

[AKU-PATNA] [101-CE]  
**CURRICULUM**  
**FOR**  
**CIVIL ENGINEERING**

**SEMESTER - IV (CIVIL ENGINEERING)**

| S.No | Paper Code | Paper Title                                  | L | T | P | Credits |
|------|------------|----------------------------------------------|---|---|---|---------|
| 1    | ESC 209    | Mechanical Engineering                       | 2 | 1 | 0 | 3       |
| 2    | PCC CE 202 | Engineering Geology                          | 2 | 0 | 2 | 3       |
| 3    | PCC CE 203 | Disaster Preparedness & Planning             | 1 | 1 | 0 | 2       |
| 4    | PCC CE 204 | Introduction to Fluid Mechanics              | 3 | 0 | 2 | 4       |
| 5    | PCC CE 205 | Introduction to Solid Mechanics              | 3 | 0 | 0 | 3       |
| 6    | PCC CE 208 | Structural Analysis                          | 3 | 1 | 0 | 4       |
| 7    | PCC CE 207 | Materials, Testing & Evaluation              | 1 | 1 | 2 | 3       |
| 8    | HSMC 252   | Civil Engineering - Societal & Global Impact | 2 | 0 | 0 | 2       |
| 9    | -          | Open Elective-I (Humanities) MOOC            | 2 | 0 | 0 | 2       |
| 10   | -          | Management I (Organizational Behaviour)      | 3 | 0 | 0 | 0       |

**PAPER CODE - ESC 209**

|                |                               |            |            |            |                 |
|----------------|-------------------------------|------------|------------|------------|-----------------|
| <b>ESC 209</b> | <b>Mechanical Engineering</b> | <b>L:2</b> | <b>T:1</b> | <b>P:0</b> | <b>CREDIT:3</b> |
|----------------|-------------------------------|------------|------------|------------|-----------------|

**Module 1**

**Basic Concepts:** Basic concepts - concept of continuum, macroscopic approach, Thermodynamic systems - closed, open and isolated. Property, state, path and process, quasistatic process, work, modes of work. Zeroth law of thermodynamics, concept of temperature and heat. Concept of ideal and real gases.

**Module 2**

**First Law of Thermodynamics:** Concepts of Internal Energy, Specific Heat Capacities, Enthalpy. Energy Balance for Closed and Open Systems, Energy Balance for

Steady-Flow Systems. Steady-Flow Engineering Devices. Energy Balance for Unsteady-Flow

## Module 3

**Second Law of Thermodynamics:** Thermal energy reservoirs, heat engines energy conversion, Kelvin and Clausius statements of second law, the Carnot cycle, the Carnot Theorem, the thermodynamic temperature scale, the Carnot heat engine, efficiency, the Carnot refrigerator and heat pump, COP. Clausius inequality, concept of entropy, principle of increase of entropy - availability, the increase of entropy principle, perpetual-motion machines, reversible and irreversible processes, Entropy change of pure substances, isentropic processes, property diagrams involving entropy, entropy change of liquids and solids, the entropy change of ideal gases, reversible steady-flow work, minimizing the compressor work, isentropic efficiencies of steady-flow devices, and entropy balance. Energy - a measure of work potential, including work potential of energy, reversible work and irreversibility, second-law efficiency, exergy change of a system, energy transfer by heat, work, and mass, the decrease of exergy principle and exergy destruction, energy balance: closed systems and control volumes energy balance.

## Module 4

**Properties Of Pure Substance:** Properties of pure substances. Thermodynamic properties of pure substances in solid, liquid and vapour phases. Phase rule, P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces. Thermodynamic properties of steam. Calculations of work done and heat transfer in non- flow and flow processes.

## Module 5

**Power Cycles:** Vapour and combined power cycles, including the Carnot vapor cycle, Rankine cycle: the ideal cycle for vapor power, the ideal reheat and regenerative and the second-law analysis of vapour power cycles. Gas power cycles, including basic considerations in the analysis of power cycles, the Carnot cycle and its value in engineering, an overview of reciprocating engines, air standard assumptions, gasoline engine Otto cycle, diesel engine cycle, gas-turbine Brayton cycle, and the second-law analysis of gas power cycles.

## Module 6

**Ideal and Real Gases and Thermodynamic Relations:** Gas mixtures - properties ideal and real gases. Equation of state, Avogadro's Law, Van Der Waals equation of state, Compressibility factor, compressibility chart. Dalton's law of partial pressure. Exact differentials, T-D relations, Maxwell's relations. Clausius Clapeyron equations, Joule - Thomson coefficient.

## Module 7

Psychrometry and psychrometric charts, property calculations of air vapour mixtures. Psychrometric process - Sensible heat exchange processes. Latent heat exchange processes. Adiabatic mixing, evaporative cooling. Use of standard thermodynamic tables, Mollier diagram, Psychrometric chart and Refrigerant property tables. Refrigeration cycles, including refrigerators and heat pumps, the ideal reversed Carnot vapour-compression refrigeration cycle, actual vapor- compression refrigeration cycles, heat pump systems, gas refrigeration cycles, and absorption refrigeration systems.

### Text/Reference Books:

- Nag.P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi.
- Cengel, Thermodynamics - An Engineering Approach Tata McGraw Hill, New Delhi.
- Sonntag, R. E., Borgnakke, C., & Wylen, G. J. V. Fundamentals of thermodynamics: Wiley.
- Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. Fundamentals of Engineering Thermodynamics: John Wiley & Sons.
- Jones, J. B., & Dugan, R. E. Engineering thermodynamics: Prentice Hall.
- Potter, M. C., & Somerton, C. W. Schaum's Outline of Thermodynamics for Engineers, McGraw-Hill.

### PAPER CODE - PCC CE 202

|              |                     |     |     |     |          |
|--------------|---------------------|-----|-----|-----|----------|
| PCC - CE 202 | Engineering Geology | L:2 | T:0 | P:2 | CREDIT:3 |
|--------------|---------------------|-----|-----|-----|----------|

The objective of this Course is to focus on the core activities of engineering geologists - site characterization and geologic hazard identification and mitigation. Through lectures, labs, and case study examination student will learn to couple geologic expertise with the engineering properties of rock and unconsolidated materials in the characterization of geologic sites for civil work projects and the quantification of processes such as rock slides, soil-slope stability, settlement, and liquefaction. Engineering geology is an applied geology discipline that involves the collection, analysis, and interpretation of geological data and information required for the safe development of civil works. Engineering geology also includes the assessment and mitigation of geologic hazards such earthquakes, landslides, flooding; the assessment of timber harvesting impacts; and groundwater remediation and resource evaluation. Engineering geologists are applied geoscientists with an awareness of engineering principles and practice—they are not engineers.

### Detailed contents:

#### Module 1

**Introduction:** Branches of geology useful to civil engineering, scope of geological studies in various civil engineering projects. Department dealing with this subject in India and their scope of work- GSI, Granite Dimension Stone Cell, NIRM. Mineralogy-Mineral, Origin and composition. Physical properties of minerals, susceptibility of minerals to alteration, basic of optical mineralogy, SEM, XRD., Rock forming minerals, megascopic identification of common primary & secondary minerals.

## Module 2

**Petrology:** Rock forming processes. Specific gravity of rocks. Ternary diagram. Igneous petrology- Volcanic Phenomenon and different materials ejected by volcanoes. Types of volcanic eruption. Concept of Hot spring and Geysers. Characteristics of different types of magma. Division of rock on the basis of depth of formation, and their characteristics. Chemical and Mineralogical Composition. Texture and its types. Various forms of rocks. IUGS Classification of phaneritic and volcanic rock.. Field Classification chart. Structures. Classification of Igneous rocks on the basis of Chemical composition. Detailed study of Acidic Igneous rocks like Granite, Rhyolite or Tuff, Felsite, Pegmatite, Hornfels. Metamorphic Aureole, Kaolinization. Landform as Tors. Engineering aspect to granite. Basic Igneous rocks Like Gabbro, Dolerite, Basalt. Engineering aspect to Basalt. Sedimentary petrology- mode of formation, Mineralogical Composition. Texture and its types, Structures, Gradation of Clastic rocks. Classification of sedimentary rocks and their characteristics. Detailed study of Conglomerate, Breccia, Sandstone, Mudstone and Shale, Limestone Metamorphic petrology- Agents and types of metamorphism, metamorphic grades, Mineralogical composition, structures & textures in metamorphic rocks. Important Distinguishing features of rocks as Rock cleavage, Schistosity, Foliation. Classification. Detailed study of Gneiss, Schist, Slate with engineering consideration.

## Module 3

**Physical Geology:** Weathering. Erosion and Denudation. Factors affecting weathering and product of weathering. Engineering consideration. Superficial deposits and its geotechnical importance: Waterfall and Gorges, River meandering, Alluvium, Glacial deposits, Laterite (engineering aspects), Desert Landform, Loess, Residual deposits of Clay with flints, Solifluction deposits, mudflows, Coastal deposits.

## Module 4

**Strength Behavior of Rocks:** Stress and Strain in rocks. Concept of Rock Deformation & Tectonics. Dip and Strike. Outcrop and width of outcrop. Inliers and Outliers. Main types of discontinuities according to size. Fold- Types and nomenclature, Criteria for their recognition in the field. Faults: Classification, recognition in field, effects on outcrops. Joints & Unconformity; Types, Stresses responsible, geotechnical importance. Importance of structural elements in

engineering operations. Consequences of failure as land sliding, Earthquake and Subsidence. Strength of Igneous rock structures.

## Module 5

**Geological Hazards:** Rock Instability and Slope movement: Concept of sliding blocks. Different controlling factors. Instability in vertical rock structures and measures to prevent collapse. Types of landslide. Prevention by surface drainage, slope reinforcement by Rock bolting and Rock anchoring, retaining wall, Slope treatment. Case study on black clay. Ground water: Factors controlling water bearing capacity of rock. Pervious & impervious rocks and ground water. Lowering of water table and Subsidence. Earthquake: Magnitude and intensity of earthquake. Seismic sea waves. Revelation from Seismic Records of structure of earth. Case Study on Elevation and Subsidence in Himalayan region in India. Seismic Zone in India.

## Module 6

**Rock masses as construction material:** Definition of Rock masses. Main features constitute rock mass. Main features that affect the quality of rock engineering and design. Basic elements and structures of rock are relevant in civil engineering areas. Main types of works connected to rocks and rock masses. Important variables influencing rock properties and behavior such as Fresh rock Influence from some minerals. Effect of alteration and weathering. Measurement of velocity of sound in rock. Classification of Rock material strength. Core logging .Rock Quality Designation. Rock mass description.

## Module 7

**Geology of dam and reservoir site:** Required geological consideration for selecting dam and reservoir site. Failure of Reservoir. Favorable & unfavorable conditions in different types of rocks in presence of various structural features, precautions to be taken to counteract unsuitable conditions, significance of discontinuities on the dam site and treatment given to such structures.

## Module 8

**Rock Mechanics:** Subsurface investigations in rocks and engineering characteristics or rocks masses; Structural geology of rocks. Classification of rocks, Field & laboratory tests on rocks, Stress deformation of rocks, Failure theories and shear strength of rocks, Bearing capacity of rocks.

## Practicals:

- Study of physical properties of minerals.
- Study of different groups of minerals.
- Study of Crystal and Crystal system.

- Identification of minerals: Silica group: Quartz, Amethyst, Opal; Feldspar group: Orthoclase, Plagioclase; Cryptocrystalline group: Jasper; Carbonate group: Calcite; Element group: Graphite; Pyroxene group: Talc; Mica group: Muscovite; Amphibole group: Asbestos, Olivine, Hornblende, Magnetite, Hematite, Corundum, Kyanite, Garnet, Galena, Gypsum.
- Identification of rocks (Igneous Petrology): Acidic Igneous rock: Granite and its varieties, Syenite, Rhyolite, Pumice, Obsidian, Scoria, Pegmatite, Volcanic Tuff. Basic rock: Gabbro, Dolerite, Basalt and its varieties, Trachyte.
- Identification of rocks (Sedimentary Petrology): Conglomerate, Breccia, Sandstone and its varieties, Laterite, Limestone and its varieties, Shales and its varieties.
- Identification of rocks (Metamorphic Petrology): Marble, slate, Gneiss and its varieties, Schist and its varieties. Quartzite, Phyllite.
- Study of topographical features from Geological maps. Identification of symbols in maps.

### Text/Reference Books:

- Engineering and General Geology, Parbin Singh, 8th Edition (2010), S K Kataria & Sons.
- Text Book of Engineering Geology, N. Chenna Kesavulu, 2nd Edition (2009), Macmillan Publishers India.
- Geology for Geotechnical Engineers, J.C. Harvey, Cambridge University Press (1982).

### PAPER CODE - PCC CE 203

|             |                                             |     |     |     |          |
|-------------|---------------------------------------------|-----|-----|-----|----------|
| PCC- CE 203 | Disaster Preparedness & Planning Management | L:1 | T:1 | P:0 | CREDIT:2 |
|-------------|---------------------------------------------|-----|-----|-----|----------|

The overall aim of this course is to provide broad understanding about the basic concepts of Disaster Management with preparedness as a Civil Engineer. Further, the course introduces the various natural hazards that can pose risk to property, lives, and livestock, etc. and understanding of the social responsibility as an engineer towards preparedness as well as mitigating the damages. The objectives of the course are i) To Understand basic concepts in Disaster Management ii) To Understand Definitions and Terminologies used in Disaster Management iii) To Understand Types and Categories of Disasters iv). To Understand the Challenges posed by Disasters vi) To understand Impacts of Disasters Key Skills.

### Detailed contents:

#### Module 1

**Introduction:** Concepts and definitions: disaster, hazard, vulnerability, risks- severity, frequency and details, capacity, impact, prevention, mitigation).

## Module 2

**Disasters:** Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunamis, landslides, coastal erosion, soil erosion, forest fires etc.); man made disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.

## Module 3

**Disaster Impacts:** Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

## Module 4

**Disaster Risk Reduction (DRR):** Disaster management cycle - its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post Disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

## Module 5

**Disasters, Environment and Development:** Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.

### Text/Reference Books:

- <http://ndma.gov.in/> (Home page of National Disaster Management Authority)
- <http://www.ndmindia.nic.in/> (National Disaster management in India, Ministry of Home Affairs).
- Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
- Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.
- Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation
- Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California, EMSA no.214, June 2003 Inter Agency Standing Committee

(IASC) (Feb. 2007). IASC Guidelines on Mental Health and Psychosocial Support in Emergency Settings. Geneva: IASC

## PAPER CODE - PCC CE 204

|            |                                 |     |     |     |          |
|------------|---------------------------------|-----|-----|-----|----------|
| PCC-CE 204 | Introduction to Fluid Mechanics | L:3 | T:0 | P:2 | CREDIT:4 |
|------------|---------------------------------|-----|-----|-----|----------|

The objective of this course is to introduce the concepts of fluid mechanics useful in Civil Engineering applications. The course provides a first level exposure to the students to fluid statics, kinematics and dynamics. Measurement of pressure, computations of hydrostatic forces on structural components and the concepts of Buoyancy all find useful applications in many engineering problems. A training to analyse engineering problems involving fluids - such as those dealing with pipe flow, open channel flow, jets, turbines and pumps, dams and spillways, culverts, river and groundwater flow - with a mechanistic perspective is essential for the civil engineering students. The topics included in this course are aimed to prepare a student to build a good fundamental background useful in the application-intensive courses covering hydraulics, hydraulic machinery and hydrology in later semesters.

### Module 1

**Basic Concepts and Definitions:** Distinction between a fluid and a solid; Density, Specific weight, Specific gravity, Kinematic and dynamic viscosity; variation of viscosity with temperature, Newton law of viscosity; vapour pressure, boiling point, cavitation; surface tension, capillarity, Bulk modulus of elasticity, compressibility.

### Module 2

**Fluid Statics:** Fluid Pressure: Pressure at a point, Pascal's law, pressure variation with temperature, density and altitude. Piezometer, U-Tube Manometer, Single Column Manometer, U-Tube Differential Manometer, Micromanometers. pressure gauges, Hydrostatic pressure and force: horizontal, vertical and inclined surfaces. Buoyancy and stability of floating bodies.

### Module 3

**Fluid Kinematics:** Classification of fluid flow : steady and unsteady flow; uniform and non-uniform flow; laminar and turbulent flow; rotational and irrotational flow; compressible and incompressible flow; ideal and real fluid flow; one, two and three dimensional flows; Streamline, path line, streak line and stream tube; stream function, velocity potential function. One-, two- and three -dimensional continuity equations in Cartesian coordinates

### Module 4



**Fluid Dynamics:** Surface and body forces; Equations of motion - Euler's equation; Bernoulli's equation - derivation; Energy Principle; Practical applications of Bernoulli's equation : venturimeter, orifice meter and pitot tube; Momentum principle; Forces exerted by fluid flow on pipe bend; Vortex Flow - Free and Forced; Dimensional Analysis and Dynamic Similitude - Definitions of Reynolds Number, Froude Number, Mach Number, Weber Number and Euler Number; Buckingham's  $\pi$ -Theorem.

## Module 5

**Laminar Flow:** Laminar flow through :circular pipes, annulus and parallel plates. Stoke's law, Measurement of viscosity Module6: 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. Dynamic Similitude- Definitions of ReynoldsNumber, Froude Number, MachNumber, Weber Number and EulerNumber. Module7: 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 Module8: 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

### Lab Experiments:

- Measurement of viscosity
- Study of Pressure Measuring Devices
- Stability of Floating Body
- Hydrostatics Force on Flat Surfaces/Curved Surfaces
- Verification of Bernoulli's Theorem
- Venturimeter
- Orifice meter
- Impacts of jets
- Flow Visualisation -Ideal Flow
- Length of establishment of flow
- Velocity distribution in pipes
- Laminar Flow

### Text/Reference Books:

- Fluid Mechanics and Machinery, C. S. P. Ojha, R. Berndtsson and P. N. Chandramouli, Oxford University Press, 2010

- Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House
- Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill
- Fluid Mechanics with Engineering Applications, R.L. Daugherty, J.B. Franzini and E.J. Finnemore, International Student Edition, McGraw Hill.

## PAPER CODE - PCC CE 205

|             |                                 |     |     |     |          |
|-------------|---------------------------------|-----|-----|-----|----------|
| PCC- CE 205 | Introduction to Solid Mechanics | L:3 | T:0 | P:0 | CREDIT:3 |
|-------------|---------------------------------|-----|-----|-----|----------|

The objective of this Course is to introduce continuum mechanics and material modelling of engineering materials based on first energy principles: deformation and strain; momentum balance, stress and stress states; elasticity and elasticity bounds; plasticity and yield design. The overarching theme is a unified mechanistic language using thermodynamics, which allows understanding, modelling and design of a large range of engineering materials. The subject of mechanics of materials involves analytical methods for determining the strength, stiffness (deformation characteristics), and stability of the various members in a structural system. The behaviour of a member depends not only on the fundamental laws that govern the equilibrium of forces, but also on the mechanical characteristics of the material. These mechanical characteristics come from the laboratory, where materials are tested under accurately known forces and their behaviour is carefully observed and measured. For this reason, mechanics of materials is a blended science of experiment and Newtonian postulates of analytical mechanics.

## Detailed contents:

### Module1

**Simple Stresses and Strains:** Concept of stress and strain, St. Venant's principle, stress and strain diagram, Elasticity and plasticity - Types of stresses and strains, Hooke's law - stress - strain diagram for mild steel - Working stress - Factor of safety - Lateral strain, Poisson's ratio and volumetric strain - Elastic moduli and the relationship between them - Bars of varying section - composite bars - Temperature stresses. Strain Energy - Resilience - Gradual, sudden, impact and shock loadings - simple applications.

### Module 2

**Compound Stresses and Strains:** Two dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr circle of stress, ellipse of stress and their applications. Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain. Relationship between elastic constants.

### Module 3

**Bending moment and Shear Force Diagrams:** Bending moment (BM) and shear force (SF) diagrams. BM and SF diagrams for cantilevers simply supported and fixed beams with or without overhangs. Calculation of maximum BM and SF and the point of contra flexure under concentrated loads, uniformly distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.

## Module 4

**Flexural Stresses:** Theory of simple bending - Assumptions - Derivation of bending equation:  $M/I = f/y = E/R$  - Neutral axis - Determination of bending stresses - Section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections - Design of simple beam sections.

## Module 5

**Shear Stresses:** Derivation of formula - Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T angle sections.

## Module 6

**Slope and deflection:** Relationship between moment, slope and deflection, Moment area method, Macaulay's method. Use of these methods to calculate slope and deflection for determinate beams.

## Module 7

**Torsion:** Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts, torsional rigidity, Combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion. Analysis of close-coiled-helical springs.

## Module 8

**Thin Cylinders and Spheres:** Derivation of formulae and calculations of hoop stress, longitudinal stress in a cylinder, and sphere subjected to internal pressures.

## List of Experiments:

- Tension test
- Bending tests on simply supported beam and Cantilever beam.
- Compression test on concrete
- Impact test
- Shear test

- Investigation of Hooke's law that is the proportional relation between force and stretching in elastic deformation
- Determination of torsion and deflection,
- Measurement of forces on supports in statically determinate beam,
- Determination of shear forces in beams,
- Determination of bending moments in beams,
- Measurement of deflections in statically determinate beam,
- Measurement of strain in a bar
- Bend test steel bar;
- Yield/tensile strength of steel bar;

### Text/Reference Books:

- Timoshenko, S. and Young, D. H., "Elements of Strength of Materials", DVNC, New York, USA.
- Kazmi, S. M. A., "Solid Mechanics" TMH, Delhi, India.
- Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004
- Crandall, S. H., N. C. Dahl, and T. J. Lardner. An Introduction to the Mechanics of Solids. 2nd ed. New York, NY: McGraw Hill, 1979
- Laboratory Manual of Testing Materials - William Kendrick Hall
- Mechanics of Materials - Ferdinand P. Beer, E. Russel Johnston Jr., John T. DEwolf - TMH 2002.
- Strength of Materials by R. Subramanian, Oxford University Press, New Delhi.

### PAPER CODE - PCC CE 208

|            |                     |     |     |     |          |
|------------|---------------------|-----|-----|-----|----------|
| PCC-CE 208 | Structural Analysis | L:3 | T:1 | P:0 | CREDIT:4 |
|------------|---------------------|-----|-----|-----|----------|

Analysis of indeterminate structures by force methods, flexibility coefficients, Energy methods: Principle of minimum potential energy, principle of virtual work, Castigliano's theorems, Reciprocal theorem, unit load method, Influence line and Rolling loads, beam, frames and arches, Muller- Breslau Principles and its applications to determinate and indeterminate structures.

Analysis of Beams and Frames: Moment Area method, Slope deflection method, Three Moment Equation, Moments distribution methods, effect of symmetry and antisymmetry, sway correction, Lateral load analysis: Portal and Cantilever methods, Matrix method of structural analysis, Displacement/Stiffness methods.

### Text/Reference Books:

- C.S. Reddy, Basic Structural Analysis, Second Edition, Tata McGraw Hill, 2005.
- R.C. Hibbeler, Structural Analysis, Pearson Education, 6th edition, 2009.
- C.K. Wang, Intermediate Structural Analysis, Tata McGraw Hill, 1984.

## PAPER CODE - PCC CE 207

|             |                                 |     |     |     |          |
|-------------|---------------------------------|-----|-----|-----|----------|
| PCC- CE 207 | Materials, Testing & Evaluation | L:1 | T:1 | P:2 | CREDIT:3 |
|-------------|---------------------------------|-----|-----|-----|----------|

The objective of this Course is to deal with an experimental determination and evaluation of mechanical characteristics and advanced behavior of metallic and non-metallic structural materials. The course deals with explanation of deformation and fracture behavior of structural materials. The main goal of this course is to provide students with all information concerning principle, way of measurement, as well as practical application of mechanical characteristics.

- Make measurements of behavior of various materials used in Civil Engineering.
- Provide physical observations to complement concepts learnt
- Introduce experimental procedures and common measurement instruments, equipment, devices.
- Exposure to a variety of established material testing procedures and techniques
- Different methods of evaluation and inferences drawn from observations

The course reviews also the current testing technology and examines force applications systems, force measurement, strain measurement, important instrument considerations, equipment for environmental testing, and computers applications for materials testing provide an introductory treatment of basic skills in material engineering towards (i) selecting material for the design, and (ii) evaluating the mechanical and structural properties of material, as well as the knowledge necessary for a civil engineer. The knowledge acquired lays a good foundation for analysis and design of various civil engineering structures/systems in a reliable manner.

### What will I learn?

- Different materials used in civil engineering applications
- Planning an experimental program, selecting the test configuration, selecting the test specimens and collecting raw data
- Documenting the experimental program including the test procedures, collected data, method of interpretation and final results
- Operating the laboratory equipment including the electronic instrumentation, the test apparatus and the data collection system
- Measuring physical properties of common structural and geotechnical construction materials
- Interpreting the laboratory data including conversion of the measurements into engineering values and derivation of material properties (strength and stiffness) from the engineering values
- Observing various modes of failure in compression, tension, and shear
- Observing various types of material behavior under similar loading conditions

### Detailed contents:

## Module 1

Introduction to Engineering Materials covering, Cements, M-Sand, Concrete (plain, reinforced and steel fibre/ glass fibre-reinforced, light-weight concrete, High Performance Concrete, Polymer Concrete) Ceramics, and Refractories, Bitumen and asphaltic materials, Timbers, Glass and Plastics, Structural Steel and other Metals, Paints and Varnishes, Acoustical material and geo-textiles, rubber and asbestos, laminates and adhesives, Graphene, Carbon composites and other engineering materials including properties and uses of these

## Module 2

Introduction to Material Testing covering, What is the “ Material Engineering” ?; Mechanical behavior and mechanical characteristics; Elasticity - principle and characteristics; Plastic deformation of metals; Tensile test -standards for different material (brittle, quasi-brittle, elastic and so on) True stress - strain interpretation of tensile test; hardness tests; Bending and torsion test; strength of ceramic; Internal friction, creep - fundamentals and characteristics; Brittle fracture of steel - temperature transition approach; Background of fracture mechanics; Discussion of fracture toughness testing -different materials; concept of fatigue of materials; Structural integrity assessment procedure and fracture mechanics

## Module 3

Standard Testing & Evaluation Procedures covering, Laboratory for mechanical testing; Discussion about mechanical testing; Naming systems for various irons, steels and nonferrous metals; Discussion about elastic deformation; Plastic deformation; Impact test and transition temperatures; Fracture mechanics -background; Fracture toughness - different materials; Fatigue of material; Creep.

**Tutorials** from the above modules covering, understanding i) Tests & testing of bricks, ii) Tests & testing of sand, iii) Tests & testing of concrete, iv) Tests & testing of soils, v) Tests & testing of bitumen & bituminous mixes, vi) Tests & testing of polymers and polymer based materials, vii) Tests & testing of metals & viii) Tests & testing of other special materials, composites and cementitious materials. Explanation of mechanical behavior of these materials.

## Practicals:

- Gradation of coarse and fine aggregates
- Different corresponding tests and need/application of these tests in design and quality control
- Tensile Strength of materials & concrete composites
- Compressive strength test on aggregates
- Tension I - Elastic Behaviour of metals & materials

- Tension II - Failure of Common Materials
- Concrete I - Early Age Properties
- Concrete II - Compression and Indirect Tension
- Compression - Directionality
- Consolidation and Strength Tests
- Tension III - Heat Treatment
- Torsion test
- Hardness tests (Brinell's and Rockwell)
- Tests on closely coiled and open coiled springs
- Theories of Failure and Corroboration with Experiments
- Concrete Mix Design as per BIS

### Text/Reference Books:

- Chudley, R., Greeno (2006), 'Building Construction Handbook' (6th ed.), R. Butterworth- Heinemann
- Khanna, S.K., Justo, C.E.G and Veeraragavan, A, ' Highway Materials and Pavement Testing', Nem Chand & Bros, Fifth Edition
- Various related updated & recent standards of BIS, IRC, ASTM, RILEM, AASHTO, etc. corresponding to materials used for Civil Engineering applications
- Kyriakos Komvopoulos (2011), Mechanical Testing of Engineering Materials, Cognella
- E.N. Dowling (1993), Mechanical Behaviour of Materials, Prentice Hall International Edition
- American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards (post 2000)
- Related papers published in international journals

### PAPER CODE - HSMC 252

|          |                                              |     |     |     |          |
|----------|----------------------------------------------|-----|-----|-----|----------|
| HSMC 252 | Civil Engineering - Societal & Global Impact | L:2 | T:0 | P:0 | CREDIT:2 |
|----------|----------------------------------------------|-----|-----|-----|----------|

The course is designed to provide a better understanding of the impact which Civil Engineering has on the Society at large and on the global arena. Civil Engineering projects have an impact on the Infrastructure, Energy consumption and generation, Sustainability of the Environment, Aesthetics of the environment, Employment creation, Contribution to the GDP, and on a more perceptible level, the Quality of Life. It is important for the civil engineers to realise the impact which this field has and take appropriate precautions to ensure that the impact is not adverse but beneficial.

### The course covers:

- Awareness of the importance of Civil Engineering and the impact it has on the Society and at global levels

- Awareness of the impact of Civil Engineering for the various specific fields of human endeavour
- Need to think innovatively to ensure Sustainability

## Module 1

Introduction to Course and Overview; Understanding the past to look into the future: Pre-industrial revolution days, Agricultural revolution, first and second industrial revolutions, IT revolution; Recent major Civil Engineering breakthroughs and innovations; Present day world and future projections, Ecosystems in Society and in Nature; the steady erosion in Sustainability; Global warming, its impact and possible causes; Evaluating future requirements for various resources; GIS and applications for monitoring systems; Human Development Index and Ecological Footprint of India Vs other countries and analysis;

## Module 2

Understanding the importance of Civil Engineering in shaping and impacting the world; The ancient and modern Marvels and Wonders in the field of Civil Engineering; Future Vision for Civil Engineering

## Module 3

**Infrastructure:** Habitats, Megacities, Smart Cities, futuristic visions; Transportation (Roads, Railways & Metros, Airports, Seaports, River ways, Sea canals, Tunnels (below ground, under water); Futuristic systems (ex, HyperLoop)); Energy generation (Hydro, Solar (Photovoltaic, Solar Chimney), Wind, Wave, Tidal, Geothermal, Thermal energy); Water provisioning; Telecommunication needs (towers, above-ground and underground cabling); Awareness of various Codes & Standards governing Infrastructure development; Innovations and methodologies for ensuring Sustainability;

## Module 4

**Environment:** Traditional & futuristic methods; Solid waste management, Water purification, Wastewater treatment & Recycling, Hazardous waste treatment; Flood control (Dams, Canals, River interlinking), Multi-purpose water projects, Atmospheric pollution; Global warming phenomena and Pollution Mitigation measures, Stationarity and nonstationarity; Environmental Metrics & Monitoring; Other Sustainability measures; Innovations and methodologies for ensuring Sustainability.

## Module 5

**Built environment:** Facilities management, Climate control; Energy efficient built environments and LEED ratings, Recycling, Temperature/ Sound control in built environment, Security systems; Intelligent/ Smart Buildings; Aesthetics of built environment, Role of Urban Arts Commissions; Conservation, Repairs & Rehabilitation



of Structures & Heritage structures; Innovations and methodologies for ensuring Sustainability

## **Module 6**

**Civil Engineering Projects:** Environmental Impact Analysis procedures; Waste (materials, manpower, equipment) avoidance/ Efficiency increase; Advanced construction techniques for better sustainability; Techniques for reduction of GreenHouse Gas emissions in various aspects of Civil Engineering Projects; New Project Management paradigms & Systems (Ex. Lean Construction), contribution of Civil Engineering to GDP, Contribution to employment(projects, facilities management), Quality of products, Health & Safety aspects for stakeholders; Innovations and methodologies for ensuring Sustainability during Project development;

## **Module 7A**

Population Dynamics covering, Population ecology- Population characteristics, ecotypes; Population genetics- Concept of gene pool and genetic diversity in populations, polymorphism and heterogeneity; (3 Lectures)

## **Module 8B**

Environmental Management covering, Principles: Perspectives, concerns and management strategies; Policies and legal aspects- Environment Protection Acts and modification, International Treaties; Environmental Impact Assessment- Case studies

**(International Airport, thermal power plant); (3 Lectures)**

## **Module 9A**

Molecular Genetics covering, Structures of DNA and RNA; Concept of Gene, Gene regulation, e.g., Operon concept; (3 Lectures)

## **Module 9B**

Biotechnology covering, Basic concepts: Totipotency and Cell manipulation; Plant & Animal tissue culture- Methods and uses in agriculture, medicine and health; Recombinant DNA Technology- Techniques and applications; (3 Lectures)

## **Module 10A**

Biostatistics covering, Introduction to Biostatistics:-Terms used, types of data; Measures of Central Tendencies- Mean, Median, Mode, Normal and Skewed distributions; Analysis of Data- Hypothesis testing and ANOVA (single factor) (4 Lectures)

## ORGANISATION OF COURSE (2-0-0)

| S.No. | Module                                            | No of Lectures |
|-------|---------------------------------------------------|----------------|
| 1     | Introduction                                      | 3              |
| 2     | Understanding the Importance of Civil Engineering | 3              |
| 3     | Infrastructure                                    | 8              |
| 4     | Environment                                       | 7              |
| 5     | Built Environment                                 | 5              |
| 6     | Civil Engineering Projects                        | 4              |

### Text/Reference Books:

- Žiga Turk (2014), Global Challenges and the Role of Civil Engineering, Chapter 3 in: Fischinger M. (eds) Performance-Based Seismic Engineering: Vision for an Earthquake Resilient Society. Geotechnical, Geological and Earthquake Engineering, Vol. 32. Springer, Dordrecht
- Brito, Ciampi, Vasconcelos, Amarol, Barros (2013) Engineering impacting Social, Economical and Working Environment, 120th ASCE Annual Conference and Exposition
- NAE Grand Challenges for Engineering (2006), Engineering for the Developing World, The Bridge, Vol 34, No.2, Summer 2004.
- Allen M. (2008) Cleansing the city. Ohio University Press. Athens Ohio.
- Ashley R., Stovin V., Moore S., Hurley L., Lewis L., Saul A. (2010). London Tideway Tunnels Programme – Thames Tunnel Project Needs Report – Potential source control and SUDS applications: Land use and retrofit options
- <http://www.thamestunnelconsultation.co.uk/consultation-documents.aspx>
- Ashley R M., Nowell R., Gersonius B., Walker L. (2011). Surface Water Management and Urban Green Infrastructure. Review of Current Knowledge. Foundation for Water Research FR/R0014
- Barry M. (2003) Corporate social responsibility – unworkable paradox or sustainable paradigm? Proc ICE Engineering Sustainability 156. Sept Issue ES3 paper 13550. p 129-130
- Blackmore J M., Plant R A J. (2008). Risk and resilience to enhance sustainability with application to urban water systems. J. Water Resources Planning and Management. ASCE. Vol. 134, No. 3, May.
- Bogle D. (2010) UK's engineering Council guidance on sustainability. Proc ICE Engineering Sustainability 163. June Issue ES2 p 61-63
- Brown R R., Ashley R M., Farrelly M. (2011). Political and Professional Agency Entrapment: An Agenda for Urban Water Research. Water Resources Management. Vol. 23, No.4. European Water Resources Association (EWRA) ISSN 0920-4741.

- Brugnach M., Dewulf A., Pahl-Wostl C., Taillieu T. (2008) Toward a relational concept of uncertainty: about knowing too little, knowing too differently and accepting not to know. Ecology and Society (2): 30
- Butler D., Davies J. (2011). Urban Drainage. Spon. 3rd Ed.
- Cavill S., Sohail M. (2003) Accountability in the provision of urban services. Proc. ICE. Municipal Engineer 156. Issue ME4 paper 13445, p235-244.
- Centre for Water Sensitive Cities (2012) Blueprint for a water sensitive city. Monash University.
- Charles J A. (2009) Robert Rawlinson and the UK public health revolution. Proc ICE Eng History and Heritage. 162 Nov. Issue EH4. p 199-206.

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