	20			

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

[Signature]

[Signature]

[Signature]



Dean-Academics
VJTI MUMBAI

Semester VII List of Professional Elective-II:

SN	Course Code	Course Title
1	WPCE4101T	Terrain Data Analysis
2	WPCE4102T	Environmental Management
3	WPCE4103T	Water Resources System Planning & Management
4	WPCE4104T	Rehabilitation of Buildings
5	WPCE4105T	Advanced Construction Techniques
6	WPSE4101T	Introduction to Nonlinear Analysis
7	WPSE4102T	Earthquake Engineering and Structural Dynamics
8	WPCE4106T	Environmental Impact Assessment

Semester VIII List of Professional Elective-III

SN	Course Code	Course Title
1	WPCE4107T	Solid and Hazardous waste Management
2	WPCE4108T	Watershed Management
3	WPCE4109T	Pavement Management System
4	WPCE4110T	Pavement Design and Construction
5	WPSE4103T	Design of Prestressed Concrete Structures
6	WPSE4104T	Geo-synthetic Engineering
7	WPCE4111T	Unit Operations & Processes in Environmental Engineering
8	WPCE4112T	Introduction and Application of AI, ML, and IOT for Civil Engineering
9	WPCE4113T	Sustainable Development

Semester VII List of Open Elective - 1:

SN	Course Code	Course Title
1	WPCE4301T	Introduction of the Application of AI tool in Engineering
2	WPCE4302T	Project Appraisal

Semester VIII List of Open Elective - 2:

SN	Course Code	Course Title
1	WPCE4303T	Climate change and Carbon Neutrality
2	WPCE4304T	Environmental Legislation and Management






Dean-Academics
VJTI MUMBAI

Semester VII

Semester - VII		PCC						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
1	WPSE4001T	Design of Steel Structures	3-1-0=4	4	20	30	50	3
Course Outcomes After completion of this course, students will be able to, 1. Apply the limit state design philosophy for analysis and design of structural steel components. 2. Apply the limit state design philosophy for analysis and design of structural steel connections. 3. Analyze and design structural steel roofing and flooring systems.								

Module	Course Contents
1	Bolted and welded connections Introduction to riveted connection, design of bolted and welded connections, axially and eccentrically loaded joints, simple connection of bracket plates to columns, beam to beam and beam to column connections, design of framed, unstiffened and stiffened seat connections.
2	Roofing system Imposed loads on flat and sloping roofs and floors, wind loads on sloping roofs and vertical cladding including effect of degree permeability and wind drag, analysis of pin-jointed trusses under various loading cases, computation of design forces in members, design and detailing of connections and supports.
3	Flooring system Concept of floor system with secondary beams, main beams and columns, design of simply supported beams using rolled steel sections.
4	Columns and Bases Design of columns under axial loads using single or multiple rolled steel sections, design of lacing, battens, columns subjected to axial load and bending, design of slab and Gusseted base.
	Recommended Reading 1 S.S. Bhavikatti, Design of Steel Structures, I.K. International Publishing House Limited, 2017. (ISBN: 9789385909559/938590955X). 2 V.L. Shah and V. Gore, Limit State Design of Steel Structures IS: 800-2007, Structures Publication, 2012. (ISBN: 8190371754). Reference Books: 1 S.K. Duggal, Limit State Design of Steel Structures, Tata McGraw-Hill Education.

	IS Codes: 1 IS 800 (2007), General Construction in Steel – Code of Practice, CED 7: Structural Engineering and Structural Section, Bureau of Indian Standards, Manak Bhavan, New Delhi. 2 IS 875 (Part 1): 1987, Dead Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, Manak Bhavan, New Delhi. 3 IS 875 (Part 2): 1987, Imposed Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, Manak Bhavan, New Delhi. 4 IS 875 (Part 3): 2017, Wind Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, Manak Bhavan, New Delhi. 5 IS 875 (Part 4): 1987, Snow Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, Manak Bhavan, New Delhi. 6 IS 875 (Part 5): 1987, Special Loads and Load Combinations, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, Manak Bhavan, New Delhi.
--	--

Semester -VII		PCC						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
2	WPCE4001T	Transportation Engineering	3-1-0=4	4	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Describe the terminology of infrastructure services like railway, docks, harbor and airport facilities. 2. Describe and sketch railway, docks and harbor and airport components. 3. Analyze the factors influencing the site selection for railway, docks, harbor, and airport facilities. 4. Design the components of railway, docks and harbor and airport. 5. Propose appropriate method of construction & maintenance required for railway, docks and harbour and airport facilities.								

Module	Course Contents
1	Introduction Role of transportation in society, Objectives of transportation system, Transportation Planning different types of modes, planning & co-ordination of different modes for Indian conditions, modern transportation system.
2	Railway Engineering Merits of rail transportation, railway gauges and gauge problems Cross section of permanent way and track components: Sleepers-functions and types, sleeper density, ballast functions and different ballast materials, ballast less track. Rails: Coning of wheels and tilting of rails, rail cross sections, wear and creep of rails rail fastenings. Geometric design: Gradients, transition curves, widening of gauges on curves, cant and cant deficiency. Point and crossing: Design of turnouts and description of track junctions. Yards: details of different types of railway yards and their functions. Signals, Line clear system, Semaphore Signals, Different types of signalling systems Construction and maintenance of railway track, methods of construction, material requirements, special measures for high speed track, monorail, metrorail, high speed train

3	Airport Engineering Aircraft characteristics and factors influencing on airport planning. Airport planning: topographical and geographical features, air traffic characteristics, and development of new airports, factors affecting airport site selection. Airport obstruction: Zoning laws, classification of obstruction, imaginary surfaces, approach zones, turning zones. Airport layout: runway orientation, wind rose diagrams, and basic runway length. Correction of runway length, airport classification, runway configuration, taxiway design, geometric standards, exit taxiways, holding aprons, location of terminal buildings, aircraft hangers and parking. Airport marking and lighting: marking and lighting of runways, taxiways and approach areas
4	Water Transportation Harbours: Selection of site, entrance and channel requirement, ship characteristics and their influence on ports management and operations, harbour maintenance. Harbour layout: harbour works, break waters, jetties, wharves, piers, berthing facilities, types and construction, dolphins. Navigational aids: buoys and lighthouses etc. Port facilities: docks, transit sheds and warehouses, general layout, containers and container yard, layout and handling equipment.
	Textbooks: 1 Saxena S.C. and Arora S. P., A Textbook of Railway Engineering, Dhanpat Rai Publications, New Delhi, 2010. (ISBN-9788189928834) 2 Khanna and Arora, Airport planning & design, Nemchand Bros, Roorkee (ISBN-9788185240688) 3 M. M. Agarwal, Indian Railway Track, Prabha & Co., Sachdeva Press, Mayapuri, New Delhi, 2018. (ASIN: B074XSTCHS) Recommended Reading: 1 Robert, Horonjeff & Mcklerrey William, J Sproule, Seth B. Young, Planning & design of Airport, McGraw Hill, New Delhi, 2010. (ISBN: 9780071446419) 2 A. D. Quinn, Design and Construction of Ports and Marine Structures, McGraw Hill, Inc, USA, 1961. (ISBN: 0070510644)

Semester - VII		PCC						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
3	WPCE4002T	Water and Wastewater Engineering	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Characterize sources and quality parameters of water and wastewater for engineering applications. 2. Analyze and design unit operations and processes for potable water treatment systems. 3. Analyze and design sewerage systems and wastewater treatment processes. 4. Evaluate the suitability of treated water and wastewater for reuse based on relevant standards and guidelines								

Module	Course Contents
1	Introduction: Importance of environmental sanitation, Impact of human upon the environment, Impact of environment upon the human.
2	Sources and characteristics of water and wastewater: Physical, Chemical, Bacteriological properties, Quality of water and wastewater at source, Water quality standards for drinking and various applications, Aerobic and anaerobic decomposition of wastewater.
3	Treatment of water: Aeration, Sedimentation: factors affecting efficiency, design values of various parameters, tube settlers; Coagulation and flocculation: Mechanisms, common coagulants, rapid mixing and flocculating, devices, G and GT values, jar test, coagulant aids - polyelectrolyte etc. Filtration: classification, slow and rapid sand filters, dual media filters, sand, gravel and under drainage system, mode of action, cleaning, limitations, operational difficulties, performance, basic design consideration, pressure filters: construction and operation; Water softening: lime soda and base exchange methods, principle reactions, design considerations; Disinfection: chlorination, chemistry of chlorination, kinetics of disinfection, chlorine demand, free and combined chlorine, break point chlorination, superchlorination, dechlorination, chlorine residual use of iodine, ozone, ultraviolet rays, and chlorine dioxide as disinfectant, well water disinfection; Treatments for removal of dissolved solids: Reverse osmosis, Distillation, Electrodialysis.

4	Wastewater treatment and disposal: Wastewater treatment: Objectives, methods of sewage treatment and various flow sheets for preliminary, primary, and clarifiers, disposal of screenings and grits; Biological treatment methods: principles, activated sludge process, sludge volume index, operational problems in activated sludge process, trickling filter; Sludge digestion: principles of anaerobic digestion, quantity and characterization of sludge, design of sludge digestion tank, disposal of digested sludge, drying beds; Disposal of wastewater: Discharge of raw and treated sewage on land and in water, Standards of disposal of raw and treated sewage on land and in water, limits of dilution, Self-purification of streams and oxygen economy.
5	Reuse and recycle of treated wastewater: Disposal of treated effluent, gardening, sewage farming, W.C. Flushing, reuse in industry.
	Textbooks: 1 S. K. Garg, Sewage Disposal and Air Pollution Engineering, Khanna Publishers, Delhi, Thirty seventh edition, 2017. (ISBN: 9788174092304) 2 S. K. Garg, Water Supply Engineering, Khanna Publishers, Delhi, 28th edition, 2010. (ISBN: 9788174091208/8174091203) 3 Manual on Water Supply and Treatment, Ministry of Works & Housing, New Delhi, 1993. 4 Manual on Wastewater Treatment, Ministry of Works & Housing, New Delhi, 2013. Reference Books: 1 T. J. McGhee, Water supply and sewerage, McGRAW Hill Inc., US, 6th editions, 1991 (ISBN: 0070609381/978-0070609389). 2 H. S. Peavy, D. R. Rowe and G. Tchobanoglous, Environmental engineering, McGRAW Hill Education, Indian edition, 1st edition 2013. (ISBN: 9351340260/978-9351340263)

Semester - VII		PCC						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
4	WPSE4001L	Design of Steel Structures Laboratory	0-0-2=2	1	ISCE:60		40	3
Course Outcomes After completion of this course, students will be able to, 1. Identify and compute the design loads on various structural steel systems. 2. Apply principles and relevant codal provisions for the analysis and design of various structural steel systems. 3. Use commercial software for analysis and design of steel structures. 4. Prepare detailed steel structural drawings.								

Module	Course Contents
A	Design of roof truss system.
B	Design of columns and columns bases
C	Design of structural steel flooring system.
D	Design of bolted and welded connections
	Recommended Reading 1 S. S. Bhavikatti, Design of Steel Structures, I.K. International Publishing House Limited, 2017. (ISBN: 9789385909559 / 938590955X) 2 N. Subramanian, Design of Steel Structures, Oxford University Press, 2011. (ISBN: 9780198068815 / 0198068816) Textbooks 1 S. K. Duggal, <i>Limit State Design of Steel Structures</i>, Tata McGraw Hill Education Private Limited, 2017. (ISBN: 9351343499 / 9789351343493) 2 V. L. Shah and V. Gore, <i>Limit State Design of Steel Structures IS: 800-2007</i>, Structures Publication, 2012. (ISBN: 8190371754) IS Codes: 1 IS 800 (2007), General Construction in Steel – Code of Practice, CED 7: Structural Engineering and Structural Section, Bureau of Indian Standards, Manak Bhavan, New Delhi. 2 IS 875 (Part 1) (1987), Dead Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, Manak Bhavan, New Delhi. 3 IS 875 (Part 2) (1987), Imposed Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, Manak Bhavan, New Delhi. 4 IS 875 (Part 3) (2017), Wind Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures,

	Bureau of Indian Standards, Manak Bhavan, New Delhi. 5 IS 875 (Part 4) (1987), Snow Loads, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, Manak Bhavan, New Delhi. 6 IS 875 (Part 5) (1987), Special Loads and Load Combinations, Indian Standard Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures, Bureau of Indian Standards, Manak Bhavan, New Delhi.
--	--

Semester - VII		Project						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
5	WPCE4801P	Project Stage I	0-0-4=4	4		ISCE:60	40	3
Course Outcome: After completion of course students will be able to 1. Review available knowledge with reference to specific problem 2. Formulate the problem and collect relevant data. 3. Define systematic approach to arrive at solution								

Module	Course Contents
	Every student has to work on a one year 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.

Semester - VII		Program Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
6	WPCE4101T	Terrain Data Analysis	3-0-0=3	3	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 Contents
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, Aerial Photographs, satellite Images
3	Digital Terrain Modelling and Analysis Sources, Representation and interpolation Electro Magnetic Interference and Vibration Measurement
4	A Sectoral Engineering System The geography of area and its irrigation systems. Listing stakeholders, i.e., villages-farmers, people with and without land, local industrial workers, agriculture-cash crops and traditional crops, irrigation department and the market. History of irrigation for the region. Protective vs. command irrigation and its consequences. Developing a methodology for assessment. An example of a design document Socio-Technical challenges-increasing irrigated area, drip irrigation and better farm practices. Groundwater regulation. Field Visit to an irrigation system. Meeting with an NGO, farmers, a state officer and an elected representative.
5	Geoinformatics Loading QGIS and a district dataset. Using a given dataset. Writing queries and manipulating appearances, Types of objects and manipulating objects. Linking Census data to GIS. Basic analysis and representation Introduction to a case-study. Basics of spatial planning queries such as computing net supply and net demand.
6	Tools and processes of feasibility analysis: Demonstrate use of tools of market survey, demand forecasting, technology comparisons, environmental analysis, cash flow, risk analysis, return of investment.
7	Data Base Development Principles, Programming and utilization
8	Compilation of Thematic Maps Visual Interpretation and Digital analysis, Digitization and Rasterization, information analysis systems: Principles and applications.

	Textbooks: 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		Program Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
7	WPCE4102T	Environmental Management	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Use the principles of environmental management to carry out policy analysis and prepare environment management plan. 2. Apply various methods of environmental impact assessment and environmental audit. 3. Apply the tools and develop strategies for an environmentally sustainable project. 4. Prepare and assess disaster management plan for infrastructural projects.								

Module	Course Contents
1	Environment legislation in India and Global scenario Government Agencies & Programs; Environmental Protection Act 1986; Ministry of Environment & Forest, Function of State Pollution Control Board & CPCB, US EPA (Environmental Protection Agency)
2	Environmental Impact Assessment Introduction – Concept of EIA- Scope and object of EIA, organization responsible for EIA, Site selection and area classification. Description of the environmental setting - Inclusion or Exclusion of environmental Items, Suggested approaches for developing a list of environmental Factors – Informational Sources for Environmental factors. Various steps of EIA – Content of EIA, Assessment methodology- Ad-hoc. EIA for Building and Construction, Hydroelectric projects, Mining, Thermal and Nuclear Power plants, Roads and Airports. Environmental Impact Assessment Notification (2006): Procedure for Environmental Clearance, List of the projects requiring Environmental Clearance, Composition of Expert Committee for Impact Assessment, Public hearing Committee, Procedure for public hearing- Project clearance.
3	Environmental Safety, Health and Safety Public health: communicable diseases, mode of transmission (epidemic and endemic diseases). Occupational health and safety, Occupational health and hazards (physical, chemical and biological), Occupational diseases prevention and control. Industrial safety standards and regulations, Accidents: definitions, prevention and control. Safety management system: concepts of safety management systems, EMS; ISO 14000, 14001 and 18001, OSHA.

4	A Sectoral Engineering System The geography of area and its irrigation systems. Listing stakeholders, i.e., villages-farmers, people with and without land, local industrial workers, agriculture-cash crops and traditional crops, irrigation department and the market. History of irrigation for the region. Protective vs. command irrigation and its consequences. Developing a methodology for assessment. An example of a design document Socio-Technical challenges-increasing irrigated area, drip irrigation and better farm practices. Groundwater regulation. Field Visit to an irrigation system. Meeting with an NGO, farmers, a state officer and an elected representative.
5	Disaster Management Disaster: Introduction, Types of natural calamities, major and minor calamities, impact of calamities. Natural disaster: cyclone, Tsunami, Flood, Landslides, Earthquake. Manmade disaster: Wars, Biological war (introduction of pathogens), misuse of atomic bombs, major accidents from industries and thermal and nuclear power plants (Bhopal gas Tragedy, Love canal disaster – London Smog). Environmental Disaster: Assessment, Planning: mitigation program, preparedness, resettlement rehabilitation, role of NGOS, GOs.
	Textbooks: 1 V. Kulkarni and T. V. Ramachandra, Environmental Management, Capital Publishing Company, New Delhi, 2006. (ISBN: 818558947X) 2 L. W. Canter, Environmental Impact Assessment, McGraw-Hill India, 2016. (ISBN:9789339220464) 3 A. K. Mhaskar, Environmental Audit (An Overview), M/s. Media Enviro, Pune. Reference Books: 1 The Environmental (Protection) Act, 1986, Universal Law Publishing Co.Pvt. Ltd. New Delhi. (ISBN: 9788175349247). 2 P. A. Erickson, Environmental Impact Assessment - Principles and Applications, Academic Press, Inc., New York, USA. (ISBN: 0122415507) 3 J. G. Rau and D. C. Wooten, Environmental Impact Analysis Handbook, McGraw Hill higher Education, USA. (ISBN: 978-0070512177/0070512175)

Semester - VII		Program Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
8	WPCE4103T	Water Resources Systems Planning and Management	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Construct and analyze watershed model and solve watershed management problem 2. Optimize the water resource system 3. Simulate water resources system								

Module	Course Contents
1	Environment legislation in India and Global scenario Watershed, Watershed-element and types, Watershed hydrology, Hydrological cycle, Precipitation, water losses, Runoff, Rainfall-Runoff analysis, Watershed problem.
2	Water Resources Management Erosion control and watershed development: their benefit towards conservation of National water wealth. Rainwater harnessing and recharge of ground water: role of society and people's participation for sustainable water resource development. Mitigation strategies for flood damage: structural and non-structural measures
3	Watershed Management techniques Spatial Decision Support Systems (SDSS) for land and water management at the watershed scale, Integrated Watershed Management, On-site and off-site management structures for soil and water conservation. Community Watershed Management.
4	Optimization Optimization Multi - objective optimization, Review of probability theory, Uncertainty and reliability analysis, Stochastic optimization - Chance constrained LP, Stochastic DP with applications, Surface water quality control, Non-linear programming.
5	Stimulation Simulation – Reliability, Resiliency and Vulnerability of water resource systems, multipurpose reservoir operation for hydropower, flood control and irrigation, Groundwater Systems, Water quality modelling, River basin Planning and management, Advanced topics.
6	Soft computing techniques Soft computing techniques ANN Genetic algorithms, Multi criteria decision making, decision Support Systems, Expert Systems, Mutagenesis.

	Textbooks: 1 G. L. Asawa, Irrigation Engineering, Wiley eastern Limited, New Delhi. (ISBN: 812240457X) 2 S. K. Garg, Irrigation Engineering & Hydraulic Structures, Khanna Publishers, 2018. (ISBN:978-8174090478/8174090479) 3 S. S. Rao, Engineering Optimization: Theory and Practice, New Age International Publishers, 3rd edition, 2013. (ISBN: 9788122427233/8122427235) 4 S. Vedula and P. P. Mujumdar, Water Resources Systems, Tata McGraw Hill Education, 2005. (ISBN: 0070590893/9780070590892) Reference Books: 1 J. D. Zimmerman, Irrigation, John Wiley & Sons, 99th edition, 1966. (ISBN: 978- 0471983798/0471983799) 2 P. N. Modi, Irrigation Water Resources and Water Power Engineering, Standard Book house, Rajsons Publications Pvt. Ltd., 9th edition, 2014. (ISBN: 9788189401290/8189401297) 3 V. P. Singh, Elementary Hydrology, Prentice Hall of India Pvt. Ltd., 1998. (ISBN: 978-0132493840) 4 R. A. Wurbs and W. P. James, Water Resources Engineering, Prentice Hall of India Private Limited, New Delhi, 2001. (ISBN: 978-0130812933/0130812935)
--	---

Semester - VII		Program Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
9	WPCE4104T	Rehabilitation of Buildings	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Conduct POE and identify various types of distresses in buildings. 2. 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 Contents
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.
8	Repair and Rehabilitation of other structures Pipelines (water/ sewage/ air/ gas): Purpose and methods of evaluation, evaluation of physical condition, methods of rehabilitation. Roads: Evaluation and performance surveys, distress evaluation, methods of resurfacing, overlays, restoring and rehabilitation. Bridges: Inspection and reporting methods, rehabilitation measures. Ports and harbours: Maintenance of ports, port buildings, and services.

	Textbooks: 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		Program Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
10	WPCE4105T	Advance Construction Techniques	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Choose the appropriate construction technique for a particular construction project. 2. Select the appropriate construction material, equipment's for a particular construction project. 3. Integrate knowledge for development of intelligent building using smart material.								

Module	Course Contents
1	Introduction to Large and heavy engineering projects Characteristics and complexities, methods statement for major activities like excavation, concreting, steel fabrication and erection for projects like earthen dams, hydropower projects, nuclear power plant, refineries and other industrial projects etc.
2	Excavation for heavy engineering projects Excavation in various types of soils, selection of equipment, safety measures in excavation, drainage in excavation, Blasting, Arrangements of Blasts and safety measures during blasts.
3	Concrete construction for heavy engineering projects Dams, Ports , Power plants: Hydropower, Thermal and nuclear Plant, Tunnelling: Tunnel construction/underground infrastructure development Selection of equipment for batching, mixing, transporting, placing and compacting for various types of jobs, safety measures during concreting, Special concretes and mortars: preplaced aggregate concrete, roller compacted concrete, grouting. RCC in cold climate Nuclear Power Plants and Petrochemical Plants: AERB Codes (Atomic Energy Regulatory Board) and cover design aspects like SSE / OBE earthquakes, seismic stability, inelastic response, performance levels, acceleration limits, crack control in concrete, cyclic loading, shock loading, impact modular construction techniques e.g. a complete segment of reactor building construction, shop including concrete floor / walls, equipment supports, piping etc its transportation and installation
4	Prefabricated construction Planning for pre-casting, selection of equipment for fabrication, transport and erection, quality measures, safety measures during erection, Different techniques of Pre-tensioning and Post-tensioning. concepts of rebar detailing software, 3D modeling, automated fabrication at site.
5	Formwork Requirement of formwork, loads carried by formwork, types of formwork such as timber formwork, Steel formwork, patent formwork, modular shuttering, slip forms, steel scaffolding.

6	Steel construction Planning for field operations, selection of equipment and erection tools, tools and methods of welding, tools and methods of cutting and joining, bridge erection: transportation of girders, quality measures, safety measures during fabrication and erection, bar bending schedules and bar cutting & bending machines
7	Specific issues related to planning, site layouts, equipment selection and pre-project activities for large size construction projects like earthen dams, concrete dams, thermal power stations, nuclear power stations, light houses, airports and ports, bridges
8	Information related to special equipment and their applications to Off-shore construction such as barges, types of barges, underground utility construction, Control of water ingress in underground structures, Micro piling
9	New materials and equipment for construction- Types of mortars, Special mortars, types of Nanomaterial such as Fly ash, micro silica, Silica fume, GGBS. Self-compacting Concrete, Ferro cements, Fire resisting materials, demolition techniques for various structures, pumping of concrete
10	Case studies of heavy construction projects
	Textbooks: 1 V. N. Vazirani and S. P.Chandola, Heavy Construction, Khanna Publishers, New Delhi (ISBN: 5551234023749) Reference Books: 1 T. Barron, Erection of constructional steelwork: a textbook for junior site engineers and students, Iliffe, London, 1963. 2 F. W. Stubbs and J. A. Havers, Handbook of Heavy Construction, McGraw-Hill, 2nd edition, 1971. (ISBN: 978-0070272781/0070272786) 3 Journals of Civil Engineering and Construction Engineering

Semester - VII		Program Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
11	WPSE4101T	Introduction to Non-Linear Analysis of structures	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course, students will be able to, 1. Apply principles of nonlinear behavior in structural stability analysis. 2. Perform stability analysis for simple and complex structures. 3. Perform plastic analysis of simple and complex steel and concrete structures. 4. Design simple and complex steel and concrete structures using plastic design methods.								

Module	Course Contents
1	Introduction to elastic stability Geometric non-linearity: basic concept. Analysis of beam column with various end conditions, use of trigonometric series.
2	Introduction to torsional buckling Pure torsion of thin walled beams of open cross section warping and warping rigidity, Torsional buckling of columns, combined buckling by torsion and flexure. Lateral torsional buckling of beams, Indian codal provisions regarding buckling of steel members (columns and beams)
3	Introduction to plastic analysis Concepts of plastic analysis of structures, Stress strain relations of steel and concrete. Concept of Redistribution of Moments, Plastic modulus, Shape factor, Plastic hinge, rotation capacity for steel and concrete plastic hinges, Fully plastic moment, moment curvature relations for rigid, semi rigid and ductile joints, Effect of Axial Force and Shear Force on the fully plastic moment of a cross section, Various types of failure mechanisms, Statical and Mechanism method for calculation of collapse loads, Lower and upper bound theorems.
4	Determination of collapse loads for steel structures Determination of Collapse loads for single and multiple span beams, carrying various types of loads, single/multi bay multi storied rigid jointed portal frames and single bay gable frames. Incremental Load Method for pin jointed and rigid jointed frames
5	Determination of collapse loads for concrete structure Collapse load analysis of single/multiple span beams by Cambridge Method. Yield Line Analysis of Slabs.

	Textbooks: M.Sathyamoorthy, Nonlinear Analysis of Structures, CRC Press, Boca Raton, Florida, 1997. (ISBN: 9781138105881/1138105880). 1 D.G. Fertis, Nonlinear Mechanics, CRC Press, Boca Raton, Florida, 1998. (ISBN: 0849390028/978-0849390029) Reference Books: 1 J.N. Reddy, Nonlinear Finite Element Analysis, Oxford University Press, 2008. (ISBN- 019852529X/978-0198525295) 2 S. Chandrasekaran, L. Nunziante, G. Serino and F. Carannante, Seismic Design Aids for Nonlinear Analysis of Reinforced Concrete Structures, Taylor and Francis, 2010. (ISBN- 1439809143/978-1439809143).
--	---

Semester - VII		Program Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
12	WPSE4102T	Earthquake Engineering and Structural Dynamics	3-0-0=3	3	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. Perform dynamic analysis of systems in the frequency and time domain. 4. Apply the principles of structural dynamics to structural design. 5. Design multistoried building structures safe and serviceable under earthquakes.								

Module	Course Contents
1	Fundamental of structural dynamics Definitions of basic problems in dynamics, static v/s dynamic loads, different types of dynamic loads, undamped 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 multistoried 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, pseudo-velocity, 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, unmped 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
	Textbooks: 1 A.K. Chopra, Dynamics of Structures, Prentice Hall, India,2007. (ISBN-8131713296/978-8131713297) Reference Books: 1 R. R. Craig, <i>Fundamentals of Structural Dynamics</i>, John Wiley and Sons, 2006. (ISBN-978-0471430445 / 0471430447) 2 Clough and Penzien, <i>Dynamics of Structures</i>, Tata McGraw Hill. (ISBN-9788123926636 / 8123926634) 3 J. M. Biggs, <i>Structural Dynamics</i>, Tata McGraw Hill. (ISBN-9332902550 / 978-9332902558) 4 N. M. Newmark and E. Rosenblueth, <i>Fundamentals of Earthquake Engineering</i>, Prentice Hall. (ISBN-013336206X / 978-0133362060) 5 K. and T. Telford, <i>Earthquake Design Practice for Buildings</i>, London, 1988. (ISBN-9780727729477 / 978-0727729477) 6 R. L. Wiegel, <i>Earthquake Engineering</i>, 2nd Edition, Prentice Hall, London, 1989. (ISBN-0132226464 / 978-0132226462) IS Codes: 1 IS 1893 (Part 1): 2002, <i>General Provisions and Buildings – Criteria for Earthquake Resistant Design of Structures</i>, Bureau of Indian Standards, Manak Bhavan, New Delhi. 2 IS 1893 (Part 4): 2002, <i>Industrial Structures Including Stack-Like Structures – Criteria for Earthquake Resistant Design of Structures</i>, Bureau of Indian Standards, Manak Bhavan, New Delhi.

Semester - VII		Program Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
13	WPCE4106T	Environmental Impact Assessment	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Describe the Environmental Impact Assessment (EIA) process and relate various government notifications 2. Formulate methodologies for prediction and assessment of various environmental impacts 3. Analyze issues and mitigation measures through case studies								

Module	Course Contents
1	Fundamental Approach To EIA History of EIA: Evolution Environmental Laws in World & India, Development of EIA in India, Environmental Clearance Procedure in India. Basic Concept of EIA: Introduction, EIA Procedure, Objective of EIA, Significance. Systematic Approach for Using EIA: Introduction, Identification of Study Area, Classification of Environmental Parameters, Terms of References, Preparation of EIA Report, Scoping in EIA, Rapid EIA: Introduction, Procedure, Advantages and Limitation. Baseline Studies in EIA, Environmental Monitoring & Management Planning, Draft and Final EIA, Impact Analysis, Final EIA Report.
2	EIA Methodologies Introduction, Criteria for the Selection of EIA Methodology, EIA Methods: Adhoc Methods, Checklists Methods, Matrices Methods, Networks Methods, and Overlays Methods.
3	Environmental Impact Statement (EIS) Introduction, Basic Concepts behind EIS, Various Stages in EIS Production, Typical EIS Outline.

4	Prediction and assessment of impacts on soil and ground water environment: introduction, soils and ground water, methodology for the prediction and assessment of impacts on soil and groundwater. Prediction and Assessment of Impacts on Surface Water Environment: Introduction, Project Which Create Impact Concerns for the Surface-Water Environment, Systematic Methods for Evaluation of Impacts of Various, Developmental Activities on Surface Water Environment. Prediction and Assessment of Impacts on Biological Environment: Introduction, General Methodology for the Assessment of Impacts on Biological Environment, Systematic Approach for Evaluating Biological Impacts. Prediction and assessment of impacts on the air environment: Introduction, a generalized approach for assessment of air pollution impact. Prediction and assessment of impacts of noise on The environment: Introduction, Basic Information of Noise, Noise Measurement, Effects of Noise on People, Systematic Methodology for Assessing Environmental Impacts of Noise. Prediction and Assessment of Impacts on the Socio-Economic Environment: Introduction, Social Assessment, Conceptual Framework for Socio Economic Assessment.
5	Case studies on Environmental Impact assessment for current projects in process.
	Textbooks: 1 L. W. Canter, <i>Environmental Impact Assessment</i>, McGraw-Hill International Editions, 2nd edition, 1995 (ISBN: 9780070097674 / 0070097674) 2 Y. Anjaneyulu and V. Manickam, <i>Environmental Impact Assessment Methodologies</i>, CRC Press, B S Publications, 2nd edition, 2011 (ISBN: 9780415665568) Reference Books: 1 D. P. Lawrence, <i>Environmental Impact Assessment</i>, Wiley Interscience, New Jersey 2 L. N. Patraik, <i>Environmental Impacts of Industrial & Mining Activities</i>, Ashish Publication House 3 R. K. Trivedi and M. P. Sinha, <i>Impact of Mining on Environment</i>, Ashish Publication House 4 J. R. Cooper, K. Randle, and R. S. Sokhi, <i>Radioactive Releases in the Environment: Impact and Assessment</i>, John Wiley & Sons, 2003 (ISBN: 9780471899242) 5 T. G. Carpenter, <i>Environment, Construction and Sustainable Development, Vol. 1: The Environmental Impact</i>, John Wiley & Sons, 2001

Semester - VII		Open Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
14	WPCE4301T	Introduction to the Application of AI Tool in Engineering	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Identify the basics of Artificial Intelligence and Machine Learning. 2. Apply AI and ML algorithms to solve problems in engineering. 3. Evaluate AI applications and ethical issues across engineering disciplines.								

Module	Course Contents
1	Introduction to Artificial Intelligence History & Evolution of AI, Types of AI, AI vs Machine Learning vs Deep Learning, Intelligent agents and PEAS framework, Problem-solving: Intelligent Agent, Blind Search Strategies, Informed Search Strategies
2	Introduction to Machine Learning Need and scope of ML, Types of Learning: Supervised, Unsupervised, Reinforcement, Linear Regression, Decision Trees, k-Means, Model training/testing, Artificial Neural Networks: Basic Concepts-Neural network Architectures, Single layer feed forward network, Multilayer feed forward network-Recurrent Networks, Perceptron networks, Back Propagation Networks, Model training & testing
3	AI Tools, Techniques, and Technologies Overview of how AI systems are built and deployed, AI-enabled sensors and instrumentation, Industry 4.0 and AI-driven, Robotics and AI integration, Computer Vision, Natural Language Processing
4	AI Applications in Engineering: AI in Civil Engineering, AI in Mechanical Engineering, AI in Electrical & Electronics Engineering, AI in Computer Science/IT---Case studies of Engineering diagnostics
5	Ethical Considerations in AI Ethical considerations in AI and ML applications, AI governance and regulatory frameworks, Sustainable and environmentally responsible AI, Future outlook: Industry 5.0, human-AI collaboration across engineering disciplines
	Recommended Reading:

	1.S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, Prentice Hall, 2010. 2. Grigoris Antoniou and Frank Van Harmelen. A semantic web primer. 3rd ed. 2012. 3. Pedro Domingos and Daniel Lowd. Markov logic: An interface layer for artificial intelligence. 2009. 4. Ethem Alpaydin, Introduction to Machine Learning, PHI Learning, 3rd edition, 2014 (ISBN: 9788120350786) 5. Andries P. Engelbrecht, Computational Intelligence: An Introduction, Wiley, 2nd edition, 2007 (ISBN: 9780470035610)
--	--

Semester - VII		Open Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
15	WPCE4302T	Project Appraisal	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of this course, students shall be able to, 1. Explain concepts of project formulation.. 2. Illustrate application of tools of data analysis for appraisal. 3. Articulate arguments to justify projects in view of various aspects. 4. Analyze and explain risks involved in undertaking a project.								

Module	Course Contents
1	Project development Projects, Capital expenditure: Importance and difficulties Phase of capital budgeting, project development cycle, aspects of appraisal.
2	Project preparation Project Conception, scouting for ideas and alternatives, Preliminary screening
3	Technical appraisal Materials and other resources, choice of technology, selection of site, plans and works schedules.
4	Market analysis Demand, past, present and future, govt. policies, demand forecasting techniques
5	Financial estimates and projections Project estimates, sources of financing, cost and financing, financial projections – balance sheet, sources and uses of funds, cash flow statement
6	Financial appraisal Urgency, payback period, accounting rate of return, net present value, internal rate of return
7	Risk analysis Measures of risk, mathematical analysis of cash flows, sensitivity and scenario analysis, decision tree analysis, Social cost benefit analysis;- rationale, different approaches.

	Text Books: 1 P. Chandra, Project Preparation, Appraisal, Budgeting and Implementation, Tata McGraw Hill, 3rd edition, 1987. (ISBN: 978-0074516287/0074516280) 2 Policy guidelines: Guidelines for the Preparation of Feasibility reports of Industrial Projects, Controller of Publications, New Delhi. Reference Books: 1. I. M. Pandey, Financial Management, Vikas Publishing House Pvt Ltd, 11th edition, 2015. (ISBN: 9789325982291) 2. D. Newnan, T. G. Eschenbach and J. P. Lavelle, Engineering Economics Analysis, Oxford University Press, 2015. (ISBN: 9780190296902) 3. R Panneerselvam, Engineering Economics, PHI Learning Pvt. Ltd, 13th edition, 2012. (ISBN: 9788120317437) 4. F. Harris and R. McCaffer, Modern Construction Management, Blackwell science, 17th Edition. 5. R. Pilcher, Principles of Construction Management, McGraw Hill London, 3rd edition. (ASIN: B01K2RD6K6) 6. United Nations Guidelines for Project Evaluation Oxford & IBH Publishing Co. Pvt. Ltd. 7. A.H. Taylor & H Shearing, Financial and Cost Accounting for Management, Trans-Atlantic Publications, London, 8th edition. (ISBN: 978-0712106337/0712106332)
--	--

Semester VIII

Semester - VIII		PCC						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
1	WPCE4003T	Construction Management	3-1-0=4	4	20	30	50	4
Course Outcomes After completion of this course, students will be able to, 1. Explain need for management and management functions. 2. Develop and analyze plans and resolve resource conflicts. 3. Relate monitoring and control issues with reference to time, cost and quality. 4. Apply project management principles and tools to improve efficiency in construction projects.								

Module	Course Contents
1	Management Definition, functions of management, advances and societal influences in construction management
2	Construction projects Merits Relationships with Project, Program and Portfolio Management, Project lifecycle, Phases of a project, agencies involved, Indian standards on construction and project management, relevant Indian Standards on construction and project management such as IS 15883 and lean construction techniques.
3	Construction project planning Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, estimating durations, sequence of activities, activity utility data.
4	Techniques of planning Bar charts, Networks: basic terminology, types of precedence relationships: finish to start, start to start, finish to finish, start to finish, preparation of CPM networks: activity on link and activity on node representation, analysis of single relationship (finish to start) networks, computation of float values, critical and semi-critical paths, calendaring networks.
5	Resource Schedule Bar chart, line of balance technique, resource constraints and conflicts, resource aggregation, allocation, smoothening and levelling
6	PERT Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion

7	Construction costs Classification of costs, time cost trade-off in construction projects, compression and decompression
8	Monitoring & control Project communications, record keeping, periodic progress reports, periodical progress meetings, earned value management, scope creep and change management, updating of plans: purpose, frequency and methods of updating common causes of time and cost overruns and corrective measures. PMI / PMBOK for efficient management of projects. Quality control of construction materials and processes as per relevant Indian Standards such as IS 456, IS 10262, and IS 516.
9	Project Closure Closeout documentation, Project punch list, Lessons Learned, as build drawing, operation and maintenance manual.
	Textbooks: 1 K. K. Chitkara, Construction Project Management- Planning, Scheduling and Controlling, Tata McGraw Hill Education, 2nd edition, 2010. (ISBN: 9780070680753/ 0070680752) 2 K. N. Jha, Construction Project Management- Theory and Practice, Pearson Education India, 2nd edition, 2015. (ISBN: 978-9332542013/9332542015) Reference Books : 1 J. M. Antilland R. W. Woodhead, Critical Path Methods in Construction Practice, Wiley- Interscience, 4th edition, 1990. (ISBN:9780471620570/0471620572) 2 2D.S. Barrie &B. C. Paulson, Professional Construction Management: Including CM, Design- Construct and General Contracting, McGraw Hill Inc, 3rd edition, 1991. (ISBN:9780070038899) 3 IS 15883:2010, Criteria for Design of Project Management System in Construction, Bureau of Indian Standards, New Delhi, India. 4 IS 456:2000, Plain and Reinforced Concrete – Code of Practice, Bureau of Indian Standards, New Delhi, India. 5 IS 10262:2019, Concrete Mix Proportioning – Guidelines, Bureau of Indian Standards, New Delhi, India.

Semester - VIII		PCC						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
2	WPCE4004T	Construction Entrepreneurship	3-1-0=4	4	20	30	50	4
Course Outcome: After completion of course students will be able to 1. Describe economics of construction environment 2. Prepare and submit bids for participating in bidding process 3. Define 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 project environment Projects in construction and the unique features, Role of a Project Manager, Project Stakeholders and governance, project delivery methods, enterprise environmental factors.
2	Business Terminologies Types of entities, Special Purpose Vehicle, Partner, Company, Sole Proprietorship firm, Trust, Society, Articles of Association and MOA, BOT, Joint venture
3	Construction enterprise organization Forms of business organization, structure of construction organization, organization structures for managing projects, management levels, organizational influences on construction project management.
4	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.
5	Construction contract Bidding process, General contract conditions (CPWD and FIDIC), sub-contracting, models of PPP
6	Bidding Estimation of costs and bidding strategies, bid preparation, bidding models
7	Planning and organizing construction site and resources Site: site layout, developing site organization, record keeping at site, Manpower: planning, organizing, staffing, motivation, Materials: concepts of planning, procurement and inventory control, Equipment: basic concepts of planning and organizing.

8	Project financing Accounting process, revenue recognition, working capital needs, financing for working capital, Funds: cash flow, sources of funds
9	Claims management Claims identification, claim quantification, claim prevention, claim resolution, contract dispute sand project closure, and settlement method. Arbitration and its detailed procedure
10	Risk in construction entrepreneurship Risk management process, insurance in construction.
11	Heath, Safety, Security and Environmental (HSSE) management on project sites Accidents; their causes and effects, costs of accidents, occupational health problems in construction, organizing for safety and health. LCA of various infrastructure components
	Textbooks: 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) 5 Bureau of Indian standards – IS 7272 (Part-1) - 1974: Recommendations for labour output constant for building works. 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: 9780470672174). 4 M. W. Martin and R. Schinzinger, Ethics in Engineering, McGraw-Hill Education, 4th edition, 2004 (ISBN: 9780072831153 / 0072831154). 5 C. Hendrickson and T. Au, Project Management for Construction – Fundamental Concepts for Owners, Engineers, Architects and Builders, Prentice Hall, Pittsburgh, 2000. 6 J. L. Riggs, D. D. Bedworth and S. U. Randhawa, Engineering Economics, Tata McGraw-Hill, 4th edition, 1996 (ISBN: 9780079122483 / 0079122485). 7 S. C. Sharma, Construction Equipments and its Management, Khanna Publishers.
--	---

Semester - VIII		PCC						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
3	WPCE4003L	Construction Management and Civil Engineering Software Laboratory	0-0-2=2	1	ISCE:60		40	2
	Course Outcome: After completion of course students will be able to 1. Develop plan for construction of civil engineering facility 2. Use project management software for generation of plans, schedules and reports.							

Module	Course Contents
1	Prepare a project plan for any one of the following projects using working drawings and appropriate Building Information Modelling (BIM) software: ☐ Residential bungalow ☐ Single-storey commercial building ☐ Single-span bridge
2	Demonstrate the use of project management software for project planning, scheduling, resource allocation, monitoring, and reporting. Study the software capabilities, input requirements, and interpretation of outputs.
3	Perform 4D construction simulation by integrating a project schedule with a 3D model to visualize the construction sequence and project execution stages.
4	Extract engineering quantities (e.g., earthwork, pavement materials, and structural quantities) from infrastructure models and prepare a basic quantity estimation report using suitable digital engineering tools
5	Evaluate the performance of flexible pavements using appropriate pavement analysis software
6	Perform basic spatial analysis, terrain visualization, and thematic mapping of project data using suitable Geographic Information System (GIS) software.
7	Develop basic 3D civil infrastructure models, including road alignments, corridors, terrain, and bridge components, using appropriate civil infrastructure modelling software.

	Textbooks: 1 K. K. Chitkara, Construction Project Management- Planning, Scheduling and Controlling, Tata McGraw Hill Education, 2nd edition, 2010. (ISBN: 9780070680753/ 0070680752) 2 K. N. Jha, Construction Project Management- Theory and Practice, Pearson Education India, 2nd edition, 2015. (ISBN: 978-9332542013/9332542015) Recommended Reading : 1. User manuals and documentation of Building Information Modelling (BIM), project management, civil infrastructure modelling, GIS, and construction simulation software. 2. Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2018). <i>BIM Handbook: A Guide to Building Information Modeling</i> (3rd ed.). Wiley. 3. Project Management Institute. (2021). <i>A Guide to the Project Management Body of Knowledge (PMBOK® Guide)</i> (7th ed.).
--	--

Semester - VIII		PCC						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
4	WPSE4001L	Structural Design and Structural Engineering Software Laboratory	0-0-2=2	1		ISCE:60	40	2
Course Outcome: After completion of course students will be able to 1. Plan and design multistoried building structures to resist all types of applicable loads. 2. Design elevated water towers of various shapes and configurations. 3. Apply pre-stressed concrete design principles in design of pre-stressed concrete girders.								

Module	Course Contents
1	Design and drawing of G+7 storied residential building (limit state method of design) Design and Drawing of G+7 Storied Residential Building for gravity and lateral loads (Wind and Earthquake) as per relevant I.S Codes. Analyze and design a G+7 storeyed residential building subjected to gravity, wind, and earthquake loads using appropriate structural analysis software in accordance with relevant Indian Standards..
2	Design of pre-stressed concrete girders Design of pre-tensioned and post-tensioned pre-stressed concrete girders.
3	Design of water tanks: (working stress method) Design of Circular and rectangular overhead water tanks both by ARE coefficient and approximate methods, supporting structure for overhead water tanks.
4	Study of tests on shake table: Conduct test on one structural model or soil slopes or rock slopes, to verify their seismic performance. An analysis report along with detailed procedure of conducting experiment/test should be submitted as term work

5	Perform structural analysis and design of reinforced concrete buildings using appropriate structural engineering software and interpret the analysis and design results. Prepare reinforcement detailing of reinforced concrete beams and slabs using suitable detailing software. Prepare detailing of built-up steel compression members using appropriate structural detailing software. Evaluate the bearing capacity of shallow foundations and the stability of slopes using suitable geotechnical analysis software.
	Textbooks: 1 Jain and Jaikrishna, Plain and Reinforced Concrete, Vol. I, Nemchand Brothers (ISBN: 8185240086 / 9788185240084). 2 V. L. Shah and Karve, Limit State Design – Reinforced Concrete Structures, Publications (ISBN: 9788190371711 / 8190371711). 3 K. Raju, Pre-stressed Concrete, Tata McGraw Hill (ISBN: 9789387886209 / 9387886204). Reference Books: 1 Dayaratnam, P. Design of Reinforced Concrete Structures. Oxford & IBH. 2 Lin, T. Y. Design of Prestressed Concrete Structures. John Wiley & Sons. 3 User manuals and technical documentation of structural analysis, structural detailing, geotechnical analysis, and spreadsheet-based engineering software adopted by the Institute

Semester - VIII		PCC						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
5	WPCE4802P	Project Stage II	0-0-8=8	4	ISCE:60		40	8
Course Outcome: After completion of course students will be able to 1. Formulate methodology for the defined problem. 2. Execute, analyze, and interpret the data to arrive at a solution. 3. Prepare the technical report and present the same.								

Module	Course Contents
	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		PE - III						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
6	WPCE4107T	Solid and Hazardous waste Management (Elective III)	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Use the principles of solid and hazardous waste management. 2. Design and optimize techniques for solid and hazardous waste management. 3. Acquire knowledge on specialized solid and hazardous waste treatment methods. 4. Analyze policies and legal implications related to solid and hazardous wastes.								

Module	Course Contents
1	Solid wastes Sources and types such as municipal solid waste, industrial solid waste, e waste, construction and demolition waste; composition and physical, chemical, and biological properties of solid wastes.
2	Functional elements of solid waste management Functional elements of solid waste management including generation, collection, handling, storage, processing, and transportation.
3	Disposal of solid waste Material separation and processing, thermal conversion, biological and chemical conversion, recycling and reuse of municipal solid wastes, landfilling, composting, gas generation, closure of landfills, and design of landfills.
4	Industrial solid waste composition 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 Municipal and hazardous solid waste collection, conveyance, treatment and disposal.

	Textbooks: 1 G. Tchobanoglous, H. Theisen and S. A. Vigil, Integrated Solid Waste Management, McGraw Hill Education (Indian Edition), 1st edition, 2014 (ISBN: 9789339205249 / 9339205243). 2 M. D. LaGrega, P. L. Buckingham and J. C. Evans, Hazardous Waste Management, Waveland Press Inc., 2nd edition, 2010 (ISBN: 9781577666936 / 1577666933). 3 A. D. Bhide and B. B. Sundaresan, Solid Waste Management in Developing Countries, National Environmental Engineering Research Institute (NEERI), Nagpur. 4 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 Reinhold Co., 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 Publishing Co., 1st edition, 1975 (ISBN: 9780442230272 / 0442230273). 5 P. A. Reinhardt and J. G. Gordon, Infectious and Medical Waste Management, CRC Press, 1st edition, 1990 (ISBN: 9780873711586 / 0873711580).
--	---

Semester - VIII		PE - III						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
7	WPCE4108T	Watershed Management (Elective-III)	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Use an integrated watershed management approach. 2. Analyze socio-economic aspects of a watershed. 3. Apply appropriate techniques to analyze and solve watershed-related problems.								

Module	Course Contents
1	Introduction and Basic Concepts Concept of watershed, introduction to watershed management, different stakeholders and their relative importance, watershed management policies and decision making.
2	Sustainable Watershed Approach & Watershed Management Practices Sustainable integrated watershed management, natural resources management, agricultural practices, integrated farming, Soil erosion and conservation. Watershed Management Practices in Arid and Semiarid Regions, Case studies, short term and long term strategic planning.
3	Disposal of solid waste material separation and processing, thermal conversion, biological and chemical conversion, recycling and reuse of municipal solid wastes, landfilling, composting, gas generation, closure of landfills, and design of landfills.
4	Integrated Watershed Management Introduction to integrated approach, Integrated water resources management, conjunctive use of water resources, rainwater harvesting; roof catchment system.
5	Social Aspects of Watershed Management Community participation, Private sector participation, Institutional issues, Socio-economy, Integrated development, Water legislation and implementations, Case studies.
6	Use of modern techniques in watershed management Applications of Geographical Information System and Remote Sensing in Watershed Management, Role of Decision Support System in Watershed Management.
7	Management of Water Quality Water quality and pollution, types and Sources of pollution, water quality modelling, environmental guidelines for water quality.

7	Storm Water and Flood Management Storm water management, design of drainage system, flood routing through channels and reservoir, flood control and reservoir operation, case studies on flood damage.
8	Drought Management Drought assessment and classification, drought analysis techniques, drought mitigation planning.
9	Water Conservation and Recycling Rainwater harvesting, Perspective on recycle and reuse, Wastewater reclamation.
	Textbooks: 1 J. V. S. Murty, Watershed Management, New Age International Publishers, New Delhi, 2nd edition, 2017 (ISBN: 9788122435184 / 8122435181). 2 J. V. S. Murty, Watershed Management in India, Wiley Eastern Limited, New Delhi, 1994 (ISBN: 8122405665 / 9788122405668). 3 A. P. Purandare and A. K. Jaiswal, Watershed Development in India, National Institute of Rural Development, Hyderabad, 1995 (ISBN: 9788185542348 / 8185542341). 4 R. Singh, Watershed Planning and Management, Yash Publishing House, Bikaner, 3rd edition, 2003 (ISBN: 9788186882122 / 818688212X). Reference Books: 1 Allam, Gamal Ibrahim Y., <i>Decision Support System for Integrated Watershed Management</i>, Colorado State University, 1994. 2 American Society of Civil Engineers, <i>Watershed Management</i>, American Society of Civil Engineers, New York, 1975. 3 Black, Peter E., <i>Watershed Hydrology</i>, Prentice Hall, London, 1991. 4 A. M. Michael, <i>Irrigation Theory and Practice</i>, Vikas Publishing House, 2nd edition, 1992 (ISBN: 9788125918677).

Semester - VIII		PE - III						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
8	WPCE4109T	Pavement Management System (Elective III)	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Acquire knowledge of pavement management systems at both network level and project level. 2. Perform functional and structural evaluation of pavements. 3. Design pavement strategies and carry out economic evaluation.								

Module	Course Contents
1	Pavement Management System (PMS) Components of PMS and their Activities, Major Steps in Implementing PMS, Inputs, Design, Construction and Maintenance, Rehabilitation and Feedback Systems. Pavement Structural Design and Economic Analysis. Emerging Technology in Pavement Management systems. life cycle cost analysis of pavements
2	Pavement distresses Distresses in flexible/rigid pavements: causes & remedies. Visual Surface distress survey procedures and techniques. Serviceability indicators for roads. Functional evaluation of pavements: Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Skid Resistance, Roughness, and Safety Aspects. Inventory System
3	Maintenance operations/alternatives Classification of maintenance operations including routine, periodic, and special maintenance. Common types of pavement maintenance such as pothole repairs, cracked surfaces, ruts and undulations, resurfacing, interface treatments, and white topping, types of white toppings, precast concrete panel roads, and rehabilitation of pavements. Bituminous thin surface courses including seal coat, surface dressing, premixed carpet, mixed seal surfacing, and micro asphalt concrete (MAC). Bituminous surface courses such as semi-dense bituminous concrete, bituminous concrete, and bitumen mastic; use of plastic waste in pavement construction. Road maintenance in high rainfall areas; choice of materials, use of modified bitumen and geo-fabrics, maintenance alternatives including recycling, and cement stabilization for road pavements.

	Textbooks: 1 L. R. Kadiyali and N. B. Lal, <i>Principles and Practice of Highway Engineering</i>, Khanna Publishers, 2017 Edition (ISBN: 9788174091659 / 8174091653). 2 S. K. Khanna and C. E. G. Justo, <i>Highway Engineering</i>, Nem Chand & Sons, Revised 10th edition, 2017 (ISBN: 9788185240930). Reference Books: 1 <i>Specifications for Rural Roads</i>, Ministry of Development of Rural Development (MORD), 2004. 2 <i>Rural Roads Manual</i>, Indian Roads Congress, September 2016 Edition. 3 D. Croney and P. Croney, <i>The Design and Performance of Road Pavements</i>, McGraw Hill Professional, 3rd edition, 1997 (ISBN: 9780070144514 / 0070144516). 4 E. J. Yoder and M. W. Witzak, <i>Principles of Pavement Design</i>, Wiley International, 2nd edition, 1991 (ISBN: 9780471977803). IS Codes: 1 IRC: 58-2012, <i>Guidelines for the Design of Rigid Pavements for Highways</i>, Indian Roads Congress. 2 <i>Guidelines for the Design of Flexible Pavements</i>, Indian Roads Congress, 3rd Revision, July 2012. 3 IRC: 81-1997, <i>Guidelines for Strengthening of Flexible Road Pavements Using Benkelman Deflection Technique</i>, Indian Roads Congress.
--	--

Semester - VIII		PE - III						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
9	WPCE4110T	Pavement Design and Construction (Elective III)	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. Modelling to analyze flexible and rigid pavements. 2. Apply pavement management concepts to effectively manage road pavements and their construction. 3. Apply various types of highway appurtenances to enhance user safety.								

Module	Course Contents
1	Pavement structure and functional attributes; factors affecting pavement design; types of wheel loads for highways and airports; development of design methods for highway and airport pavements.
2	Stresses in flexible pavements using single-layer, two-layer, and three-layer theories; equivalent wheel load factor (EWF) and equivalent single wheel load (ESWL); load coverage concepts
3	Stresses in rigid pavements including load stresses, temperature stresses, and combined stresses.
4	Evaluation of subgrade and pavement materials including group index, FAA classification, CBR, triaxial compression test, dynamic and resilient modulus; embankment design and construction; grading requirements for aggregates; selection of base and sub-base materials including stabilized materials; selection of different grades of bitumen; types of bituminous surfaces; skid qualities; bituminous mix design; and design aspects of paving concrete.
5	Flexible pavement design for airports using Corps of Engineers (CBR) method, FAA method, CDOT method, and Asphalt Institute method. Highway pavement design using empirical methods without soil strength criteria, empirical methods based on soil strength (CBR), design procedure as per Road Note 29 (UK), IRC (1984) guidelines, AASHTO method, and Asphalt Institute method.
6	Rigid pavement design for airports using PCA methods, Corps of Engineers method, and FAA method; joints and reinforcement requirements; rigid pavement design for highways using current British procedure and IRC method.

7	Drainage of pavements including importance and principles of good drainage, surface drainage, subsurface drainage, role of shoulders, and use of geotextiles; culverts and causeways including their importance, types, and site selection.
8	Evaluation and strengthening of pavements including flexible and rigid pavement distresses, condition and evaluation surveys, present serviceability index, roughness measurement, Benkelman Beam deflection, design of overlays, skid resistance, and its measurement.
9	Economics of pavement types including basis for comparison, period of analysis, initial construction cost, maintenance cost, vehicle operation cost, and equivalencies in pavement thickness.
10	Economic evaluation of highway schemes including basic principles of economic evaluation, net present value method, benefit–cost ratio method, and internal rate of return method.
11	Concrete road construction including mix design, concrete strength, size and gradation of aggregates, workability, preparation of base, formwork, placing of reinforcement, compaction and finishing, curing, and joints.
12	Quality control in highway engineering including importance of quality control, process control and end-product control, statistical methods in quality control, control charts, and frequency of testing.
	Textbooks: 1 L. R. Kadiyali and N. B. Lal, <i>Principles and Practice of Highway Engineering</i>, Khanna Publishers, 2017 Edition (ISBN: 9788174091659 / 8174091653). 2 S. K. Khanna and C. E. G. Justo, <i>Highway Engineering</i>, Nem Chand & Sons, Revised 10th edition, 2017 (ISBN: 9788185240930). Reference Books: 1 D. Croney and P. Croney, <i>The Design and Performance of Road Pavements</i>, McGraw Hill Professional, 3rd edition, 1997 (ISBN: 9780070144514 / 0070144516). 2 E. J. Yoder and M. W. Witczak, <i>Principles of Pavement Design</i>, Wiley International, 2nd edition, 1991 (ISBN: 9780471977803).

Semester - VIII		PE - III						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
10	WPSE4103T	Design of Prestressed Concrete Structures (Elective III)	3-0-0=3	3	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. Evaluate losses in pre-stressed concrete sections 3. Design pre-stressed concrete sections 4. Analyze and design determinate pre-stressed structural members								

Module	Course Contents
1	Introduction to pre-stressed concretes Basic concept and general principles, materials used and their properties, methods and techniques of pre-stressing, pre-stressing systems, loss of pre-stress, segmental box girder. pre-stressed material testing and calibration, Introduction to enabling works for pre-stressed concrete
2	Analysis of pre-stressed concrete sections Loading stages and computation of section properties, critical sections under working load for pre-tensioned and post tensioned members, load balancing method of analysis of pre-stressed concrete beams.
3	Design of pre-stressed concrete sections for flexure General philosophy of design, design approaches in working stress method and limit stress method, critical conditions for design, limit state of collapse in flexure, permissible stresses in concrete and steel, kern points, choice and efficiency of sections, cable profiles and layouts, cable zone, deflections of pre-stressed concrete members.
4	Design for shear Calculation of principle tension under working load, permissible principle tension, shear strength calculation under limit state of collapse for both sections cracked and un-cracked in flexure
5	End zone stresses in pre-stressed concrete members Transfer of pre-stress in pretension member: pretension transfer bond, transmission length, end zone reinforcement Anchor zone stresses in post tensioned members: stress distribution in end block, anchor zone reinforcement

6	Design of pre-stressed concrete beams Design of simply supported pretension and post tensioned slabs and beams, introduction to application of pre-stressing to continuous beams, linear transformation and concordance of cables.
5	Miscellaneous structures Design of tension and compression members-design of sleepers, tanks, pipes and poles. Partial pre-stressing-definition, methods of achieving partial pre-stressing, merits and demerits of partial prestressing, design of pre-stressed concrete roads, design of launching girder
	Textbooks: 1 N. Krishna Raju, Pre-stressed Concrete, Tata McGraw Hill Publishing Co., 2018. (ISBN: 9789387886209 / 9387886204) 2 G.S. Pandit and S.P. Gupta, Prestressed Concrete, CBS Publishers and Distributors Pvt. Ltd., Second Edition, 2014. (ISBN: 9788123901534 / 8123901534) Reference Books: 1 T.Y. Lin, <i>Design of Pre-stressed Concrete Structures</i>, John Wiley and Sons Inc., 2010. (ISBN: 9788126528035 / 8126528036) 2 J. Libby, <i>Modern Pre-stressed Concrete</i>, Springer Science & Business Media, 2012 3 A.E. Naaman, <i>Pre-stressed Concrete Analysis and Design</i>, McGraw-Hill College, 2014. (ISBN: 9789332901469 / 9332901465) 4 Y. Guyon, <i>Pre-stressed Concrete</i>, Contractors Record, 1955. (ASIN: B0000CIK24) 5 N. Rajgopalan, <i>Prestressed Concrete</i>, Narosa Publishing House, 2002. (ISBN: 9788173195433 / 8173195439)

Semester - VIII		PE III						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
11	WPSE4104T	Geosynthetic Engineering	3-0-0=3	3303	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 Historical development of geosynthetics; types of geosynthetics including geotextiles, geogrids, geonets, geomembranes, and geocomposites. 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 Use of geosynthetics for separation and reinforcement in flexible pavements; 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, <i>Engineering with Geosynthetics</i>, Tata McGraw Hill, New Delhi, 1990 (ISBN: 007460323X / 9780074603239). 2 M. Robert Koerner, <i>Designing with Geosynthetics</i>, Prentice Hall, New Jersey, U.S., 2012 (ISBN: 9781465345240 / 1465345248). 3 S. K. Shukla, <i>Handbook of Geosynthetic Engineering: Geosynthetics and Their Applications</i> (ISBN: 9780727741752 / 0727741756). Reference Books: 1 M. Robert Koerner, <i>Construction and Geotechnical Methods in Foundation Engineering</i>, McGraw Hill, New York, 1985 (ISBN: 0070352453 / 9780070352452). 2 R. A. Jewell, <i>Soil Reinforcement with Geotextiles</i>, CIRIA, London, 1996 (ISBN: 0860174255 / 9780860174257). 3 N. W. M. John, <i>Geotextiles</i>, John Blackie and Sons Ltd., London, 1987 (ISBN: 0216919959 / 9780216919952). 4 <i>Proceedings of the Conference on Polymer and Reinforcement</i>, Thomas Telford Co., London, 1984 (ISBN: 0727702424 / 9780727702425).

Semester - VIII		PE III						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
12	WPCE4111T	Unit Operations & Processes in Environmental Engineering	3-0-0=3	3	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 Contents
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.

	Textbooks: 1 T. D. Reynolds and P. D. Richards, <i>Unit Operations and Processes in Environmental Engineering</i>, PWS Publishing Company, 2nd edition, 1996 (ISBN: 0534948847) 2 Robert Noyes, <i>Unit Operations in Environmental Engineering</i>, 2nd Edition, William Andrew Publishing, 1994 (ISBN: 978-0815513438) 3 M. N. Rao and A. K. Datta, <i>Wastewater Treatment: Rational Methods of Design and Industrial Practices</i>, Oxford and IBH Publishing, 3rd edition, 2007 (ISBN: 9788120417120) 4 <i>Manual on Water Supply and Treatment</i>, Ministry of Works & Housing, New Delhi, 1993 5 <i>Manual on Wastewater Treatment</i>, Ministry of Works & Housing, New Delhi, 2013 Reference Books: 1 M. Robert Koerner, <i>Construction and Geotechnical Methods in Foundation Engineering</i>, McGraw Hill, New York, 1985 (ISBN: 0070352453 / 9780070352452). 2 R. A. Jewell, <i>Soil Reinforcement with Geotextiles</i>, CIRIA, London, 1996 (ISBN: 0860174255 / 9780860174257). 3 N. W. M. John, <i>Geotextiles</i>, John Blackie and Sons Ltd., London, 1987 (ISBN: 0216919959 / 9780216919952). 4 <i>Proceedings of the Conference on Polymer and Reinforcement</i>, Thomas Telford Co., London, 1984 (ISBN: 0727702424 / 9780727702425).
--	---

Semester - VIII		PE III						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
13	WPCE4112T	Introduction and Application of AI, ML, and IOT for Civil Engineering	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 4. Identify the basics of Artificial Intelligence and Machine Learning. 5. Indicate how AI and ML can improve different activities in civil engineering. 6. Apply AI and ML algorithms to solve problems in civil engineering. 7. Develop skills to apply AI and ML algorithms for solving problems in civil engineering.								

Module	Course Contents
1	Introduction to AI and ML: Brief review of History of AI and ML, Related fields. Introduction to Artificial Neural Networks: Biological Neurons and Biological Neural Networks, Artificial Neural Networks, Activation Functions, Back-propagation Neural Networks, Training Methods, Basic definition of supervised and unsupervised Learning. Introduction to Machine Learning: Introduction (Different Types of Learning) Hypothesis Space, Inductive Bias, Evaluation and Cross Validation
2	AI and ML in Construction Management: Introduction to construction management, Schedule optimization using ML algorithms, Resource allocation and risk management with AI, Predictive analytics for infrastructure maintenance. Case studies: AI-driven construction project management systems
3	Infrastructure Monitoring and Management: Introduction to infrastructure monitoring, IoT and sensor data integration with ML, Implementation of AI and ML algorithms using Python. Ethical considerations in AI and ML applications, Regulatory challenges and standards in civil engineering, Future trends and emerging technologies in AI and ML for civil engineering
4	Structural Analysis and Design Optimization:

	Application of AI/ML in Structural Analysis. Design Optimization Techniques using Genetic Algorithms and Neural Networks, Case Studies: Predictive Maintenance and Optimal Design Solutions, Structural health monitoring with AI techniques, Case studies: predictive modelling for structural integrity assessment.
5	Design Optimization using Machine Learning: Introduction to design optimization, Genetic algorithms and optimization techniques. Neural network-based optimization. Application of ML in optimal design of civil engineering structures
	Recommended Reading: 1. Mark Fenner, Machine Learning with Python for Everyone, Addison-Wesley Professional, 1st edition, 2019 (ISBN: 9780134845622) 2. U. Dinesh Kumar and Manaranjan Pradhan, Machine Learning using Python, Wiley, 1st edition, 2019 (ISBN: 9788126579907) 3. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, PHI Learning, 1st edition, 2003 (ISBN: 9788120321861) 4. Tom M. Mitchell, Machine Learning, McGraw-Hill Education, 1st edition, 1997 (ISBN: 9780070428072) 5. Ethem Alpaydin, Introduction to Machine Learning, PHI Learning, 3rd edition, 2014 (ISBN: 9788120350786) 6. Andries P. Engelbrecht, Computational Intelligence: An Introduction, Wiley, 2nd edition, 2007 (ISBN: 9780470035610)

Semester - VII		Open Elective						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
14	WPCE4113T	Sustainable Development	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of this course, students shall be able to, 1. Describe sustainable development, development processes, and relate the impact of various levels of development. 2. Formulate the methodology for assessment of sustainability of a project using various indicators. 3. Apply environmental legislations to various development processes and projects.								

Module	Course Contents
1	Development Goals and means of development, MDG's and SDG's sustainable development, Comparing levels of development, GDP, GNP, global development level.
2	Industrialization and Post-industrialization era Major structural shifts, knowledge revolution, implications for development sustainability
3	Environmental episodes Ozone depletion, global warming, greenhouse effect, Bhopal gas tragedy etc.
4	Pollutions Major sources, permissible standards and controls of urban air pollution, water pollution, Solid and hazardous waste disposals
5	Climate Change The Risk of Global Climate Change
6	Environmental legislation Legislative provisions and measures towards sustainability
7	Indicators of Development Sustainability Composition of National wealth, Accumulation of National Wealth as an Indicator of Sustainable Development, Development Goals and Strategies, Gross happiness index, Millennium Development Goals, Role of National Development Policies, Life cycle assessment, Carbon footprint

	Textbooks: 1 Tatyana P. Soubbotina, Beyond Economic Growth: An Introduction to Sustainable Development, World Bank Institute Learning Resources Series, 2nd Edition, 2004. (ISBN: 0-8213-5933-99) 2 P. P. Rogers, F. J. Jalal, and J. A. Boyd, An Introduction to Sustainable Development, Earthscan Publications, 2nd Edition, 2008. (ISBN: 9781844075201 / 1844075206) Reference Books 1 T. Strange and A. Bayley, Sustainable Development: Linking Economy, Society, Environment, 2008. (ISBN: 9789264047785) 2 H. G. Brauch, Sustainable Development and Sustainability Transition Studies, Springer Briefs in Environment, Security, Development and Peace Series. 3 G. Marletto, S. Franceschini, C. Ortolani, and C. Sillig, Mapping Sustainability Transitions: Networks of Innovators, Techno-Economic Competences and Political Discourses, springer Briefs in Business, 2016. (ISBN: 9783319422725 / 9783319422749)
--	---

Semester - VIII		OE II						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
15	WPCE4303T	Climate change and Carbon Neutrality	3-0-0=3	3	20	30	50	3
Course Outcome: After completion of course students will be able to 1. An ability to identify and analyze issues related to the earth's atmosphere and air pollution-related environmental problems 2. Ability to identify the key principles, causes, and consequences of climate change 3. Development of competency in the use of various air quality modelling software and evaluation of carbon footprints 4. Evaluate key indicators, future projections, and impacts of carbon in research and development								

Module	Course Contents
1	Composition of dry ambient air and properties of air. Definition of air pollution, classification of air pollutants, and units used for classification of air pollutants. History of air pollution at global and national levels. Scope of the problem in general, urban, rural, and specific contexts. Sources of air pollution including natural and man-made sources. Major pollutants from different sources in the Greater Mumbai area and other Indian cities. Emission factors
2	Meteorological aspects of air pollution including large-scale wind circulation such as geostrophic wind, gradient wind, cyclones, and anticyclones. Planetary boundary layer, lapse rate, atmospheric stability conditions, wind velocity profile, and maximum mixing depth
3	Introduction to climate and the earth's natural greenhouse effect. Radiative balance and importance of water. Effects of climate change on human health, plants, animals, and material properties
4	Greenhouse gases and the role of carbon dioxide and other greenhouse gases along with their emissions. Concerns of developed and developing parts of the world. The earth's carbon reservoirs, biogeochemistry, and carbon cycling. Global ocean circulation including introduction and overview. Introduction to climate change with advances in computer modelling
5	Climate change agreements and the evolution of global climate policy including UNFCCC, Kyoto Protocol, Paris Agreement, and Conference of Parties. Pledges of COP26 and future climate action scenarios
6	Carbon neutrality and net zero emissions. Scope I, Scope II, and Scope III emissions. Carbon footprints

	Textbooks: 1 Hall, New Jersey, 3rd edition, 2015 (ISBN: 9789332555150) 2 Air Pollution by Henry C. Perkins, McGraw Hill Publications 3 Air Pollution by Wark and Warner 4 Climate and Eco-systems, David Schimel, Princeton University Press, 2013 5 Climate Crisis: An Introductory Guide to Climate Change, David Archer and Stefan Rahmstorf, Cambridge University Press, 2001 6 Global Warming and Climate Change, Grover Velma I, Science Publishers, 2008 7 UNFCCC, 2008. <i>Compendium on Methods and Tools to Evaluate Impacts of, and Vulnerability and Adaptation to, Climate Change</i>. Available at https://unfccc.int/files/adaptation/nairobi_workprogramme/compendium_on_methods_tools/application/pdf/20080307_compendium_m_t_complete.pdf 8 UNFCCC, 2006. <i>UNFCCC Handbook</i>. Available at https://unfccc.int/resource/docs/publications/handbook.pdf 9 UNFCCC and UNEP, 2002. <i>Climate Change Information Kit</i>. Available at https://unfccc.int/resource/iuckit/cckit2001en.pdf 10 Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, John Wiley, New York, 1998
--	--

Semester - VIII		OE II						
SN	Course Code	Course Title	L-T-P (Hours/Week)	Credit	TA	MST	ESE	ESE hours
16	WPCE4304T	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. 4 : 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 Environmental 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 Environmental 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; implementation 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 infectious wastes. Preventive and reactive strategies 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 legislation – 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 analysis of Environmental management, Shukla S. S., Shrivastva P. R. 1992, commonwealth publishers New Delhi 2003