CE 201 Strength of Materials (3) [2-1-2-4-3]

Introduction to deformable bodies, types of materials and their responses. Overview of 2-D and 3-D structural elements. Introduction to mechanical testing of materials. Need for a mathematical model. Review of matrix algebra, a brief introduction to indicial notations, scalar, vector, dot product, cross product, tensors, matrix addition, multiplication, characteristic equation, eigenvalues and eigen vectors. Kinematics of deformable bodies-1-D Definition of strain, and introduction to various strain measures, Concepts of large and small deformation. Deformation mapping and deformation gradient. Generalized definition of strain for 3-D bodies, strain-displacement relationships, and compatibility conditions. 2-D Mohr's circle. Principle strains in 3D. Definition of stresses, various stress measures, the concept of stress-vector and stress-tensor, Cauchy relation, stress resultants. Principle stresses in 2D and 3D. Constitutive relations, types of material and material responses, the concept of isotropy, orthotropy, anisotropy etc, generalized Hooke's law. The concept of plane strain and plane stress problems. Balance laws in solid mechanics, force balance or equilibrium equations. Derivation of equilibrium equations by using the strength of materials approach in the Cartesian coordinate system. Theorem of virtual displacement and its application in deriving the equilibrium equations. Pure bending of beams- Concept of shear force and bending moment diagrams. Moment-curvature relationship. Euler Bernoulli beam theory. Macaulay's method for solving beams under transverse load. Energy method, strain energy, and complementary strain energy, Castigliano's theorems, Maxwell-Betti theorem, the theorem of minimum potential energy. The concept of buckling, buckling of rods, derivation of governing equations, solving column buckling problems. Torsion of members, torsion of thin and thick-walled members, derivation of St Venant’s theory for torsion of circular member. Calculation of shear center for thin-walled members.

CE 202Fundamentals of Fluid Mechanics (2) [2-1-0-3-2]

Properties of Fluid- Physical properties of fluids, Newton's Law of Viscosity, dynamic and kinematic viscosity, classification of fluids, Newtonian and Non Newtonian fluids, ideal and real fluids, compressibility, cohesion, adhesion, surface tension, capillarity, vapour pressure; Fluid Statics- The basic equation of hydrostatics, concept of pressure head, Measurement of pressure (absolute, gauge), Application of the basic equation of hydrostatics. Piezometers, simple and differential manometers, inclined manometers, total pressure force and, center of pressure for plane and curved surfaces, Practical applications (gate, dams, lock gates); Buoyancy and Floatation- Principle of floatation and buoyancy, Equilibrium of floating bodies, Stability of Floating bodies, metacentre, metacentric height, Stability of submerged bodies; Fluid Kinematics- Velocity and acceleration of fluids, local and advective acceleration, types of flow: steady and unsteady, uniform and nonuniform, laminar and turbulent, rotational and irrotational, circulation and vorticity. Equations of streamline and equipotential lines, flownets for one dimensional; Fluid Dynamics-Forces acting on fluid mass in motion, Euler's equation of motion along a streamline and its integration, Assumptions of Bernoulli's equation, Kinetic energy correction factor, Hydraulic Grade line and total energy line, Introduction to Navier- Stokes equations, Linear momentum equation and momentum correction factor, angular momentum, Application of continuity, Bernoulli and momentum equations. Flow through orifices and mouthpieces under free and submerged condition, Discharge/velocity measurement: Pitot tube, Venturimeter, orificemeter, Laminar and Turbulent flow: Basic definitions, Reynolds Experiment, Stoke’slaw, Methods of measurement of viscosity, Transition from laminar to turbulent flow, Basic features of turbulent flow, Prandtl’s mixing length theory; Dimensional analysis and physical model studies- Dimensions of physical quantities, Dimensional homogeneity, Dimensional analysis using Bukingham's Pai theorem, important dimensionless parameters and their significance. Geometric; Kinematic and Dynamic similitude; Model laws, Type of models Applications of dimensional analysis and studies to fluid flow problems; Boundary layer theory- Development of boundary layer on a flat plate, Nominal, displacement,

momentum and Energy thicknesses. Laminar, turbulent and transitional boundary layer, Application of momentum equation for boundary layer development, Local and mean drag coefficient, Hydro dynamically smooth and rough boundaries, Boundary layer separation and its control

CE 203Computer Aided Building Drawing(1) [0-0-2-1-1]

Building Planning and layout, Introduction to Computer Aided Design Tools-Basic Commands and simple drawings, Building Components- Doors, Windows etc, Structural Elements- Beams, Columns etc, Structural Elements- Slabs, Staircase, Structural Elements- Foundations, Roof truss in structural steel sections, Plan of Two storied residential building, Section of Two storied residential building, Elevation of Two storied residential building, Factory building with trusses supported on Brick walls and pillars, Building Information Modelling (BIM) training.

CE 301Structural Analysis I (2) [2-1-0-3-2]

Statically determinate structures, determination of forces in cables, trusses, beams and frames, bending moment, shear force and axial force diagrams. Deflection of a statically determinate truss, beams, and frames using the principle of virtual work, moment-area method, Conjugate-beam method. Energy Principles, Maxwell's and Betti's laws, Castigliano's methods. Statically indeterminate structures, the degree of static and kinematic indeterminacies for trusses, and frames. Analysis of statically indeterminate structures, the concept of compatibility conditions. Analysis of indeterminate structures by flexibility method, consistent deformation method, strain energy method, influence coefficient method, column analogy method. Influence line diagram, the concept of influence lines using equilibrium methods, influence line diagram using Müller-Breslau principle for statically determinate and indeterminate structures.

CE 302Pipe and Open Channel Hydraulics (3) [2-1-2-4-3]

Introduction - Recapitulation of fluid mechanics concepts, introduction of hydraulic approach; Flow through Pipes- Laminar flow, Turbulent flow, Frictional head loss, Losses in transitions and fittings, Concept of equivalent length, Applications of Continuity equation, Bernoulli's/Energy equations, Momentum equation, Dynamic forces on pipe transitions, Flow through various pipe-networks, Solution algorithms, Transient flow, governing equations, water hammer, surge tank, Hydraulic transmission of power through pipes; Flow in Open Channels- Introduction to open channel flow, velocity and pressure distribution, rigid and mobile beds, uniform flow, critical flow, types of open channel flow, Specific Energy, Specific force, Hydraulic jump, Applications of Continuity equation, Bernoulli's/Energy equations and Momentum equation; Critical flow: critical depth, specific energy diagram, Computational of Critical depth, Channel hump, contraction and expansion; Uniform flow: Basic concepts, Manning's and other equations, Computation of normal depth, Compound sections, Design of open channels; Non-uniform flow: Gradually and rapidly varied flow, Governing equations of Gradually varied flow, Classification of gvf, Computation of gvf profiles, Direct step and Standard step methods, Numerical solutions.

CE 303Soil Mechanics (3) [2-1-2-4-3]

Engineering Geology - Soil Formation and Composition, Soil Types, Regional Soil Deposits of India; Soil Structure & Clay Minerology- Structure of Clay Minerals, Different Types of Clay Minerals, Soil Structure; Index Properties and Soil Classifications- Phase Diagrams, Some Important Relationships, Water Content Determination, Specific Gravity of Soils, Index Properties of Soils, Grain Size Analysis, Consistency of Clay (Atterberg's Limits), Classification of Soils; Effective Stress, Capillarity & Permeability- Effective Stress Principle, Capillary Rise of Water in Soils,

Permeability of Soil, Darcy's law, Constant head & Falling head test, Factors affecting permeability, Permeability of Stratified Soils, Types of Head, Seepage and Quick Sand Condition; Seepage Through Soil - Seepage forces, Flow Net, Graphical Methods for obtaining Flow Nets, Introduction to Filter design; Vertical Stresses in Soil due to Applied Load- Stresses within the soil mass, Introduction to Boussinesq equations, Newmark's Chart; Compaction- Theory of Compaction, Laboratory Tests, Factors affecting Compaction,Engineering Behaviour of Compacted Soils, Field Compaction, Machines used for Compaction; Consolidation- Compaction characteristics, Components of Total Settlement, Compressibility, Void Ratio- Effective Stress Relationships, Mechanics of Consolidation, Terzaghi's Theory of Consolidation, Consolidation Tests, Computation of Settlement; Shear Strength of Soil- Stress at a point: Mohr Circle of Stresses, Mohr Coulomb Failure Criterion, Measurement of Shear Strength: Direct Shear, Triaxial, UCS, Vane Shear, Tests

CE 304Geomatics (3) [2-1-2-4-3]

Introduction to Geomatics- Hours History of Surveying and Mapping, Importance of Geomatics Engineering, Maps and Maps Numbering System; Concept of Datum and Map Projection System- Coordinate System in Two and Three Dimensions, Datums, Geodetic Coordinate System, Coordinate Transformation, and Map Projection Systems; Conventional Field Survey- Introduction to Conventional Surveying Instruments and their Working Principles. The concept of Distance and Angular Measurements in Surveying. Sources of Errors in Conventional Surveying. Modern Field Survey Systems- IntroductionandDevelopment in the field of surveying. Working Principles of Instruments - Total Station, Global Positioning Systems, LASER based instruments. Sources of Error in the Measurements and their removal; Space Technology for Surveying- Remote Sensing and Photogrammetry - Fundamentals. Types of Photographs, Stereoscopy, Geometry of Photographs, Concept of Relief and Tilt Displacements, Digital Photogrammetry, Digital Image Processing; Geographic Information System- Introduction to Geographic Information System, Types of Data, Generation of Database, Concepts of Digital Maps, Integration of Information and Analysis;Applications of Geomatics Engineering- Topographic Mapping, Digital elevation models, Deformation Studies, Engineering Surveys, Land Use and Land Cover Mapping.

GE 102Material Science for Civil Engineers(3) [3-1-0-5-3]

Multiscale nature of materials. Classification of Engineering materials, advanced engineering materials. Atomic structure of material atomic bonding, binding energy, secondary bonding or van der Waals bonding, the structure of crystalline materials- unit cell, crystal lattice, metallic crystal structures, Bravais lattice, crystal plane, Miller indices, Bragg's law, mono-crystals, poly-crystals, crystal structure determination using XRD, noncrystalline solid. Overview of defects in crystals, point defects, line defects, interfacial defects, volume defects, inclusions. A brief introduction to dislocation theory edge dislocation and screw dislocation, Polymer structures, Chemistry of polymer molecules, molecular shape, molecular structure, thermoplastic and thermosetting polymers, polymer crystallinity, Defects in Polymers. Mechanical properties of materials- Stress and strain response, elastic deformation, plastic deformation. Characterization of material response under tension, compression, and shear. Overview of material failure: fracture, fatigue, creep. Materials used in civil engineering, concrete, ferrous metal, non-ferrous metal, wood, polymers, composites, an overview of their physical properties, mechanical properties, their characteristic behavior under external stress. Materials for making concrete, the chemical composition of cement, cement types, cement classification, and cement manufacturing. Types of aggregates and their classification, characterization, properties, testing procedures. Quality of mixing water, water for washing aggregates, curing water. Concrete chemistry, physical properties of green and hardened concrete, proportioning concrete mixes, factors affecting the properties of concrete, curing of concrete, concrete admixtures, destructive and non-destructive tests for concrete. Special types of cement and cement concrete, acid-resistant concrete, reinforced cement concrete, prestressed concrete, polymer concrete, fiber reinforced concrete, lightweight concrete, high strength concrete, ready mixed concrete, self-

compacting concrete, high-performance concrete, and shotcrete. Mortars classification, characteristics of good mortar, mortar constituents, and their testing. Structures of ferrous metal, types of ferrous metal, steel, hot rolled and cold formed sections, reinforcing steel bars, rusting and corrosion, testing of steel sections, alloy steel, stainless steel. Non-ferrous metals, Aluminum, Copper, Zinc, Lead, Tin, Nickel. Advanced composites in Civil Engineering, Polymer composites, textile composites, fiber reinforced composites, wood-polymer composites, sandwich composites. Overview of mechanical properties and testing of composites. Clay and its Classifications, physical properties of Clays, clay products. Bricks, different types of bricks, testing of bricks, defects in bricks, types of brick walls and joints. Road materials, Bitumen, tar, pitch, Asphalt, general properties, testing. Miscellaneous building materials, heat insulating materials, sound insulating materials, waterproofing materials, geosynthetics, smart materials. Sustainable materials, introduction to sustainability. Materials life cycle assessment, recycling issues of various materials.

CE 401Structural Analysis II (2) [2-1-0-3-2]

A review of the matrix algebra, matrix addition, multiplication, inversion, transformation, a solution of linear simultaneous equations, the concept of eigenvalues and eigen vectors. Various types of structural nonlinearities, linear and nonlinear structural analysis, determinate and indeterminate structures, Types of structural loads, Structural elements, Equilibrium equations and compatibility equations, Brief review of energy methods, Stiffness and flexibility method. The slope-deflection method with and without support settlement, analysis of determinate and indeterminate beams. Moment distribution method. Stiffness matrix method for 2D beams, trusses, and frames. Thermomechanical problems. Geometric nonlinear problems, the solution of geometric nonlinear problems using stiffness method. Introduction to computer program and applications to 2D building frames. Analysis of elastic instability. Introduction to finite element method, the meshing of structure, shape function, 2D finite element shape functions, kinematics, plane stress and plane strain 2-D elements, and types of finite elements.

CE 402 Water Resources Engineering (3) [3-1-0-5-3]

Introduction to Hydrology- Hydrological cycle; various hydrological processes; elementary concepts of precipitation, evaporation, transpiration, evapotranspiration and infiltration.Streamflow Hydrographs- Selection of site; various methods of discharge measurements; factors affecting runoff; rainfall-runoff relationships; runoff hydrograph; unit hydrograph theory; S-curve hydrograph; synthetic unit hydrograph; use of unit hydrograph; Floods- estimation of peak flow, rational formula and other methods, flood frequency analysis, Gumbel's method, Design floods; Irrigation Engineering- Necessity of irrigation; water requirement of crops; soil classification; soil moisture and crop water relationship, factors governing consumptive use of water, design of irrigation canals; Reservoir Planning- Types of developments: storage and diversion works; Purpose: single and multipurpose; investigation for locating reservoir; selection of site; dependability calculations; estimation of required storage; mass curves; reservoir sedimentation; flood routing; height of dam; reservoir operation; economics of reservoir planning, benefit-cost ratio; Ground Water Hydrology- Occurrence of subsurface water and groundwater; types of aquifers; aquifer parameters; steady state well hydraulics, pumping tests; groundwater resource estimation; Water logging and drainage- Causes of water logging; preventive and curative measures; drainage of irrigation of lands; reclamation of water logged, alkaline and saline lands; Lift irrigation schemes - various components and their design principles; Application of water- water management and distribution, warabandi.

CE 404Reinforced Concrete Structures (4) [3-1-2-6-4]

Materials for Reinforced Concrete- properties and testing of cement, water, fine and coarse aggregates, brief introduction to admixtures; Properties of Reinforced Concrete- Compressive strength, tensile strength, stress-strain behavior, modulus of elasticity, ductility, shrinkage, creep,

characteristic strength, grades of concrete, design stress-strain curve of concrete; types and grades, stress-strain behavior, and design stress-strain curve of reinforcing steel; Methods of Design of Reinforced Concrete Structures- Working stress and limit state design methods; Concrete mix design procedures; Design of R.C. Beams- Singly and doubly reinforced rectangular/flanged sections, design for shear, bond and anchorage of reinforcement, limit states of deflection and cracking; Design of Slabs- Design of one way slabs, two-way slabs; Design of R.C. Columns- Design of axially loaded and eccentrically loaded compression members, effect of small and large eccentricities; Design of Footings- Foundation types, design of isolated footings, introduction to combined footings; Concept of Earthquake Resistant Design (ERD): Design philosophy and Material Behaviour under earthquake, Four virtues of ERD: Stiffness, Strength, ductility and Configurations, Introduction to Capacity design concepts, Introduction to IS:1893 and IS: 13920, Ductile Design and Detailing of Earthquake Resistant Structures

CE 403Foundation Engineering (2) [2-1-0-3-2]

Soil Exploration: Different methods of Soil Exploration, Methods of Boring, Collection of Soil Samples, Field Tests: SPT, CPT, PMT; Lateral Earth Pressure- Earth pressure at rest, active and passive earth pressures, introduction to Rankine's earth pressures, Coulomb's lateral earth pressure theory; Types of Foundation- Introduction to foundation engineering, different types of foundation, Requirements of good foundation; Bearing capacity of shallow foundations- Failure mechanism, Terzaghi's bearing capacity equation, bearing capacity from field tests, Foundations subjected to eccentric and inclined loads. Foundation Settlement- calculation, settlement problems, stress in soil mass, immediate settlement calculation, field plate load tests; Design of shallow foundations- Geotechnical and structural design of isolated footings, strip, rectangular and trapezoidal combined footings – strap – balanced footings; Deep Foundations- types of piles and their applications, single pile and pile group - load capacity – settlements, pile load test, negative skin friction, under reamed pile foundations, other deep foundations; Stability of Slopes- Infinite and Finite Slopes, Stability of infinite slopes, finite slopes, Analysis of finite slopes.

CE 405Water and Wastewater Treatment Engineering (3) [2-1-2-4-3]

Water demand and suitable sources: Population forecasting methods, Water demand for various purposes, Choice of suitable water sources.**Water quality, Water treatment processes and distribution systems**: Evaluation of water quality parameters, Unit operations and processes of water treatment viz: Coagulation-Flocculation; Filtration; Disinfections; Aeration and Gas transfer; Precipitation;Softening; Adsorption and Ion exchange and Membrane processes. Considerations of Water treatment plant; Design of urban water distribution network; Rural Water supply.**Fundamentals of Engineered Wastewater collection and treatment systems:** Estimation of wastewater quantity, Wastewater characteristics, Basics on environmental microbiology. Unit operations and processes for wastewater treatment vi. Physical, chemical and biological methods. Sludge management.**Natural wastewater treatment systems and low-cost sanitation:** Ponds and Lagoons; Wetlands and Root-zone systems. Design principles of Septic tanks and soak-pits.

CE 406Steel Structures (3) [3-1-0-5-3]

Introduction to structural steel, material properties, types of material failures, testing. Types of steel structures, fabrication of steel structures. Action on structures, modes of failure in steel structures, philosophy of designing steel structure. Instabilities in steel structure, global and local P-delta effects, Euler buckling, local buckling, lateral torsional buckling, distortional buckling, and coupled instabilities. Types of structural steel members, introduction to design codes, the design of tension and compression members, the design of flexural members, the design of beam-columns, the design of plate girders. Structural fasteners, riveting, welding, bolting, failure of connections, block shear

failure. Properties and design of fasteners. Design of pinned connection, fixed connection, partially fixed connection and base plates. Design of steel trusses, moment resisting frames, silos.

CE 407Transportation Engineering (4) [3-1-2-6-4]

Classification, economical relevance of transportation, Transportation system concept and its components.Cross sectional elements, sight distance and its application, super elevation, horizontal alignment, and vertical alignment.Pavement layers, Pavement materials, tests on pavement materials – soil, aggregate, asphalt.Mix design of asphaltic pavements, structural design of asphaltic pavements, types of bituminous construction, Pavement maintenance and rehabilitation.Introduction to traffic engineering; Traffic control devices – signs, markings, signals, islands; types of intersection.Traffic flow characteristics-speed, flow, density; traffic studies and data collection.Components of a railway track, geometric design of railway track.Airport runway orientation –factors affecting, design..