4CE4-01: Geotechnical Engineering-I

## 4CE4-01: Geotechnical Engineering-I

**Credit: 3Max** **Marks: 100 (IA=30, ETE=70)**

**3L+0T+0P** **End Term Exam: 3 Hours**

**Course Objectives**

1. To familiarize the students with the concepts of geotechnical engineering and its related applications in Civil Engineering.
2. Understand Mechanism of compaction, factors affecting, and effects of compaction on soil properties.
3. To explain role of water in soil behavior and how soil stresses, permeability and quantity of seepage including flow net are estimated.

**Course Outcomes:** Upon completion of this course the students will be able to:

1. Fundamental knowledge of soil and soil mass.
2. Basic introduction and determination of index properties of soil.
3. Conduct experimental studies to determine soil properties.
4. Carried out the process of soil compaction and soil stabilization.

| S.N. | Contents | Hours |
|---|---|---|
| 1 | **Fundamental Definitions & Relationships:** Soil and soil mass constituents, Water content, specific gravity, void ratio, porosity, degree of saturation, air void and air content, unit weights, density index. Interrelationship of these terms.<br>**Index Properties:** Determination of index properties of soil, water content, specific gravity, particle size distribution, sieve and sedimentation analysis, consistency limits, void ratio, and density index. | 5 |
| 2 | **Soil Classification:** Classification of soil for general engineering purposes, particle size, textural H.R.B. Unified and I.S. Classification systems.<br>**Flow through Soils:** Soil water absorbed capillary and free water, Darcy's law of permeability of soil and its determination in laboratory, Field tests, factors affecting permeability, permeability of stratified soil masses.<br>**Seepage:** Seepage pressure, Laplace's equation for seepage, Flownet construction, Uplift pressure, piping, principle of drainage by Electro Osmosis, Phreatic line. | 11 |
| 3 | **Stresses in Soil Mass:** Total effective and neutral pressure, calculation of stresses. Influence of water table on effective stress, quicksand phenomenon. Shear Strength of Soils: Mohr's circle of stress, shear strength of soil, parameters of shear strength, Coulomb's failure envelope, determination of shear parameters by Direct Shear Box. Triaxial and unconfined compression test apparatus. | 12 |
| 4 | **Soil Compaction:** Principles of soil compaction, laboratory compaction tests, Proctor's test, Modified Proctor tests, Measurement of field compaction, field methods of compaction and its control, dry and wet of optimum. Factors affecting compaction. | 8 |
| 5 | **Soil Stabilization:** Soil stabilization, Mechanical Stabilization, Stabilization with cement, Lime, and bitumen. | 6 |
| | **Total** | **42** |

**SUGGESTED READINGS**

1. Ranjan G., Rao, A.S.R. (2016). Basic and Applied Soil Mechanics. New Age International, New Delhi.
2. Budhu, M. (2011). Soil Mechanics and Foundation, John Wiley & Sons, Inc.
3. Holtz R and Kovacs, WD, Thomas C. Sheahan (2010): Introduction to geotechnical engineering, Pearson.
4. Arora, K.R. (2020). Soil Mechanics & Foundation Engineering, Standard Publisher Dist. ISBN-13:978-8180141126.
5. Gulhati, Shashi K & Datta Manoj (2017). Geotechnical Engineering Principles and Practices, McGraw Hill Education.
6. Coduto, Donald P., Yeung, Man-chu R., Kitch, William A. (2017). Geotechnical Engineering Principles and Practices, Pearson Education Ltd.
7. Lambe. T. William and Whitman, Robert V. (2012). Soil Mechanics: Wiley India Pvt Ltd, ISBN-13: 978-8126539918.

4CE4-02: Mechanics of Solids

## 4CE4-02: Mechanics of Solids

**Credit: 4Max** **Marks: 100 (IA=30, ETE=70)**

**3L+1T+0P** **End Term Exam: 3 Hours**

**Course Objectives**

1. To understand the basic concepts of the stresses and strains for deformable bodies
2. To appreciate the development of internal forces and resistance mechanism for one dimensional and two-dimensional structural elements
3. Relationship between internal forces developed and deformations occurred in the physical object
4. To analyze and understand different internal forces and stresses induced due to representative loads on structural elements
5. To analyze and understand principal stresses due to the combination of two-dimensional stresses on an element, and failure mechanisms in different materials
6. To evaluate the behavior of members under torsion (shafts), compression (columns and struts), bending (beams), and internal pressure (pressure vessels)

**Course Outcomes:** Upon completion of this course the students will be able to:

1. To evaluate the strength of various structural elements under internal forces such as compression, tension, shear, bending and torsion.
2. To suggest suitable material from among the available in the field of manufacturing
3. To evaluate the behavior and strength of structural elements under the action of compound stresses and thus understand failure concepts.
4. To understand the basic concept of analysis and design of members subjected to torsion.
5. To understand the basic concept of analysis and design of structural elements such as columns and struts.

| S.N. | Contents | Hours |
|---|---|---|
| 1 | **Introduction**<br>A revisit to method of sections, Existence of internal forces in bodies,<br>Concept of stress and stress resultants, Stress components on plane surface (normal and shear stresses), Elements of stress tensor and their representation on infinitesimal element in rectangular coordinates, Stress tensor as matrix, Stress tensor's symmetry property, Introduce that Elements of stress tensor change by choosing different reference axes in the material,<br>Representation of different states of stress on infinitesimal volume element: Plane stress, triaxial stress, biaxial stress, uniaxial stress,<br>Uniaxial tension test on steel bar: Apparatus, gauge length, Engineering stress and true stress, notion of uniaxial strain, Engineering and true stress-strain diagram of mild steel in tension and compression, Young's modulus of elasticity, Typical engineering stress-strain diagrams in tension for structural steel, aluminum, rubber, wood etc., and in compression for copper, cast iron,<br>Idealized constitute relations (behavior) diagrams of real materials: Perfectly rigid, perfectly plastic, Elasto-plastic, Proof-stress for relevant materials,<br>Material properties, Homogeneity and isotropy properties, Poisson's ratio and its determination from uniaxial tension test, Definition of strain energy from stress-strain curve: Resilience and toughness of linear elastic materials, Generalized Hooke's law: Hooke's law for normal stresses, | 9 |

| | | |
|---|---|---|
| | Shear strain, Hooke's law in shear, stress circle | |
| 2 | **Uniaxial loaded members**<br>Axially loaded bars: Uniaxial state of stress on transverse sections, State of stress on inclined sections, maximum normal and shear stresses,<br>Changes in lengths of axially loaded members- prismatic bars, cables;<br>Changes in lengths under non-uniform conditions-bars with intermediate axial loads, bars consisting of prismatic segments, bars with continuously varying loads or dimensions;<br>Thermal expansion of bars, thermal stresses in bars confined between a) rigid supports and b) partially yielding supports<br>Stresses in Statically Indeterminate Structures,<br>Strain energy - elastic and inelastic strain energy, strain-energy density, volumetric strain | 5 |
| 3 | **Torsion**<br>Torsional deformations of a circular bar - shear stress and strains outside and within the bar and in circular tubes; angle of twist; limitations of the torsion formula;<br>Hollow circular bar (tube) - shear stresses, torsion formula for thin-walled tubes;<br>Torsion of stepped and composting shafts;<br>Stresses and strains in pure shear- stresses on inclined planes, strains in pure shear;<br>Strain energy in torsion (pure shear); | 5 |
| 4 | **Shear Forces and Bending Moments**<br>Introduction to types of beams, different types of support reactions, types of loads, shear forces and bending moments, relationships between loads, shear forces, and bending moments – for distributed, concentrated and couple loading;<br>Shear-force and bending moment diagrams for concentrated load, uniform load, several concentrated loads, combination of loads, couple loading<br>**Stresses in Beams**<br>Pure bending and non-uniform bending, Theory of flexure for initially straight beams, distribution of bending stresses across the beam cross-section, curvature of a beam, longitudinal strains in beams, normal stresses in beams, moment-curvature relationship, flexure formula and limitations; Strain Energy due to bending<br>Shear stresses in beams of rectangular cross section, circular cross section, beams with flanges - shear formula; distribution of shear stresses on transverse section, maximum and minimum shear stresses and limitations; applications on built-up beams, Shear flow and shear center | 10 |
| 5 | **Analysis of Stress and Strain**<br>Plane stress- stresses on inclined sections, transformation equations for plane stress;<br>Principal stresses and maximum shear stresses; Mohr's circle for plane stress; Hooke's law for plane stress; Relation between various elastic constants, Tri-axial stress - maximum shear stresses, | 5 |

| | | |
|---|---|---|
| | Stresses and strains in the thin walls of spherical pressure vessels and cylindrical pressure vessels; Members subjected to combined loadings,<br>Concept of theory of failure. | |
| 6 | **Deflections of Beams**<br>Differential equations of the deflection curve; Deflections by integration of the second-order bending-moment (moment-curvature) equation; deflections by integration of the shear-force and load equations (fourth-order equation);<br>Using method of superposition for obtaining deflections in complex loading and support conditions | 4 |
| 7 | **Columns**<br>Buckling and Stability- Critical Load, Equilibrium,<br>Euler buckling theory - Columns with pinned ends, column fixed at the base and pinned at the top, column with both ends fixed, effective length of columns, critical stress<br>Columns with eccentric axial loads, the Secant formula for columns | 4 |
| | **Total** | **42** |

**SUGGESTED READINGS**

1. Hibbeler, R.C. (2018). Mechanics of Materials, Pearson, ISBN-13: 978-9332584037.
2. Popov, E.P. (1999). Engineering Mechanics of Solids, Prentice-Hall (India).
3. Beer, F.P., Johnston, Jr., E.R., DeWolf, J.T. and Mazureu, D.E. (2009). Mechanics of Materials, 5th Edition, McGraw Hill
4. Crandall, S.H., Dahl, N.C. and Lardner, T.J., Sivakumar, M.S. (2017). An Introduction to the Mechanics of Solids, 3rd Edition, McGraw Hill

4CE4-03: Environmental Engineering

## 4CE4-03: Environmental Engineering

**Credit: 3Max** **Marks: 100 (IA=30, ETE=70)**

**3L+1T+0P** **End Term Exam: 3 Hours**

**Course Objectives**

1. To understand various sources of water supply and assessment of water quantity and quality.
2. To be familiar with water distribution Network and water treatment procedures
3. Students will be acquainted with wastewater characteristics, pollution and wastewater treatment.
4. To identify the sewage problems in locality and provide solutions.

**Course Outcomes:** Upon completion of this course the students will be able to:

1. Understand treatment of water and justify type of pipes, joints in pipe & various valves useful in water supply.
2. Apply different analysis techniques for the measurement of physical and chemical parameters of water and wastewater.
3. Understand the design of water treatment units.
4. Draw layout of distribution system.
5. Understand the design of sewerage system and wastewater treatment units.

| S.N. | Contents | Hours |
|---|---|---|
| 1 | Sources of Water Supply: Surface water, ground water, springs, wells & galleries. Quantity and Quality of Water: Quantity of water per capita, variation in seasonal and hourly consumption. Forecasting of population. Standards of purity for public water supply (I.S. and WHO standards).<br>Raw Water: Lakes and river intakes, raw water pumping. Treatment of Water: Aeration, screening, simple sedimentation, Quiescent and continuous flow types of tanks. Coagulation of water, principle of coagulation, coagulation followed by sedimentation, mixing basins. | 9 |
| 2 | Filtration: Slow sand filters, rapid sand filters, comparison of two filters. Disinfection: Treatment with excess lime, ozone, ultraviolet rays, boiling, chlorine and compound of chlorine for disinfection. Water Softening: Zeolite process, its limitation & advantages. | 8 |
| 3 | Pipes for Water Supply: Different types of pipes used in water supplies. Joints in Pipes: Bell& spigot joint, cement joint, mechanical joint, flanged joint. Valves: Air valve, reflux valve, safety valve, sluice valve. System of Supply: Constant & intermittent supply of water & its disadvantage. Layout of distribution system. | 8 |
| 4 | Sewage Disposal: Introduction, systems of sewage disposal, conservancy system & water carriage system. Separate, Combined and partially separate system, their advantages & disadvantages. Suitability of separate sewerage system for India. Manhole, drop manhole. Shape of sewers. Laying the sewers. | 7 |
| 5 | Design of Sewers: Quantity of sewage, provision for future population, Quantity of storm water, design of sewers, Estimating storm water by time of concentration method. Testing of sewer line. Cleaning of sewers. Preliminary Treatment: screening, disposal of screening, skimming tank, grit chamber, disposal of grit.<br>Sewage Treatment: Principle of sewage, sedimentation, filtration, intermittent sand filter, introduction of trickling filter. Advantage & disadvantage of trickling filter. | 10 |
| | **Total** | **42** |

**SUGGESTED READINGS**

1. Hussain, S.K. (2017). Textbook of water supply & Sanitary Engineering. Oxford & IBH Publishing co. Pvt. Ltd., New Delhi.
2. Davis M. L. and Cornwell D. A. (2012). Introduction to Environmental Engineering. Rangewala, S.C. (2016). Fundamentals of water supply & sanitary engineering. Charotar Publisher House, Anand.
3. Syed R. Qasim. (2010). Wastewater Treatment Plants, CRC Press, Washington D.C.
4. Garg, S.K. (2015). Water supply & sanitary engineering. Khanna Publishers. New Delhi.
5. Gray N.F. (2006). Water Technology. Elsevier India Pvt. Ltd., New Delhi.
6. Manual on Sewerage and Sewage Treatment Systems Part A, B and C (2013) CPHEEO, Ministry of Urban Development, Government of India, New Delhi.
7. Birdie, G. S., and Birdie. (2010). Water Supply and Sanitary Engineering.
8. Metcalf and Eddy. (2010). Wastewater Engineering–Treatment and Reuse, Tata McGraw-Hill Company, New Delhi.
9. Garg, S.K. (2015). Environmental Engineering, Khanna Publishers, New Delhi, Vol. II
10. Punmia, B.C., Jain, A.K., and Jain, A.K. (2010). Environmental Engineering, Vol. II, Laxmi Publications.
11. Manual on Water Supply and Treatment: Ministry of Urban Dev., New Delhi.

4CE4-04: Hydraulics Engineering

## 4CE4-04: Hydraulics Engineering

**Credit: 3Max** **Marks: 100 (IA=30, ETE=70)**

**3L+0T+0P** **End Term Exam: 3 Hours**

**Course Objectives**

1. To impart basic knowledge about the open channel flows with analysis of uniform flow, gradually varied flows and rapidly varied flows.
2. Expose to basic principles of working of hydraulic machineries.
3. To understand the engineering hydrology and canal hydraulics

**Course Outcomes:** Upon completion of this course the students will be able to:

1. Describe the basics of open channel flows, associated classifications.
2. Analysis of uniform flow in steady state conditions with specific energy concept and its application.
3. Analyze steady gradually varied flow, water surface profiles and its length calculation using direct and standard step methods.
4. Acquired knowledge about hydraulic machines like pumps and turbines.
5. Analyze surface hydrological data and draw hydrograph and other useful parameters and design economical channel section.

| S.N. | Contents | Hours |
|---|---|---|
| 1 | Dimensional Analysis & Models: Dynamical Similarity and Dimensional Homogeneity Model experiment, geometric, Kinematic and Dynamic similarity. Reynold's, Froude's, Weber's, Euler and Mach numbers. Distorted river models and undistorted models, proper choice of scale ratios. Scale effect. Principle of dimensional analysis Rayleigh method, Buckingham theorem. | 7 |
| 2 | Turbulent flow, Reynolds equations, Prandtl's mixing length theory, Equations of velocity distribution and friction coefficient Boundary Layer Theory: Concept of boundary layer, laminar and turbulent boundary layers, boundary layer thickness, von Karman integral equation, laminar sub-layer, hydro-dynamically smooth and rough boundaries, separation of flow and its control, cavitation. | 6 |
| 3 | Open Channel Flow: Uniform, Non-Uniform, and variable flow. Resistance equations of Chezy and Manning. Section factor for uniform flow. Most efficient rectangular, triangular, and trapezoidal sections. Velocity distribution in open channels.<br>Gradually Varied Flow: Prismatic channels, Specific energy of flow. Critical depth in prismatic channels. Alternate depths. Rapid, critical and sub critical flow, Mild, steep, and critical slopes. Classification of surface curves in prismatic channels and elementary computation. | 8 |
| 4 | Rapidly Varied Flow: Hydraulic jump or standing wave in rectangular channels. Conjugate or sequent depths Losses in jump, location of jump. velocity distribution in open channels.<br>Impact of Free Jets: Impact of a jet on a flat or a curved vane, moving and stationary vane. Introduction of Hydraulic machine – Type of pumps and turbines and its brief description. Draft tube and its principle. | 7 |
| 5 | Hydrology: Definition, Hydrologic cycle, Application to Engineering problems, measurement of rainfall, rain gauge, peak flow, flood frequency method, catchment area formulae, Flood hydrograph, Rainfall analysis, Infiltration, Runoff, Unit hydrograph and its determination, | 8 |

| | | |
|---|---|---|
| | Estimation of runoff. | |
| 6 | Canal Hydraulics: Types of canals, parts of canal irrigation system, channel alignment, assessment of water requirements, estimation of channel losses, design of channels, regime and semi theoretical approaches (Kennedy's Theory, Lacey's Theory), cross section of channels. | 6 |
| | **Total** | **42** |

**SUGGESTED READINGS**

1. Modi P.N. and Seth. (2013). Hydraulics and Fluid Mechanics including Hydraulic Machines. Standard Book House New Delhi. 19th edition.
2. S K Som (2012). Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd.
3. Ven Te Chow. (2009). Open Channel Hydraulics, McGraw Hill, New York.
4. Mays L. W. (2005). Water Resources Engineering, John Wiley & Sons (WSE), New York.
5. Garg S.K. and Rajeshwari Garg. (2021). Elementary Irrigation and Water Resources Engineering.
6. Mays L. W. (2005). Water Resources Engineering, John Wiley & Sons (WSE), New York.

4CE4-05: Construction Management

## 4CE4-05: Construction Management

**Credit: 3Max** **Marks: 100 (IA=30, ETE=70)**

**3L+0T+0P** **End Term Exam: 3 Hours**

**Course Objectives**

The objective of this course is to study:

1. Economics and flow of a civil construction project, from planning to execution to dismantling,
2. Involvement of different stakeholders in diverse ways
3. Optimization of project resources at different phases of construction

   so as to help a student to be able to conveniently plug-in at any stage of future construction project.

**Course Outcomes:** Upon completion of this course the students will be able to:

1. Understand and appreciate construction project handling and economics
2. Appreciate and estimate time-value of money and assets
3. Perform cost estimation of construction components
4. Plan a basic construction project and perform network analysis
5. Exercise levelling resources on basic small-scale projects
6. Have knowledge of construction industry quality, safety aspects, claims and dispute mechanisms.

| S.N. | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Construction Projects**<br>Introduction to Construction Projects, Types and features, Phases of Construction Project, Project Stakeholders. (Agencies involved and their methods of execution)<br>**Economics and Cost Estimation**<br>Project Cost Estimation from Client's perspective: Rate Analysis and Specifications, Time Value of Money, Economic Decision Making.<br>**Tendering and Contracts**<br>Tendering Process and Construction Contract, Cost Estimate from Contractor's Perspective (Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail etc) | 8 |
| 2 | **Project Planning and Network - I**<br>Project Resources, Project Plan, Work Breakdown Structure (WBS),<br>Steps in Project Planning: a) Prepare WBS, b) Obtain durations, cost expenditure and resource requirement for each activity, c) Obtain relationship between activities<br>Planning Terminology: Event, Activity, Network, Precedence, Logic, Duration, Forward/Backward Pass, Float/Slack Time, Critical Path,<br>Network Diagrams: Types like Arrow Networks (traditional AOA), Node Networks (modern AON), and superiority of Node networks, Preparation of Network Diagrams; Precedence Tables, Contiguous and Interruptible Activities, | 6 |
| 3 | **Project Planning and Network - II**<br>Network Analysis | 8 |

| | | |
|---|---|---|
| | CPM: Critical path method with AOA and AON networks<br>PERT: Where to use and where not, Distributions, data binning and histogram examples, Most likely and expected durations, Probability density (PDF) and cumulative probability (CPF) functions, Standard normal distribution and z-tables, PERT calculations by drawing CPM network such as a) Determine the duration (or finish date) of the project, given the probability/likelihood b) Determine the probability of finishing the project, given the deadline | |
| 4 | **Project Scheduling and Control**<br>Resource Scheduling, Resource Levelling, Resource constraints and conflicts, line of balance technique,<br>Resource categories such as a) Labor (planning, organizing, staffing, motivation), b) material (concepts of planning, procurement, and inventory control) and c) equipment; Funds: cash flow, sources of funds<br>Network crashing (compression the schedule)<br>Broad classification of resource scheduling: a) Resource levelling and b) resource allocation, Solve examples on resource levelling<br>Classification of costs, Time-Cost trade-off, Duration Shortening, Time-Cost Monitoring and Control using S-curve, Earned-value Analysis | 10 |
| 5 | **Construction Claims and Disputes**<br>Construction Claims and Disputes, Claim Identification, Compensations, Disputes Causes, Dispute Resolution Mechanisms, Legal Proceedings.<br>**Construction Quality and Safety**<br>Quality control: Concept of quality, PDSA Cycle, Quality of constructed structure, Quality control and management, Use of manuals and checklists for quality control, Role of inspection, Basics of statistical quality control<br>Quality control in RC structures: Quality of grouting and welds; Introduction to construction audit<br>Safety and health on project sites: accidents; their causes and effects, costs of accidents, occupational health problems in construction, organizing for safety and health | 10 |
| | **Total** | 42 |

**SUGGESTED READINGS**

1. Barrie, D.S., Paulson B.C. (2013). Professional Construction Management, McGraw Hill.
2. Mubarak S.A. (2019). Construction project scheduling and control. 4th Edition John Wiley & Sons.
3. Jha K.N., (2015). Construction Project Management: Theory and Practices, Pearson Press, 2nd Edition.
4. Chitkara, K.K. (2019). Construction Project Management, Tata McGraw Hill.
5. Joy, P.K. (2000). Handbook of Construction Management, Macmillan Publishers India.
6. King, R.W., Hudson, R. (1985). Construction Hazard and Safety Handbook, Butterworths.
7. Antill J.M., Woodhead R.W. (1982). Critical Path Methods in Construction Practice, Wiley.

4CE2-01: Advanced Engineering Mathematics

## 4CE2-01: Advanced Engineering Mathematics

**Credit: 3Max** **Marks: 100 (IA=30, ETE=70)**

**3L+0T+0P** **End Term Exam: 3 Hours**

**Course Objectives**

1. To familiarize the students with linear algebra and transform calculus
2. To make the students appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated

**Course Outcomes:** Upon completion of this course the students will be able to:

1. Construct analytic functions and use their conformal mapping property in application problems.
2. Apply transform methods for solving linear differential equations in engineering applications

| S.N. | Contents | Hours |
|---|---|---|
| 1. | **Introduction to Linear Algebra**:<br>Algebraic Structures, Sets, Groups, Vector Spaces, Subspaces, Linear independences Linear Transformations, Addition, scalar multiplication and product of linear transformations,<br>Polynomials of linear transformations, Constant coefficient linear differential operator, Null Space of linear transformations, Inverse of a linear transformation, | 8 |
| 2. | **Laplace Transform**:<br>Definition and existence of Laplace transform, Properties of Laplace Transform and formulae,<br>Unit Step function, Dirac Delta function, Heaviside function,<br>Laplace transforms of periodic functions. Finding inverse Laplace transforms by different methods, convolution theorem. Evaluation of integrals by Laplace transform,<br>Solving ODEs by Laplace transforms method | 8 |
| 3. | **Solution of IVP using Laplace Transforms**:<br>Introduction to Initial Value Problems (IVP), Functions of exponential order, Convergence behavior of piecewise continuous function of exponential order,<br>Salient features of Laplace Transforms: Linear, one-to-one, existence valid for only functions of exponential order<br>Laplace Transforms of differentiation and integration, Shifting Theorems, Laplace Transform tables<br>Coupled Linear Differential Equations: Forced-damped vibration (derive equations for two-particle-mass system), Free-undamped vibrations, and then Uncoupling those LDEs using Laplace transform and further solving using inverse Laplace transform | 10 |
| 4. | **Fourier Series and Fourier Transforms**:<br>Fourier series: Introduction, derivation and physical interpretation; Fourier series expansion of periodic functions: Square wave, triangular wave, sawtooth wave,<br>Fourier Complex Sine and Cosine transforms, properties of Fourier Transforms, inverse Fourier transforms, Convolution theorem, Parseval's theorem | 10 |

| | | |
|---|---|---|
| | Application of Fourier transforms to differential equations (heat equation and wave equations) | |
| 5. | **Z-Transforms**:<br>Definition, properties and formulae, Convolution theorem, inverse Z-transform,<br>Application of Z-transform to solve difference equation | 6 |
| | **Total** | **42** |

**SUGGESTED READINGS**

1. Robert G. Kuller, Donald R. Ostberg, Fred W. Perkins, Donald L. Kreider. (1966). An Introduction to Linear Analysis. Addison-Wesley Pub. Co.
2. Erwin Kreyszig. (2017). Advanced Engineering Mathematics. John Wiley and Sons, 10th Edition, New Delhi.
3. Grewal B.S. (2017). Higher Engineering Mathematics. Khanna Publishers, 44th Edition, New Delhi.
4. Bali N., Goyal M., and Watkins C. (2009). Advanced Engineering Mathematics. Firewall Media, 7th Edition, New Delhi.
5. Glyn James. (2011). Advanced Modern Engineering Mathematics. Pearson Education, 4th Edition, New Delhi.
6. Peter V. O'Neil (2012). Advanced Engineering Mathematics, Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi.
7. Ramana B.V. (2010). Higher Engineering Mathematics, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi.

4CE4-20: Environmental Engineering Lab

## 4CE4-20: Environmental Engineering Lab

**Credit: 1Max** **Marks: 100(IA: 60, ETE: 40)**

**0L+0T+2P**

**Course Objectives**

1. To understand the basic characteristics of water and wastewater
2. To analyze the physical, chemical, and bacteriological characterization of water and wastewater.

**Course Outcomes:** Upon completion of this course the students will be able to:

1. Apply analysis techniques to assess the physical and chemical parameters of water and wastewater.
2. Recommend the degree of treatment required for the water.
3. Quantify the pollutant concentration in water and wastewater.
4. Microscopic studies of water and wastewater.

| S.N. | Contents |
|---|---|
| Part A | Physical, chemical, and bacteriological characterization of water and chemical dose determination for water treatment by performing following laboratory experiments:<br>1. To determine the pH value and the turbidity of a given sample of water<br>2. To determine the conductivity of a given water sample<br>3. To determine the free residual chlorine and chloride concentration in a sample of water<br>4. To determine the optimum coagulant dose<br>5. To determine the temporary and permanent hardness in a given water sample<br>6. To determine the dissolved oxygen (DO) in a given sample of water.<br>7. Microscopic studies of water |
| Part B | Physical, chemical, and bacteriological characterization of wastewater and strength assessment of wastewater by performing following laboratory experiments:<br>1. To determine the acidity and alkalinity of a wastewater sample<br>2. To determine total, suspended, dissolved and settable solids in a wastewater sample<br>3. To determine volatile and fixed solids in a wastewater sample<br>4. To determine the chloride concentration in a wastewater sample<br>5. To determine the sulphate concentration in a wastewater sample<br>6. To determine the BOD of a given wastewater sample<br>7. To determine the COD of a given wastewater sample<br>8. Microscopic studies of a wastewater |

**SUGGESTED READINGS**

1. Manual on Water Supply and Water treatment. Ministry of Urban Development, Govt. of India, New Delhi.
2. Standard methods for the examination of water and wastewater. (2012). 21st Edition, Washington: APHA.
3. Dr D. R. Khanna and Dr R. Bhutiani. (2008). Laboratory Manual of Water and Wastewater Analysis.
4. Sawyer, C. N., McCarty, P. L., and Perkin, G.F. (2002). Chemistry for Environmental Engineering and Science, 5th edition McGraw-Hill Inc.
5. B. Kotaiah and Dr. N. Kumara Swamy. (2007). Environmental Engineering Laboratory Manual, Charotar Publishing House Pvt. Ltd., 1st Edition.

4CE4-21: Hydraulics Engineering Lab

## 4CE4-21: Hydraulics Engineering Lab

**Credit: 1Max** **Marks: 100(IA: 60, ETE: 40)**

**0L+0T+2P**

**Course Objectives**

1. To understand the basic concepts of hydraulics
2. To develop an understanding of the model studies of hydraulic structures and design of open channel sections under different situations

**Course Outcomes:** Upon completion of this course the students will be able to:

1. Derive the relationship among the sequent depths of steady rapidly varied flow and estimating energy loss in hydraulic jump with exposure to positive and negative surges.
2. Analyze the water surface profiles under different flow situations

| S.N. | Contents |
|---|---|
| 1 | To prepare the slope calibration chart for an experimental flume. |
| 2 | To study the velocity distribution in open channel flow. |
| 3 | To determine the Manning's roughness coefficient of an experimental flume over different roughness beds. |
| 4 | To conduct the laboratory flume experiment for construction of specific energy curves for various discharges. |
| 5 | To conduct the laboratory flume experiment for plotting of gradually varying flow (GVF) profiles. |
| 6 | To compare the experimental GVF profiles with computed GVF profiles. |
| 7 | To conduct the laboratory flume experiment for determination of energy loss in various types of hydraulic jumps. |
| 8 | To determine the coefficient of discharge of sharp crested weir and broad crested weir. |
| 9 | To determine the coefficient of discharge of Venturi flume. |
| 10 | To determine the coefficient of discharge of Parshall flume. |

**SUGGESTED READINGS**

1. Modi P.N. and Seth, S.M. (2003). Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House, New Delhi.
2. S K Som; Gautam Biswas and S Chakraborty. (2012). Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd.
3. Ven Te Chow. (2009). Open Channel Hydraulics, McGraw Hill, New York.
4. Dr. G L Asawa (2019). Laboratory Work in Hydraulic Engineering, New Age International (P) Ltd., Publishers, ISBN 9788122418101
5. Raikar R.K. (2012). Laboratory Manual Hydraulics and Hydraulic Machines, Prentice Hall India Learning Private Limited.

4CE4-22: Civil Engineering Lab-II

## 4CE4-22: Civil Engineering Lab-II

**Credit: 1Max** **Marks: 100(IA: 60, ETE: 40)**

**0L+0T+2P**

**Course Objectives**

1. To impart knowledge and skill relevant to the mechanical properties of materials subjected to different types of loading.

**Course Outcomes:** Upon completion of this course the students will be able to:

1. Apply the knowledge of testing steel rod subjected to tension and torsion.
2. Explain the hardness of different metals.
3. Exert knowledge about the testing of helical spring and carriage spring.
4. Acquire the knowledge about double shear test on metal and impact test on metal.

| S.N. | Contents |
|---|---|
| 1 | Tests on Mild steel to obtain stress-strain relationship, and to determine material constants: a) Young's Modulus, b) Poisson's ratio, and to characterize, yield stress and strain, ultimate stress, stress at fracture, fracture strain |
| 2 | Tension test on Tor steel (HYSD bars) and proof stress |
| 3 | Torsion Test on Mild Steel Circular Bar |
| 4 | Bend and Rebend Test on structural reinforcement steel bars |
| 5 | Impact test on metal specimen (Izod and Charpy) |
| 6 | Hardness Tests on Ferrous and Non-Ferrous Metals: Brinell and Rockwell Tests |
| 7 | Modulus of Rupture of Wooden Beam |
| 8 | Characterization of concrete using NDT methods: a) Ultrasonic Pulse Velocity (UPV) test (for Elasticity modulus) (IS 516 - Part 5, Sec 1 :2018), b) Rebound Hammer test (for strength) (IS 516 - Part 5, Sec 4 :2020), and finally using c) compressive strength test in CTM (IS 516) |

**SUGGESTED READINGS**

1. Strength of Materials Laboratory Manual, Anna University, Chennai-600025.
2. IS 432 (Part I) -1992 – Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
3. Rajput, R.K. (2014). Strength of Materials, S. Chand & Company Ltd., New Delhi.
4. S.D. Hasan. (2020). Civil Engineering Materials and their testing. ISBN 9788173197390
5. Sood, Hemant. (1996). Laboratory manual on testing of Engineering materials. New Age International (P) Ltd., ISBN 9788122407570
6. M.L. Gambhir, Neha Jamwal. (2017). "Building and Construction Materials: Testing and Quality Control (Lab Manual Series)".

4CE4-23: Geotechnical Engineering Lab -I

## 4CE4-23: Geotechnical Engineering Lab -I

**Credit: 1Max** **Marks: 100(IA: 60, ETE: 40)**

**0L+0T+2P**

**Course Objectives**

1. Introduce the students to the basic concepts and principles of soil mechanics.
2. Determine the index and engineering properties of soil.

**Course Outcomes:** Upon completion of this course the students will be able to:

1. Conduct experimental studies to determine soil properties.
2. Evaluate the compaction and consolidation characteristics of soils in engineering practices.
3. Determine the shear strength of soils.

| S.N. | Contents |
|---|---|
| | **Laboratory Work:**<br>The students will be introduced to Index and Engineering properties of soils to complement the theory component of the course by performing experiments. They will perform related experiments as per the Standards and Specifications. |
| 1. | Determination of field density by Core cutter & Sand replacement method |
| 2. | Grain size Analysis by Mechanical & Hydrometer Method. |
| 3. | Determination of Specific Gravity by Pycnometer. |
| 4. | Determination of Liquid Limit, Plastic limit & Shrinkage limit. |
| 5. | Determination of Permeability by constant head & variable head permeameter. |
| 6. | Consolidation Test |
| 7. | Unconfined Compression Test. |
| 8. | Direct Shear Test. |

**SUGGESTED READINGS**

1. Ranjan G. & Rao. (2007). Basic and Applied Soil Mechanics. New Age International, New Delhi.
2. Holtz, R.D., Kovacs, W.D., Sheahan, T.C. (2013). Introduction to geotechnical engineering by John Wiley New York.
3. Braja M. Das. (2014). Principles of Geotechnical Engineering, Cengage learning Pvt. Ltd, 8th Edition.
4. William A Kitch. (2011). Geotechnical Engineering Lab manual, Kendall/Hunt Publishing Co, U.S.