Latest Version
3-7-25

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
Third 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]

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE, MUMBAI-400 019.
Civil & Env. Engg. Dept.

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.

Program Outcomes

PO-1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering and technology to the solution of complex mechanical engineering Problems.
PO-2	**Problem analysis**: Identify, formulate, review existing literature, and analyze complex engineering problems to reach substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/Development of solutions**: Design solutions for mechanical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for societal, economical and environmental considerations.
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.

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PO-5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex mechanical engineering activities with an understanding of the limitations.
PO-6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO-7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**Communication**: Communicate effectively with the engineering community and with society at large, including the ability to comprehend, create effective reports, make effective presentations, and give and receive clear instructions.
PO-11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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Credit Framework for T.Y. B.Tech Civil Engineering [Working Professional] - Semester - V

Sr.	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
								TA	MST	ESE
1	WPSE3001T	Structural Analysis – II	3	1	0	4	4	20	30	50
2	WPCE3001T	Environmental Studies and Environmental Engineering	3	1	0	4	4	20	30	50
3	WPSE3002T	Geotechnical Engineering	3	0	0	3	3	20	30	50
4	WPSE3003T	Concrete Technology	3	0	0	3	3	20	30	50
5	WPCE3002T	Building Drawing and Services	3	0	0	3	3	20	30	50
6	WPSE3003L	Concrete and Soil Laboratory	0	0	2	2	1	ISCE :60		40
7	WPCE3002L	Building Drawing and Services Laboratory	0	0	2	2	1	ISCE :60		40
8	WPCE3001L	Environmental Engineering Laboratory	0	0	2	2	1	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, **PCC** Program Core, **MDM** Multi-Disciplinary Minor **VSEC** Vocational and Skill Enhancement Course, **OE** Open Elective, **VEC** Value Education Course

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE, MUMBAI-400 019. Civil & Env. Engg. Dept.

Dean-Academics V.J.T.I. MUMBAI

Credit Framework for T.Y. B.Tech Civil Engineering [Working Professional] - Semester - VI

Sr.	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
								TA	MST	ESE
1	WPSE3004T	Design of RCC and PSC Structures	3	1	0	4	4	20	30	50
2	WPCE3003T	Quantity Survey and Estimation	3	1	0	4	4	20	30	50
3	WPCE3004T	Risk and Value Management	3	0	0	3	3	20	30	50
4	WPCE3005T	Pavement Engineering	3	0	0	3	3	20	30	50
5	WPCE3101T*	Program Elective I	3	0	0	3	3	20	30	50
6	WPSE3004L	Design of RCC Laboratory	0	0	2	2	1	ISCE :60		40
7	WPCE3003L	Quantity Survey and Estimation Laboratory	0	0	2	2	1	ISCE :60		40
8	WPCE3005L	Transportation Engineering Laboratory	0	0	2	2	1	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, **PCC** Program Core, **MDM** Multi-Disciplinary Minor **VSEC** Vocational and Skill Enhancement Course, **OE** Open Elective, **VEC** Value Education Course

Semester VI List of Professional Elective-1:

SN	Course Code	Course Title
1	WPCE3101T	Geographic Information System
2	WPCE3102T	Advanced Hydrology
3	WPSE3101T	Advanced Structural Analysis
4	WPCE3103T	Construction Equipment and Automation
5	WPSE3102T	Advanced Foundation Engineering
6	WPSE3103T	Soil Dynamics and Machine Foundation
7	WPCE3104T	Engineering Geology

Dean-Academics
V.J.T.I. MUMBAI

Semester V

Semester - V		PCC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	WPSE3001T	Structural Analysis II	3-1-0=4	4	20	30	50	3

Course Outcomes

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

1. Identify the stable and unstable structures and evaluate the degree of static and kinematic indeterminacy.
2. Determine the deflection of statically determinate and indeterminate structures under different loads and support conditions.
3. Analyze indeterminate structures by using force method.
4. Analyze indeterminate structures by using displacement method.

Module	Course Contents
1	**General:** Classification of structural forms, Stability of structures, Static and kinematic indeterminacy of structures, behavior of symmetric structures, symmetric and anti-symmetric loads, distinction between linear and nonlinear material and geometric behavior of structures.
2	**Deflection of statically determinate structure** Review of general theorems based on virtual work and energy methods, introduction to the concept of complimentary energy, absolute and relative deflections caused by loads, temperature changes and other causes, application to determinate beams, pin jointed frames and rigid jointed frames. Deflection of truss by Williot–Mohr diagrams.
3	**Analysis of indeterminate structures by flexibility method** Flexibility coefficients and their use in the formulation of compatibility equations. Application of Castigliano's theorem of least work to propped cantilevers, fixed beams, continuous beams, simple pinjointed frames including effect of lack of fit of members, simple rigid jointed frames and two hinged arches.
4	**Analysis of indeterminate structures by stiffness method** Stiffness coefficients and their use for formulation of equilibrium equation, direct stiffness method, slope deflection method, moment distribution method, applications of these methods to indeterminate beams, simple rigid jointed frames and rigid jointed frames with inclined members, including the effect of settlement/rotation of supports.

	Recommended Reading 1 B.N. Thadani and J.P. Desai, Modern Methods in structural Analysis, Weinall Book Corporation, 1998. (ISBN-021026957X/978-0210269572) 2. Pandit and Gupta, Matrix Method in Structural Analysis, Tata McGraw Hill, 2008. (ISBN- 0070667357/978-0070667358) 3. L.S. Negi and R.S. Jangid, Structural Analysis, Tata McGraw Hill, 2008. 4. Gupta and Pandit, Structural Analysis Vol. I & II, Tata McGraw Hill,2008. (ISBN- 0070667357/978-0070667358) 5. Gare and Weaver, Analysis of Framed Structure, CBS Publication, 2nd Edition, 2004. (ISBN:978- 8123911519/8123911513). **Textbooks** 1. 1. S.B. Junnarkar, Structural Mechanics Vol. II, Charotar Publishers, 2015. (ISBN- 9385039024/978-9385039027) 2. C.S. Reddy, Basic Structural Analysis, Tata McGraw Hill, 2004. (ISBN-0070702764/978- 0070702769) 3. C.K. Wang, Intermediate Structural Analysis, Tata McGraw Hill, 2010. (ISBN-0070702497/978-0070702493).

Semester - V		PCC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
2	WPCE3001 T	Environmental Studies and Environmental Engineering	3-1-0=4	4	20	30	50	3
	Course Outcomes After completion of course, students will be able to 1. Identify and describe various elements of the water supply, sewerage, solid waste, and air & noise pollution. 2. Use and apply knowledge of various types of pollution with their sources, effects on the environment, and quantifications. 3. Analyze various types of pollution with their plans to control / treatment measures. 4. Design and compare sewerage systems and stormwater drains.							

Module	**Course Contents**
1	**Water:** Water Supply systems: Need for planned water supply schemes, Sources of Water, Water demand and Potable, industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, various valves used in W/S systems, service reservoirs, and design.
2	**Sewage:** Sewage: Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage: Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems Storm Water: Quantification and design of Stormwater; Sewage and Sullage, Pollution due to improper disposal of sewage, National River cleaning plans, recycling of sewage, quality requirements for various purposes.
3	**Air:** Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution - Occupational hazards, Urban air pollution: automobile pollution, Chemistry of combustion, Automobile engines, quality of fuel, operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and

	limitations
4	**Noise** Basic concept, measurement, effects, and various control methods
5	**Municipal solid waste:** Composition and various chemical and physical parameters of MSW, MSW management: Collection, transport, treatment, and disposal of MSW. Special MSW: waste from commercial establishments and other urban areas, solid waste from construction activities, biomedical wastes, Effects of solid waste on the environment: effects on air, soil, water, and health hazards. Disposal of solid waste: segregation, reduction at source, recovery and recycle Disposal methods; integrated solid waste management
6	**Hazardous Waste:** Types and nature of hazardous waste, HW Schedules of regulating authorities.
7	**Legal Provisions:** Government authorities and their roles, along with the legal aspects related to water supply, sewage disposal, solid waste management, and monitoring and control of environmental pollution Building (Energy conservation building code compliant/GRIHA/Svagriha)
	Recommended Reading 1. Terrence J. Mcghee, E. W. Steel, Water Supply and Sewerage, McGraw-Hill College; 6th Revised edition, (ISBN: 0070609381) 2. CPHEEO Manual on Water Supply & Treatment 3. Manual on Water Supply and Treatment, (latest Ed.), Ministry of Works & Housing, New Delhi. 4. Manual on Wastewater Treatment, (latest Ed.), Ministry of Works & Housing, New Delhi. 5. Tchobanoglous, Theissen & Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw-Hill Higher Education; 2 edition, (ISBN: 0070632375) 6. H. S. Peavy, D. R. Rowe, G. Tchobanoglous, Environmental Engineering, Tata-Mcgraw Hill (1991), (ISBN: 9351340260) 7. IS 10500: 2012 Drinking Water – Specification 8. IS 3025 Method of Sampling and Test (Physical and Chemical) For Water

Semester - V		PCC						
S.N.	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
3	WPSE3002T	Geotechnical Engineering	3-0-0=3	3	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Evaluate earth pressures and apply them to check the external stability of retaining structures. 2. Analyse and design using stress distribution of shallow foundations by shear and settlement criteria under different loading and soil conditions. 3. Evaluate the load-carrying capacity and settlement of deep foundation by shear and settlement criteria for different soil conditions under axial load. 4. Apply principles of Three-Dimensional Consolidation and soil reinforcement for soft soil improvement. 5. Interpret and use results of soil investigation for design of Geotechnical systems.							

Module	Course Contents
1	**Lateral earth pressure theories** Earth pressure theories, earth pressure at rest (elastic equilibrium). Rankine's Earth Pressure (limiting or plastic equilibrium): active and passive earth pressure for horizontal and inclined backfill including non-homogenous deposit, Coloumb's Wedge Theory: mathematical approach, condition for failure plane, graphical methods, passive pressure by friction circle method.
2	**Earth retaining structures** Stability analysis of cantilever retaining wall or sheet piles in sand and clay.
3	**Stress Distribution in Soil** Boussinesq's Formula for point load, line load, circular and rectangular area, and embankment loading. New Marks Influence chart.
4	**Bearing capacity of shallow foundation** Definitions of ultimate bearing capacity, gross, net, and safe pressures, allowable bearing pressure, types of shallow foundations modes of failures. Bearing capacity theories: Terzaghi's approach, Vesic's approach, and IS 6403 (1981) method. Bearing capacity based on Standard Penetration Test. Settlement estimation, plate load test (IS1888), and SPT for estimation of settlements. Bearing capacity of foundation on compact and weathered rock.
5	**Axially loaded pile foundations** Introduction, necessity, and classification of pile foundation, classification of piles. Pile capacity and settlement based on static analysis, single and group piles in sand and

	clay, critical depth method, dynamic methods and their limitations, in-situ penetration tests and pile load test as per IS 2911 specifications, negative skin friction.
6	**Ground improvement techniques** Ground improvement techniques: Stone columns and sand/band drains. Basic principle of for Reinforced Earth wall or Soil nailing.
7	**Planning of subsurface investigation** Planning of investigation programs and Geophysical methods. Soil reports.
	Recommended Reading 1. K. Terzaghi and R. B. Peck, Gholamreza Mesri, Soil Mechanics in Engineering Practice, Wiley and Sons, 1996. (ISBN-8126523816/978-8126523818). 2. H. Winterkorn and F.Y. Fang, Foundation Engineering Handbook, CBS Publishers & Distributors, New Delhi, 1990. (ISBN 9788123905457). 3. J. E. Bowles, Foundation Analysis and Design, McGraw-Hill Book Co, 2001. (ISBN-0071188444/ 978-0071188449). 4. P. Shamsher and H. Sharma, Pile Foundations in Engineering Practice, Wiley and Sons, 1990. (ISBN-0471616532/978-0471616535). 5. P. Purushothama Raj, Ground Improvement Techniques (HB), Laxmi Publication Pvt Ltd., New Delhi, 2005. (ISBN-9788170080985/978-8170080985). 6. M. R. Hausmann, Engineering Principles of Ground Modification, McGraw-Hill Inc., US, 1990. (ISBN-0070272794/978-0070272798). 7. R.D. Holtz and W.D. Kovacs, An introduction to geotechnical engineering, Prentice Hall, 1981. (ISBN-9332507619/978-9332507616). 8. IS 1892 (1979), Subsurface Investigation for Foundation. 9. IS 6403 (1981), Determination of Bearing Capacity of Shallow Foundation. 8. IS 8009 Part I (1978), Calculation of Settlement of Foundation and Shallow Foundation Subjected to Symmetrical Static Vertical Loads. 9. IS 12070 Code Practice and Construction of Shallow Foundations on Rocks. **Textbooks** 1. G. Ranjan and A.S.R. Rao, Basic and Applied Soil Mechanics, New Age International Pvt. Ltd., 2005. (ISBN: 9788122440393/8122440398. 2. V.N.S. Murthy, Advanced Foundation Engineering, CBS Publishers and Distributors, New Delhi, 2016. (ISBN- 9788123915067). 3. B. M. Das, Principles of Foundation Engineering, PWS Publishing Company, 2012. (ISBN-978-8131518786).

Semester - V		PCC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
4	WPSE3003T	Concrete Technology	3-0-0=3	3	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Define the functional role of all ingredients of concrete and their use for normal and special purpose concrete. 2. Apply the principle of sustainability for the utilization of waste, novel and innovative materials for use in concrete. 3. Formulate concrete mix for normal and special purpose concrete. 4. Use of various non-destructive testing procedures for evaluation of concrete properties.							

Module	**Course Contents**
1	**Properties of ingredients** Properties of coarse and fine aggregates and their influence on concrete, types of cement and their use, Grades of ordinary Portland cement, Portland pozzolana cement, rapid hardening Portland cement, hydrophobic cement, low heat Portland cement and sulphate resisting Portland cement as per relevant I.S. codes. Types of aggregates and their properties. Testing of aggregates as per relevant IS Codes.
2	**Properties of different types of concrete** Concrete for structural work, lightweight concrete, high-density concrete, biological concrete, workability, durability and strength requirements, effect of w/c ratio on properties of fresh and hardened concrete, acceptability criteria, laboratory testing of fresh and hardened concrete, Fire resistant properties of hardened concrete.
3	**Concreting methods** Process of manufacturing of concrete, transportation, placing, compaction, and curing of concrete. Extreme weather concreting, special concreting methods, vacuum dewatering– underwater concrete, special formwork., Plum Concrete, Self Compacting Concrete
4	**Admixtures** Plasticizers, Retarders, Accelerators, and other Admixtures. Test on Admixtures, Chemistry, and Compatibility with concrete. GGBS fly Ash, Metakaolin, Silica Fumes, crush sand
5	**Ready mix concrete** Requirements of ready-mix concrete, properties of RMC, transit mixer details, Automation, instrumentation, and Layout of RMC plant.

6	**Concrete mix design** Mix Design for compressive strength by I.S. methods, road note method, British method, ACI Method, Mix design for flexural strength.
7	**Concrete for repairs and rehabilitation of structures** High-Performance Concrete, Polymer Concrete, Fiber Reinforced Concrete, Lightweight concrete and its manufacture, Polymer Impregnated Cement Concrete, Polymer Modified Cement concrete, and Ferro Cement, and Special Tests for concrete used for repairs and rehabilitation.
8	**Non-destructive testing of concrete** Rebound hammer test, Ultrasonic pulse velocity test, Magnetic particle testing, Liquid penetration testing, Visual testing, Laser Testing methods, Leak Testing, Impact echo test, carbonation test, Half-cell potentiometer and corrosion of steel, Core test and relevant provisions of I.S. codes
	Recommended Reading 1. A.R. Santhakumar, Concrete Technology, Oxford University Press, New Delhi, 2018. (ISBN- 9780195671537, 978-0195671537). 2. IS 10262-(2009) Recommended Guidelines for Concrete Mix Design, Bureau of Indian Standards, New Delhi, 2009. 3. IS10262 (2009), Mix Design 4. IS269 (2015), Ordinary Portland Cement (33 Grade). 5. IS12269 (2013), Ordinary Portland Cement (53 Grade). 6. IS650 (1991), Specification of Standard Sand. 8. IS383 (1970), Specification for Coarse and Fine aggregate. **Textbooks** 1. M.L. Gambhir, Concrete Technology, McGraw Hill Book Company, Fifth Edition, 2017. (ISBN-1259062554, 978-1259062551). 2. M.S. Shetty, Concrete Technology, Theory and Practice, S. Chand Publication, Sixth Edition, 2018. (ISBN- 9788121900034,978-8121900034) 3. B.L. Gupta and A. Gupta, Concrete Technology, Jain Book Agency, 2013. (ISBN-8180140407, 978-8180140402).

Semester - V		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
5	WPCE3002T	Building Drawing and Services	3-0-0=3	3	20	30	50	3
	Course Outcome: **1.** Implement principles of planning of buildings **2.** Design and draw various constructional drawings of the buildings. **3.** Plan various building services.							

Module	Course Content:
1	**Planning Principles and Laws for Buildings:** Concept of built environment and its application in planning. Recommendation of National building code, Building Bye-laws, RERA.
2	**Planning and Drawing of Building: -** Preparation of constructional details and drawings - Plan (Single line and Double line plan), Elevation, Section, Site plan, Foundation plan, Terrace plan, Layout Plan Planning of Load bearing and RCC structures such as • Residential building • Building for Education – School, College, Library • Building for health – Dispensary, Hospital Industrial Structure • Building for Entertainment -Theatre, clubhouse, sports club. • Other structure - Office, Hostel, Guest house.
3	**Building's Water Supply and Drainage System: -** Design of water supply, wastewater, and stormwater collection systems for various types of buildings. Pumps and Pump House.
4	**Electrical Services: -** Domestic Supply, Distribution Circuits, basic wiring systems. Design and planning: - Lighting of staircase, corridors. Automatic Water Level Controller, Closed Circuit Security Monitors with Intercom/ EPBX facility, Common Dish TV antenna, Use of Solar Panels as source of power, Lightening Conductor for High-rise Buildings.
5	**Fire Protection System: -** Introduction, Fire protection, requirement of water quantity estimation. Systems of firefighting external and internal. Wet and dry risers, smoke alarm, Sprinkler system. Safety corridors in High-rise structures. Fire retarding coating.
6	**Elevators and Escalators: -** Introduction, Types of elevators and escalators. Essential features - its size and

	requirement of minimum numbers, Safety norms. Control systems, electrical requirements, and generator backup.
7	**Heating, Ventilation and Air Conditioning:** Ventilation, functional requirement, Heat balance system of ventilation, General rules and regulations in artificial ventilation system, Central air conditioning: - ducting and glass claddings. Wind Rose Diagram.
8	**Green building:** Introduction, Benefits, National priorities, rating system, checklist, Site selection and planning, Water efficiency, Energy efficiency, Materials, Indoor environmental quality, Innovation and design process. Introduction to concepts of LEED and GRIHA.
	Text Books: 1. M.G.Shah, Kale, Patki, Building Drawing with an Integrated Approach to Built Environment, Tata McGraw-Hill Education India, 5th edition, 2011, (ISBN: 9780071077873, 0071077871). 2. Building Services Environmental And Electro Mechanical Services, Second Revised, 2014, (ISBN: 9788175259805) 3. B.L. Gupta and A. Gupta, Concrete Technology, Jain Book Agency, 2013. (ISBN-8180140407/978-8180140402). 4. IS 2720, Various relevant parts. 5. T.W. Lambe and R.V. Whitman (1979). 'Soil Mechanics', John Wiley and Sons, New York, USA. (ISBN: 978-0-471-51192-2). 6.B.M. Das, Soil Mechanics Laboratory Manual, Oxford University Press, Ninth Edition, June 2015, (ISBN- 9780190209667). **Recommended Reading:** 1) Bureau of Indian Standards, " HAND BOOK OF FUNCTIONAL REQUIREMENTS OF BUILDINGS, (SP-41 & SP- 32)", BIS 1987 and 1989, (SP-41: ISBN: 8170610117) 2) Croome, J. D. & Roberts, B. M., "AIR-CONDITIONING AND VENTILATION OF BUILDINGS VOL-1". Pergamon Press, (ISBN: 0080247792) 3) SP-35 (1987): Handbook of Water supply & drainage-BIS, (SP- 35: ISBN: 8170610095) 4) N.B.C.-2016, Volume 1 & 2, BIS, (ISBN: 8170610990)

Semester - V		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
6	WPSE3003L	Concrete and Soil Laboratory	0-0-2=2	1	ICSE:60		40	3

Course Outcome:

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

1. Determine the physical and material properties of fresh and hardened concrete using destructive and non-destructive techniques.
2. Evaluate the properties of admixtures.
3. Carry out concrete mix design for ordinary and special concrete.
4. Evaluate the shear parameters of soil with an appropriate selection of required tests.
5. Determine the compressibility parameters and California bearing ratio of soils.
6. Compile the experimental results and prepare the geotechnical report for a given site.

Sl. No.	Course Content:
1	**Course Contents** **1. List of experiments for concrete technology** 1. To determine the effect of the W/C ratio on workability (slump cone, compaction factor, and strength) 2. Preparing of Concrete mix design using environmental friendly materials such as FlyAsh, Silica Fumes, Metakaolin & GGBS 3. Study of various Non-destructive testing of concrete and some applications (Rebound hammer, ultrasonic, carbonation) 4. Secant modulus of elasticity of concrete and indirect tensile test on concrete. 5. Study of admixtures and their effect on the workability and strength of concrete. 6. Modulus of rupture of concrete. 7. Permeability test on concrete 8. Flexural test on concrete beam (central point load and two point load) 9. Shrinkage and creep test

	A) Technical Seminar on testing of Concrete and soil
	2. List of experiments for geotechnical engineering 1. Direct Shear Test under UU/CD condition. 2. Soaked California Bearing Ratio. 3. Unconfined Compression Strength Test. 4. Triaxial Test in UU condition. 5. Consolidation Test. 6. Geotechnical report writing based on test results or real-life problems.
	Text Books 1. M.L. Gambhir, Concrete Technology, McGraw Hill Book Company, Fifth Edition, 2017. (ISBN-1259062554, 978-1259062551). 2. M.S. Shetty, Concrete Technology, Theory and Practice, S. Chand Publication, Sixth Edition, 2018. (ISBN- 978-8121900034). 3. B.L. Gupta and A. Gupta, Concrete Technology, Jain Book Agency, 2013. (ISBN-8180140407/978-8180140402). 4. IS 2720, Various relevant parts. 5. T.W. Lambe and R.V. Whitman (1979). 'Soil Mechanics', John Wiley and Sons, New York, USA. (ISBN: 978-0-471-51192-2). 6.B.M. Das, Soil Mechanics Laboratory Manual, Oxford University Press, Ninth Edition, June 2015, (ISBN- 9780190209667). **Recommended Reading** 1. Dante Fratta, Jennifer Aguettant, Lynne Roussel-Smith, CRC Press, May 2007 2. IS10262 (2009), Mix Design. 3. IS269 (1989), Ordinary Portland Cement (33 Grade). 4. IS12269 (1987), Ordinary Portland Cement (53 Grade). 5. IS650 (1991), Specification of Standard Sand. 6. IS383 (1970), Specification for Coarse and Fine aggregate. 7. IS2720 Part (1 to 41), Determination of Physical Properties of Soil. 8. SP36 Part I (1987), Compendium of IS on Soil Engineering, Part I – Laboratory tests of Soils for Civil Engineering Purpose. Part II – Field Testing of Soils for Civil Engineering Purposes. 9. A.R. Santhakumar, Concrete Technology, Oxford University Press, New Delhi, 2018. (ISBN-978-0195671537). 10. A.M. Neville, Properties of Concrete, Pearson Publication, London, 2012. (ISBN- 978-0273755807).

	11. IS 10262-(2009) Recommended Guidelines for Concrete Mix Design, Bureau of Indian Standards, New Delhi, 2009. 12. IS10262 (2009), Mix Design 13. IS269 (2015), Ordinary Portland Cement (33 Grade). 14. IS12269 (2013), Ordinary Portland Cement (53 Grade). 15. IS650 (1991), Specification of Standard Sand. 8. IS383 (1970), Specification for Coarse and Fine aggregate. 16. R F Craig, Soil Mechanics, Chapman & Hall. 2004. (ISBN-9780415327039/0415327032). 17. Venktatramaiah, Geotechnical Engineering, New Age International.2009. (ISBN-9386649705/978-9386649706). 18. A. Singh, Soil Engineering in Theory and Practice, Standard Publishers and Distributors, New Delhi. 2009. (ISBN-8123900392/978-8123900391). 19. Taylor D.W., Fundamentals of Soil Mechanics, Asia publications Bombay, 2013. (ISBN: 9781258766924, 1258766922).

Semester - V		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
7	WPCE3002L	Building Drawing and Services Laboratory	0-0-2=2	1	ISCE: 60		40	3
	Course Outcome: **1.** Draw various constructional drawings of buildings. **2.** Use of ICT tools for preparing construction drawings. **3.** Prepare Line plan for various public buildings **4.** Prepare layout of various building services.							

Sl. No.	**Course Content:**
1	Preparation of a detailed constructional plan for a residential building.
2	Preparation of Front Elevation, Detailed Sectional View, Site Plan, Foundation Plan, Terrace Plan, and Layout Plan.
3	Concept of perspective drawing- one-point, two-point, three-point, and uses.
4	Preparation of line plans of various public buildings like: • Building for Education – School, College. Library • Building for health –Dispensary, Hospital Industrial Structure • Building for Entertainment-Theatre, Club House, Sports Club. • Other Structure- Office, Hostel, Guest house.
5	Prepare layout plan and sectional view for water supply and drainage for a building.
6	Prepare an electrical connections plan.
7	Fire Protection System: Design of emergency exits and emergency vehicle routes with fire protection symbols
A	A seminar on field execution of different construction and drawing tasks
	Text Books: 1. Scott Onstott, AutoCAD 2018 and AutoCAD LT 2018 Essentials, Wiley (2017), (ISBN: 9788126569298) 2. M. G. Shah, Kale, Patki, Building Drawing with an Integrated Approach to Built

	Environment, Tata McGraw-Hill Education India, 5th edition, 2011, (ISBN: 9780071077873, 0071077871). 3. Building Services Environmental and Electro Mechanical Services, Second Revised, 2014, (ISBN: 9788175259805) **Recommended Reading:** 1) Bureau of Indian Standards, "Hand book of functional requirements of buildings, (SP-41 & SP- 32)", BIS 1987 and 1989, (SP-41: ISBN: 8170610117) 2) Croome, J. D. & Roberts, B. M., "AIR-CONDITIONING AND VENTILATION OF BUILDINGS VOL-1". Pergamon Press, (ISBN: 0080247792) 3) SP-35 (1987): Handbook of Water supply & drainage-BIS, (SP- 35: ISBN: 8170610095) 4) N.B.C.-2016, Volume 1 & 2, BIS, (ISBN: 8170610990)

Semester - VI		PCC					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
8	WPCE3001L	Environmental Engineering Laboratory	0-0-2=2	1	ISCE:60		40	3

Course Outcomes

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

1. Perform tests and analyze results of water and wastewater samples.
2. Assess the accuracy and precision of analytical results.
3. Use advanced water and wastewater characterization tools

Sl. No.	Course Content:
	List of experiments in water and wastewater samples: 1 Determination of alkalinity of water sample. 2 Determination of hardness of water sample. 3 Determination of pH value of water and wastewater sample. 4 Determination of turbidity of water sample. 5 Determination of the optimum dose of coagulant by Jar test. 6 Determination of residual chlorine in water sample. 7 Determination of chlorides in water sample. 8 Determination of conductivity of the water sample. 9 Determination of total solids, suspended solids, dissolved solids and volatile solids in water and wastewater sample. 10 Determination of Dissolved Oxygen (D.O.) in water sample. 11 Determination of Chemical Oxygen Demand (COD) of sample of wastewater 12 Determination of Bio-Chemical Oxygen demand of wastewater sample. 13 Determination of Sludge Volume Index (SVI) of the wastewater sample. 14 Determination of Coli-form Bacteria in water sample by Most Probable Number (M.P.N.) test.

	A. A seminar on the water quality evaluation .
	Text Books: 1 Standard Methods for the Examination of Water and Wastewater, jointly published by American public health association (APHA),American Water Works Association (AWWA), Water Pollution Control Federation (WPCF) and Water Environment Federation (WEF),23rd edition, 2017. (ISBN: 9781625762405/1625762402) **Recommended Readinf:** 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) 3 Relevant Indian Standards Specifications 4 CPHEEO manual on water supply and treatment, Ministry of urban development, May 1999. 5 CPHEEO manual on sewerage and sewage treatment systems, Ministry of urban development, Dec 2013.

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SEMESTER - VI

Semester - VI		PCC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	WPSE3004T	Design of Reinforced and Pre-stressed concrete	3-1-0=4	4	20	30	50	3

Course Outcomes

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

1. Implement concept of working stress method for analysis and design of RCC structural elements.
2. Implement concept of limit state method for analysis and design of RCC structural elements.
3. Apply principles of pre-stressed concrete for design of PC.

Module	Course Contents
1	**Working stress method and ultimate load method of design:** Reinforced Concrete Fundamentals (working Stress Method): Concept of reinforced concrete, stress strain characteristics of concrete and steel reinforcement, elastic theory, singly reinforced, balanced section, under reinforced section and over reinforced section.
2	**Limit state method of design:** Concepts of probability and reliability, characteristic loads, characteristic strength, partial safety factors for loads and materials, introduction to limit states of collapse in flexure, direct compression, shear and limit states of serviceability in deflection and cracking, design of singly and doubly reinforced rectangular and T sections for flexure. Design of members in shear and bond. Design of columns for Axial Load, Uni-axial bending moment and Bi-axial bending moment as per IS Code method. Design of one-way and two-way slabs. Design of beam subjected to bending and torsion. Design of Isolated square and rectangular footings subjected to axial load and moments, Design of combined foundations. Design of Doglegged, Open well type staircases. Design of Flat slab and post-tensioned slab
3	**Pre-stressed concrete:** Basic principles of pre-stressed concrete: Materials used and their properties, methods, and systems of pre-stressing. Losses in pre-stress, analysis of various types of sections subjected to pre-stress and external loads. Prestressed and post-tensioned members
	Recommended Reading 1. P. Dayaratnam, Design of Reinforced Concrete Structures, Oxford & IBH. (ISBN-9789386479785/9386479788). 2. T.Y. Lin, Design of Prestressed Concrete Structures, John Wiley and Sons

	Inc., 2010. (ISBN-9788126528035/978-8126528035). 3. P.D. Arthur and V. Ramkrishnan, Ultimate Strength Design for Structural Concrete, Wheeler &Co. Pvt Ltd. (ISBN- 0273403230, 978-0273403234). 4. B.P. Hughes, Limit State Theory for Reinforced Concrete Design, Pitman. (ISBN-0273010239, 978-0273010234). 5. IS456 (2000), Plain and Reinforced Concrete. 6. IS 875 (1987), Part I- Design Loads (Other than earthquake) for Buildings and Structures (Dead Loads). 7. IS 875 (1987), Part II- Design Loads (Other than earthquake) for Buildings and Structures(Imposed Loads). 8. IS 875 (2015), Part III- Design Loads (Other than earthquake) for Buildings and Structures (Wind Loads). 9. IS 875 (1987), Part IV- Design Loads (Other than earthquake) for Buildings and Structures (Snow Loads). **Textbooks** 1 Jain and Jaikrishna, Plain and Reinforced Concrete, Vol. I, Nemchand Brothers.(ISBN-8185240086/978-8185240084). 2 V. L. Shah and Karve, Limit State Design - Reinforced Concrete Structures Publications. (ISBN- 9788190371711/8190371711). 3 N. Krishna Raju, Pre-stressed Concrete, Tata McGraw Hill. (ISBN-9789387886209/9387886204).

Semester - VI		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
2	WPCE3003T	Quantity Survey and Estimation	3-1-0 = 4	4	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Estimate quantities of different items of civil engineering works. 2. Prepare specifications for different items of civil works. 3. Analyze rates for various items of works. 4. Prepare tender documents for civil works. 5. Perform valuation of different civil engineering structures.							

Module	**Course Contents**
1	**Introduction** Estimate, purpose, types, comparison, units of measurement, rules for deductions as per IS:1200
2	**Approximate Estimates** Various types, and their relative importance. Factors to be considered, purpose, different methods. Estimation by various methods
3	**Detailed Estimates** Methods of preparation of estimates for projects such as Building R.C.C and load bearing, Roads, miscellaneous works like Manhole, water storage tanks, septic tanks etc. Bar bending schedules, Mass haul Diagrams, Earthwork Calculations, work charged establishment, schedule of rates, provisional sum, Bill of quantities, centage charges, contingencies, administrative approval, technical sanction, Market survey of basic materials, thumb rules for computation of different materials for buildings. Percentage break up of costs.
4	**Specifications** Types, requirements, and importance, drafting of specifications, detailed specifications for the buildings, roads, minor bridges, and industrial structures.
5	**Rate analysis** Purpose, importance, and necessity of the same, factors affecting task work, daily output from different equipment, rate analysis of common building items
6	**Contract and Tender** Preparation of tender documents, importance of inviting tenders, tender notice, contract types, relative merits, prequalification. general and special conditions,

	termination of contracts, extra work and items, penalty and liquidated charges, Settlement of disputes, R.A. Bill & Final Bill, Payment of advance, insurance, claims, and price variation. Methods of registration of contracts, Online Process, Documents required, E tendering Procedures, Various types of contracts and tender Accepting procedure B1 Percentage Rate B2 Item rate C Lump sum Basis EPC Engineering Procurement and Construction AMC Annual Maintenance Contract Hybrid Annuity Module Swiss Challenge Method
7	**Valuation** Different terms used, the role of a valuer, purpose and necessity of the same. Capitalised Value, Years purchase, sinking fund, depreciation, types of values, Purpose of valuation, Different methods of valuation for (i) open plots, (ii) open plots with existing residential & commercial structures, (iii) leasehold properties. Use of valuation tables and formulae. Arbitration Cases, Taxation in the Construction Industry
8	**Project Implementation** Agency involved in Implementation, methods of implementation like BOT, BOOT, BOO, BOLT, EPC etc
9	Estimates and Costing of Bridges, Roads, DPR Preparation, Socio-Economic Impact, ENV, Clearances, Statutory bonds,
	Recommended Reading 1 M Chakraborti, Estimating, Costing, Specification & Valuation in Civil Engineering, Chakraborti (2006), (ISBN: 818530436X) 2 Dutta B. N., Estimating and Costing In Civil Engineering, UBS Publishers' Distributors Pvt. L td; 28th Revised Edition edition (2016), (ISBN: 8174767703). 3 Patil B.S., Building & Engineering Contracts, Mrs. S. B. Patil; 2011 edition (2011), (ISBN:8190979701). 4 Joy P. K., Handbook of Construction Management, Macmillan Publishers India (2000), (ISBN: 0333926935)

Semester - VI		PCC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
3	WPCE3004T	Risk and Value Management	3-0-0=3	3	20	30	50	3

Course Outcomes

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

1. Able to conduct value management and risk analysis exercise
2. Able to predict life cycle costs
3. Able to gather requirements and generate alternatives to satisfy needs
4. Able to determine appropriate risk response

Course Content

1	**Value engineering introduction, definitions:** Value, value engineering, value analysis, value management, Habits, Roadblocks & attitudes and their relation to value engineering
2	**Function Analysis:** Function & its role in achieving value, function in terms of its cost & worth, Graphical function analysis, function analysis technique Creative thinking: creative people, creative processes, conducting creative session
3	**Life cycle costing:** Purpose and implications, economic principles for life cycle costing, types of life cycle costs.
4	**Risks:** risks in construction, risk management framework Risk identification: sources of risk, risk classification, risk effects, common tools and techniques of identification; Risk analysis: risk measurement, qualitative and quantitative techniques; Risk response: risk management plan, risk retention, risk reduction, risk transfer, risk avoidance, attitudes towards risk
5	**Risks in construction projects:** Money, time and technical risks, contracts and risks, risks in the context of global project teams
6	**An Integrated Approach to Value and Risk Management:** Need of integration, The integrated process, timing, Project stages and study types, Critical success factor; A framework for introducing value and risk management into an organization

References:

1) Value engineering, Larry Zimmerman, Glen Hart, VanNostrand Reinhold Co
2)Techniques of value analysis & engineering, Lawrence Miles, McGraw Hill book Co
3) Risk management & construction, R Flangan& G Norman, Wiley-Blackwell
4)Practical risk management in construction industry, Leslie Edwards, Thomas Telford
5)Value and Risk Management: A Guide to Best Practice; Michael Dallas MA (Cantab), MICE, FIVM, Wiley

Semester – VI		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
4	WPCE3005T	Pavement Engineering	3-0-0 = 3	3	20	30	50	3
	Course Outcome: After completion of this course, students will be able to, 1. Use knowledge on Traffic study, highway planning, geometric design of pavements. 2. Acquire the basic knowledge of Construction techniques of Flexible and Concrete pavements. 3. Plan various highway cross sectional element. 4. Carry out structural design flexible and rigid pavements. 5. Design pavement material mix for flexible and rigid pavements.							

Module	Course Contents
1	**Introduction to Highway Engineering:** Traffic engineering definitions: functions, organization and importance, necessity of understanding the behavior of road user and vehicle characteristics, human factors governing the road user behavior- power performance and other vehicular characteristics.
2	**Traffic Engineering & Control:** Traffic studies and surveys: Speed studies: presentation of data, journey time and delay study, uses and various methods, relative merits and demerits. Vehicular volume counts: types, various available methods, relative merits and demerits, planning of traffic counts, vehicle occupancy surveys. Origin: destination surveys, need and uses, various available methods, checks for accuracy, presentation of data, Parking surveys: needs and types Highway Capacity, PCU, Level of Service, Factors affecting Highway capacity and level of Service
3	**Geometric Design of Highways** Terrain classification, design speed, vehicular characteristics, highway cross-section elements Sight distance: introduction to sight distance, reaction time, analysis of safe sight distance, analysis of overtaking sight distance, Intermediate sight distance. Design of horizontal alignment: horizontal curves, design of super elevation and its provision, radius at horizontal curves, widening of pavements at horizontal curves, analysis of transition curves. Design of vertical alignment: different types of gradients, grade compensation on curves, analysis of vertical curves, summit curves, valley curves. Intersection: at grade and grade separated intersections, speed change lanes, Canalization, Design of rotary intersection and mini roundabout, Determination of optimal signal time by Webster method

4	**Design of Pavements:** Types of pavements, comparison of different types of pavements, functions of pavement components, pavement design factors, design wheel load, equivalent single wheel load, repetition of loads, equivalent wheel load factors, strength characteristics of pavement materials, climatic variation design of flexible highway pavement as per IRC approach Stresses in rigid highway pavements, critical load positions, stresses due to loads, stresses due to temperature change, combined loading and temperature stresses, Joints in rigid pavements: transverse joints, longitudinal joints, fillers and sealers
5	**Highway Construction** Equipment used for construction, embankment design and construction, construction of different Types of roads: water bound macadam, different types of bituminous pavements, cement concrete pavements, Modern Techniques for construction of Roads (Bituminous and concrete roads)
6	**Highway Maintenance & Rehabilitation** Pavement failures: flexible pavement failures, rigid pavement failures, maintenance of different types of pavements: assessment and need for maintenance, pavement management system, evaluation of pavements: structural evaluation of pavements, functional evaluation of pavements, strengthening of existing pavements: object of strengthening, types of overlays, design of different types of overlays
	Text Books: 1 L. R. Kadiyali, N. B. Lal, Principles and Practice of Highway Engineering, Khanna Publications, 2005 (ISBN- 9788174091659) 2 Partha Chakroborty, Principles of Transportation Engineering, PHI Learning, 1st edition 2011, (ISBN-9788120320840) 3 Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, John Wiley, Principles of Highway Engineering and Traffic Analysis, 4th Edition, (ISBN-9781118120149)
	Recommended Reading: 1 Morlok, E. R., An Introduction to Transportation Engineering and Planning, McGraw Hill Kagakusha International Student Edition, (ISBN: 0070431329) 2 Hay, W. W., Introduction to Transportation Engineering. John Wiley and Sons, New York, (1988), 2nd edition, (ISBN: 0471364339) 3 Papacostas, C. S., Fundamentals of Transportation Engineering, Prentice Hall of India, New Delhi, (1987), (ISBN: 0133448703) 4 IRC 37 –Design of Flexible Pavement 2012, 5 IRC-58- Design of Rigid Pavement 2002 6 IRC-SP62 Design of Low volume roads-2014

Semester - VI		VSEC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
6	WPSE3004L	Design of RCC Laboratory	0-0-2=2	1	ISCE: 60		40	3

Course Outcomes

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

1. Analyze and design beam, column, slab, foundation, staircases and cantilever and counterfort retaining walls.
2. Draw detailed structural drawings for slab, beam, column, foundation, staircases and cantilever and counterfort retaining walls.

Module	**Course Contents**
1	1. Design and drawing of singly reinforced, doubly reinforced rectangular and T-section simply supported and continuous beam. 2. Design and drawing of one-way, two-way, simply supported, and continuous slab systems. 3. Design and drawing of Dog-legged and open wall-type staircases. 4. Design and drawing of columns and foundations. 5. Design and drawing of the Retaining wall. (Cantilever and counterfort) A) A Seminar on field execution of RCC designs and drawings.
	Recommended Reading 1. P.Dayaratnam, Design of Reinforced Concrete Structures, Oxford & IBH. (ISBN-9789386479785/9386479788). 2. T.Y. Lin, Design of Prestressed Concrete Structures, John Wiley and Sons Inc., 2010. (ISBN-9788126528035/8126528036). 3. P.D.Arthur and V.Ramkrishnan, Ultimate Strength Design for Structural Concrete, Wheeler&Co. Pvt Ltd. (ISBN-0273403230/978-0273403234). **Textbooks** 1. Jain and Jaikrishna, Plain and Reinforced Concrete, Vol. I, Nemchand Brothers.(ISBN-8185240086/978-8185240084). 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).

Semester - VI		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
7	WPCE3003L	Quantity Survey and Estimation Laboratory	0-0-2 = 2	1	ISCE:60		40	3
	Course Outcome: After completion of course students will be able to 1. Formulate specifications for different items of civil engineering works 2. Prepare estimate of civil engineering structures. 3. Analyze the rates of different construction activities							

	Course Contents
	1. To prepare an estimate of a residential building. 2. To compute the quantities of reinforcement from bar bending schedules. 3. To prepare the estimate of a septic tank. 4. To prepare the estimate of road work. 5. To draft the specifications for various civil engineering works. 6. To analyze the rates for various items of works. A) Seminar on comparison of state schedule of rates for different works
	Text Books: 1 M Chakraborti, Estimating, Costing, Specification & Valuation in Civil Engineering, Chakraborti (2006), (ISBN: 818530436X) 2 Dutta B. N., Estimating and Costing In Civil Engineering, UBS Publishers Distributors Pvt. Ltd; 28th Revised Edition (2016), (ISBN: 8174767703). 3 Joy P. K., Handbook of Construction Management, Macmillan Publishers India (2000), (ISBN: 0333926935)

Semester - VI		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
8	WPCE3005L	Transportation Engineering Laboratory	0-0-2=2	1	ISCE: 60		40	3
	Course Outcome: **1.** Perform quality control Tests needed for pavement construction and maintenance. **2.** Prepare mix design for pavements. **3.** Plan and conduct traffic studies for estimating traffic flow characteristics. **4.** Conduct physical evaluation of pavements using modern tools and equipment.							

Sl. No.	**Course Content: (List of Experiments)**
1	**Bituminous / Asphalt Pavement Design:** Marshall stability, Mix design for pavements: Water Bound Macadam, Bituminous Macadam, and Asphalt concrete, Mastic asphalt pavements
2	**Traffic Studies:** Spot Speed Study, Traffic volume studies, Delay studies
3	**Physical Evaluation of Pavements:** Physical verification and Roughness Measurement: Merlin, Bump Integrator Test, Roughometer tests
4	**Structural Evaluation of Pavements:** Benkelman Beam Test, Bump Integrator Test, Deflectometer tests, Skid Resistance Test,
5	**Non-destructive Tests:** Evaluation of bitumen content of core samples.
5	**Evaluation of soil subgrade for flexible pavements** C.B.R test (soaked and unsoaked Lab, Field), Tests on Soils: Density of soil, moisture content, Plasticity index of soil.
A)	Seminar on field testing of bitumen and asphalts during the construction of roads
	Text Books 1. Rao D.V. B, Rao G. V, and Pahari, K. Highway Material Testing and Quality Control, Dreamtech Press, 2019 (ISBN: 9389447321) 2. Ministry of Road Transport and Highways, by Indian Road Congress, 5th Revision 2013, reprint July 2016, (ISBN: 9788193293201). 3. Asphalt Institute Manual Series No.2 (MS-2) Mix design methods for Asphalt concrete and other hot mix types Lexington Ky, 7th edition.

PROGRAM ELECTIVE COURSES

Semester - VI		PEC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	WPCE3101T	Geographic Information System	3-0-0=3	3	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Acquire a basic understanding of GIS modelling concepts, components, requirements and applications 2. Create spatial and non-spatial models for presentation, analysis and decision-making 3. Use of GIS software modules 4. Design and execute a workflow using GIS techniques appropriate to an applied field							

Module	Course Contents
1	**Basic concepts of GIS:** Information systems, spatial and non-spatial information, geographical concepts and terminology, advantages of GIS, basic components of GIS, commercially available GIS hardware and software, organization of data in GIS
2	**GIS data:** Field data, statistical data, Maps, aerial photographs, satellite data, points, line and area feature, vector and raster data, advantages and disadvantages, data entry through keyboard, digitizers and scanners, digital data, preprocessing of data-rectification and registration, interpolation techniques, use of different plugins.
3	**Data management:** DBMS, various data models, run-length encoding, quadtrees, data analysis-data layers, analysis of spatial and non-spatial data, data overlay and modelling, data processing: raster based and vector based, data presentation –hardcopy devices, softcopy devices
4	**Remote sensing and GIS integration:** Principles of electromagnetic remote sensing, imaging characteristics of remote sensing systems, extraction of metric and descriptive information from remotely sensed images, integration of remote sensing and GIS

5	**Application of GIS:** Map revision, land use land cover (LULC), agriculture, forestry, archaeology, municipal geology, water resources, dam site selection, canal site selection, catchment area detection, rivers and its tributaries location finding, Environmental Impact Assessment Oceanography, soil erosion, land suitability analysis, change detection
	Reference Books: 1. Lo C P, Yeung A K W, Concepts and Techniques of Geographic Information Systems,2nd edition, Prentice Hall India (August 20, 2006), (ISBN: 013149502X). 2. Kang-tsung Chang, Introduction to Geographic Information Systems, Tata mcGraw Hill,2007- 7th edition, (ISBN: 9780078095139) 3. K. Anji Rao, Remote sensing and Geographical Information System, BS Publications,3rd edition, 2008, (ISBN: 9788178001357)

Semester - VI		PEC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
2	WPCE3102T	Advanced Hydrology	3-0-0=3	3	20	30	50	3
	Course Outcome: After completion of course students will be able to: 1. Measure and analyse the meteorological data 2. Model surface and subsurface water flow 3. Optimize the water resource system.							
Module	**Course Contents**							
1	**Introduction and Basic Concepts:** System Components, Planning and management, Concept of a system, Advantages and limitations of systems approach, Modelling of Water Resources Systems, Simulation and optimization, Economics in water resources, Challenges in water sector							
2	**Measurement and Processing of meteorological Data:** Measurement and Processing of Rainfall Data, Stream flow Data, Meteorological Data, Ground Water data, Data acquisition and management of spatial data, Hydrological databases and Dissemination of Data, Statistical Analysis of Data: Regression, Correlation and Data Generation							
3	**Measurement of flow:** Techniques, latest methods for measuring depth, current-meter types, calibration, numerical examples on mid/ mean section methods, stage discharge rating curve, coefficient of correlation.							
4	**Surface flow modelling techniques:** Hydrological and hydraulics flow model, Reservoir routing, channel routing, general operation of flood forecasting, forecasting methods adopted in India, forecasting by unit hydrograph method.							
5	**Subsurface flow modelling techniques:** Yield, transmissibility, Darcy's law, Dupuit's theory of unconfined flow, steady flow towards fully penetrating wells in case of confined and unconfined aquifers.							
6	**Optimization:** Economics in water resources, modelling of water resources systems, Constrained and unconstrained optimization, Linear programming with applications to reservoir sizing, reservoir operation, Dynamic programming with applications to water allocation, capacity expansion, reservoir operation							
	Reference Books: 1. G L Asawa, Elementary Irrigation Engineering, New Age International Publisher (1999), (ISBN: 8122412025) 2. S K Garg, Irrigation Engineering & Hydraulic Structures, Khanna Publishers 2017, (ISBN: 8174090479) 3. P N Modi, Irrigation Water Resources & Water Power Engineering, Standard Brookhouse; Edition: 9th, Year-2014 edition (2014), (ISBN:							

	8189401297) 4. V.P. Singh, Elementary Hydrology, Prentice Hall of India Pvt. Ltd., New Delhi-110001, 1994, (ISBN: 0132493845) **Recommended Reading** 1. J D Zimmerman, Irrigation, John Wiley & Sons; 99th edition (1 September 1966), (ISBN: 0471983799) 2. Varshney, Gupta & Gupta, Theory and Design of Irrigation Structures, Nem Chand & Bros, (ISBN: 8185240485) 3. Punmia B C &Pande B Blal, Irrigation Engineering and Water Power Engineering, Laxmi Publications; Revised edition (2016), (ISBN: 9788131807637)

Semester - VI		PEC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
3	WPSE3101T	Advanced Structural Analysis	3-0-0=3	3	20	30	50	3
	Course Outcome: After completion of course students will be able to: 1. Analyse frames and trusses using direct and matrix forms of stiffness method 2. Analyse frames and trusses using matrix flexibility method. 3. Apply approximate methods for analysis of 2D building frames. 4. Analyse structural steel sections and to evaluate collapse loads of steel structures using the concept of plastic analysis. 5. Draw the Influence Line Diagram for indeterminate structures using the Muller Breslau's Principle.							
Module	**Course Contents**							
1	**Introduction to stiffness method in matrix form:** Definition of Stiffness coefficient, member stiffness matrix for prismatic truss and beam elements, properties of the member stiffness matrix, coordinate transformation matrix, stiffness matrix in local and global coordinate axes system. Global stiffness matrix, Boundary conditions, calculation of equivalent joint loads. Solution of Equilibrium equations for displacements. Evaluation of Internal forces in members. Application of matrix stiffness method to beams, pin jointed trusses and rigid jointed plane frames.							
2	**Conventional form of stiffness method, moment distribution method:** Application to frames involving sway, consideration of symmetry and anti-symmetry of loads on symmetric structures, modification of stiffness and carryover factors for symmetric and anti-symmetric loads.							
3	**Flexibility method in matrix form:** Definition of Flexibility coefficient, Selection of primary determinate structure, Structure flexibility matrix, compatibility equations. Evaluation of Redundant forces, computation of internal forces and joint displacements. Applications to continuous beams, pin jointed trusses and rigid jointed plane frames.							
4	**Conventional form of flexibility method:** Elastic Centre method and its application to rigid jointed portal frames, box frames and fixed arches. Column analogy method and its application to the determination of stiffness coefficients, carry over factors and fixed end moments for non-prismatic members.							
5	**Muller Breslau principle**: Application of Muller Breslau Principle for influence line diagrams for statically indeterminate structures such as propped cantilevers, fixed beams and continuous beams.							

6	**Approximate methods for analysis of building frames:** Substitute frame, cantilever and portal methods applied to 2D Frames.
7	**Introduction to plastic analysis of steel structures:** Concept of plastic Hinge. Calculation of plastic moment carrying capacity and shape factor for a given structural steel cross-section. Determination of collapse load for single and multiple-span steel beams.
	Reference Books: 1. R.K. Livesley, Matrix Methods of Structural Analysis, Pergamon Press 1964. (ISBN-0080188885). 2. J.M. Gere and W. Weaver, Analysis of Framed Structure, Van Nostrand, 965. (ISBN-8123911513/978-8123911519). 3. Wilbur, Elementary Structural Analysis, Literary Licensing, 2012. (ISBN-1258242907/978-1258242909). 4. S.A. Raz, Analytical Methods in Structural Analysis, New Age Int. Publishers, 2001. (ISBN-8122413048/978-8122413045). 5. B.N. Thadani, Modern Methods in Structural Mechanics, Asia Publishing House 1964. (ISBN-021026957X/978-0210269572). 6. B.G. Neal, Plastic Methods of Structural Analysis, Chapman and Hall, 1985. (ISBN-0412214504/978-0412214509). 7. Laursen, Structural Analysis, Tata McGraw Hill, 1988. (ISBN-9789332901476/9332901473). 8. C.K. Wang, Intermediate Structural Analysis, Tata McGraw Hill, 2016. (ISBN-13:978-070702493). 9. Pandit and Gupta, Matrix Method in Structural Analysis, Tata McGraw Hill, 2015. (ISBN-0070667357/978-0070667358).

Semester – VI		PEC	Construction Engineering and Management					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
4	WPCE3103T	Construction Equipment and Automation	3-0-0=3	3	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Classify construction equipment and evaluate selection criteria, productivity, maintenance, and economic aspects. 2. Able to prepare inventory analysis and make material purchase decisions. 3. Analyze and monitor equipment and material requirements 4. Apply materials management principles for estimation, procurement, inventory control, and waste minimization in construction.							

Module	Course Contents
1	**Introduction to Construction Equipment:** Classification of construction equipment, factors influencing equipment selection, productivity and operational efficiency, maintenance strategies, safety considerations in equipment usage, economic aspects including cost analysis, investment, operational expenses, and depreciation.
2	**Construction Machinery for Earthmoving, Material Handling, and Roadworks** Earthmoving and excavation equipment: Excavators, bulldozers, loaders, scrapers, and trenchers; working principles, applications, and performance parameters; operational cost analysis and efficiency considerations. Material handling and transportation equipment: Cranes, hoists, conveyors, and forklifts; hauling equipment such as dumpers, tippers, and trailers; selection criteria for different construction applications; safety measures in material handling and transportation. Concrete and road construction equipment: Concrete mixers, batching plants, and concrete pumps; asphalt pavers, compactors, and rollers; advancements in paving and compacting technologies for improved construction efficiency and durability.
3	**Automation and Advanced Technologies in Construction** Construction automation and robotics: Introduction to automation in construction; robotic applications such as 3D printing and robotic arms; AI applications in predictive maintenance and project scheduling; IoT-based smart construction technologies for real-time monitoring and resource optimization. Advanced technologies and digital transformation: Building Information

	Modeling (BIM) and digital twin technology; drone applications in surveying and site monitoring; case studies on automation in mega projects, showcasing real-world implementation and challenges.
4	**Equipment Management** Mechanization on construction projects, selection of major and minor equipment, production estimating, sizing and matching of equipment Sources of construction equipment: purchase, rent and lease, old and new equipment. Economics of equipment, useful / economic life of equipment, equipment operation and service, maintenance, depreciation, obsolescence and replacement. Equipment management systems, organizations, record keeping, training to operators
5	**Materials Management** Importance, estimation of materials, Classification and codification, ABC analysis Purchase function: legal aspects of purchase, inventory control, concept of EOQ Stores management, minimizing wastage, Material management systems, Organizations, record keeping
	Textbooks 1. Peurifoy, R. L., Schexnayder, C., Shapira, A., & Schmitt, R. "Construction Planning, Equipment, and Methods." McGraw-Hill Education. 2. Mahesh Varma, "Construction Equipment and Its Planning and Application," Metropolitan Book Company. 3. R. L. Peurifoy, "Construction Equipment Management for Engineers, Estimators, and Owners," McGraw Hill. 4. S. W. Nunnally, "Construction Methods and Management," Pearson. **Recommended Reading** 1. R. Chudley & R. Greeno, "Advanced Construction Technology," Pearson Education. 2. Varma Mahesh, Construction Equipment, its Planning & Application, Metropolitan & Co 3. Gopalkrishnan, Materials Management 4. Nunnally, Managing construction equipment, Prentice Hall

Semester - VI		PEC						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
5	WPSE3102T	Advanced Foundation Engineering	3-0-0=3	3	20	30	50	3
	Course Outcome: After completion of course students will be able to: 1 Evaluate shear strength behaviour of soil under different drainage conditions and compressibility potential under complex pore pressure conditions. 2 Determine stresses due to applied loads for the analysis of settlement. 3 Explain the advanced methods of computation of bearing capacity for homogenous, layered and sloping soil deposit under the axial or eccentric/inclined loads and settlement for different types of soil. 4 Evaluate techniques of axial load carrying capacity of piles embedded in soil and weathered rock and lateral load capacity in granular soil. 5 Illustrate the methods of ground improvement technique for improvement of weak soil.							
Module	**Course Contents**							
1	**Consolidation & stress and strain behaviour of soil**: Terzaghi's theory of One-Dimensional Consolidation – derivation of equation (solution for different conditions of excess pore water pressure), degree of consolidation and average degree of consolidation, Field consolidation curves, Consolidation settlement of NC and OC clays, practical applications. Mohr – Coulomb's criteria, Shear strength of sand and clays. Skemton's pore pressure parameters. Soil elastic modulus.							
2	**Estimation of stresses:** Boussinesq's theory, Westergard's theory, Newmarks charts.							
3	**Bearing capacity and settlement analysis of shallow foundations:** Bearing Capacity theories – Terzaghi solution (detailed approach), Vesic's theory. IS 6403 (1981) method and Skempton's method, Meterhof's theory. Assumptions in estimates of ultimate loads, Effect of shape, embedment of footing, eccentricity and inclination in loading. Effect of compressibility (including critical rigidity index), Bearing capacity of non-uniform soils (Meyerh of & Hamnna). Foundation on Sloping Ground., Settlement Analysis: Elastic theory by Steinbrenner factor Schmertmman's method, Secondary settlement. Bearing capacity of foundation on compact and weathered rock. Introduction to Raft foundation.							

4	**Pile Foundation:** Pile load tests using girders and anchors, Separation of skin friction and end bearing capacity. Capacity from in-situ tests (SPT and SCPT). Piles in weathered rock: IS 14593 (1998), empirical methods, Special auguring tools & machines for forming the piles, Pile termination criteria. Piles subjected lateral load (Rees and Matlock Method). Introduction of pile raft and Uplift Capacity.
5	**Ground improvement:** Dynamic compaction, basics of vacuum consolidation. Geological properties of reinforced soils, Design of Reinforced Earth wall using Geogrid using BS 8006 or other relevant codes, soil nailing. Instrumentation – mainly pore pressure gauges and settlement gauges and their applications.
6	**Introduction to soil structures interaction:** Introduction to soil - Foundation interaction problems, Sol behaviour, Foundation behaviour, Interface, behaviour, soil response models, Winkler, Elastic continuum.
	Text Books: 1. B.M. Das, Shallow Foundation- Bearing Capacity & Settlement, Taylor & Francis. (ISBN-9788131518786). 2. V.N.S. Murthy, Advanced Foundation Engineering, CBD Publishers and Distributors, New Delhi, 2010. (ISBN- 9788123915067/978-8123915067). 3. 3. B.M. Das, Advanced Soil Mechanics, CRC Press, 4th Edition, Taylor &Fransis 2012. (ISBN-978-8131518786) **Recommended Reading:** 4. K. Terzaghi and R.B. Peck, Soil Mechanics in Engineering Practice, Wiley and Sons, 1996. (ISBN- 8126523816/978-8126523818). 5. A. Singh, Soil Mechanics and Foundation Engineering, Vol I & Vol II, Standard bookHouse, 2013. (ISBN-8123900392/978-8123900391). 6. R.D. Holtz and W.D. Kovacs, An introduction to geotechnical engineering, Prentice Hall, 1981. (ISBN-10: 9332507619/978-9332507616). 7. H. Winterkorn and F.Y. Fang, foundation Engineering Handbook, CBS Publishers & Distributors, New Delhi, 1990. (ISBN 9788123905457). 8. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill Book Co,2001. (ISBN-13: 978-0071188449). 9. P. Shamsher and H. Sharma, Pile Foundations in Engineering Practice, Wiley and Sons,1990. (ISBN-13: 978-0471616535). 10. R. Purushothama, Ground Improvement Techniques (HB), Laxmi Publication Pvt Ltd., New Delhi, 2005. (ISBN-10: 9788170080985/978-8170080985). 11. M.R. Hausmann, Engineering Principles of Ground Modification McGraw-Hill Inc., US, 1990. (ISBN-978-0070272798). 12. R.M. Koerner, Designing with Geosynthetics, (Third Edition), Prentice Hall, 1997. 13. S. Saran, Soil Dynamics and Machine Foundations, Galgotia Publications pvt.ltd. (ISBN 817515-266-4).

	14. IS 1892 (1979), Subsurface Investigation for Foundation. 15. IS 6403 (1981), Determination of Bearing Capacity of Shallow Foundation. 16. IS 8009 Part I (1978), Calculation of Settlement of Foundation and Shallow Foundation Subjected to Symmetrical Static Vertical Loads. 17. IS 2911 Part I (2010), Design and Construction of Pile Foundations, Part I Concrete Piles. 18. IS 14593(1998), Design and Construction of Bored Cast-in-situ Pile Founded on Rocks- Guidelines. 19. IS 12070 (1995) Code and Practices for Design and Construction of Shallow Foundations on Rocks. 20. IS 1888 (1982), Method of Load Test on Soil. 21. IS 1904 (1986), Design and Construction of Foundation in Soil – General Requirements. 22. IS 15284 Part I (2003), Design and Construction for Ground Improvement – Guidelines, Part I – Stone Columns.

Semester - VI		Program Elective Course (PEC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
6	WPSE3103T	Soil Dynamics and Machine Dynamics	3-0-0 = 3	3	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Apply theory of vibrations to solve dynamic soil problems 2. Calculate the dynamic properties of soils using laboratory and field tests 3. Analyze and design behavior of a machine foundation resting on the surface, embedded foundation and foundations on piles by elastic half space concept. 4. Analyze and design vibration isolation systems							

Module	**Course Contents**
1	**Introduction** Vibration of elementary systems-vibratory motion-single degree freedom system-free and forced vibration with and without damping
2	**Waves and wave propagation** Wave propagation in an elastic homogeneous isotropic medium- Raleigh, shear and compression waves-waves in elastic halfspace
3	**Dynamic properties of soils** Elastic properties of soils-coefficient of elastic, uniform, and non-uniform compression-shear-effect of vibration dissipative properties of soils-determination of dynamic properties of soil- codal provisions
4	**Machine foundation** Types, Design criteria, Permissible amplitudes and Bearing pressure, Degrees of freedom, Analysis under different modes of vibration of block foundation Design criteria-dynamic loads – simple design procedures for foundations under reciprocating machines - machines producing impact loads - rotary type machines.
5	**Vibration isolation** Vibration isolation technique - mechanical isolation- foundation isolation-isolation by location isolation by barriers- active passive isolation tests.
	Textbooks 1 S. Saran, “Soil Dynamics and Machine Foundations”, Galgotia Publications Pvt. Ltd., 2016. (ISBN: 9788175157279/8175157275).

2 S. Prakesh and V.K Puri, Foundation for machines, McGraw-Hill 1998.(ISBN- 0471846864/978-0471846864).
3 S.L.Kramar, "Geotechnical Earthquake Engineering", Prentice Hall International series, Pearson Education (Singapore) Pvt. Ltd. (ISBN: 9788131707180, 8131707180).
4 K. Rao, Dynamics Soil Tests and Applications, Wheeler Publishing, New Delhi, 2003.(ISBN-8175442034/978-8175442030).

Recommended Reading

1 K. Rao, "Vibration Analysis and Foundation Dynamics", Wheeler Publishing, New Delhi,1998.(ISBN 8175440015).
2 IS code of Practice for Design and Construction of Machine Foundations, McGraw-Hill,1996.
3 P. J. Moore, "Analysis and Design of Foundation for Vibration", Oxford and IBH,1995. (ISBN-9061915252/978-9061915256).
4 Barkan, "Dynamics of Bases and Foundations", 2nd Edition McGraw Hill Publishing,1970. (ISBN-9780070036505/978-0070036505).
5 Richart, Hall and Woods, "Vibration of Soils and Foundations", Prentice Hall, 1981.
6 Shamsher Prakash, "Soil Dynamics", 3rd Edition, John Wiley, 2000.(ISBN- 0139417168/978-0139417160).

Semester - VI		Program Elective Course (PEC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
7	WPCE3104T	Engineering Geology	3-0-0 = 3	3	20	30	50	3
	Course Outcome: After completion of course students will be able to 1. Develop the ability to perform basic engineering geological assessments and analysis. 2. Develop the ability to perform basic engineering geological assessments and analysis. 3. Understand the relevance of Engineering Geology in complex projects, .							

Module	Course Contents
1	**Introduction to Engineering Geology** Fundamental concepts leading to the formation of the Earth, including rocks and minerals. General geology, surface features, external and internal agents modifying the earth, weathering, decomposition, earth movements, and rock formation. Classification of igneous, sedimentary, and metamorphic rocks. Study of rock textures, mineral compositions, and their significance in civil engineering applications.
2	**Structural Geology and Geomorphology** Understanding geological structures such as faults, folds, joints, and fractures. Modes of occurrence of igneous rocks and their engineering significance. Physiographic divisions of India and their geological characteristics. Historical geology, principles of stratigraphy, and the significance of geological formations in civil engineering activities. Field-based exercises on geological mapping and identifying rock formations.
3	**Groundwater and Stability of Slopes** Types of groundwater, water table, and depth zones of saturation. Influence of rock structures on groundwater movement, geological work of running water, and river valley development. Analysis of stability of slopes in consolidated materials, causes of landslides, impact of dip and slope angles, role of vegetation, and treatment techniques. Case studies on slope stabilization and groundwater movement analysis.

4	**Engineering Explorations and Site Investigations** Verification of surface data by subsurface exploration techniques, including drilling, test pits, trenches, exploratory tunnels, and geophysical methods. Comparative reliability of data obtained by drilling and excavation. Engineering significance of geological structures such as stratification, dips, folds, faults, fractures, and fault zones. Practical exercises on subsurface investigation methods and data interpretation for construction projects.
5	**Infrastructure Development and Geological Considerations** Impact of geological conditions on infrastructure projects such as tunnels, dams, and reservoirs. Geological considerations for site selection, including foundation rock stability, permeability, and water retention characteristics. Role of geological conditions in determining reservoir sites and preventing leakage. Case studies on dam failures, tunneling challenges, and geological risk assessments.
6	**Emerging Trends in Engineering Geology and Applications** Application of remote sensing and GIS in geological studies. Role of engineering geology in disaster risk reduction, earthquake zones, and infrastructure planning. Public-private participation in geological risk management for infrastructure projects. Integration of geological studies into urban and regional planning. Exercises on preparing feasibility reports and geological risk assessment reports for infrastructure development.
	Recommended Reading 1 R.B. Gupte: A Text Book of Engineering Geology (New Edition) – P.V.G. Publications, Pune 2 M. Anji Reddy: A Text Book of Remote Sensing and Geographical Information Systems – 2nd Edition, BS Publication 3 N. Chenna Kesavulu: A Textbook of Engineering Geology 4 Pradeep Kumar Guha: Remote Sensing for Beginners, East West Publications 5 Parbin B. Singh: Engineering and General Geology (2013 edition), S K Sons Publication 6 G.B. Mahapatra: Textbook of Physical Geology 7 Mukherjee: Textbook of Geology - 4th Edition, The World Press Pvt. Ltd, Calcutta