Civil and Infrastructure Engineering

SL. No	Course code		Name of Course	L-T-P-C	Proposed Level (UG/PG)
1	CE 101	CE101T	Introduction to Civil Engineering	2-1-0-6	UG
2	CE 201	CE201C	Building and Construction Materials	1-1-2-6	UG
3	CE 202	CE202T	Surveying and Geomatics	2-1-0-6	UG
4	CE 203	CE202C	Building Planning and Drawing	2-0-2-6	UG
5	CE 204	CE201T	Hydraulic Engineering	2-1-0-6	UG
6	CE 205	CE203T	Structural Analysis	2-1-0-6	UG
7	CE 211		Fluid Mechanics and Hydraulics Laboratory	0-0-3-3	UG
8	CE 212	CE202L	Surveying and Geomatics Laboratory	0-0-3-3	UG
9	CE 206	CE204T	Water Resources Engineering	2-1-0-6	UG
10	CE 306	CE306T	Design of Steel Structures	2-1-0-6	UG
11	CE 310		Sensors Technologies and Instrumentation in civil Engineering	1-1-2-6	UG
12	CE 308	CE307T	Foundation Engineering	2-1-0-6	UG
13	CE 309	CE308T	Estimation and Costing in Civil Engineering	1.5-0 -0 -3	UG
14	CE 401	CE309T	Construction Engineering and Management	3-0-0-6	UG
15	CE 301	CE301T	Environmental Studies	3-0-0-6	UG
16	CE 302	CE302T	Design of Concrete Structures	2-1-0-6	UG
17	CE 303	CE303T	Geotechnical Engineering	2-1-0-6	UG

18	CE 304	CE304T	Transportation Engineering	2-1-0-6	UG
19	CE 305	CE305T	Environmental Engineering	2-1-0-6	UG
20	CE 307	CE101T	Introduction to Civil Engineering	2-0-2-6	UG
21	CE 311	CE302L	Transportation Engineering Laboratory	0-0-3-3	UG
22	CE 312	CE303L	Geotechnical Engineering Laboratory	0-0-3-3	UG
23	CE 313	CE304L	Environmental Engineering Laboratory	0-0-3-3	UG
24	CE 314		Civil Engineering Software Laboratory	0-0-3-3	UG
25	CE 402	CE401P	BTP-1	0-0-6-6	UG
26	CE 403		Civil and Infrastructure Engineering Design	1-0-1-3	UG
27	CE 404	CE402P	BTP-II	0-0-6-6	UG
28	CE 405	CE401T	Basics of Railway, Airport, Bridge and Tunnel Engineering	2-1-0-6	UG
29	CE 406	CE402T	Ports, Harbours and Inland Waterways	2-1-0-6	UG
30	CE 407	CE403T	Applications of Geosynthetics	3-0-0-6	UG
31	CE 408	CE404T	Introduction to Earthquake Engineering	3-0-0-6	UG
32	CE 409	CE405T	Introduction to Ground Improvement	3-0-0-6	UG
33	CE 421	CE406T	Introduction to Geotechnical Earthquake Engineering	3-0-0-6	UG
34	CE 422	CE407T	Environmental Geotechnics	3-0-0-6	UG
35	CE 601	CE801T	Pavement Engineering	3-0-0-6	PG
36	CE 602	CE802T	Geosynthetic Engineering	3-0-0-6	PG
37	CE 910	CE801S	Seminar	0-0-4-4	PG
38	CE 603	CE801C	3D Concrete Printing Technology	2-0-2-6	PG

39	CE 604	CE802C	Modern Construction Materials and Techniques	2-0-2-6	PG
40	CE 605	CE803C	Advanced Soil mechanics	2-1-0-6	PG
41	CE 606		Vibration and Structural Dynamics	2-1-0-6	PG
42	CE 607	CE804T	Advanced Concrete Structure	2-1-0-6	PG
43	CE 315		Civil Engineering credit Seminar	0-0-3-3	
44			Building Materials and Construction	3-0-0-6	UG
45		CE205T	Building Drawing Practice	0-0-3-3	UG
46		CE203L	Construction Materials Laboratory	0-0-3-3	UG
47		CE204L	Sustainable Infrastructure Planning	3-0-0-6	UG
48		CE206T	Hydraulics and Hydraulic Machinery	3-0-0-6	UG
49		CE207T	Sensors and Instrumentation in Civil Engineering Laboratory	0-0-3-3	UG
50		CE408T	Advanced Structural Analysis	3-0-0-6	UG
51		CE409T	Non-Destructive Techniques in Civil Engineering	3-0-0-6	UG
52		CE410T	Repair and Rehabilitation of Infrastructure	3-0-0-6	UG
53		CE201L	Fluid Mechanics Lab	0-0-3-3	UG
54		CE208T	Water Resources Engineering	**2-1-0-6**	UG
55		CE301C	Sensor Technologies & Instrumentation in Civil Engineering	2-0-0-6	UG
56		CE306L	Sensors and Instrumentation in Civil Engineering Laboratory	0-0-3-3	UG
57		CE305L	Civil Engineering Software Laboratory	**0-0-3-3**	UG
58		CE401C	Civil and Infrastructure Engineering Design	1-0-1-3	UG
59		CE403P	Intensive B.Tech. Project	--	UG
60		CE404P	Research and Development Project in Civil Engineering	--	UG
61		CE601T	Ecology and Stream Pollution		
62		CE408T	Fluid Mechanics Lab	2-0-2-6	UG

1	**Title of the course (L-T-P-C)**	**Environmental studies (3-0-0-6)**
2	**Pre-requisite courses(s)**	**Nill**
3	**Course content**	**Module A:** Natural Resources, Ecosystems, Biodiversity and its conservation: Natural resources and ecosystems, Forest, grassland, desert and aquatic ecosystems, biodiversity at global, national and local levels, conservation of biodiversity **Module B:** Air Pollution Introduction to understanding air quality management, fundamental processes of meteorology, Air Pollutants – Gaseous and particulate, Criteria for pollutants, ambient and source standards, Aerosols: Characterisation of aerosols, size distributions, measurement methods; Transport behaviour: diffusion, sedimentation, inertia; Visibility; principles of particulate control systems. **Module C:** Water Treatment Discussion of water quality constituents and introduction to the design and operation of water and wastewater treatment processes. **Module D:** Solid Waste Management and Climate Change Different aspects of solid and hazardous waste management. Climate change and greenhouse gas emissions, technologies would reduce the greenhouse gas emissions. Climate change and its possible causes. **Module E:** Sociology/Environmentalism Description: Environmentalism in sociological tradition, Sustainability, North-South divide, Political economy approaches in environmental studies, Debates over environmental issues. **Module F:** Economics Energy economics and financial markets, Market dynamics, Energy derivatives, Energy Efficiency; Sustainable Development: Concept, Measurement & Strategies, Interaction between Economic Development and the Environment **Module G:** Philosophy Environmental ethics, Deep ecology, Practical ecology, Religion and attitude towards environmental ethics, Ecofeminism and its evolution. **Module H**: Field work and project: visit to a local area to document environmental assets, case studies of a simple ecosystem and group discussions on current environmental issues.
4	**Texts/References**	**1.** Cunningham W.P. and Cunningham M.A. (2002), Principles of Environmental Science, Tata McGraw-Hill Publishing Company, New Delhi. **2.** Dasgupta, P. and Maler, G. (eds.), (1997), The Environment and Emerging Development Issues, Vol. I, Oxford University Press, New Delhi. **3.** Jackson, A.R.W. and Jackson, J.M. (1996), Environmental Sciences: The Environment and Human Impact, Longman Publishers. **4.** Nathanson, J.A., (2002), Basic Environmental Technology, Prentice Hall of India, New Delhi **5.** Redclift, M. and Woodgate, G. (eds.), (1997), International Handbook of Environmental Sociology. **6.** Srivastava, K.P. (2002), An Introduction to Environmental Study, Kalyani Publishers, Ludhiana. **7.** Review articles from literature.

1	**Title of the course** (L-T-P-C)	**Introduction to Civil Engineering** **2-1-0-6**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Introduction and Scope of Civil Engineering**: Basics of Engineering and Civil Engineering; Broad disciplines of Civil Engineering; Importance of Civil Engineering, History of Civil Engineering: Early constructions and developments over time, ancient monuments of the world, Civil Engineering aspects of Indian heritage structures. Civil Engineering Specializations: Structural Engineering, Geotechnical Engineering, Water Resources Engineering, Environmental Engineering, Transportation Engineering, Construction Management, Ocean Engineering, Remote Sensing and GIS, Energy and Sustainable Infrastructure. **Megastructures of Civil Engineering**: Design, Construction and Structural Details of Some of the Megastructures of the World. Mega Civil Engineering Projects of India. Failure Case Studies in Civil Engineering: Structures, Foundations, Dams, Pavement Systems, and the Geo-environment. Some Major Civil Engineering Challenges **Materials in Civil Engineering**: Stones, bricks, mortars, Plain, Reinforced & Prestressed Concrete, Construction Chemicals, Structural Steel, High Tensile Steel, Carbon Composites, Plastics in Construction, 3D printing, Recycling of Construction & Demolition wastes, Sustainable Building Materials. **Introduction to Plan Reading, and Construction Techniques**: Scale drawings of floor plans, sections, and elevations; Plan types, Interpretation of plans. Components of a building. Typical loads and forces in Civil Engineering structures. Introduction to estimation and costing. **Smart Cities and Current Trends in Construction Industry**: Application of Machine Learning (ML) and Artificial Intelligence (AI) in Civil Engineering. Position of construction industry vis-à-vis other industries, plan outlays for construction; current budgets for infrastructure works; Possible scopes for a career, Importance of ethics in engineering.
4	**Texts/References**	**Reading:** **1.** J. E. Gordon, "STRUCTURES: Or Why Things Don't Fall Down", Da Capo Press; Reprint edition, 2003. **2.** Paul A. Bosela, Pamalee A. Brady, Norbert J. Delatte, M. Kevin Parfitt "Failure Case Studies in Civil Engineering: Structures, Foundations, and the Geoenvironmental", American Society of Civil Engineers; 2nd edition 2013. **3.** P.C. Varghese "Building Materials", Prentice Hall India Learning Private Limited; 2nd edition, 2015. **4.** Gary Anglin, "Introduction to Estimating, Plan Reading and Construction Techniques", Routledge; 1st edition, 2019. **5.** You-Lin Xu, Jia He "Smart Civil Structures", CRC Press; 1st edition, 2019. **References:** **1.** Pijush Samui, Dookie Kim, Nagesh Iyer, Sandeep Chaudhary, "New Materials in Civil Engineering", 1st edition, Elsevier, 2020. **2.** Saeed Moaveni, "Engineering Fundamentals: An Introduction to Engineering" Cengage Learning India Pvt. Ltd.; Fourth edition, 2011. **3.** J. E. Gordon, "The New Science of Strong Materials – Or Why You Don`t Fall through the Floor", Princeton University Press, 2020. **4.** BIS, "National Building Code of India", Bureau of Indian Standards, 2017. **5.** M.W.Martin and R.Schinzinger, "Ethics in Engineering" McGraw Hill Education; Fourth edition, 2017. **6.** S.S. Bhavikatti and M.V. Chitawadagi "Building Planning and Drawing", Dreamtech Press, 2019.

1	**Title of the course** (L-T-P-C)	**Building and Construction Materials** **1-1-2-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**UNIT I-STONES – BRICKS – CONCRETE BLOCKS-9** Stone as building material – Criteria for selection – Tests on stones – Deterioration and Preservation of stonework – Bricks – Classification – Manufacturing of clay bricks – Tests on bricks – Compressive Strength – Water Absorption – Efflorescence – Bricks for special use – Refractory bricks – Concrete blocks – Lightweight concrete blocks. **UNIT II- LIME – CEMENT – AGGREGATES – MORTAR-9** Lime – Preparation of lime mortar – Cement – Ingredients – Manufacturing process – Types and Grades – Properties of cement and Cement mortar – Hydration – Compressive strength – Tensile strength – Fineness– Soundness and consistency – Setting time – fine aggregates – river sand – crushed stone sand – properties – coarse Aggregates – Crushing strength – Impact strength – Flakiness Index – Elongation Index – Abrasion Resistance – Grading **UNIT III-CONCRETE-9** Concrete – Ingredients – Manufacturing Process – Batching plants –mixing – transporting – placing – compaction of concrete –curing and finishing – Ready mix Concrete – Mix specification. **UNIT IV-TIMBER AND OTHER MATERIALS-9** Timber – Market forms – Industrial timber– Plywood – Veneer – Thermocol – Panels of laminates Steel – Aluminum and Other Metallic Materials – Composition – Aluminium composite panel – Market forms – Mechanical treatment – Paints – Varnishes – Distempers – Bitumens **UNIT V-MODERN MATERIALS-9** Glass – Ceramics – Sealants for joints – Fibre glass reinforced plastic – Clay products – Refractories – Composite materials – Types – Applications of laminar composites – Fibre textiles– Geomembranes and Geotextiles for earth reinforcement.
4	**Texts/References**	**TEXTBOOKS** **1.** Varghese.P.C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2015. **2.** Rajput. R.K., "Engineering Materials", S. Chand and Company Ltd., 2008. **3.** Gambhir.M.L., "Concrete Technology", 3rd Edition, Tata McGraw Hill Education, 2004 **4.** Duggal.S.K., "Building Materials", 4th Edition, New Age International, 2008. **REFERENCES:** • Jagadish.K.S, "Alternative Building Materials Technology", New Age International, 2007. • Gambhir. M.L., & Neha Jamwal., "Building Materials, products, properties and systems", Tata McGraw Hill Educations Pvt. Ltd, New Delhi, 2012. • IS456 - 2000: Indian Standard specification for plain and reinforced concrete, 2011 • IS4926 - 2003: Indian Standard specification for ready–mixed concrete, 2012 • IS383 - 1970: Indian Standard specification for coarse and fine aggregate from natural Sources for concrete, 2011 • IS1542-1992: Indian standard specification for sand for plaster, 2009 IS 10262-2009: Indian Standard Concrete Mix Proportioning –Guidelines, 2000.

1	**Title of the course** (L-T-P-C)	**Surveying and Geomatics** **2-1-0-6**
2	**Pre-requisite courses(s)**	
3	**Course content**	**1.** Introduction to Plane & Geodetic Surveying, Fundamental Principles, Traversing, Leveling, Instrumentation **2.** Digital Levels, Total Station- Basics, Different types of surveying methods, Different sources of errors, Error adjustments **3.** GNSS- Basic concepts, Different types of GPS errors, Different types of GNSS based surveying techniques **4.** Ground Penetrating RADAR- Basics, Survey techniques, GPR Radargram Interpretation **5.** LiDAR concepts- Terrestrial LiDAR, Airborne LiDAR overview **6.** Unmanned Aerial System (UAS) Photogrammetry & Remote Sensing overview
4	**Texts/References**	**1.** B.C. Punmia, A.K. Jain and A.K. Jain, Surveying, Vol. 1 and II, 5th or later editions, Laxmi Publications, New Delhi, 2015. **2.** Chandra A. M., Higher Surveying, New Age International Publishers, 2007 **3.** Chandra A. M., Plane Surveying, New Age International Publ., 2007 **4.** James, M Anderson & Edward M Mikhail., Surveying Theory and Practice, Tata Mc Graw Hill, 2012 **5.** Charles D Ghilani, Paul R Wolf., Elementary Surveying, Prentice Hall, 2012 **6.** Satheesh Gopi, R. Sathikumar, and N. Madhu. Advanced Surveying: Total Station, GIS and Remote Sensing 1st Edition, 2007, Pearson India **7.** Charles D. Ghilani, Elementary Surveying: An Introduction to Geomatics (15th Edition) Pearson Publishers. 2017 **8.** Pinliang Dong, Qi Chen. LiDAR Remote Sensing and Applications, 1st Edition, CRC Press **9.** Harry M. Jol. Ground Penetrating Radar Theory and Applications, 1st Edition, 2009, Elsevier publications. **10.** Journal articles as informed by the instructor.

1	**Title of the course** (L-T-P-C)	**Building Planning and Drawing** **2-0-2-6**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Functional planning of buildings**: Sustainability and concept of green building, General aspects to consider for planning, byelaws and regulations, Selection of the site for building construction, Principles of planning, Orientation of building and its relation to the outside environment **Components of buildings**: Foundation, and its functional requirements, Characteristics of soil, types of foundations, construction of the foundation; Masonry: Definitions of terms used in masonry, materials used, stone masonry, brick masonry, different bonds used for brick masonry, permissible stress of brick masonry work; Floors and Roofs: Components of a floor, materials used for floor construction, different types of flooring, types of roofs, basic roofing elements, and roof coverings; Staircases: Functional requirements of a good stair, type of steps, type of stairs, planning a staircase. **Functional requirements to be considered for design and construction of buildings**: Damp proofing, fire protection, and thermal insulation, causes and effects of dampness on buildings, materials and methods used for damp proofing, fire hazards, grading of buildings according to fire resistance, fire resisting properties of common building materials, fire-resistant construction, general methods of thermal insulation and thermal insulating materials. **Civil Engineering Drawing**: Drawing various plans and elevations, isometric views & perspective views of civil engineering structures like buildings, bridges, retaining walls, dams, pipelines, and water tanks with design notations, Drawing staircases in 3D. **Detailing**: Detailing of reinforcement in concrete structures
4	**Texts/References**	**READING:** **1**. Arora S. P., and Bindra S. P, "Building Construction", Dhanpat Rai Publications, 2010. **2**. Varghese P. C, "Building Construction", PHI Learning Pvt. Ltd., 2nd edition, 2016. **3**. S.S. Bhavikatti and M.V. Chitawadagi "Building Planning and Drawing", Dreamtech Press, 2019. **4.** AutoCAD 2020, "A Project-Based Tutorial" Kishore; Illustrated edition, 2020. **REFERENCES**: **1.** N. Kumara Swamy, A. Kameswara Rao, "Building Planning and Drawing", Charotar Publishing House Pvt. Ltd.; 9th Edition, 2019. **2.** BIS, "National Building Code of India", Bureau of Indian Standards, 2017. **3.** Rangwala "Civil Engineering Drawing", Charotar Publishing House Pvt. Ltd.; 3rd Edition,2017. **4.** Francis D. K. Ching"Building Construction Illustrated", Wiley; 6th edition, 2020. **5.** AutoCAD Manual.

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

1	**Title of the course** (L-T-P-C)	**Structural Analysis** **2-1-0-6**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	1. **Method of consistent deformation**: Indeterminate beams - Propped cantilever, Fixed and Continuous beams - Analysis for shear force and bending moment - Clapeyron's theorem of three moments - Slope and deflection - effect of sinking of supports. 2. **Slope - Deflection Method**: Analysis and application to continuous beams - portal frames (single bay - Single storey). 3. **Moment-Distribution Method**: Analysis of continuous beams and portal frames (single storey single bay). 4. **Analysis of pin jointed frames** (one degree redundancy); Forces in indeterminate pin jointed frames due to temperature variation and lack of fit; 5. **Influence lines and Moving Loads for beams**: Maximum bending moment and shear force diagrams for simply supported spans traversed by single point load - two concentrated loads - Uniformly distributed load, shorter and longer than the span - enveloping parabola and equivalent uniformly distributed load, determination of maximum bending moment and shear force for a system of concentrated loads on simply supported girders - focal length of a girder - counter bracing. 6. **Influence lines and Moving Loads for trusses**: Influence lines for simple trusses, Muller - Breslau Principle, Influence lines for reactions, shear force at a point and bending moment at a section of beams with fixed ends and two span continuous beams.
4	**Texts/References**	**REFERENCES:** **1**. R.C. Hibbeler, Structural Analysis, 8th Edition, Pearson Education **2**. Junarkar. S. B and Shah H.J- Mechanics of Structures Vol 1 & Vol.2 – 27th Edition, Charotar Publishers, 2008. **3**. Wang C.K. - Intermediate Structural Analysis – Tata McGraw Hill Publishers, 2010. **4**. L.S. Negi, Theory and Problems in Structural Analysis, Tata McGraw Hill Pub, 1997. **5**. Reddy C.S.- Basic Structural Analysis - Tata McGraw- Hill Publishing Company Ltd.

1	**Title of the course** (L-T-P-C)	**Fluid Mechanics and Hydraulics Laboratory** **0-0-3-3**
2	**Pre-requisite courses(s)**	
3	**Course content**	1. Flow over circular cylinder 2. Measurement of jet forces 3. Bernoulli's Principle 4. Stability of floating bodies 5. Horizontal flow from a tank 6. Pipe friction for laminar and turbulent flow 7. Turbulent velocity profile in a circular pipe 8. Calibration of orifice-meter and Venturimeter 9. Performance characteristics of centrifugal pump 10. Performance characteristics of Francis turbine 11. Performance analysis of Pelton wheel 12. Performance characteristics of reciprocating pump 13. Performance characteristics of centrifugal pump in series and parallel configuration
4	**Texts/References**	1. YA Çengal, JM Cimbala, Fluid Mechanics: Fundamentals and Applications, McGraw-Hill, 2006 2. SL Dixon, and CA Hall, Fluid Mechanics and Thermodynamics of Turbomachinery, Elsevier, 2014.

1	**Title of the course** (L-T-P-C)	**Surveying and Geomatics Laboratory** **0-0-3-3**
2	**Pre-requisite courses(s)**	
3	**Course content**	1. Introduction to Survey Instruments 2. Compass Traverse 3. Theodolite Traverse 4. Differential Levelling 5. Profile and Cross Section Survey 6. Trigonometric Levelling 7. Tacheometric Surveying 8. Total Station Surveying 9. GPS Surveying 10. Surveying & Mapping using Global Navigation Satellite System (GNSS)
4	**Texts/References**	1. B.C. Punmia, Ashok Kumar Jain, Ashok Kr. Jain, Arun Kr. Jain., Surveying I & II, Laxmi Publications, 2015 2. James, M Anderson & Edward M Mikhail., Surveying Theory and Practice, Tata Mc Graw Hill, 2012 3. Charles D. Ghilani, Elementary Surveying: An Introduction to Geomatics (15th Edition) Pearson Publishers. 2017

1	**Title of the course** (L-T-P-C)	**Water Resources Engineering** **2-1-0-6**
2	**Pre-requisite courses(s)**	
3	**Course content**	**Module 1***:* Introduction - hydrologic cycle, water-budget equation, history of hydrology, world water balance, applications in engineering, sources of data. **Module 2:** Precipitation - forms of precipitation, characteristics of precipitation in India, measurement of precipitation, rain gauge network, mean precipitation over an area, depth-area-duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India. **Module 3:** Abstractions from precipitation - evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration, evapotranspiration equations, potential evapotranspiration over India, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, measurement of infiltration, modelling infiltration capacity, classification of infiltration capacities, infiltration indices. **Module 4:** Runoff - runoff volume, SCS-CN method of estimating runoff volume, flow-duration curve, flow-mass curve, hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, unit hydrograph surface water resources of India, environmental flows. **Module 5**: Ground water and well hydrology - forms of subsurface water, saturated formation, aquifer properties, geologic formations of aquifers, well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests. **Module 6:** Water withdrawals and uses – water for energy production, water for agriculture, water for hydroelectric generation; flood control. Analysis of surface water supply, Water requirement of crops-Crops and crop seasons in India, cropping pattern, duty and delta; Quality of irrigation water; Soil-water relationships, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation; Methods of applying water to the fields: surface, sub-surface, sprinkler and trickle / drip irrigation. **Module 7:** Distribution systems - canal systems, alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels, alluvial channels, Kennedy's and Lacey's theory of regime channels. Canal outlets: non-modular, semi-modular and modular outlets. Water logging: causes, effects and remedial measures. Lining of canals, types of lining. Drainage of irrigated lands: necessity, methods. **Module 8:** Dams and spillways - embankment dams: Classification, design considerations, estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical profile. Arch and buttress dams. Spillways: components of spillways, types of gates for spillway crests; Reservoirs- Types, capacity of reservoirs, yield of reservoir, reservoir regulation, sedimentation, economic height of dam, selection of suitable site.

4	**Texts/References**	• K Subramanya, Engineering Hydrology, Mc-Graw Hill. • K N Muthreja, Applied Hydrology, Tata Mc-Graw Hills • K Subramanya, Water Resources Engineering through Objective Questions, Tata Mc-Graw Hill. • G L Asawa, Irrigation Engineering, Wiley Eastern • L W Mays, Water Resources Engineering, Wiley. • J D Zimmerman, Irrigation, John Wiley & Sons • C S P Ojha, R Berndtsson and P Bhunya, Engineering Hydrology, Oxford .

1	**Title of the course** (L-T-P-C)	**Design of Steel Structures** **2-1-0-6**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	**1.** Introduction: General- Types of Steel – Mechanical behavior of steel – Measures of Yielding – Measures of Ductility – Types of Structures – Structural Steel Sections. **2.** Methods of Structural design: Introduction-Design Philosophies- Working Stress method- Ultimate Strength method-Load and Resistant factor- Limit State Method-Partial safety factor-Load-Load combinations- Classification of Cross sections- General aspects in the design. **3.** Design of Steel fasteners: Types of fasteners – Riveted connections- Bolted connections- Assumptions- Failure of bolted joints – Strength of bolted joints – Design examples – Design of Welded connections – Butt weld- fillet weld – Design examples. **4.** Design of Tension Members: General – Modes of Failure of Tension member- Analysis of Tension members- Example - Design steps – Design examples – Lug angles – Design. **5.** Design of Compression Members: General – Strength of Compression members- Design Compressive strength- Example on analysis of Compression members – Design of Angle struts – Design Examples- Built up Columns- Design of Lacing – Design of Battens- Design Examples- Design of Roof members. **6.** Design of Beams: General- Lateral Stability of Beams- Bending Strength of Beams –Plastic Section Modulus - Design Examples. **7.** Design of Beam Columns: Behaviour of members under combined loading – Modes of Failures – Design Examples. **8.** Design of Column Splices and Column Base: Design of Column Splice-Design Examples- Design of Column Base- Slab Base- Gusseted Base- Design Examples.
4	**Texts/References**	**REFERENCES:** **1.** Limit State Design of Steel Structures – S.K.Duggal, TMH Education Pvt Ltd, 2nd Edition, 2014 **2.** IS-800-2007, BIS Publication **3.** Steel Structures : Design and Practice- N.Subramanian, Oxford Pub, 2011 **4.** Design of Steel structures – S.S. Bhavikatti, IK International Pub Pvt Ltd, 4th Edition **5.** Design of Steel structures – L.S. Negi, McGraw Hill Education, 2nd Edition, 2017

1	**Title of the course** (L-T-P-C)	**Sensors Technologies and Instrumentation in civil Engineering** **1-1-2-6**
2	**Pre-requisite courses(s)**	
3	**Course content**	**Module 1:** Fundamentals of Measurement, Sensing and Instrumentation covering definition of measurement and instrumentation, physical variables, common types of sensors; Describe the function of these sensors; Use appropriate terminology to discuss sensor applications; and qualitatively interpret signals from a known sensor type, types of instrumentation, Sensor Specifics, Permanent installations, Temporary installations. **Module 2**: Sensor Installation and Operation covering to: i) Predict the response of sensors to various inputs; ii) Construct a conceptual instrumentation and monitoring program; iii) Describe the order and methodology for sensor installation; and iv) Differentiate between types of sensors and their modes of operation and measurement and v) Approach to Planning Monitoring Programs, Define target, Sensor selection, Sensor siting, Sensor Installation & Configuration, Advanced topic, Sensor design, Measurement uncertainty **Module 3:** Data Analysis and Interpretation covering a) Fundamental statistical concepts, b) Data reduction and interpretation, c) Piezometer, Inclinometer, Strain gauge, etc. d) Time domain signal processing, e) Discrete signals, Signals and noise and f) a few examples of statistical information to calculate are: Average value (mean), On average, how much each measurement deviates from the mean (standard deviation), Midpoint between the lowest and highest value of the set (median), Most frequently occurring value (mode), Span of values over which your data set occurs (range) **Module 4**: Frequency Domain Signal Processing and Analysis covering Explain the need for frequency domain analysis and its principles; Draw conclusions about physical processes based on analysis of sensor data; Combine signals in a meaningful way to gain deeper insight into physical phenomena, Basic concepts in frequency domain signal processing and analysis, Fourier Transform, FFT (Fast Fourier Transform), Example problems: Noise reduction with filters, Leakage, Frequency resolution **Module 5:** Visit a built/site under construction that has internet tools such as BMS, BIM, SCADA, etc. and prepare a report detailing the technical features, productivity advantages, functioning, etc.; identify at least five interesting software systems used in Civil Engg. and their key features **Tutorials** from the above modules demonstrating clearly the understanding and use for the sensors and instruments used for the problems posed and inferences drawn from the measurement and observations made along with evaluation report
4	**Texts/References**	• Alan S Morris (2001), Measurement and Instrumentation Principles, 3rd/e, Butterworth Heinemann • David A. Bell (2007), Electronic Instrumentation and Measurements 2nd/e, Oxford Press • S. Tumanski (2006), Principle of Electrical Measurement, Taylor & Francis • Ilya Gertsbakh (2010), Measurement Theory for Engineers, Springer

1	**Title of the course** (L-T-P-C)	**Foundation Engineering** **2-1-0-6**
2	**Pre-requisite courses(s)**	
3	**Course content**	**Soil Exploration**: Introduction and different methods – Direct methods, Semi-direct and Indirect methods; Sampling in soils and rocks; Subsurface exploration program - Preparation of bore logs and preparation of exploration report. **Lateral Earth Pressures**: Lateral earth pressure theory, Different types of earth pressures, Rankine's active and passive earth pressures, pressure distribution diagram for lateral earth pressures against retaining walls for different conditions in cohesionless and cohesive soils, Coulomb's active and passive earth pressure theory, Culmann's graphical construction, Problems **Shallow Foundations and Bearing Capacity**: Types of shallow foundations and choice, basic requirements, Significance of these foundations. Bearing capacity of foundation: Bearing capacity – Basic Definitions, Factors affecting bearing capacity, Estimation of Bearing capacity by different methods, Analytical measures – Terzaghi's and Meyerhof methods and calculations, Field measures – SPT, CPT and Plate load tests. **Settlement of foundation**: Settlement analysis – Types of foundation settlement, Components of settlements - their estimation, Allowable settlement values, Effects, Causes and remedial measures of total and differential settlements. **Deep Foundations** – types of deep foundations, pile foundations: Classification and uses, Load carrying capacity calculations by different methods – static methods, dynamic methods, in-situ penetration tests, piles load test; Negative skin friction; under reamed pile foundations; Pile groups – Necessity, Efficiency, Group capacity and settlements.
4	**Texts/References**	**READING:** **1.** Braja M. Das and Khaled Sobhan, "Principles of Geotechnical Engineering", Cengage India Private Limited, Ninth edition, 2017. **2.** Muni Budhu, "Foundations and Earth Retaining Structures", John Wiley & Sons, 2018. **3.** Swami Saran, "Analysis and Design of Substructures: Limit State Design", Oxford & IBH Publishing Co Pvt. Ltd, 2nd edition, 2018. **4.** Rodrigo Salgado, "The Engineering of Foundations, Slopes and Retaining Structures", CRC Press; 2nd edition, 2022. **REFERENCES:** **1.** P.C. Varghese, "Design of Reinforced Concrete Foundations", Prentice Hall India Learning Private Limited, 2009. **2.** N.N. Som and S.C. Das, "Theory and Practice of Foundation Design", Prentice Hall India Learning Private Limited, 2003 **3.** R. Katzenbach, S. Leppla, and D. Choudhury, "Foundation Systems for High-Rise Structures", CRC Press, 1st edition, 2019. **4.** Wei Dong Guo, "Theory and Practice of Pile Foundations", CRC Press, 1st edition, 2012.

1	**Title of the course** (L-T-P-C)	**Estimation and Costing in Civil Engineering** **1.5-0-0-3**
2	**Pre-requisite courses(s)**	
3	**Course content**	**1.** Introduction to estimates: Purpose of estimating; Different types of estimates - their function and preparation; Building estimates: Schedule of rates, Units of measurements, units of works; Road Estimates Volume of earthwork, Different methods, Earthwork for hill roads; Railway and canal works Estimates for a new track railway line; earthwork in canals. **2.** Analysis of rates: Preparation for analysis of rates. Quantity of materials per unit rate of work, labour estimate. **3.** Specifications: Necessity, types of specifications, specifications for different civil engineering materials. **4.** Contracts: Essentials of contracts, types of engineering contracts advantages and disadvantages. **5.** Tenders: tender forms, tender documents & notices time limits, necessity. **6.** Valuation: Purpose, difference between value and cost, qualifications and functions of a valuer, scrap & salvage value, sinking fund, capitalised value.
4	**Texts/References**	**1.** Chakraborti, M, Estimation, costing, specifications and valuation in civil engineering National Halftone Co. Calcutta, 2005. **2.** Dutta B.N., Estimation and costing in civil engineering: theory and practice UBS Publishers Distributors Ltd, 2006. **3.** Birdie, G.S. - Estimation and costing in civil engineering Dhanpat Rai Publishing co. ltd.

1	**Title of the course** (L-T-P-C)	**Construction Engineering and Management** **3-0-0-6**
2	**Pre-requisite courses(s)**	NIL
3	**Course content**	**Fundamentals of construction project management**: Introduction, Project Initiation, and Planning, Time Value of Money, Investment Analysis, Cost-Benefit Analysis; Construction schedule management: Work Breakdown Structures, Development of project activity networks, Precedence Diagram Method, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Line Balance Methods in scheduling. **Construction material management**: Resources in construction, Resource levelling, the crashing of project schedules, earned value analysis **Construction Quality and safety**: Safety and occupational hazards in construction, Fundamentals of quality control in construction, Safety in construction - Cost of Accidents - Safety norms - Safety aids **Introduction to Construction Contracts**: Estimation, Tenders & Contracts - EOI-Prequalification - Types of Contracts - Terminology used, fundamentals of delay analysis and claims, Construction Finances – decision making, **Advances in construction management**: Introduction to Building Information Modelling (BIM), Lean construction, and Integrated Project Delivery in construction
4	**Texts/References**	**READING:** **1.** Kumar Neeraj Jha, "Construction Project Management: theory and practice" Pearson Education India; 2nd edition, 2015. **2.** F. Lawrence Bennett, "The Management of Construction: A Project Lifecycle Approach", Routledge; 1st edition, 2016. **3.** S. Choudhury "Project Management", McGraw Hill Education, 2017. **REFERENCES:** **1.** Riggs, James L., David D. Bedworth, and Sabah U. Randhawa., "Engineering Economics", McGraw Hill Education; 4th edition, 2004. **2.** Garold D. Oberlender, "Project management for engineering and construction", McGraw Hill Education; Second edition, 2014. **3.** Chitkara, K. K. "Construction Project Management", McGraw-Hill; Forth Edition, 2019.

1	**Title of the course** (L-T-P-C)	**Design of Concrete Structures** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**1.** Design philosophy - Working stress and limit state methods. **2.** Design of RC beam sections for flexure using working stress method **3.** Design of RC beam sections for flexure, shear and torsion using limit state methods **4.** Design of RC beam elements - detailing, curtailment and serviceability **5.** Design of one-way slabs, design of two-way slabs, design of slabs for serviceability, design of continuous slab systems. **6.** Design of short columns under pure compression, design of short columns under compression, and uniaxial and biaxial bending **7.** Principles of structural design of footings, design of isolated RC footings **8.** Design of cantilever Retaining walls- Design of RC Circular Water tank. **9.** Principles of Reinforcement Detailing
4	**Texts/References**	**REFERENCES:** **1.** Krishnaraju N. (2016). *Design of Reinforced Concrete Structures*, 4th Edition, CBS Publishers & Distributors CBS, New York. **2**. Subramanian N. (2013). *Design of Reinforced Concrete Structures*, Oxford University Press, Maryland, USA. **3**. Pillai S. U., Menon D. (2021). *Reinforced Concrete Design*, 4th Edition, McGraw Hill.

1	**Title of the course** (L-T-P-C)	**Geotechnical Engineering** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Introduction:** Soil formation- Major soil deposits of India. Basic Definitions and Relationships: 3-phase soil system, Volumetric relationships, and weight -volume relationships. Determination of Index Properties: Water content, Specific gravity, Grain size distribution by sieve and hydrometer analysis, Relative density, Atterberg limits and indices. Classification of Soils: Classification of soil systems – Particle size classification, Textural classification, AASHTO classification, Unified soil classification and Indian soil classification- Field identification of soils. **Soil-Water**: Types of soil water, Capillarity in soils, Permeability of soils, Darcy's law, Determination of permeability of soils, Permeability of stratified soils, Field permeability determination, Seepage velocity, Absolute coefficient of permeability, Factors affecting permeability- Effective stress principle- Effective stress under different field conditions- Seepage Pressure-Flow nets, Quicksand condition. **Compaction and Consolidation of Soils**: Compaction: Definition and importance of compaction – Standard Proctor compaction test, Modified compaction test- Factors affecting compaction- Influence of compaction on soil properties – Field compaction and its control, Relative compaction. Stress distribution in Soils: Importance of estimation of stresses in soils – Boussinesq's and Westergaard's theories for point loads, uniformly loaded circular and rectangular areas, pressure bulb, variation of vertical stress under point load along the vertical and horizontal planes – Newmark's influence chart, Contact pressure distribution in sands and clays. Consolidation: Types of compressibility – Immediate settlement – Primary consolidation and secondary consolidation – Stress history of clay, normally consolidated soil, Over consolidated soil and under consolidated soil- preconsolidation pressure and its determination- Consolidation test, Estimation of settlements -Terzaghi's 1-D consolidation theory – Coefficient of consolidation and its determination - Spring analogy. **Shear Strength:** Definition and use of shear strength - Source of shear strength Normal and Shear stresses on a plane – Mohr's stress circle- Mohr-Coulomb failure theory- Measurement of shear strength, Drainage conditions -Direct shear test, Triaxial shear test, Unconfined compression test and vane shear test – Factors affecting shear strength of granular soils and cohesive soils. Skempton's pore pressure parameters. Introduction to stress paths. **Stability of Soil Slopes**: Types of slopes – Types of slope failures – Slip circle method, Determination of centre of critical slip circle – Taylor's stability charts and their use, Stabilization of soil slopes
4	**Texts/References**	**READING:** **1.** Ranjan G. and Rao A.S.R. (2016). *Basic and Applied Soil Mechanics*, Third edition, New Age International Pvt Ltd. **2.** Budhu M. (2016). *Soil Mechanics and Foundations*, India edition, Wiley. **3.** Venkataramaiah C. (2018). *Geotechnical Engineering*, Sixth edition, New Age International. **4.** Murthy V.N.S., (2018). *Soil Mechanics and Foundation Engineering*, CBS Publishers. **5.** Arora K.R. (2020). *Soil Mechanics and Foundation Engineering*, Standard Publishers Distributors. **REFERENCE:** **1.** Terzaghi K., Peck R.B. and Mesri G. (2009). *Soil Mechanics in Engineering Practice*, Third edition, Wiley India Pvt Ltd. **2.** Lambe T.W. and Whitman R.V. (2012). *Soil Mechanics*, Wiley India Pvt Ltd. **3.** Powrie W. (2013). *Soil Mechanics: Concepts and Applications*, 3rd edition, CRC Press. **4.** Knappett J. and Craig R.F. (2019). *Craig's Soil Mechanics*, 9th edition, CRC Press.

1	**Title of the course** (L-T-P-C)	**Transportation Engineering** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**1.** Highway Network Planning: Different modes of transportation, role of highway transportation, classification, network patterns, planning surveys, preparation of plans, final report, master plan, evaluation by saturation system, 20 year road development plans, salient features, determination of road lengths, introduction to highway economics. **2.** Highway Alignment And Geometric Design: Principles of highway alignment, requirements, controlling factors, engineering surveys, importance of geometric design, design controls and criteria, cross section elements, pavement surface characteristics, camber, carriageway, kerbs, road margins, formation, right of way, typical cross sections, sight distance, stopping sight distance, overtaking sight distance, sight distance at intersections, design of horizontal alignment, super elevation, transition curves, design of vertical alignment, gradients, vertical curves. **3.** Traffic Engineering Principles: Traffic characteristics; components of traffic stream: flow- speed-Density, measurement and analysis, q-k-v relationships, design hourly volume, concept of EPCU, capacity and level of service, parking studies and road safety. **4.** Pavement Materials and Mix Design: Types of pavement structures, functions of pavement component layers, materials used in pavements, basic soil properties relevant to pavement applications, properties of aggregate, blending of aggregates, tests on bitumen, grading of bitumen, bituminous mix design using Marshall method. **5.** Design of Pavements: Stresses in flexible pavements: layered system concepts, stress solution for one, two and three layered systems, fundamental design concepts; variables considered in pavement design: axle types, standard and legal axle loads, ESWL, EWLF, vehicle damage factor, ADT, AADT, growth factor, lane distribution factor, directional distribution factor, tyre pressure, contact pressure, design life; design of flexible pavement using IRC method; stresses in rigid pavements: Westergaard's theory and assumptions, stresses due to curling, stresses and deflections due to loading, frictional stresses, design of joints; design of rigid pavement using IRC method.
4	**Texts/References**	**1.** Kadiyali L.R. (2017). *Traffic Engineering and Transport Planning*, Ninth Edition, Khanna Publishers, New Delhi, India. **2.** Khanna, S.K., Justo C.E.G. and Veeraragavan. (2017). *Highway Engineering*, Tenth Edition, Nem Chand and Bros., Roorkee, India. **3.** Huang, Y.H. (2008) *Pavement Analysis and Design*, Pearson Prentice Hall, New Jersey, USA. **4.** Khisty C. J. and Lall. B. K. (2002) *Transportation Engineering – An Introduction*, Third Edition, Prentice Hall of India Pvt. Ltd, New Delhi, India. **5.** Kandhal, P.S. (2016). *Bituminous Road Construction in India*, PHI Learning Pvt. Ltd., New Delhi, India. **6.** Papacostas C.S. and Prevedouros. P.D. (2002) *Transportation Engineering and Planning*, Third Edition. Prentice Hall of India Pvt. Ltd, New Delhi, India. **7.** Yoder, E.J. and Witczak. M.W. (2012) *Principles of Pavement Design*, Second Edition, John Wiley and Sons, New York, USA.

1	**Title of the course** (L-T-P-C)	**Environmental Engineering** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**Module 1:** Water: -Surface sources, subsurface sources, physical, chemical and biological characteristics, Estimation of water demand, water consumption rate, fluctuations in rate of demand, design period, population forecasting methods. water quality indices, water safety plans, Water Supply systems, Need for planned water supply schemes, Water demand industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design. **Module 2:** *Water Treatment:* aeration, sedimentation, coagulation flocculation, filtration, disinfection, **Module 3:** Wastewater treatment: *Sewage*- Domestic and Stormwater, Quantity of Sewage, Sewage flow variations. Conveyance of sewage- Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems. Small bore systems, Storm Water-Quantification and design of Storm water; Sewage and Sullage, Pollution due to improper disposal of sewage, National River cleaning plans, Wastewater treatment, aerobic and anaerobic treatment systems, suspended and attached growth systems, recycling of sewage – quality requirements for various purposes. **Module 4:** Introduction to Advanced oxidation processes; emerging treatment technologies; Industrial wastewater treatment **Module 5:** *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 **Module 6***: Noise*- Basic concept, measurement and various control methods. **Module 7***: Solid waste management*-Municipal solid waste, Composition and various chemical and physical parameters of MSW, MSW management: Collection, transport, treatment and disposal of MSW. Special MSW: waste from commercial establishments and other urban areas, solid waste from construction activities, biomedical wastes, Effects of solid waste on environment: effects on air, soil, water surface and ground health hazards. Disposal of solid waste-segregation, reduction at source, recovery and recycle. Disposal methods- Integrated solid waste management. Hazardous waste: Types and nature of hazardous waste as per the HW Schedules of regulating authorities . **Module 8:** *Building Plumbing*-Introduction to various types of home plumbing systems for water supply and waste water disposal, high rise building plumbing, Pressure reducing valves, Break pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used. **Module 9:** Government authorities and their roles in water supply, sewerage disposal. Solid waste management and monitoring/control of environmental pollution.
4	**Texts/References**	**1.** Masters G. M. (1991). *Introduction to Environmental Engineering and Science*, 1st edition, Pearson. **2.** Vesilind P. A., Morgan S. M. (2008). *Introduction to Environmental Engineering*, Second Edition, Nelson Engineering. **3.** Peavy H. S., Rowe D.R, Tchobanoglous G. (1985) *Environmental Engineering*, Mc-Graw -Hill International Editions, New York. **4.** MetCalf and Eddy. *Wastewater Engineering, Treatment, Disposal and Reuse*, Tata McGraw-Hill, New Delhi.

		5. Manual on Water Supply and Treatment. Ministry of Urban Development, New Delhi. **6.** Patil S.M. (2007) Plumbing Engineering. Theory, Design and Practice, Third Edition. **7.** Tchobanoglous G., Theissen H. & Vigil S. A. (1993). Integrated Solid Waste Management, Second Edition, McGraw Hill Publication. **8.** Manual on Sewerage and Sewage Treatment Systems, Part A, B and C. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development.

1	**Title of the course** (L-T-P-C)	**Transportation Engineering Laboratory (0-0-3-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**1.** Tests on Aggregate: aggregate gradation, combined flakiness and elongation tests, specific gravity test, water absorption test, aggregate impact test, Los Angeles abrasion test, demonstration of soundness test. **2.** Tests on Bitumen: penetration test, flash and fire point tests, ductility test, softening point test, specific gravity test, demonstration of absolute and kinematic viscosity tests, demonstration of rolling thin film oven test, bitumen grading. **3.** Tests on Bituminous Mixtures: bituminous mix design using Indian and International practices, stripping value of aggregates, demonstration of retained tensile strength test, demonstration of bitumen extraction, resilient modulus. **4.** Tests on Soil: California bearing ratio test. **5.** Field tests: pavement unevenness using MERLIN, and pavement layer density using sand replacement method, deflection studies, pavement evaluation studies. **6.** Traffic Studies: traffic volume studies for mid-block section and intersection, spot speed studies, headway distribution studies, parking usage survey
4	**Texts/References**	**1.** Khanna S. K. and Justo C.E.G, Highway Material Testing (Laboratory Manual), Nem Chand & Bros, Roorkee. **2.** Relevant IRC/BIS/ASTM Specifications **3.** Relevant highway design software manual Relevant IRC/BIS/ASTM codes.

1	**Title of the course** (L-T-P-C)	**Geotechnical Engineering Laboratory** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**1.** Index properties of soils a. Determination of moisture content b. Determination of specific gravity c. Grain size analysis d. Determination of consistency limits e. Determination of relative density f. Determination of field density **2.** Engineering Properties of soils . Determination of the coefficient of permeability of a soil a. Determination of the relationship between the moisture content and density of soils b. Determining the settlement due to primary consolidation c. Measurement of undrained shear strength of cohesive soils having low shear strength (less than 30 kPa) for which triaxial or unconfined tests cannot be performed d. Measurement of shear strength of soils on a predefined shear plane e. Determination unconfined compressive strength of soils f. Determination of shear strength of soils g. Determination of Soil Suction h. Determination of CBR (California Bearing Ratio) i. Determination of swelling potential of soils **3.** In-situ Properties of soils . Determination of bearing capacity of a soil using plate load test a. Determination of in-situ shear strength of soils b. Determination of in-situ unconfined compressive strength c. To measure material's in-situ resistance to penetration.
4	**Texts/References**	**READING:** **1.** Head K.H. and Epps R. J. (2006). Manual of Soil Laboratory Testing vol I, 3rd Edition, Whittles Publishing. **2.** Head K.H. and Epps R. J. (2011). Manual of Soil Laboratory Testing vol II, 3rd Edition, Whittles Publishing. **3.** Head K.H. and Epps R. J. (2014). Manual of Soil Laboratory Testing vol III, 3rd Edition, Whittles Publishing. **4.** Das B.M. (2022). Soil Mechanics Laboratory Manual, 10th Ed., London, OUP USA.

1	**Title of the course** (L-T-P-C)	**Environmental Engineering Laboratory** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**List of experiments** **1.** Determination of the turbidity, electrical conductivity, and pH of the given sample **2.** Determination of solids **3.** Determination of alkalinity, acidity and hardness **4.** Analysis of ions: copper, chloride and sulfate **5.** Estimation of optimum coagulant dosage **6.** Determination of Chemical oxygen demand (COD) **7.** Determination of Dissolved Oxygen (DO), and Biochemical oxygen demand (BOD) **8.** Determination of Break Point Chlorination **9.** Bacterial estimation **10.** Determination of specific gravity
4	**Texts/References**	1. APHA Manuals, 2. APHA/AWWA/WPCF Publishing, Washington, D.C., latest edition

1	**Title of the course** (L-T-P-C)	**Civil Engineering Software Laboratory (0-0-3-3)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**1.** AutoCAD- Computer-aided design software to create precise 2D and 3D drawings. **2.** Autodesk Revit -To design a building and structure and its components in 3D. **3.** Autodesk 3ds Max -A visualization tool for civil engineers and transport infrastructure planners. **4.** Autodesk Civil 3D – A Civil Engineering design and documentation software that supports Building Information Modeling (BIM) workflows. **5.** Staad Pro- Structural analysis & design computer program **6.** PrimaVera- A project, program, and portfolio management tool **7.** ArcGIS- A geospatial software to view, edit, manage and analyze geographic data and patterns. **8.** PLAXIS 2D and 3D- A geotechnical finite element analysis software to model, simulate, analyze geotechnical engineering problems. **9.** ANSYS with Civil FEM and CFD modules - A finite element analysis and design software for Civil Engineering Projects including Computational Fluid Dynamics (CFD) simulation package to predict the impact of fluid flows on structures. **10.** GeoStudio- An integrated software for solving slope stability, groundwater flow, and Geo-Environmental challenges. **11.** Vissim- A microscopic multi-modal traffic flow simulation software package
4	**Texts/References**	**READING:** **1**. Software manuals

1	**Title of the course** (L-T-P-C)	**Civil and Infrastructure Engineering Design** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Introduction and Scope of Civil Engineering**: Basics of Engineering and Civil Engineering; Broad disciplines of Civil Engineering; Importance of Civil Engineering, History of Civil Engineering: Early constructions and developments over time, ancient monuments of the world, Civil Engineering aspects of Indian heritage structures. Civil Engineering Specializations: Structural Engineering, Geotechnical Engineering, Water Resources Engineering, Environmental Engineering, Transportation Engineering, Construction Management, Ocean Engineering, Remote Sensing and GIS, Energy and Sustainable Infrastructure. **Megastructures of Civil Engineering**: Design, Construction and Structural Details of Some of the Megastructures of the World. Mega Civil Engineering Projects of India and world. Futuristic Mega Projects in Civil Engineering. Failure Case Studies in Civil Engineering: Structures, Foundations, Dams, Pavement Systems, and the Geo-environment. Some Major Civil Engineering Challenges **Materials in Civil Engineering**: Stones, bricks, mortars, Plain, Reinforced & Prestressed Concrete, Construction Chemicals, Structural Steel, High Tensile Steel, Carbon Composites, Plastics in Construction, 3D printing, Recycling of Construction & Demolition wastes, Sustainable Building Materials. **Introduction to Plan Reading, and Construction Techniques**: Scale drawings of floor plans, sections, and elevations; Plan types, Interpretation of plans. Components of a building. Typical loads and forces in Civil Engineering structures. Introduction to estimation and costing. **Smart Cities and Current Trends in Construction Industry**: Application of Machine Learning (ML) and Artificial Intelligence (AI) in Civil Engineering. Position of construction industry vis-à-vis other industries, plan outlays for construction; current budgets for infrastructure works; Possible scopes for a career, Importance of ethics in engineering.
4	**Texts/References**	**READING:** **1.** Gordon, J. E. (2003). *STRUCTURES: Or Why Things Don't Fall Down*, 3rd Ed., Da Capo Press; Cambridge, USA **2.** Paul A. B., Pamalee A. B, Norbert J. D., Parfitt, M. K. (2013). *Failure Case Studies in Civil Engineering: Structures, Foundations, and the Geoenvironment*, 2nd Ed., American Society of Civil Engineers, Reston. **3.** Varghese, P. C. (2015). *Building Materials*, 2nd Ed., Prentice Hall India Learning Private Limited, New Delhi. **4.** Anglin, G. (2019). *Introduction to Estimating, Plan Reading and Construction Techniques*, 1st Ed., Routledge, New York. **5.** Xu, Y. L., Jia, H. (2019). *Smart Civil Structures*, 1st Ed., CRC Press, New York. **REFERENCES:** **1.** Samui, P., Kim, D., Iyer, N. R, Chaudhary, S. (2020). *New Materials in Civil Engineering*, 1st Ed., Butterworth-Heinemann, Oxford. **2.** Moaveni, s. (2011). *Engineering Fundamentals: An Introduction to Engineering*, 4th Ed., Cengage Learning India Pvt. Ltd., New Delhi **3.** Gordon, J. E. (2020). *The New Science of Strong Materials – Or Why You Don`t Fall through the Floor*, Princeton University Press, New Jersy. **4.** BIS, "National Building Code of India", Bureau of Indian Standards, 2017. **5.** Martin M. W., and Schinzinger, R. (2017). *Ethics in Engineering*, 4th Ed., McGraw Hill Education, New Delhi. **6.** Bhavikatti, S. S. and Chitawadagi, M. V. (2019). *Building Planning and Drawing*, 1st Ed., Dreamtech Press, New Delhi.

1	**Title of the course** (L-T-P-C)	**Basics of Railway, Airport, Bridge and Tunnel Engineering (2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Scope of Railway Engineering, Classification of Routes, Railway Gauge, Track alignment, track geometric design, Track Structure, Railway Curves, Conventional—Manual Track Maintenance Practices, Mechanised Track Maintenance, Track Renewal, Track Stresses, Derailment Investigations; Ballastless track for metros, Track standards for ultra high-speed lines. Scope of Bridge Engineering, types of various bridges, load transfer mechanisms in various bridges, design principles of box culvert, design of deck slab bridge, design of interior panel of slab, design of T-beam bridge Scope of Tunnel Engineering, Tunneling in Hard Rock: Sequence of operation, faces of attack, Methods of tunneling in hard rock, fundamentals of design, Tunneling in Soft Ground: Types and factors affecting the choice of method to sort ground, Methods of tunneling in soft rocks, fundamentals of the design. Aircraft characteristics, obstruction criteria; air traffic control, runways: orientation, geometric standards, capacity, configuration, taxiway: geometric standards, fillets, high speed exit taxiway, apron-gate area and circulation, terminal building - functional areas and facilities, planning and site selection, pavement design and evaluation, visual aids.
4	**Texts/References**	**READING** **1.** Chandra, Satish and Agarwal, M.M., (2013). Railway Engineering, 2nd Ed., Oxford University Press India. **2.** Raju N.K., (2019). Design of Bridges, 5th Ed., Oxford & IBH Publishing, India. **3.** Bickel, J.O., and Kuesel T.R., King E.H., (2018). Tunnel Engineering Handbook, 2nd Ed., CBS Publishers and Distributors, India. **4.** McKelvey, F., Young, R.H.S. & Sproule, W. (2010). Planning and Design of Airports, 5th Ed., McGraw-Hill, India. **REFERENCES** **5.** Mundrey, J.S., (2017). Railway Track Engineering, , 5th Ed., McGraw Hill Education (India) Private Limited, India. **6.** Victor D. J., (2019). Essentials of Bridge Engineering, 6th Ed., Oxford, U.K. **7.** Bieniawski, Z.T., Rotterdam A.A., (2020). Rock Mechanics and Design in Mining and Tunneling, CBS Publishers,India.

1	**Title of the course** (L-T-P-C)	**Ports, Harbours and Inland Waterways** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	Introduction: Ports and harbours – the water and land infrastructure, planning of ports and harbours. The fundamentals: Tide and current conditions inside harbour, water circulation; breakwaters, jetties and quay walls; mooring, berthing and ship motion inside the port; model studies, physical and mathematical studies Importance of wave action, siltation, navigability, and berthing facilities. Design of Port Infrastructure considering cargo handling, cargo storage, integrated transport of goods, planning multipurpose port terminals. Wave conditions for human safety on quays and breakwaters, forcecasting / nowcasting of wave and current conditions for port operations, dredging and navigability, hazard scenarios. Maintenance of waterways, construction of environmentally engineered banks, dredging, and disposal processing and storing of polluted dredged material Planning, construction, expansion and renovation of port and Inland Port Infrastructure. Global trade and port restructuring impact of possible climate change scenarios, sustainable development strategies for cities and ports.
4	**Texts/References**	**READING** **1.** Ozha & Ozha, "Dock and Harbour Engineering", 8th edition, Charotar Publishing House Pvt. Ltd., 2017. **2.** Muir Wood, A.M., and Fleming. C.A., "Coastal Hydraulics", 2nd Edition, Hallstead Press, 2013. **3.** C Venkatramaiah, "Transportation Engineering, Vol. 2: Railways, Airports, Docks and Harbours, Bridges and Tunnels", Universities Press, 2016. **REFERENCES** **1.** Kamphuis J. W., "Introduction to Coastal Engineering and Management" World Scientific, 2020. **2.** V. Sundar, S. A. Sannasiraj "Coastal Engineering : Theory And Practice" World Scientific, 2019.

1	**Title of the course** (L-T-P-C)	**Applications of Geosynthetics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	• Introduction: Principles of reinforced soil through Mohr circle analysis; an overview of the development and applications of various geosynthetics - the geotextiles, geogrids, geonets, geomembranes, and geo composites. • Testing methods for geosynthetics- Techniques for testing different index properties, strength properties, 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 • Reinforced soil retaining walls: Different types of walls like wrap-around walls, full-height panel walls, discrete-facing panel walls, and modular block walls Design methods as per BS-8006 and FHWA methods Construction methods for reinforced soil retaining walls • Reinforced soil slopes: Basal reinforcement for construction on soft clay soils, construction of steep slopes with reinforcement layers on competent soils, Different slope stability analysis methods like planar wedge method, bi-linear wedge method, and circular slip methods • Soil Confinement Systems: Concept of confinement, Gabion walls, Crib walls, Sandbags and Geotubes, Evergreen systems, and fabric formwork.
4	**Texts/References**	**READING**: **1.** Koerner, R.M. (2012). Designing with geosynthetics (6th Edition Vol 1), 6th Ed., Xlibris, United States. **2.** Koerner, R.M. (2012). Designing with geosynthetics (6th Edition Vol 2), ; 6th Edition Xlibris, United States. **3.** Shukla, S.K. (2016). An Introduction to Geosynthetic Engineering, 1st Ed., CRC Press, United States. **REFERENCES:** **4.** Jonathan T. H. Wu (2019). Geosynthetic Reinforced Soil (GRS) Walls, 1st Ed., Wiley-Blackwell, Singapore. **5.** G. L.S. Babu, (2005). An Introduction to Soil Reinforcement and Geosynthetics,1st Ed., Universities Press, India.

1	**Title of the course** (L-T-P-C)	**Introduction to Earthquake Engineering** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**UNIT I ELEMENTS OF EARTHQUAKE ENGINEERING-9** Earthquake magnitude and intensity, Focus and Epicentre, Causes and Effects of Earthquakes, Characteristics of Earthquake, Seismic zone mapping, Basics of Structural Dynamics**.** **UNIT II STRUCTURAL SYSTEMS FOR SEISMIC RESISTANCE-9** Structural systems – building configuration, frames, walls, dual systems – response in elevation – plan – influence of structural classification- Concepts of seismic design. **UNIT III ANALYSIS FOR EARTHQUAKE LOADS-9** IS: 1893-2002- Seismic Coefficient method- modal analysis- Applications to multi-storied building frames – water tanks – chimneys. **UNIT IV DUCTILE DETAILING**-9 Ductility of R.C structures- Confinement- detailing as per IS-13920-1993-moment redistribution – principles of design of beams, columns – beam column joints – soft story concept. **UNIT V BASE ISOLATION-9** Isolation systems – Effectiveness of base isolation
4	**Texts/References**	**READING:** **1.** Anil Chopra(2020), *Dynamics of Structures: Theory and Applications to Earthquake Engineering*, 5TH Ed., Pearson Publishers Pvt. Ltd. New Delhi, India. **2.** R.W. Clough and J. Penzien (2015), *Dynamics Of Structures, 2nd Ed.,* CBS Publishers, New Delhi, India. **3.** I.S. 1893 : *Criteria for Earthquake Resistance design of Structures*", 2016. **4.** Pankaj Agarwal and Manish Shrikhande (2006), *Earthquake Resistant Design of Structures*, Prentice Hall India Learning Pvt. Ltd., New Delhi, India. **REFERENCE:** **1.** Edmund Booth (2013), *Earthquake Design Practice for Buildings*,3rd Ed., ICE Publishing, New Delhi, India. **2.** Roberto Villaverde (2009), *Fundamental Concepts of Earthquake Engineering*, 1st Ed., CRC Press, UK.

1	**Title of the course** (L-T-P-C)	**Introduction to Ground Improvement** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**UNIT I INTRODUCTION TO GROUND MODIFICATION-9** Need and objectives of Ground Improvement, Classification of Ground Modification Techniques – suitability and feasibility, Emerging Trends in ground improvement. **UNIT II MECHANICAL MODIFICATION-9** Methods of compaction, Shallow compaction, Deep compaction techniques – Vibro-floatation, Blasting, Dynamic compaction, preloading and Precompression sand compaction piles, Lab and Field compaction control. **UNIT III HYDRAULIC MODIFICATION-9** Methods of dewatering – open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains, Design of prefabricated vertical drains. **UNIT IV PHYSICAL AND CHEMICAL MODIFICATION-9** Stabilisation with admixtures like cement, lime, calcium chloride, fly ash, and bitumen; Grouting: Categories of grouting, Compaction and Consolidation Grouting, Art of grouting, Grout materials, Grouting techniques, and control. **UNIT V REINFORCED EARTH TECHNOLOGY9** Concept of soil reinforcement, reinforcing materials, and Backfill criteria, Art of reinforced earth technology, Design and construction of reinforced earth structures. **Ground Anchors and Soil Nailing:** Types of ground anchors and their suitability, Uplift capacity of anchors; Soil nailing and Applications
4	**Texts/References**	**READING:** **1.** M. R. Haussmann (2013), *Engineering principles of ground modification*, McGraw Hill Education, new Delhi, India. **2.** P. P. Raj (2016), *Ground Improvement Techniques*, 2nd Ed., Laxmi Publications, New Delhi, India. **3.** J. Han (2018), *Principles and Practice of Ground Improvement*, Wiley Publishing, New Delhi, India. **4.** G. L.S. Babu (2005) , *An Introduction to Soil Reinforcement and Geosynthetics*", 1st Ed., Universities Press Pvt. Ltd., New Delhi, India. **REFERENCE:** **1.** F. G., Bell (2019), *Engineering Treatment of Soils*, 1st Ed., CRC Press, UK. **2.** Peter G. Nicholson (2014), *Soil Improvement and Ground Modification Methods*, 1st Ed., Butterworth-Heinemann Publishing, UK.

1	**Title of the course** (L-T-P-C)	**Introduction to Geotechnical Earthquake Engineering** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**UNIT I SEISMOLOGY AND EARTHQUAKES-9** Basic earthquake principles: Introduction–Internal structure of earth–Plate tectonics faults–seismic waves–Seismograph–Classification of earthquakes–Magnitude and intensity of earthquakes- Seismic zones in India. **UNIT II: SOIL DYNAMICS-9** Dynamics of discrete system –Soil structure interaction–Vibratory system–free and forced vibration without and with damping–Base shaking–Dynamic soil properties–problems. **UNIT III LIQUEFACTION-9** Introduction–mechanism–laboratory liquefaction studies– factors that govern Liquefaction in the field–Liquefaction analysis–cyclic stress ratio from the SPT, DCPT and shear wave velocity-FS against liquefaction– Anti Liquefaction measures– problem. **UNIT IV BEARING CAPACITY ANALYSIS FOR EARTHQUAKES-9** Introduction– one third increases in bearing capacity pressure for seismic condition–Bearing capacity analysis for liquefied soil–granular soil with earthquake induced pore water–Bearing capacity analysis for cohesive soil weakened by the earthquake– problems **UNIT V SLOPE STABILITY ANALYSIS FOR EARTHQUAKE-9** Introduction–inertia slope stability: pseudo static method, newmark method–weakening slope stability: flowslides, liquefaction induced lateral spreading, strain softening soil–restrained retaining walls and temporary retaining walls–problems
4	**Texts/References**	**READING:** • Swami Saran (2021), *Dynamics of Soils and Their Engineering Applications*, 1ST Ed., CRC Press, UK. • Steven L. Kramer (2003), *Geotechnical Earthquake Engineering*, Prentice Hall Inc. Education, New Delhi, India. • Robert W. Day (2012), *Geotechnical Earthquake Engineering Handbook*", McGraw Hill Publishers, New Delhi, India. • Ikuo Towhata (2010), *Geotechnical Earthquake Engineering*, Springer-Verlag Heidelberg, Germany. **REFERENCE:** • Braja M. Das, Zhe Luo (2017), *Principles of Soil Dynamics*,3rd Ed., Cengage Learning India Pvt. Ltd., New Delhi, India. • Kenji Ishihara (1996), *Soil Behaviour in Earthquake Geotechnics*, Clarendon Press, New York, USA. • Milutin Srbulov (2008), *Geotechnical Earthquake Engineering: Simplified Analyses with Case Studies and Examples*, Springer Nature, Switzerland. • IS 1893, Indian Standard Criteria for earthquake-resistant Design of Structures, 2016.

1	**Title of the course** (L-T-P-C)	**Introduction to Geotechnical Earthquake Engineering** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	
3	**Course content**	**UNIT I SEISMOLOGY AND EARTHQUAKES-9** Basic earthquake principles: Introduction–Internal structure of earth–Plate tectonics faults–seismic waves–Seismograph–Classification of earthquakes–Magnitude and intensity of earthquakes- Seismic zones in India. **UNIT II: SOIL DYNAMICS-9** Dynamics of discrete system –Soil structure interaction–Vibratory system–free and forced vibration without and with damping–Base shaking–Dynamic soil properties–problems. **UNIT III LIQUEFACTION-9** Introduction–mechanism–laboratory liquefaction studies– factors that govern Liquefaction in the field–Liquefaction analysis–cyclic stress ratio from the SPT, DCPT and shear wave velocity-FS against liquefaction– Anti Liquefaction measures– problem. **UNIT IV BEARING CAPACITY ANALYSIS FOR EARTHQUAKES-9** Introduction– one third increases in bearing capacity pressure for seismic condition–Bearing capacity analysis for liquefied soil–granular soil with earthquake induced pore water–Bearing capacity analysis for cohesive soil weakened by the earthquake– problems **UNIT V SLOPE STABILITY ANALYSIS FOR EARTHQUAKE-9** Introduction–inertia slope stability: pseudo static method, newmark method–weakening slope stability: flowslides, liquefaction induced lateral spreading, strain softening soil–restrained retaining walls and temporary retaining walls–problems
4	**Texts/References**	**READING:** • Swami Saran (2021), *Dynamics of Soils and Their Engineering Applications*, 1ST Ed., CRC Press, UK. • Steven L. Kramer (2003), *Geotechnical Earthquake Engineering*, Prentice Hall Inc. Education, New Delhi, India. • Robert W. Day (2012), *Geotechnical Earthquake Engineering Handbook*", McGraw Hill Publishers, New Delhi, India. • Ikuo Towhata (2010), *Geotechnical Earthquake Engineering*, Springer-Verlag Heidelberg, Germany. **REFERENCE:** • Braja M. Das, Zhe Luo (2017), *Principles of Soil Dynamics*,3rd Ed., Cengage Learning India Pvt. Ltd., New Delhi, India. • Kenji Ishihara (1996), *Soil Behaviour in Earthquake Geotechnics*, Clarendon Press, New York, USA. • Milutin Srbulov (2008), *Geotechnical Earthquake Engineering: Simplified Analyses with Case Studies and Examples*, Springer Nature, Switzerland. • IS 1893, Indian Standard Criteria for earthquake-resistant Design of Structures, 2016.

1	**Title of the course** (L-T-P-C)	**Environmental Geotechnics** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nil
3	**Course content**	**Soil as a multiphase system**: Soil-environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium. **Soil mineralogy**; significance of mineralogy in determining soil behavior; Mineralogical characterization. **Mechanisms of soil-water interaction**: Diffuse double layer models; Force of attraction and repulsion; Soil-water-contaminant interaction; Theories of ion exchange; Influence of organic and inorganic chemical interaction. **Introduction to unsaturated soil mechanics**; water retention property and soil-water characteristic curve; flow of water in unsaturated soil. **Concepts of waste containment facilities**; desirable properties of soil; contaminant transport and retention; contaminated site remediation. **Introduction to advanced soil characterization techniques**; volumetric water content; gas permeation in soil; electrical and thermal properties; pore-size distribution; contaminant analysis
4	**Texts/References**	**READING:** **1.** Fang, H.Y. and Chaney, R.C. (2016). Introduction to Environmental Geotechnology, 2nd Ed., CRC Press India. **2.** Oweis, I.S. and Khera, R.P. (1998). Geotechnology of Waste Management, 2nd Ed., PSW Publishing Company, USA. **3.** Mitchell, J.K., and Soga, K. (2012). Fundamentals of Soil Behaviour , 3rd Ed., Wiley, India. **4.** Rowe, R.K., et.al., (2004). Barrier Systems for Waste Disposal Facilities, 2nd Ed., CRC Press, India. **5.** Reddi, L.N. and Inyang, H.F, (2020). Geoenvironmental Engineering: Principles and Applications, 1st Ed., CRC Press, India. **6.** Fredlund, D. G., Rahardjo, H., Fredlund M. D. (2012). Unsaturated Soil Mechanics in Engineering Practice, 1St Ed., Wiley-Interscience, Inida. **REFERENCE:** **1.** Hari, D.S. and Krishna R.R., (2004). Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Wiley, India. **2.** Acar, Y.B. and Daniel, D.E., (1995). Geoenvironmental 2000: Characterization, Containment, Remediation & Performance in Environmental Geotechnics, ASCE, U.S. **3.** Singh, D. N. , Asadi, A. and Sai G.V. S. N., (2022). Environmental Geotechnology: Meeting Challenges Through Need-based Instrumentation, World Scientific Publishing Co Pte Ltd., Singapore. **4.** David, D. E. and Koerner, R. M. (2007). Waste Containment Facilities, ASCE Press, U.S. **5.** Bouazza, A. , Bowders, J. J. (2020). Geosynthetic Clay Liners for Waste Containment Facilities, 1st Ed., CRC Press, India. **6.** R. Kerry Rowe (2012). Geotechnical and Geoenvironmental Engineering Handbook, 1st Ed., Springer, Germany . **7.** Ning Lu, William J. Likos, (2013). Unsaturated Soil Mechanics, Wiley, India.

1	**Title of the course** (L-T-P-C)	**Pavement Engineering** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Materials used for construction of subgrade, aggregate base course, bituminous base, and surface course of pavements. • Understanding different tests: CBR, Durability, Freeze-Thaw, Rasilient Modulus, Soil-suction, relationship between DCP and CBP, CBP and Mr, and other parameters. • Introduction to bitumen production and process, penetration, and viscosity grading system for bitumen. Modification of bitumen using polymer and crumb rubber. Visco-elastic system. Understanding mixing and Compaction temperature of bitumen. • Introduction to different type of mixes: Hot mix asphalt, cold mix asphalt. Understanding volumetric calculation. Marshall and Superpave mix design of different types of mixes. Performance tests: fatigue and rutting tests, moisture induced damage and test, resilient modulus, dynamic modulus/flow number/flow time. • Recycling, foam mix asphalt, recycle technologies, and warm mix asphalt, construction of perpetual pavements. Cement concrete mix design for pavements. • Introduction to flexible pavements and design factors, Stress, and strain analysis of flexible pavement. Introduction to multilayers elastic theory. Analysis of pavements. Using software such as IITPAVE and KENPAVE • Stress and Stain (Deflection) analysis of rigid pavements. Analysis of pavement using software such as IITRIGID and KENLAYER, and others. • Design of flexible pavement as per IRC 37 method for stabilized and un-stabilized base and subgrade layers • Introduction to different types of overlays on flexible and rigid pavements and their design philosophy. • Pavement performance evaluation and distresses. Different types of rehabilitation and maintenance strategies. • Construction practices for building flexible and rigid pavement.
4	**Texts/References**	• F. L. Roberts, P.S. Kandhal, E.R. Brown, D.Y. Lee, and T.W. Kennedy “Hot Mix Asphalt Materials, Mixture Design and Construction,” National Asphalt Pavement Association Research and Education Foundation, Second Edition, 1996, USA. • Y.H. Huang “ Pavement Analysis and Design,” 2nd Edition, 2004, Pearson Prentice Hall, USA • Asphalt Institute, SP-1: Performance Grading of Asphalt Binder Specification and Testing. • N. Delatte “ Concrete Pavement Design, Construction, and Performance” Taylor and Francis • MORT&H- Specifications for Roads and Bridges, 5th Revision, 2013. • IRC: 37-2012. “ Tentative Guidelines for the Design of Flexible Pavements, “ Indian Road Congress, Delhi. • IRC: 58-2011. “ Tentative Guidelines for the design of Rigid pavements,” Indian Road Congress, Delhi.

1	**Title of the course** (L-T-P-C)	**Geosynthetic Engineering** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Introduction: Principles of reinforced soil through Mohr circle analysis; an overview of the development and applications of various geosynthetic- the geotextiles, geogrids, geonets, geomembranes, and recomposites; Testing methods for geosynthetics-Techniques for testing of different index properties, strength properties, 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. • Reinforced soil retaining walls and slops: Different types of wall like wrap-around walls, full-height panel walls, discrete-facing panel walls, and modular block wall Design methods as per BS-8006 and FHWA methods bi-linear wedge method, and circular slip methods • Geosynthetics applications in foundations, landfills, drainage, and filtration: Binquet and Lee's approach for analysis of foundations with reinforcement layers: Different components of modern landfills, collection techniques for leachate, application of different geosynthetic like geonets, geotextiles for drainage in landfills, use of geomembranes and Geosynthetic Clay Liner (GCL) as barriers; Filtration in different type of soil and criteria for selection of geotextiles • Geosynthetic application in Transportation Engineering: Geosynthetics for separation and reinforcement in flexible pavements, design by Giroud Noiray approach, reflection cracking, and control using geosynthetics; Use of geosynthetic for railway Tracks.
4	**Texts/References**	• R. M. koener, "Designing with geosynthetic", 6th Edition (Vols 1 and 2) Xlibris., 2012. • R. A. Jewell, "Soil Reinforcement with Geotextiles", Special Publication No. 123, CIRIA, Thoms Telford. Landon, UK, 1996. • G. L. Sivakumar Babu, "An Introduction to soil reinforcement and Geosynthetics", University Press, 2005. • G.V. Rao. And G. V. S. S. Raju, "Engineering with Geosynthetics", McGraw Hill Education India Pvt Ltd., 1998. • S.K. Shukla, " An Introduction to Geosynthetic Engineering", CRC Press, UK, 2016. • K. Rajagopal, "Geosynthetics and Reinforced Soil Structure " NPTEL Video Course, MHRD, Govt. India 2013.

1	**Title of the course** (L-T-P-C)	**3D Concrete Printing Technology**
2	**Pre-requisite courses(s)**	CE 201 Building and Construction Materials CE203 Building Planning and Drawing CE 205 Structural Analysis CE 302 Design of Concrete Structures CE 307 Instrumentation in Civil Engineering
3	**Course content**	**UNIT – I: Introduction to 3D Concrete Printing** History and evolution of 3D concrete printing, types of 3D concrete printers and their capabilities, various 3D printing technologies, advantages, and challenges of 3D concrete printing, and problems facing in the construction industry. **UNIT – II: Material Sciences, Process, and Sustainability** Materials properties, materials characterization, concrete mix design for 3D printing, fibre reinforcement and additives, sustainable materials for 3D printing. Components of 3D concrete printing system, on-site printing vs. Factory printing. On-site mixing systems; delivering print materials to the site. Economic Breakdown and life cycle assessment of to achieve sustainability. **UNIT – III: Structural Design and Analysis** Design considerations for 3D printed structures, mechanical properties, engineering properties of 3D printed concrete, durability aspects of 3D printed concrete, finite element analysis (FEA) for 3D printed elements. Case studies on 3D printed buildings. **UNIT – IV: Automation and Robotics** Robotics systems in 3D concrete printing; sensors and feedback control, programming, and scripting for automation; Building Information Modelling (BIM) for sustainable design of 3D concrete printing. 5D modelling of 3D printing concrete structure. Technology prospectives and insights. **UNIT – V: 3D Subtractive Manufacturing in Construction** Concept of 3D subtractive manufacturing and its integration with 3D concrete printing, Potential applications, and benefits of combining additive and subtractive processes in construction, designing and manufacturing components using integrated technologies. **Practice Sessions:** • Operating 3D concrete printers • Designing and 3D printing small-scale projects • Troubleshooting and maintenance
4	**Texts/References**	**1.** Sanjayan, J. G., Nazari, A., & Nematollahi, B. (2019) D concrete printing technology: construction and building applications. Butterworth-Heinemann. **2.** Miryousefi Ata, Sara; Kazemian, Ali; Jafari, Amirhosein (March 7, 2022). "Application of Concrete 3D Printing for Bridge Construction: Current Challenges and Future Directions". Construction Research Congress 2022. American Society of Civil Engineers. pp. 869–879. **3.** Mohammad, Malek; Masad, Eyad; Al-Ghamdi, Sami G. (December 17, 2020). "3D Concrete Printing Sustainability: A Comparative Life Cycle Assessment of Four Construction Method Scenarios". Buildings. 10 (12): 245. doi:10.3390/buildings10120245. **4.** Varun Sharma; P.M. Pandey (November 16, 2022), “Additive and Subtractive Manufacturing Processes: Principles and Applications”, CRC Press.

1	**Title of the course** (L-T-P-C)	**Modern Construction Materials and Techniques**
2	**Pre-requisite courses(s)**	CE201 Building and Construction Materials CE 205 Structural Analysis
3	**Course content**	**UNIT – I: Introduction to Modern Construction Materials and Techniques** Overview of the construction industry; Trends in construction materials and techniques and sustainability and resilience in construction. **UNIT – II: Admixtures and Special Concretes** Cement chemistry and concrete performance overview; chemical admixtures: water reducers, set controllers. Mineral Admixtures: fly ash, LC^3; GGBS and other industrial by-products. High strength concrete, high performance concrete, self-compacting concrete, self-healing concrete, light weight concrete and mass concrete, high density concrete and concrete for 3D printing. Nanotechnology in concrete. **UNIT – III: Sustainable Building and Composite Materials** Green building materials and their properties; Energy-efficient materials and technologies; Life cycle assessment and environmental impact. Life cycle assessment and environmental impact, Fibre-reinforced composites, and use of composites in structural applications. **UNIT – IV: Emerging Building Systems and Techniques** Prefabrication and modular construction, 3D printing in construction; Smart buildings and IoT applications. Building with renewable materials (wood, bamboo), Passive design and energy-efficient construction; Case studies on sustainable construction projects. Case studies on resilience in construction.
4	**Texts/References**	**1.** Mehta, P. K., and Monteiro, P. J. M., Concrete: Microstructure, Properties, and Materials, Fourth Edition (Indian Edition), McGraw Hill, 2014. **2**. Neville, A. M., Properties of Concrete, Pitman Publishing, Inc., MA, 1981. **3**. J. Newman and B. S. Choo, Eds., Advanced Concrete Technology, Four Volume Set, Elsevier, 2003. **4.** Council, E., & Faculties, E. Modern Building Materials, Structures and Techniques. **5**. ENGINEERS, C. Modern Building Materials, Structures and Techniques. **6**. Watts, A. (2019). *Modern Construction Case Studies: Emerging Innovation in Building Techniques*. Birkhäuser. 7. Academic Papers

1	**Title of the course** (L-T-P-C)	**Advanced Soil mechanics** **2-1-0-6**
2	**Pre-requisite courses(s)**	Geotechnical Engineering
3	**Course content**	**Module 1 (Introduction)**: Soil Composition, Index Properties, Soil Classification, Soil Structure **Module 2 (Shear Strength of Soils):** Mohr-Coulomb Failure Theory, Response of Soils to Shearing Force, Drained and Undrained Strength, Laboratory and Field Tests, Factors Affecting Shear Strength, Useful Correlations. **Module 3 (Theory of Elasticity):** Stress-Strain Relationship for various loading conditions, Elastic Stress Analysis, Introduction to Computer Program SIGMAW. **Module 4 (Theory of Plasticity and Models for Soils):** Elements of Plasticity, Yield Criteria, Post-yield Behavior, Elastic-Perfectly Plastic Model, Hardening Plasticity Based Model. Introduction to computer program PLAXIS **Module 5 (Slope Instability):** Introduction, Infinite Slope, Finite Slope, Stability analyses: General, Ordinary & Bishop's Methods of slices, Spencer & Janbu Metods of Slope Stability Analysis, Application of software: SLOPE/W, Wedge Method, Stability Charts
4	**Texts/References**	**Textbooks/ Reference Books:** **1**. Das, B.M., Advanced Soil Mechanics (5th edition), CRC Press, Taylor and Francis Group, 2020 **2**. Budhu, M., Soil Mechanics and Foundation (3rd edition), John Wiley & Sons Inc, 2011 **3**. A.P.S. Selvadurai, Plasticity & Geomechanics, Cambridge University Press, 2002 **4**. Jean-Louis Briaud. Geotechnical Engineering: Unsaturated and Saturated Soils (1st Edition). Wiley, 2013. **5**. Renato Lancellotta. Geotechnical Engineering (2nd Edition), CRC Press, 2009.

1	**Title of the course** (L-T-P-C)	**Vibration and Structural Dynamics** **2-1-0-6**
2	**Pre-requisite courses(s)**	-
3	**Course content**	**Module 1 (Introduction)**: • **Basics of Structural Dynamics** Introduction of Structural Dynamics Equation of Motion Types of Analysis/Static and Dynamic load Degrees of Freedom . (Ex: Generation of Stiffness matrix) Dynamic Equilibrium Equation Solution of Equilibrium Equation • **Free Vibration of SDOF** Undamped free Vibration Solution, Natural Period/Frequency Energy in Free Vibration Damped Free Vibration Types of damping Logarithmic decrement equation **Module 2** • **Forced Vibration of SDOF** Undamped Forced vibration Amplitude & Phase Angle Dynamic amplification factor for deflection (Rd) Damped Forced vibration Relationship between Rd, Rv and Ra • **Force Transmission, Vibration Measurement** Resonant frequency and Half power band width Force Transmission and Isolation Design of Vibration Measuring Instruments **Module** • **Response to Arbitrary Motions** Response to Unit Impulse Response to Arbitrary Force (Duhamel's Integral) Response to Step and Ramp Forces Response to Rectangular Pulse, Half Sinusoidal wave • **Numerical Methods of Solution** Time Stepping Methods Central Difference Method Newmark's Method **Module 4 Response Spectrum** Concept of Response Spectrum Uses of Response Spectrum Special Cases in Spectrum Development of Tripartite Plot Example: Base Shear and Base Moment Response of Structure in Frequency Domain • **Multi-Degree of Freedom Systems** Equation of Motion for MDOF System Solution of Equation, Natural Frequencies, and mode Shapes Modal Orthogonality Approximate Method for finding Natural frequency **Module 5 Earthquake Response of MDOF Systems** Time History Analysis Response Spectrum Analysis 3D Dynamic Analysis • **Dynamic Response of Continuous Systems** Vibration of Continuous systems Shear behavior and bending behavior Generalized SDOF • **Dynamics of Rigid Blocks** Dynamics of Rigid Blocks Non-Structural Elements Floor Response Spectrum

		• **Vibration Control** Introduction to Vibration Control Active Control Passive Control Design of Tuned Mass Damper
4	**Texts/References**	**Textbooks:** • Anil K. Chopra, Dynamics of structures, 3rd Edition, 2007, Pearson. • R. W. Clough, Joseph Penzien, Dynamics of structures, 1st Edition, 1975, McGraw-Hill. • W. T. Thompson, M.D.Dahleh, C. Padmanbhan ,Theory of Vibrations, 5th Ed.,2008, Pearson Education. **Reference Books:** • Leonard Meirovitch, Elements of Vibration Analysis, 1st Edition,1986 ,McGraw-Hill

1	**Title of the course** (L-T-P-C)	**Advanced Concrete Structure** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	--
3	**Course content**	**Introduction:** History of Reinforced Concrete (RC), advantages of RC, load paths, introductions to different structural systems used in modern concrete construction **Materials:**Stress-Strain Behaviour of concrete and steel under Compression and Tension, Behaviour of concrete under multi-axial stress, High strength concrete, lightweight concrete, Failure theories for concrete under Combined stress state, Tension-stiffening of Concrete, Effects of creep, shrinkage and temperature on material and structural behaviour **Durability Aspects in Reinforced Concrete Design:**Deterioration mechanisms of concrete, Alkali silica reaction, Sulphate attack, corrosion of steel, durability considerations in concrete mix design, methods to check loss of durability in concrete. Cover to reinforcement, Cracking and spalling of concrete, Periodic maintenance and its cost, Breakdown of concrete due to Freezing and thawing effect. **Behaviour under Pure Axial Loads:** Basic Laws of Mechanics, Load displacement behaviour of RC members under pure axial compression and tension, Role of concrete and steel in compression and tension; differences in Behaviour of high strength and normal strength concrete **Behaviour and Design under Flexure:** Analysis at ultimate; Moment-curvature and load-deflection relationships, Effect of reinforcement ratios and concrete strength on moment-curvature Behaviour; Flexural design aspects using IS Code **Analysis and Design for Shear:** Relationship between flexure and shear, Effect of shear span to depth ratio, Definition of nominal shear, critical sections for shear, concept of Mohr circle; different failure modes in shear; Internal resisting mechanisms under shear **Analysis and Design for Torsion:** Behaviour of reinforced concrete members subjected to Torsion, Design methods of Torsion, Difference between equilibrium and compatibility torsion; concepts behind the derivation of code equations; concept of equivalent shear and bending; design examples, Design for combined loading (Torsion + Bending + Shear) **Columns:** Concept of effective length; short columns vs slender column, Effect of confinement, Derivation of axial compression and bending interaction curves, Design of slender columns; Design for biaxial bending **Serviceability Checks:** Difference between short-term and long-term deflections; estimation of deflections, estimation of crack widths and shrinkage cracks, vibrations and fatigue **Analysis and Design of Two-way Slabs:** Difference between one way and two-way slabs; limitations of code coefficient method; direct design method; equivalent frame method; Yield line analysis of slabs, Design of two-way slabs with a commercial package and comparing results from direct Design and equivalent frame methods **Special Topics:** Design of Shear Walls, Design of Curved beams, Moment redistribution in continuous beams; bond and development length, curtailment of reinforcing steel Introduction to Strut and Tie Method; Design of Deep beams and corbels, Design of Footings: isolated and combined footings; Beam-column joints.

4	**Texts/References**	**Textbooks:** • S. Unnikrishna Pillai and Devdas Menon, Reinforced Concrete Design, 3rd Edition, 2009, Tata Mcgraw Hill • J. Wight and J.G. MacGregor, Reinforced Concrete - Mechanics & Design, 6th Edition,2011, Prentice-Hall. • A Nilson, D Darwin, C Dolan Design of Concrete Structures, 14 edition, 2009, McGraw-Hill Education. **Reference Books:** • N.SUBRAMANIAN ,Design of RCC Structures,2013,1st Ed., Oxford University Press **Codes and Standards:** **1. IS 456: 2000** — Plain and reinforced concrete – Code of practice (fourth revision) **2. SP 16: 1980** — Design Aids (for Reinforced Concrete) to IS 456: 1978. **3. IS 875 (Parts 1-5): 1987** — Code of practice for design loads (other than earthquake) for buildings and structures (second revision) **4. SP 24: 1983** — Explanatory Handbook on IS 456: 1978 **5. SP 34: 1987** — Handbook on Concrete Reinforcement and Detailing.

1	**Title of the course** (L-T-P-C)	**Building Materials and Construction** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Introduction to Building materials and Construction (4 Hrs.) Functions of Buildings and Structures in General, Loads on Buildings as per IS875, IS1893 and NBC. Functional Requirement of buildings and necessity by laws. Role of Materials in Construction. • Stone, Bricks, Lime and Aggregates (6 Hrs.) Stone as building material – Criteria for selection – Tests on stones. Bricks – Classification – Manufacturing of clay bricks – Tests on bricks. Concrete blocks – Lightweight concrete blocks. Lime – Preparation of lime mortar. Fine aggregates and its properties, coarse aggregates and its properties. • Cement, Mortar and Concrete (12 Hrs.) Cement – Ingredients – Manufacturing process – Types and Grades – Properties of cement, Hydration of cement, Chemical reaction, Structure of cement paste, Consistency and setting. Lime and supplementary cementations materials. Properties of cement mortar. • Concrete as a material, its ingredients and Concrete Production Process including prefabrication, modular coordination. Mix design of concrete, fresh concrete, strength concrete, durability of concrete. Cement, water and aggregates selection for concrete • Other Building Materials (8 Hrs) Metals with reference to Structural Steel: Structure and its role in properties of steel. Strengthening mechanism in metals. Behaviour in service and corrosion. Uses of metals in civil engineering. Timbers, industrial timbers, glasses. Plastics and Polymers in Construction, admixture paints, sealants, adhesives and water proofing materials. • Traditional and Contemporary Construction Practices (8 Hrs) Brick and other masonry construction, Selection of bricks/masonry units and mortar for masonry. Requirements of walls and types of walls. Masonry design requirements as per IS 1905. Thermal insulation, Room acoustics. BIM, 3 D printing, Green Building. Supplements: • Industry Visits • Expert Talks
4	**Texts/References**	1. Varghese.P.C. (2015). Building Materials, 2nd Ed., PHI Learning Pvt. Ltd, New Delhi, India. 2. Rajput. R.K. (2008). Engineering Materials,3rd Ed., S. Chand and Company Ltd. New Delhi, India. 3. Gambhir.M.L.(2004). Concrete Technology, 3rd Ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, India. 4. Duggal.S.K. (2008). Building Materials, 4th Ed.,, New Age International, New Delhi, India. 5. Jagadish K.S., Venkatarama Reddy B.V., and Nanjunda Rao K.S. (2007). Alternative Building Materials Technology, New Age International, New Delhi, India. 6. Gambhir M.L., & Neha Jamwal (2012). Building Materials, products, properties and systems, Tata McGraw Hill Education Pvt. Ltd, New Delhi, India. 7. IS456 – 2000 (2021): Plain and reinforced concrete-code of practice. Bureau of Indian Standards, New Delhi 8. IS4926 - 2003: Indian Standard specification for ready–mixed concrete,Bureau of Indian Standards, New Delhi.

		9. IS383 – 1970 (2011): Indian Standard specification for coarse and fine 10. aggregate from natural Sources for concrete, Bureau of Indian Standards, New Delhi. 11. IS1542-1992(2009): Indian standard specification for sand for plaster, Bureau of Indian Standards, New Delhi 12. IS 10262-2009: Indian Standard Concrete Mix Proportioning –Guidelines, Bureau of Indian Standards, New Delhi.

1	**Title of the course** (L-T-P-C)	**Building Drawing Practice** **0-0-3-3**
2	**Pre-requisite courses(s)**	--
3	**Course content**	1. Drawing various plans and elevations, isometric views & perspective views of civil engineering structures like buildings, bridges, retaining walls, dams, pipelines, and water tanks with design notations, drawing staircases in 3D 2. Detailing of reinforcement in concrete structures 3. The typical exercises include the following: * Introduction *2-D line drawing using a. Absolute Co-ordinate Method. b. Relative Co-ordinate Method c. Polar Co-ordinate Method * Isometric view of 2-D truss, brick bonds, and brickbats *Cross-section of a masonry foundation *Symbols a. Water supply and sanitary fixtures b. Electrical installations c. Building materials 6. Plan, elevation, and section of a single room 7. Plan, elevation, and section of a single-story residential building 8. Plan, elevation, and section of a two-story building 9. Plan and elevation of an RCC overhead tank 10. Plan and section elevation of a doglegged and open newel staircase 11. Cross section and plan of the one-way roof slab, beam, and column showing the details of reinforcement
4	**Texts/References**	References: 1. S.S. Bhavikatti and M.V. Chitawadagi (2019), Building Planning and Drawing, Dreamtec Press, New Delhi, India. 2. N. Kumara Swamy and A. Kameswara Rao (2019), Building Planning and Drawing, 9th Ed., Charotar Publishing House Pvt. Ltd. New Delhi, India.

1	**Title of the course** (L-T-P-C)	**Construction Materials Laboratory** **0-0-3-3**
2	**Pre-requisite courses(s)**	--
3	**Course content**	This course provides hands-on experience in testing construction materials to assess their properties, quality, and suitability for civil engineering applications. 1. Tests on Bricks and Blocks – Evaluate compressive strength, water absorption, and efflorescence. 2. Tests on Fine and Coarse Aggregates – Assess particle size distribution, specific gravity, bulk density, and impact resistance. 3. Tests on Lime and Cement – Determine consistency, setting time, soundness, and strength. 4. Tests on Cement Mortar – Analyze workability, flow, and compressive strength. 5. Tests on Fresh Properties of Concrete - Conduct slump, flow, compaction factor, and Vee-Bee consistency tests. 6. Tests on Strength Properties of Concrete - Measure compressive, flexural, and split tensile strength. 7. Tests on Steel – Examine tensile strength, elongation, and yield properties. 8. Tests on Timber and Wood – Assess moisture content, bending `strength, and hardness. 9. Tests on Tiles – Evaluate water absorption, flexural strength, and surface quality. 10. Demonstration on 3D Concrete Printing – Explore digital fabrication in construction. 11. Demonstration on Pavement Materials and Geosynthetics – Understand advanced road and ground reinforcement materials. Supplements: • Industry Visits
4	**Texts/References**	1. Varghese.P.C. (2015). Building Materials, 2nd Ed., PHI Learning Pvt. Ltd, New Delhi, India. 2. Gambhir M.L., & Neha Jamwal (2012). Building Materials, products, properties and systems, Tata McGraw Hill Education Pvt. Ltd, New Delhi, India. 3. IS456 – 2000 (2021): Plain and reinforced concrete-code of practice. Bureau of Indian Standards, New Delhi. 4. IS4926 - 2003: Indian Standard specification for ready–mixed concrete, Bureau of Indian Standards, New Delhi. 5. IS383 – 1970 (2011): Indian Standard specification for coarse and fine aggregate from natural Sources for concrete, Bureau of Indian Standards, New Delhi. 6. IS1542-1992(2009): Indian standard specification for sand for plaster, Bureau of Indian Standards, New Delhi. 7. IS 10262-2009: Indian Standard Concrete Mix Proportioning –Guidelines, Bureau of Indian Standards, New Delhi.

1	**Title of the course** (L-T-P-C)	**Sustainable Infrastructure Planning** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	Traditional Building Planning: • Functional Planning of Buildings: General aspects to consider for planning, byelaws and regulations, selection of the site for building construction, principles of planning, orientation of the building and its relation to the outside environment • Materials, Components and Functional Requirements of Building: Masonry: definitions of terms used in masonry, materials used, stone masonry, brick masonry, different bonds used for brick masonry, permissible stress of brick masonry work; floors and roofs: components of a floor, materials used for floor construction, different types of flooring, types of roofs, basic roofing elements, and roof coverings; Staircases: Functional requirements of a good stair, type of steps, type of stairs, planning a staircase, guidelines for accessible buildings; damp proofing, fire protection, and thermal insulation Sustainable Planning in Civil Engineering: • The concept of sustainability and green building, sustainable construction materials, and life cycle assessment • Sustainable construction techniques, green building rating system, sustainable design in practice. • Sustainable infrastructure planning in structural engineering, geotechnical • engineering, transportation engineering, and water resources engineering
4	**Texts/References**	References: • Varghese P. C (2016), Building Construction, 2nd Ed., PHI Learning Pvt. Ltd. New Delhi, India. • Bhavikatti S.S. and Chitawadagi M.V. (2019), Building Planning and Drawing, Dreamtec Press, New Delhi, India. • McLennan J. F. (2004), The Philosophy of Sustainable Design: The future of architecture., Ecotone Publishing. • Montoya M. (2011), Green Building Fundamentals, Pearson Higher Education. • Kibert C. J. (2016), Sustainable Construction - Green Building Design and Delivery, John Wiley & Sons. • Leffers, M.R. (2010), Sustainable Construction and Design, Pearson HigherEducation.

1	**Title of the course** (L-T-P-C)	**Hydraulics and Hydraulic Machinery** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Module 1: Laminar Flow- Laminar flow through: circular pipes, annulus, and parallel plates. Stoke's law, Measurement of viscosity. • Module 2: Turbulent Flow- Reynolds experiment, Transition from laminar to turbulent flow. Definition of turbulence, scale and intensity, Causes of turbulence, instability, mechanism of turbulence, and effect of turbulent flow in pipes. Reynolds stresses semi-empirical theories of turbulence, Prandtl's mixing length theory, universal velocity distribution equation. Resistance to flow of fluid in smooth and rough pipes, Moody's diagram. • Module 3: Boundary Layer Theory: Concepts of boundary layer flows, Laminar and turbulent boundary layers, Integral momentum equation for boundary layer flows, Boundary layer separation and control, Drag and lift. • Module 4: Dimensional Analysis and Hydraulic Similitude: Dimensional homogeneity, Rayleigh method, Buckingham's Pi method and other methods. Dimensionless groups. Similitude, Model studies, Types of models. Application of dimensional analysis and model studies to fluid flow problem. • Module 5: Introduction to Open Channel - Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channelflow, Velocity Distribution of channel section. • Module 6: Uniform Flow-Continuity Equation, Energy Equation and Momentum Equation, Characteristics of Uniform Flow, Chezy's formula, Manning's formula. Factors affecting Manning's Roughness Coefficien "n". Most economical section of channel. Computation of Uniform flow, Normal depth. • Module 7: Non-Uniform Flow- Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth. Channel Transitions. Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity-Current meter, Floats, Hot-wire anemometer. Gradually Varied Flow-Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile. Computation of water surface profile by graphical, numerical, and analytical approaches, Direct Step method, Graphical Integration method, and Direct Integration method. • Module 8: Hydraulic Jump- Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length, and height of the jump, location of the jump, Types, applications, and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges. Dynamics of Fluid Flow-Momentum principle, applications: Force on plates, pipe bends, moments of momentum equation, • Module 9: Flow through Pipes: Loss of head through pipes, Darcy- Wiesbatch equation, minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flows in dead-end pipes, siphon, power transmission through pipes, nozzles. Analysis of pipe networks: Hardy Cross method, water hammer in pipes and control measures, branching of pipes, three reservoir problems. • Module 10: Hydraulic Machinery: Classification of hydraulic machines, Euler's equation of turbo machines, one-dimensional flow analysis and velocity triangles, Concepts of Design of Pelton turbine, Francis turbine, Kaplan turbine, Design of

		centrifugal pump, axial flow pump, Selection of hydraulic machines.
4	**Texts/References**	References: • Fluid Mechanics, F M White, Fluid Mechanics, McGraw Hill Education India Private Limited, 2017, 8 th Edition. • Robert W. Fox, Philip J. Pritchard, Alan T. McDonald, Introduction to Fluid Mechanics, Student Edition Seventh, Wiley India Edition, 2011. • C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, Fluid Mechanics and Machinery, C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, Oxford University Press, 2010. • Modi P M and S M Seth, Hydraulics and Fluid Mechanics, Standard Book House, 2019 • K Subramanya Theory and Applications of Fluid Mechanics, Tata McGraw Hill. • K Subramanya, Open channel Flow, Tata McGraw Hill, 2017 • V T Chow, Open Channel Hydraulics, McGraw Hill. 2010 • James A Fay , Introduction to Fluid Mechanics, Prentice Hall of India, 2012

<table>
<tr><td>1</td><td>Title of the course
(L-T-P-C)</td><td>Sensors and Instrumentation in Civil Engineering
Laboratory
0-0-3-3</td></tr>
<tr><td>2</td><td>Pre-requisite courses(s)</td><td>--</td></tr>
<tr><td>3</td><td>Course content</td><td>
<table>
<tr><th>SL. No.</th><th>Experiment Name</th></tr>
<tr><td>1</td><td>To study the characteristics of a three-pinned arch under various load conditions</td></tr>
<tr><td>2</td><td>To investigate a simple suspension bridge structure and measure the cable tension under various loads.</td></tr>
<tr><td>3</td><td>To study the rectangular portals subjected to vertical loads</td></tr>
<tr><td>4</td><td>To study plastic theory and limit state design in portal frames</td></tr>
<tr><td>5</td><td>To study bending moments and sway in portal frames</td></tr>
<tr><td>6</td><td>To determine the soil lateral stress and soil lateral stiffness</td></tr>
<tr><td>7</td><td>To study the deformation behaviour of footing</td></tr>
<tr><td>8</td><td>To measure the water potential of soil</td></tr>
</table>
</td></tr>
<tr><td>4</td><td>Texts/References</td><td>Reading:

• AS Morris (2001), Measurement and Instrumentation Principles, Butterworth Heinemann, 3rd edition.
• DVS Murthy (2013), Transducers and Instrumentation, PHI, 2nd edition.
• D Patranabis (2003), Sensors and Transducers, PHI, 2nd edition
• S Tumanski (2006), Principle of Electrical Measurement, Taylor & Francis, 1st edition.
• AD Helfrick and WD Cooper (2015), Modern Electronic Instrumentation & Measurement Techniques, Pearson India, 1st edition.

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1	**Title of the course** (L-T-P-C)	**Advanced Structural Analysis** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Approximate Analysis of Statically Indeterminate Structures (8 L) Analysis of trusses, Vertical Loads on Building Frames, Portal Frames and Trusses, Lateral Loads on Building Frames: Portal Method and Cantilever Method. • Truss Analysis (2D) Using the Stiffness Matrix Method (12 L) Fundamentals of the Stiffness Method, Member Stiffness Matrix, Displacement and Force Transformation Matrices, Member Global Stiffness Matrix, Truss Stiffness Matrix, Application of the Stiffness Method for Truss Analysis, Trusses Having Thermal Changes and Fabrication Errors. • Space-Truss Analysis (10 L) Statically determinate and indeterminate space trusses: Member Stiffness Matrix, Member Global Stiffness Matrix, Truss Stiffness Matrix, Application of the Stiffness Method for Truss Analysis. Computer programming for analysis of 3D trusses. • Plane Frame Analysis Using the Stiffness Method (8 L) Frame-Member Stiffness Matrix, Displacement and Force Transformation Matrices, Frame-Member Global Stiffness Matrix, Application of the Stiffness Method for Frame Analysis. • Space Frame Analysis Using the Stiffness Method (8 L) Frame-Member Stiffness Matrix, Displacement and Force Transformation Matrices, Frame-Member Global Stiffness Matrix. Computer programming for analysis of 3D structures.
4	**Texts/References**	• Hibbeler, R. C. (2023). Structural Analysis. United States: Pearson Books. • Kassimali, A. (2011). Matrix Analysis of Structures SI Version. United States: Cengage Learning. • Weaver, W., Gere, J. M. (2012). Matrix Analysis Framed Structures. United States: Springer US.

1	**Title of the course** (L-T-P-C)	**Non-Destructive Techniques in Civil Engineering** **3-0-0-6**
2	**Pre-requisite courses(s)**	--
3	**Course content**	• Introduction to NDT in Civil Engineering (6 Hrs.) Importance of NDT in infrastructure maintenance and failure prevention, Advantages and limitations of NDT over destructive testing, Overview of IS 13311, ASTM, and ACI standards for NDT methods • Surface and Near-Surface Inspection Techniques (10 Hrs.) Rebound Hammer Test (Schmidt Hammer) – Principle, equipment, correlation with compressive strength, Penetration Resistance Test – Windsor probe and Pull-out test, Dye Penetrant Testing (DPT) – Surface crack detection. Ultrasonic Pulse Velocity (UPV) Test – Wave propagation, interpretation of test results, Radiographic Testing (X-ray & Gamma Ray) – Basics of radiography, applications in structural inspection, Magnetic Particle Testing (MPT) – Detection of cracks in steel structures • Structural Integrity and Load Testing (10 hrs.) Strain Gauge Techniques – Principle, types of strain gauges, applications in monitoring bridge deflections, Acoustic Emission Testing – Crack initiation and propagation monitoring, Half-cell Potential Test – Corrosion monitoring in reinforced concrete. Ground Penetrating Radar (GPR) – Detection of buried utilities, voids, and rebar assessment. • Recent Development in NDT (10 Hrs.) Infrared Thermography – Thermal imaging for moisture and delamination detection, Fiber Optic Sensors – Distributed sensing for real-time health monitoring, Digital Twin Technology – AI-driven structural condition assessment. AI, Machine Learning & Data-Driven NDT Approaches; Wireless and Remote Monitoring. Advanced Materials Testing Techniques. Case Studies. **Hands on Sessions:** • Rebound hammer, UPV, and Half-cell potential tests on real structures • Thermographic imaging for moisture detection in buildings • GPR scanning of pavements and underground utilities • AI-based image processing for crack detection
4	**Texts/References**	• Balayssac, J. P., & Garnier, V. (2018). Non-Destructive Testing and Evaluation of Civil Engineering Structures. Elsevier. • Malhotra, V. M., & Carino, N. J. (2004). Handbook on Non-destructive Testing of Concrete (2nd ed.). CRC Press. • Cartz, L. (1995). Non-destructive Testing. ASM International. • ASM International. (1992). ASM Handbook, Vol. 17: Non-destructive Evaluation and Quality Control. ASM International. • Maierhofer, C., Reinhardt, H. W., & Dobmann, G. (2010). Non- Destructive Evaluation of Reinforced Concrete Structures: Non- Destructive Testing Methods. Woodhead Publishing. • Mix, P. E. (2005). Introduction to Non-destructive Testing: A Training Guide (2nd ed.). Wiley-Interscience. **NPTEL Courses**: **6.** NPTEL Course: "Concrete Engineering and Technology" by Prof. Sudhir Misra, IIT Kanpur. **7.** NPTEL Course: "Theory and Practice of Non-Destructive Testing" by Prof. Ranjit Bauri, IIT Madras.

1	**Title of the course** (L-T-P-C)	**Repair and Rehabilitation of Infrastructure** **3-0-0-6**
2	**Pre-requisite courses(s)**	-
3	**Course content**	• Introduction to Repair and Rehabilitation of Methods (4 Hrs.) Need for repair and rehabilitation of structures; Factors affecting deterioration: environmental, material, design, and loading-related causes. Relevant Codes & Standards: IS 13311, IS 456, IS 13935, ACI 546R-14,ASTM C876. • Structural Distress & Failure Mechanisms (8 Hrs.) Concrete Structures: Cracking, corrosion, spalling, alkali-silica reaction (ASR), sulfate attack; Steel Structures: Fatigue, buckling, welding defects, corrosion protection; Masonry & Heritage Structures: Material degradation, settlement cracks, biological growth Case studies on failure analysis of Dam, bridges, buildings, and industrial structure etc. • Damage Assessment and Repair Materials (9 Hrs.) Visual Inspection & Condition Assessment, Non-Destructive Testing (NDT) Methods, Destructive Testing: Core sampling, petrography, chloride and carbonation testing. Cementitious, polymer-based, epoxy, fiber-reinforced composites (FRP), Corrosion inhibitors, protective coatings, self-healing concrete. • Repair and Strengthening Techniques (9 Hrs.) Repair Techniques: Crack injection, jacketing, epoxy bonding, grouting, patch repair. Corrosion control measures: Cathodic protection, re- alkalization. Strengthening of Beams and Columns, Slabs and Foundations, Bridges and Highways, Dams etc. • Recement Developments and Sustainable Rehabilitation (6 Hrs.) Digital technology, advanced strengthening techniques, sustainable and eco-friendly repair techniques. Future trends and innovation, and Case studies **Hands on Sessions**: • Damage assessment • Demonstration on Strengthening Techniques
4	**Texts/References**	• Bhattacharjee, B. (2019). Concrete Structures: Repair, Rehabilitation and Retrofitting. • Krishna, R. N., & Santhakumar, A. R. (2022). Repair and Rehabilitation of Structures. Rajsons Publications Pvt. Ltd. • Devi, G. N. (2021). Maintenance, Repair, Rehabilitation, and Retrofitting of Structures. Dreamtech Press. • Mehta, P. K., & Monteiro, P. J. M. (2014). Concrete: Microstructure Properties, and Materials (4th ed.). McGraw-Hill Education. • Raikar, R. N. (1994). Diagnosis and Treatment of Structures in Distress. R&D Centre, Structwel Designers & Consultants. • American Concrete Institute. (2014). ACI 546R-14: Guide to Concrete Repair. • Bureau of Indian Standards. (2002). Handbook on Repair and Rehabilitation of RCC Buildings.