# Civil and Infrastructure Engineering

| Semester V | | | | | | |
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| **S.No** | **Course Code** | **Course Name** | **L** | **T** | **P** | **C** |
| 1 | CE302T | Design of Concrete Structures | 2 | 1 | 0 | 6 |
| 2 | CE303T | Geotechnical Engineering | 2 | 1 | 0 | 6 |
| 3 | CE304T | Transportation Engineering | 2 | 1 | 0 | 6 |
| 4 | CE302L | Transportation Engineering Laboratory | 0 | 0 | 3 | 3 |
| 5 | CE303L | Geotechnical Engineering Laboratory | 0 | 0 | 3 | 3 |
| 6 | CE305T | Environmental Engineering | 2 | 1 | 0 | 6 |
| 7 | CE304L | Environmental Engineering Laboratory | 0 | 0 | 3 | 3 |
| 8 | CE305L | Civil Engineering Software Laboratory | 0 | 0 | 3 | 3 |
| | | Total Credits | | | | 36 |

# Civil and Infrastructure Engineering

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| 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.<br>2. Design of RC beam sections for flexure using working stress method<br>3. Design of RC beam sections for flexure, shear and torsion using limit state methods<br>4. Design of RC beam elements - detailing, curtailment and serviceability<br>5. Design of one-way slabs, design of two-way slabs, design of slabs for serviceability, design of continuous slab systems.<br>6. Design of short columns under pure compression, design of short columns under compression, and uniaxial and biaxial bending<br>7. Principles of structural design of footings, design of isolated RC footings<br>8. Design of cantilever Retaining walls- Design of RC Circular Water tank.<br>9. Principles of Reinforcement Detailing |
| 4 | **Texts/References** | **References:**<br>1. Krishna Raju N. (2016). Design of Reinforced Concrete Structures, 4th Edition, CBS Publishers & Distributors CBS, New York.<br>2. Subramanian N. (2013). Design of Reinforced Concrete Structures, Oxford University Press, Maryland, USA.<br>3. Pillai S. U., Menon D. (2021). Reinforced Concrete Design, 4th Edition, McGraw Hill. |

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| 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.<br><br>**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.<br><br>**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.<br><br>**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.<br><br>**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:**<br>1. Ranjan G. and Rao A.S.R. (2016). Basic and Applied Soil Mechanics, Third edition, New Age International Pvt Ltd.<br>2. Budhu M. (2016). Soil Mechanics and Foundations, India edition, Wiley.<br>3. Venkataramaiah C. (2018). Geotechnical Engineering, Sixth edition, New Age International.<br>4. Murthy V.N.S., (2018). Soil Mechanics and Foundation Engineering, CBS Publishers. |

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| | | 5. Arora K.R. (2020). Soil Mechanics and Foundation Engineering, Standard Publishers Distributors.<br>**Reference:**<br>1. Terzaghi K., Peck R.B. and Mesri G. (2009). Soil Mechanics in Engineering Practice, Third edition, Wiley India Pvt Ltd.<br>2. Lambe T.W. and Whitman R.V. (2012). Soil Mechanics, Wiley India Pvt Ltd.<br>3. Powrie W. (2013). Soil Mechanics: Concepts and Applications, 3rd edition, CRC Press.<br>4. Knappett J. and Craig R.F. (2019). Craig's Soil Mechanics, 9th edition, CRC Press. |

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| 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.<br>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.<br>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.<br>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.<br>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.<br>2. Khanna, S.K., Justo C.E.G. and Veeraragavan. (2017). Highway Engineering, Tenth Edition, Nem Chand and Bros., Roorkee, India.<br>3. Huang, Y.H. (2008) Pavement Analysis and Design, Pearson Prentice Hall, New Jersey, USA.<br>4. Khisty C. J. and Lall. B. K. (2002) Transportation Engineering – An Introduction, Third Edition, Prentice Hall of India Pvt. Ltd, New Delhi, India.<br>5. Kandhal, P.S. (2016). Bituminous Road Construction in India, PHI Learning Pvt. Ltd., New Delhi, India.<br>6. Papacostas C.S. and Prevedouros. P.D. (2002) Transportation Engineering and Planning, Third Edition. Prentice Hall of India Pvt. Ltd, New Delhi, India.<br>7. Yoder, E.J. and Witczak. M.W. (2012) Principles of Pavement Design, Second Edition, John Wiley and Sons, New York, USA. |

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| 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.<br>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.<br>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.<br>4. Tests on Soil: California bearing ratio test.<br>5. Field tests: pavement unevenness using MERLIN, and pavement layer density using sand replacement method, deflection studies, pavement evaluation studies.<br>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.<br>2. Relevant IRC/BIS/ASTM Specifications<br>3. Relevant highway design software manual Relevant IRC/BIS/ASTM codes. |

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| 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<br>a. Determination of moisture content<br>b. Determination of specific gravity<br>c. Grain size analysis<br>d. Determination of consistency limits<br>e. Determination of relative density<br>f. Determination of field density<br>2. Engineering Properties of soils<br>a. Determination of the coefficient of permeability of a soil<br>b. Determination of the relationship between the moisture content and density of soils<br>c. Determining the settlement due to primary consolidation<br>d. 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<br>3. Measurement of shear strength of soils on a predefined shear plane<br>a. Determination unconfined compressive strength of soils<br>b. Determination of shear strength of soils<br>c. Determination of Soil Suction<br>d. Determination of CBR (California Bearing Ratio)<br>e. Determination of swelling potential of soils<br>4. In-situ Properties of soils<br>a. Determination of bearing capacity of a soil using plate load test<br>b. Determination of in-situ shear strength of soils<br>c. Determination of in-situ unconfined compressive strength<br>d. To measure material's in-situ resistance to penetration. |
| 4 | **Texts/References** | **Reading:**<br>1. Head K.H. and Epps R. J. (2006). Manual of Soil Laboratory Testing vol I, 3rd Edition, Whittles Publishing.<br>2. Head K.H. and Epps R. J. (2011). Manual of Soil Laboratory Testing vol II, 3rd Edition, Whittles Publishing.<br>3. Head K.H. and Epps R. J. (2014). Manual of Soil Laboratory Testing vol III, 3rd Edition, Whittles Publishing.<br>4. Das B.M. (2022). Soil Mechanics Laboratory Manual, 10th Ed., London, OUP USA. |

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| 1 | **Title of the course**<br>(L-T-P-C) | **Environmental Engineering**<br>**(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.<br>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.<br><br>**Module 2:** Water Treatment: aeration, sedimentation, coagulation flocculation, filtration, disinfection,<br><br>**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.<br><br>**Module 4:** Introduction to Advanced oxidation processes; emerging treatment technologies; Industrial wastewater treatment<br><br>**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<br><br>**Module 6:** Noise- Basic concept, measurement and various control methods.<br><br>**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.<br><br>**Module 8:** Building Plumbing-Introduction to various types of home plumbing systems for water supply and wastewater disposal, high rise building plumbing, Pressure reducing valves, Brake pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used.<br><br>**Module 9:** Government authorities and their roles in water supply, sewerage disposal. Solid waste management and monitoring/control of environmental pollution. |

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| 4 | **Texts/References** | 1. Masters G. M. (1991). Introduction to Environmental Engineering and Science, 1st edition, Pearson.<br>2. Vesilind P. A., Morgan S. M. (2008). Introduction to Environmental Engineering, Second Edition, Nelson Engineering.<br>3. Peavy H. S., Rowe D.R, Tchobanoglous G. (1985) Environmental Engineering, Mc-Graw -Hill International Editions, New York.<br>4. MetCalf and Eddy. Wastewater Engineering, Treatment, Disposal and Reuse, Tata McGraw-Hill, New Delhi.<br>5. Manual on Water Supply and Treatment. Ministry of Urban Development, New Delhi.<br>6. Patil S.M. (2007) Plumbing Engineering. Theory, Design and Practice, Third Edition.<br>7. Tchobanoglous G., Theissen H. & Vigil S. A. (1993). Integrated Solid Waste Management, Second Edition, McGraw Hill Publication.<br>8. Manual on Sewerage and Sewage Treatment Systems, Part A, B and C. Central Public Health and Environmental Engineering Organization, Ministry of Urban Development. |

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| 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**<br>1. Determination of the turbidity, electrical conductivity, and pH of the given sample<br>2. Determination of solids<br>3. Determination of alkalinity, acidity and hardness<br>4. Analysis of ions: copper, chloride and sulfate<br>5. Estimation of optimum coagulant dosage<br>6. Determination of Chemical oxygen demand (COD)<br>7. Determination of Dissolved Oxygen (DO), and Biochemical oxygen demand (BOD)<br>8. Determination of Break Point Chlorination<br>9. Bacterial estimation<br>10. Determination of specific gravity |
| 4 | **Texts/References** | 1. APHA Manuals,<br>2. APHA/AWWA/WPCF Publishing, Washington, D.C., latest edition |

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