Basics of Engineering

Structural Analysis

Module 1: General theorems : Theorems relating to elastic structures, Principle of virtual work, Strain energy in elastic structures, complementary energy, Castigliano"s theorem, Betti"s and Maxwell"s reciprocal theorems.

Module 2: Deflection of statically determinate structures: Deflection of determinate beams by Double integration Macaulay"s, Moment area and Conjugate beam methods, Principle of virtual work (unit load method) and Castigliano"s theorem, Deflection of determinate pin jointed trusses and rigid jointed frames by principle of virtual work (unit load method),b Strain Energy and Castigliano"s theorem.

Module 3: Influence lines for statically determinate structures : Influence lines for cantilever, simply supported beam, overhanging beam and pin jointed trusses, criteria for maximum shear force and bending moment under moving loads for simply supported beams, absolute maximum bending moment

Module 4: Elastic arches : determination of normal thrust, shear force and bending moment for parabolic and segmental three hinged arches, Influence lines for normal thrust, shear force and bending moment for three hinged parabolic arch.

Module 5: Suspension bridges: Suspension cable with three hinged stiffening girder, influence line diagrams for horizontal tension in the cable, shear force and bending moment at any section of the stiffening girder

Module 6: Struts: struts subjected to axial loads, concept of buckling, Euler"s formula for strut with different support conditions, Euler"s and Rankine"s design formulae. Struts subjected to eccentric and lateral loads, struts with initial curvature.

Building Materials

Module 1: Building Materials-Classification of Building materials, requirements of building materials and products, functional, aesthetical and economic. Study of properties of materials: physical, mechanical, chemical, biological, aesthetical and other complex properties like durability, reliability, compatibility, and economic characteristics.

Module 2: Surface Finishes-Pointing: types, plastering: materials and types, painting, Building facia, Materials and products based on mineral binders, gypsum, lime, plaster of paris, cement, hydraulic lime, mortars and concrete, gypsum-concrete products.
Paints and Varnishes: types and uses.

Module 3: Bricks and Tiles- Structural Clay products, Classification, Common clay brick, face bricks and tiles, ceramic tiles, paving blocks. Brick masonry, stone masonry and block masonry.

Module 4: Doors and windows- Types, materials used, manufacture of doors and windows, fixtures. Grill work – materials used, manufacture. Metal and metal alloys: Products made of ferrous and non ferrous metals, Aluminum alloys, Types and Uses, Anticorrosive treatment. Glass types and uses. Wood varieties and uses, defects in timber, preservative treatments, and wood composites: particle and medium density fibre boards etc.

Module 5: Floors and roofs- Floors; types of floors, floor finishes, suitability. Roofs; materials used, types, wooden and steel trusses, roof coverings, roof drainage. Synthetic Polymer resins and resins based materials, floor covering, wall facing, heat insulating and sound proofing plastics, water proofing and sealing resins, adhesives.

Engineering Surveying

Module 1: Introduction- Various types of surveying- based on methods and instruments, classifications, uses and necessity of geodetic surveying, photographic, astronomy and hydrographic surveying. Diagonal scale, various types of venires, micrometers on surveying instruments, principles of surveying. Chain surveying, instruments required for linear measurement, minor instruments for setting out right angle.

Module 2: Leveling and contouring-Definitions, technical terms, different types of levels such as dumpy, quickset, precise, auto temporary and permanent adjustments of dumpy and auto level. Different methods of leveling, reduction of levels,problems. Difficulties in leveling work, corrections and precautions to be taken in leveling work. Contour – definitions, contour interval, equivalent, uses and characteristics of contour lines, direct and indirect methods of contouring. Running a level line, L section, cross section, methods of interpolation. Grade contour- definition, use, setting out in field. Computation of volume by trapezoidal and prismoidal formula, volume from spot levels, volume from contour plan.

Module 3: Plane table surveying-Definitions, uses and advantages, temporary adjustments. Different methods of plane table surveying. Two point problem. Errors in plane table survey, use of telescopic alidade.

Module 4: Traverse Surveying-Compass: Bearings- different types, compass – prismatic, surveyor, whole circle, reduced bearings, Local Attraction. Theodolite:- Various parts and

axis of transit, technical terms, temporary and permanent adjustments of a transit, horizontal and vertical angles, methods of repetition and reiteration. Different methods of running a theodolite traverses, Gales" traverse table, balancing of traverse by Bow-Ditch"s transit and modified transit rules.Problems on one-plane and two-plane methods, omitted measurements. Precautions in using theodolite, errors in theodolite survey. Use of theodolite for various works such as prolongation of a straight line, setting out an angle.

Module 5: Setting out works- General horizontal and vertical control, setting out of foundation plan for load bearing and framed structure, batter board, slope and grade stakes, setting out with theodolite. Setting out of sewer line, culvert, use of laser for works. Setting out center line for tunnel, transfer of levels to underground work Project / route survey for bridge, dam and canal. Checking verticality of high rise structures.
Module 6: Areas- Area of a irregular figure by Trapezoidal rule, average ordinate rule, Simpson"s 1/3 rule, various co ordinate methods. Planimeter: types of planimeter including digital planimeter, area of zero circle, use of planimeter.

Fluid Mechanics

Module1: Properties of Fluids- Mass density, specific weight, specific gravity, specific volume, vapour pressure, compressibility, elasticity, surface tension, capillarity; Newton"s law of viscosity, classification of fluids, dynamic viscosity and kinematics viscosity, variation of viscosity with temperature; Basic concept applicable to fluid mechanics.

Module2: Fluid Statics-

*Measurement of Pressure:*Pressure variation in a static fluid, PASCAL"s law, Units and scales of pressure measurement –Atmospheric pressure, Absolute Pressure, Gauge Pressure and Vacuum Pressure, Hydrostatic Paradox. Piezometer,U-Tube Manometer, Single Column Manometer,U-Tube Differntial Manometer , Inverterd U-Tube Differntial Manometer, Micromanometers. Mechanical Pressure Gauges.

Hydrostatic force on plane and curved surface- Total Pressure and Center of Pressure, Pressure

Diagram, Total Pressure on Plane Surfaces and Depth of Center of Pressure, Total Pressure on Curved Surfaces, Practical applications of Total Pressure and Center of Pressure

Buoyancy and Flotation- Buoyant force, Buoyancy and Center of Buoyancy, Archimedes Principle, Principle of Floatation. Metacentre and Metacentric Height, Equilibrium of Floating bodies and Submerged bodies Evaluation of Metacentric Height –Theoretical Method and Experimental Method. Oscillation of Floating Body.

Fluids in Relative Equilibrium: Static fluid subjected to uniform linear acceleration. Liquid containers subjected to constant horizontal acceleration and constant vertical acceleration, Liquid containers subjected to constant rotation

Module3: Fluid Kinematics- Fluid flow Methods of analysis of fluid motion, Streamlines, Path lines, Streak lines and Stream tubes.Types of fluid flow Steady and unsteady flow, Uniform and non-uniform flow, Laminar, Transitional and Turbulent flow Reynolds number, Reynolds Experiment, Rotational and Irrotational flow, Subcritical , Critical and Supercritical flow, Compressible and Incompressible Flow , One , Two and Three dimensional Circulation and vorticity, Velocity potential and Stream function, Flow net

Module4: Fluid Dynamics- Euler"s equation, Bernoulli"s equation, Energy correction factor.
*Module5:*Flow Measuring Devices- Measurement of discharge- Venturi meter, Orifice meter, Nozzle meter, Bend meter, Rotometer. Measurement of velocity -Pitot tube. Orifice - Classification, Flow through a Reservoir Opening i.e. Orifice, Trajectory of free –jet, Hydraulic Coefficients, Experimental determination of hydraulic coefficient, Small and large orifice, Time of emptying a tank with orifice. Mouthpieces-Classification, External cylindrical mouthpiece, Convergent – divergent mouthpiece, Borda"s mouthpiece. Notches and Weirs -Discharge over a rectangular notch and a triangular notch, Velocity of approach, End contractions, Cippoletti Notch, Discharge over a stepped notch, Time of emptying a tank with notch or weir, Ventilation of weir, Proportional Weir or Sutro Weir.
*Module6:*Flow Past immersed bodies- Drag and lift, Types of drag, Drag on a sphere, cylinder, flat plate and Airfoil, Karman Vortex Street, effect of free surface and compressibility on drag .Development of lift on immersed bodies, Lift, Magnus Effect and Circulation, lift characteristics of airfoils, polar diagram.
Module 7: Compressible flow-Basic equations of flow (elementary study), Mach number, Mach cone, Area – Velocity relationship, Stagnation Properties; Ideal fluid flow- Uniform flow, source and sink, doublet, free vortex.

1. Hydrostatics
2. Measurement of viscosity
3. Study of Pressure Measuring Devices
4. Stability of Floating Body
5. Hydrostatics Force on Flat Surfaces/Curved Surfaces
6. Bernoulli"s Theorem
7. Calibration of Flowmeter
8. Calibration of Orifices
9. Calibration of Mouthpieces
10. Calibration of Notches
11. Calibration of Weirs
12. Flow Visualisation -Ideal Flow
13. Length of establishment of flow
14. Velocity distribution in pipes
15. Laminar Flow

Structural Analysis Advanced

Module 1: General- Types of structures occurring in practice and their classification, Stable and

unstable Structures, statical and kinematical determinacy and indeterminacy of structures, symmetric structure, Symmetrical and anti symmetrical loads, distinction between linear and non linear behavior, material and geometric non-linearity.

Module 2: Analysis of Indeterminate Structures by Flexibility Method- Flexibility coefficients and their use in formulation of compatibility equations, Castigliano"s theorem of least work, application of above methods to propped cantilevers, fixed beams, continuous beams, simple pin jointed frames including effect of lack of members, simple rigid jointed frames and two-hinged arches

Module 3: Analysis of Indeterminate Structures by Stiffness Method: Stiffness coefficients for prismatic members and their use for formulation of equilibrium equation, direct stiffness method slope deflection method, moment distribution method, applications of the above methods to indeterminate beams and simple rigid jointed frames, rigid jointed frames with inclined member but having only one translational DoF in addition to rotational DoF"s, including the effect of settlement of supports.

Engineering Surveying II

Module 1: Curves-Definitions of different terms, necessity of curves and types of curves. Simple circular curves and compound curves, office and field work, linear methods of setting out of curves. Angular methods for setting out of curves, two theodolite and Rankine deflection angle methods. Reverse and transition curves, their properties and their advantages, design of transition curves, shift, spiral angle.Composite curves – office and field work, setting out of curve by angular method, composite curve problems.Vertical curves – definitions, geometry and types, tangent correction and chord gradient methods, sight distance on a vertical curve, difficulties in setting out curves and solutions for the same

Module2: Modern surveying instruments-Electronics in surveying, general principles used in the instruments. Auto levels, self compensating instrument, Digital Level. Electronic distance measurements - types, principles, applications of Total Station in surveying, corrections for field observations. Electronic digital theodolite – types, uses and applications, concept of total station. Use of computer in survey work for level computation and plotting contour plan.

Module 3: Tacheometric surveying-Principles and uses, advantages, stadia formula, different methods of tacheometer, subtense bar method, location details by tacheometer, stadia diagram and tables, error and accuracy in tacheometry survey work

Module 4: Global Positioning System (G.P.S)-G.P.S. Segments: Spaces Segment, Control Segment, User Segment, Features of G.P.S. Satellites, Principle of Operation, Surveying with G.P.S.: Methods of observations, Absolute Positioning, Relative Positioning, differential G.P.S., Kinematics of G.P.S., G.P.S. Receivers: Navigational Receivers, Surveying Receivers, Geodetic Receivers, Computation of Co- ordinates:- Transformation from Global to Local Datum , Geodetic Coordinates to map co- ordinates , G.P.S. Heights and mean sea level Heights. Applications of G.P.S.

Module 5: Remote Sensing(RS)-Electromagnetic remote sensing process. Physics of radiant energy: Nature of Electromagnetic radiation, Electromagnetic spectrum.Energy Source and its Characteristics. Atmospheric influences: Absorption, Scattering. Energy interaction with Earth Surfaces: Spectral reflectance Curve. Image Acquisition: Photographic sensors, Digital Data, Earth Resource satellites, Image resolution. Image Interpretation. Applications of RS.

Module 6: Geographical Information System-Information systems, spatial and non- spatial information, geographical concept and terminology, advantages of GIS, Basic component of GIS. Commercially available GIS hardware and Software. Field data, statistical data, maps, aerial Photographs, satellite data, points , lines, and areas features, vector and raster data, data entry through keyboard, digitizer and scanners, preprocessing of data rectification and registration, interpolation techniques.

1. To find the constants of a tacheometer and to verify field distances.
2. A project for preparing L section and cross section, block contouring and tacheometric survey.

3. Height and distance problems in tacheometric surveying.
4. Study of satellite images and its interpretation
5. Determination of horizontal, sloping and vertical distance between any two points by using Total Station
6. Geo-registration of map and its digitization by using suitable GIS software.
7. Map editing, vector and raster analysis of digitized map by using suitable GIS software.
8. Collection of field data like point data, line data and area data by using surveying and mapping GPS receiver.

Hydraulics and Hydraulic Machinery

Module 1: Laminar Flow- Laminar flow through: circular pipes, annulus and parallel plates. Stoke's law, Measurement of viscosity.

Module 2: Turbulent Flow- Reynolds experiment, Transition from laminar to turbulent flow. Definition of turbulence, scale and intensity, Causes of turbulence, instability, mechanism of turbulence and effect of turbulent flow in pipes. Reynolds stresses, semi- empirical theories of turbulence, Prandtl"s mixing length theory, universal velocity distribution equation. Resistance to flow of fluid in smooth and rough pipes, Moody"s diagram.

Module 3: Boundary Layer Analysis-Assumption and concept of boundary layer theory. Boundary-layer thickness, displacement, momentum & energy thickness, laminar and Turbulent boundary layers on a flat plate; Laminar sub-layer, smooth and rough boundaries. Local and average friction coefficients. Separation and Control.

*Module 4:*Dimensional Analysis and Hydraulic Similitude: Dimensional homogeneity, Rayleigh method, Buckingham"s Pi method and other methods. Dimensionless groups. Similitude, Model studies, Types of models. Application of dimensional analysis and model studies to fluid flow problem.

Module 5: Introduction to Open Channel Flow-Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section.

*Module 6:*Uniform Flow-Continuity Equation ,Energy Equation and Momentum Equation , Characteristics of uniform flow , Chezy"s formula , Manning"s formula. Factors affecting Manning"s Roughness Coefficient „n ".Most economical section of channel. Computation ofUniform flow, Normal depth.

Module 7 Non-Uniform Flow- Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth.Channel Transitions. Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity- Current meter, Floats, Hot-wire anemometer. Gradually Varied Flow-Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile.

Computation of water surface profile by graphical, numerical and analytical approaches. Direct Step method, Graphical Integration method and Direct integration method.

Module 8: Hydraulic Jump- Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types ,applications and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges. Dynamics of Fluid Flow-Momentum principle, applications: Force on plates, pipe bends, moments of momentum equation,

Module 9: Flow through Pipes:Loss of head through pipes, Darcy-Wiesbatch equation, minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flows in dead end pipes, siphon, power transmission through pipes, nozzles.

Analysis of pipe networks:
Hardy Cross method, water hammer in pipes and control measures , branching of pipes , three

reservoir problem

Module 10: Computational Fluid Dynamics:

Basic equations of fluid dynamics, Grid generation, Introduction to in viscid incompressible flow, Boundary layer flow as applicable to C.F.D.

Hydro informatics:

Concept of hydro informatics –scope of internet and web based modeling in water resources engineering.

1. Flow Visulization
2. Studies in Wind Tunnel
3. Boundary Layer
4. Flow around an Aerofoil / circular cylinder
5. Uniform Flow
6. Velocity Distribution in Open channel flow
7. Venturi Flume
8. Standing Wave Flume
9. Gradually Varied Flow
10. Hydraulic Jump
11. Flow under Sluice Gate
12. Flow through pipes
13. Turbulent flow through pipes
14. Flow visualization
15. Laminar flow through pipes
16. Major losses / Minor losses in pipe

Soil Mechanics

Module 1: Introduction-Definitions: soils, soil mechanics, soil engineering, rock mechanics, geotechnical engineering. Scope of soil engineering.Comparison between soil and rock.Basic Definitions and Relationships-Soil as three-phase system in terms of weight, volume, voids ratio, and porosity. Definitions: moisture content, unit weights, degree of saturation, void ratio, porosity, specific gravity, mass specific gravity etc. Relationship between volume- weight, void ratio-moisture content, unit weight- percent air voids, saturation- moisture content, moisture content-specific gravity etc.Determination of various parameters such as: Moisture content by oven dry method, pycnometer, sand bath method, torsional balance method radioactivity method, and alcohol method. Specific gravity by density bottle method, pycnometer method, measuring flask method. Unit weight by water displacement method, submerged weight method, core cutter method, sands replacement method.

Module 2: Plasticity Characteristics of Soil-Introduction to definitions of: plasticity of soil, consistency limits-liquid limit, plastic limit, shrinkage limit, plasticity, liquidity and consistency indices, flow & toughness indices, definitions of activity and sensitivity. Determination of: liquid limit, plastic limit and shrinkage limit.Use of consistency limits. Classification of Soils-Introduction of soil classification: particle size classification, textural classification, unified soil classification, Indian standard soil classification system.Identification: field identification of soils, general characteristics of soil in different groups.

Module 3: Permeability of Soil-Introduction to hydraulic head, Darcy's law, validity of Darcy's law. Determination of coefficient of permeability: Laboratory method: constant head method, falling head method. Field method: pumping- in test, pumping- out test.Permeability aspects: permeability of stratified soils, factors affecting permeability of soil. Seepage Analysis-Introduction, stream and potential functions, characteristics of flow nets, graphical method to plot flow nets.

Module 4: Effective Stress Principle-Introduction, effective stress principle, nature of effective stress, effect of water table.Fluctuations of effective stress, effective stress in soils saturated by capillary action, seepage pressure, quick sand condition.Compaction of Soil- Introduction, theory of compaction, laboratory determination of optimum moisture content and maximum dry density.

Compaction in field, compaction specifications and field control.

Module 5: Consolidation of Soil-Introduction, comparison between compaction and consolidation, initial, primary & secondary consolidation, spring analogy for primary consolidation, consolidation test results, basic definitions, Terzaghi"s theory of consolidation, final settlement of soil deposits, consolidation settlement: one- dimensional method, secondary consolidation.

Module 6: Shear Strength-Principle planes parallel to the coordinate axes, Mohr"s circle, important characteristics of Mohr"s circle, Mohr-Coloumb theory, types of shear test: direct shear test, merits of direct shear test, triaxial compression tests, test behaviour of UU, CU and CD tests, relation between major and minor principal stresses, unconfined compression test, vane shear test.

Module 7: Stability of Slopes-Introduction, different factors of safety, types of slope failures, analysis of finite and infinite slopes, wedge failure Swedish circle method, friction circle method, stability numbers and charts. Soil Exploration- Introduction, methods of investigation, methods of boring, soil samplers and sampling, number and deposition of trail pits and borings, penetrometer tests, borehole logs, geophysical methods.

1. Field Density using Core Cutter method.
2. Field Density using Sand replacement method.
3. Natural moisture content using Oven Drying method.
4. Field identification of Fine Grained soils.
5. Specific gravity of Soil grains.
6. Grain size distribution by Sieve Analysis.
7. Grain size distribution by Hydrometer Analysis.
8. Consistency limits by Liquid limit
9. Consistency limits by Plastic limit
10. Consistency limits by Shrinkage limit.
11. Permeability test using Constant Head test method.
12. Permeability test using Falling Head method.
13. Compaction test: Standard Proctor test.
14. Compaction test: Modified Proctor test.
15. Relative density.
16. Consolidation Test.
17. Triaxial Test (UU)
18. Direct Shear Test.
19. Unconfined Compression Strength Test.
20. California Bearing Ratio.

Transportation Engineering

Module 1: Highway planning-Classification of roads, brief history of road development in India, present status of roads in India, road patterns, saturation systems, highway alignment: basic requirements for an ideal alignment, factors governing highway alignment, highway location surveys and studies, highway alignment in hilly areas, drawings and reports, highway project preparation.

Module 2: Geometric design of highways-Terrain classification, design speed, vehicular characteristics, highway cross-section elements Sight distance: introduction to sight distance, reaction time, analysis of safe sight distance, analysis of overtaking sight distance, intersection sight distance. Design of horizontal alignment: horizontal curves, design of super elevation and its provision, radius at horizontal curves, widening of pavements at horizontal curves, analysis of transition curves. Design of vertical alignment: different types of

gradients, grade compensation on curves, analysis of vertical curves, summit curves, valley curves. Intersection: at grade and grade separated intersections, speed change lanes, Canalization, Design of rotary intersection and mini roundabout.

Module 3: Traffic engineering & control-Traffic engineering definitions: functions, organization and importance, necessity of understanding the behaviour of road user and vehicle characteristics,

human factors governing the road user behaviour- power performance and other vehicular characteristics. Traffic studies and surveys: Speed studies: presentation of data, journey time and delay studies, uses and various methods, relative merits and demerits Vehicular volume counts: types, various available methods, relative merits and demerits, planning of traffic counts, vehicle occupancy surveys. Origin: destination surveys, need and uses, various available methods, checks for accuracy, presentation of data. Parking surveys: needs and types. Study of various photographic techniques available for traffic studies.Traffic signs and marking: types, location, height etc., miscellaneous traffic control aids like roadway delinators, hazard markers, object marker, speed breakers, rumble strips etc., Street lighting: needs, definitions, laws of illumination, methods of discernment, glare problem, light lantern arrangement, types of lamps, planning and designing.
Module 4: Pavement materials- Stone aggregates: desirable properties, tests, requirements of aggregates for different types of pavements. Bituminous materials: types, tests on bitumen, desirable properties, selection of grade of bitumen. Bituminous mix design: principle, methods, modified binders.
Module 5: Design of pavements-Types of pavements, comparison of different types of pavements, functions of pavement components, pavement design factors, design wheel load, equivalent single wheel load, repetition of loads, equivalent wheel load factors, strength characteristics of pavement materials, climatic variation; design of flexible highway pavement as per IRC approach, design of flexible airport pavements, Stresses in rigid highway pavements, critical load positions, stresses due to loads, stresses due to temperature change, combined loading and temperature stresses, Joints in rigid pavements: transverse joints, longitudinal joints, fillers and sealers.
Module 6: Highway construction- Equipment used for construction, embankment design and construction, construction of different Types of roads: water bound macadam, different types of bituminous pavements, cement concrete pavements, Construction of soil stabilized roads: different soil stabilization methods, use of geo-textiles and geo-grids.
Module 7: Highway drainage- Necessity, surface draining, highway sub drainage, draining of city streets
Module 8: Highway maintenance & rehabilitation- Pavement failures: flexible pavement failures, rigid pavement failures, maintenance of different types of pavements: assessment and need for maintenance, pavement management system, evaluation of pavements: structural evaluation of pavements, functional evaluation of pavements, strengthening of existing pavements: object of strengthening, types of overlays, design of different types of overlays.

Environmental Engineering

Module 1: Water:- Water Supply systems, Need for planned water supply schemes, Sources of Water, Water demand and Potable, industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design.

Module 2: Sewage- Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage- Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems. Storm Water- Quantification and design of Storm water; Sewage and Sullage, Pollution due to improper disposal of sewage, National River cleaning plans, recycling of sewage – quality requirements for various purposes.

Module 3: Air - Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution- automobile pollution, Chemistry of combustion, Automobile engines, quality of fuel, operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and limitations

Module 4: Noise- Basic concept, measurement and various control methods.

Module5: Solid waste management-Municipal solid waste, Composition and various chemical and physical parameters of MSW, MSW management: Collection, transport, treatment and disposal of MSW. Special MSW: waste from commercial establishments and other urban areas, solid waste from construction activities, biomedical wastes, Effects of solid waste on environment: effects on air, soil, water surface and ground health hazards. Disposal of solid waste-segregation, reduction at source, recovery and recycle. Disposal methods- Integrated solid waste management. Hazardous waste: Types and nature of hazardous waste as per the HW Schedules of regulating authorities.

Module 6: Building Plumbing-Introduction to various types of home plumbing systems for water supply and waste water disposal, high rise building plumbing, Pressure reducing valves, Break pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used.

Module 7: Government authorities and their roles in water supply, sewerage disposal. Solid waste management and monitoring/control of environmental pollution.

Reinforced Cement Concrete Design

Module 1: Reinforced Concrete Fundamentals (working Stress Method)- Concept of reinforced concrete, stress strain characteristics of concrete and steel reinforcement, elastic theory, singly reinforced, balanced section, under reinforced section and over reinforced section, analysis and design of singly reinforced doubly reinforced rectangular and T- sections, design of one way and two way slab as per IS-456, shear and bond stresses and design for shear and bond, design of axially loaded columns, analysis of sections subjected to bending and axial forces(tension or compression).

Module 2: Brief introduction to fundamentals of ultimate strength theory: curved stress distribution, compressive stress block, simplified rectangular stress block as per Whitney's approach, ultimate moment of resistance of singly reinforced section

Module 3: Limit state method of design as per IS 456- Concepts of probability and reliability, characteristic loads, characteristic strength, partial safety factors for loads and materials, introduction to limit states of collapse in flexure, direct compression, shear and limit states of serviceability in deflection and cracking, design of singly and doubly reinforced rectangular and T sections for flexure, design of members in shear and bond, design of axially loaded columns, design of one-way and two-way slabs, design of beam subjected to bending and torsion.

Engineering Geology and Rock Mechanics

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.

Module3: Physical Geology- Weathering. Erosion and Denudation. Factors affecting weathering and product of weathering. Engineering consideration. Superficial deposits and its geotechnical importance: Water fall 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 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 inten.sity 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 constituting rock mass. Main features that affects the quality of rock engineering and design. Basic element and structures of rock those 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 giving to such structures.
Module 8: Rock Mechanics- Sub surface 9nvestigations in rocks and engineering characteristics or rocks masses; Structural geology of rocks. Classification of rocks, Fieldd & laboratory tests on rocks, Stress deformation of rocks, Failure theories and sgeer strength of rocks, Bearing capacity of rocks.

1. Study of physical properties of minerals.
2. Study of different group of minerals.
3. Study of Crystal and Crystal system.
4. 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.

5. 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.
6. Identification of rocks(Sedimentary Petrology): Conglomerate, Breccia, Sandstone and its varieties , Laterite, Limestone and its varieties, Shales and its varieties.
7. Identification of rocks (Metamorphic Petrolody): Marble, slate, Gneiss and its varieties, Schist and its varieties. Quartzite, Phyllite.
8. Study of topographical features from Geological maps. Identification of symbols in maps.

Transportation Engineering II

Module 1: Introduction- Role of transportation in society, Objectives of transportation system, different types of modes, planning & co-ordination of different modes for Indian conditions

Module 2: Railway Engineering- Merits of rail transportation, railway gauges and gauge problems; Cross section of permanent way and track components: Sleepers-functions and types, sleeper density, ballast functions and different ballast materials. Rails: Coning of wheels and tilting of rails, rail cross sections, wear and creep of rails, rail fastenings. Geometric design: Gradients, transition curves, widening of gauges on curves, cant and cant deficiency. Point and crossing: Design of turnouts and description of track junctions.Yards: details of different types of railway yards and their functions. Signaling and interlocking: classification of signals, interlocking of signals and points, control of train movements. Construction and maintenance of railway track, methods of construction, material requirements, special measures for high speed track, maintenance of tracks and traffic operations

Module 3: Airport Engineering- Aircraft characteristics and their influence on airport planning. Airport planning: topographical and geographical features, air traffic characteristics, and development of new airports, factors affecting airport site selection. Airport obstruction: Zoning laws, classification of obstruction, imaginary surfaces, approach zones, turning zones. Airport layout: runway orientation, wind rose diagrams, and basic runway length. Correction of runway length, airport classification, geometric design, airport capacity, run way configuration, taxiway design, geometric standards, exit taxiways, holding aprons, location of terminal buildings, aircraft hangers and parking. Airport marking and lighting: marking and lighting of runways, taxiways and approach areas.Terminal area and airport layout: Terminal area, planning of terminal building, Apron: size of the gate position, number of gate position, aircraft parking system; Hanger: general planning considerations, blast considerations. Air traffic control: Air traffic control aids, Enroute aids, landing aids. Airport Drainage: requirement of airport drainage, design data, surface drainage design, subsurface drainage design.

Module 4: Water Transportation-Harbors: Selection of site, entrance and channel requirement, ship characteristics and their influence on ports management and operations, harbor maintenance. Harbor layout: harbor works, break waters, jetties, wharves, piers, berthing facilities, types and construction, dolphins. Navigational aids: buoys & lighthouses. Port facilities: docks, transit sheds and warehouses, general layout, containers and container yard, layout and handling equipment.

Environmental Engineering II

Module 1: Water-Man's environment: Importance of environmental sanitation. Quality of water: Wholesomeness and palatability; physical, chemical, bacteriological standards. Treatment of water; impurities in water-processes for their removal – typical flow-sheets. Sedimentation: factors affecting efficiency, design values of various parameters, tube settlers. Coagulation and flocculation: mechanisms, common coagulants, rapid mixing and flocculating devices, G and GT values, Jar test, coagulant aids - polyelectrolyte etc. Filtration: classification, slow and rapid sand filters, dual media filters, sand, gravel and under-drainage system, mode of action, cleaning, limitations, operational difficulties, performance, basic design consideration, pressure filters: construction and operation. Water softening: lime soda and Base Exchange methods, principle

reactions, design considerations, sludge disposal. Miscellaneous treatments: removal of iron and manganese, taste, odour and colour, principles and methods; de-fluoridation, reverse osmosis. Disinfection: chlorination, chemistry of chlorination, kinetics of disinfection, chlorine demand, free and combined chlorine, break point chlorination, super chlorination, de- chlorination, chlorine residual, use of iodine, ozone, ultraviolet rays and chlorine dioxide as disinfectants, well water disinfection. Introduction to advanced treatment methods : reverse osmosis, electro – dialysis, floatation, micro filtration, ultra filtration, Nan filtration.

Module 2: Sewage- Characteristics of sewage: composition, chemistry of sanitary sewage, B.O.D., C.O.D., aerobic and anaerobic decomposition. Sewage Disposal: discharge of raw and treated sewage on land and water, standards for disposal of raw and treated sewage on land and water, limits of dilution. Self purification of streams: oxygen economy, sewage farming. Sewage treatment: aims, methods of treatment and various flow-sheets for preliminary, primary, secondary and tertiary treatment, screens, grit chambers, primary and secondary clarifiers, disposal of screenings and grit. Biological treatment methods; principles, trickling filter operation, re-circulation, activated sludge process and its modifications, hydraulic design of trickling filter and activated sludge process, sludge volume index, operational problems in activated sludge process and trickling filters, stabilization ponds.
Sludge digestion: principles of anaerobic digestion, quantity and characterizations of sludge, design of sludge digestion tanks, disposal of digested sludge, drying beds. Low cost sanitation: septic tanks and Anaerobic Filter - principles, operation and suitability, design values, disposal of treated effluent. Tertiary Treatment methods – general description

1. Alkalinity
2. Hardness
3. pH
4. Turbidity
5. Jar test
6. Residual chlorine
7. Chlorides
8. Solids: suspended solids, dissolved solids, total solids, volatile solids
9. Dissolved oxygen
10. Chemical oxygen demand (COD)
11. Biochemical oxygen demand (BOD)
12. Sludge volume index (SVI)
13. Most probable number (MPN)

Design of Steel Structures

Module 1: Joints- Introduction to riveted connection, Design of bolted and welded connections, axially and eccentrically loaded joints, simple connection of bracket plates to columns, beam to beam and beam to column connections, design of framed, un-stiffened and stiffened seat connections.

Module 2: Roofing System- Imposed loads on flat and sloping roofs and floors, wind loads on sloping roofs and vertical cladding including effect of degree permeability and wind drag, analysis of pin- jointed trusses under various loading cases, computation of design forces in members, design and detailing of connections and supports, wind bracing for roof system, supported on columns.

Module 3: Flooring System- Concept of floor system with secondary beams, main beams and columns, design of simply supported beams using rolled steel sections, design of built- up sections.

Module 4: Welded Plate Girder- Proportioning and design of section and connections,

curtailment of flange plates, design of web splices, design of stiffeners.

Module 5: Columns and Bases- Design of columns under axial loads using single or multiple rolled steel sections, design of lacing and battens, columns subjected to axial load and bending, design of slab and Gusseted base.

Construction Technology

Module 1: Construction Equipment-Standard types of equipment , special equipment, cost of owning and operating equipment, depreciation costs, investment and operating costs, economic life, sources of construction equipment, factors affecting selection of construction equipment, balancing of equipment. Study of equipment with reference to available types and their types and their capacities, factors affecting their performance.Earthmoving Equipment- Tractors and attachments, dozers and rippers, scrapers , shovels, draglines, trenching machines, clamshell, hoes, trucks and wagons, dumpers, rollers and compactors. Drilling and blasting equipments- Bits, jackhammers, drifters, drills, blasting material, firing charge, safety fuse, electric blasting caps, drilling patterns, transporting and handling of explosives. Pile driving equipment- Types, pile driving hammers, single acting and double acting, differential acting hammers, hydraulic and diesel hammers, vibratory drivers. Pumping equipment- Reciprocating, diaphragm & centrifugal pumps, well point system. Stone crushing equipment- jaw, gyratory and cone crushers, hammer mills, roll crushers, rod and ball crushers, aggregate screens and screening plants, portable plants. Concrete manufacture, transport, placing and compacting equipment, mixers, central batching and mixing plants, pavers, transit mixers, concrete pumps shotcrete. Air Compressor. Equipment for moving materials, builder"s hoists, forklifts , cranes, belt- conveyors, cableways, ropeways.

Module 2: Tunneling- Geo-technical investigations, selection of alignment, methods of tunneling in soft soils and in hard rock, sequence of operations for drilling and blasting method, mechanical moles, boomers, tunnel boring machines, mucking, ventilation of tunnels, dust control, types of tunnel supports, sequence of lining operation, lining with pneumatic placers and by pump crete method.

Module 3: Bridge Construction- Geo-technical investigation , Site selection , Launching of bridges by incremental launching, using false work, balanced cantilever construction method.

Module 4: Steel Construction- Planning for field operations, selection of equipments and erection tools and method of welding, tools and methods of cutting and joining, safety measures during fabrication and erection.

Module 5: Concrete Construction- Concreting under water, concreting in different weather conditions, mass concreting, vacuum concreting, Self Compacted Concrete, Roller Compacted Concrete.

Module 6: Ground Improvement Techniques- Sand drains, stone column, diaphragm wall, rock anchors, Reinforced earth technology.

Module 7: Special equipments and their application to Off-shore construction, cofferdams, Foundation grouting.

Quantity Survey and Estimation

Module 1: Estimates-Various types, their relative importance. factors to be considered, complete set of Estimate. Approximate estimates- importance, purpose, different methods. Use of CBRI Equations for the same. Methods of preparation of estimates for projects such as: Building R.C.C., Load bearing, Road, Culvert, Irrigation; Water supply and sewerage: miscellaneous works like Manhole, water storage tank, septic tanks; Trusses of steel, Industrial Shed.

Module 2: Measurements for various items- Use of relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Earthwork Calculations

Module 3: Material survey-Thumb rules for computation of materials requirement for different materials for buildings, percentage breakup of the cost, cost sensitive index, market survey of basic materials.
Module 4: Specifications-Types, requirements and importance, detailed specifications for the buildings, roads, minor bridges and industrial structures.
Module 5: Rate analysis-Purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment.
Module 6: Tender- Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and items, penalty and liquidated charges, Settlement of disputes,
R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc.
Module 7: Introduction to acts pertaining to-Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights.
Module 8: Use of computers in quantity surveying.

1. To find out the approximate estimate of a multistoried building by approximate method.
2. Detailed estimate of the following with the required material survey for the same.

a. ground plus three storied building (RCC)
b. bridge with minimum 2 spans
c. factory building
d. road work
e. cross drainage work
f. load bearing structure

3. Preparation of valuation report in standard Government form.
4. Assignments on rate analysis, specifications and simple estimates.
5. Detailed estimate of minor structure.
6. Bar bending schedule.

Water Resources Engineering

Module 1: Introduction- irrigation, water resources in India, need of irrigation in India, development of irrigation in India, impact of irrigation on human environment, irrigation systems: minor and major, command area development.

Module 2: Hydrology- hydrologic cycle, rainfall – runoff process, factors affecting runoff, runoff hydrograph, runoff computations, flood discharge calculations, unit hydrograph method, S-hydrograph.

Module 3: Water requirement of crops-Crops and crop seasons in India, cropping pattern, duty and delta; Quality of irrigation water; Soil-water relationships- soil characteristics significant from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation; Methods of applying water to the fields: surface, sub-surface, sprinkler and trickle / drip irrigation.

Module 4: Ground water and well hydrology- Ground water resources, occurrence of ground water, methods of ground water exploration, well irrigation; Well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests, design of water wells.

Module 5: Distribution system-Canal systems, alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels carrying clear and sediment laden

water, alluvial channels carrying clear and sediment laden water, Kennedy"s and Lacey"s theory of regime channels. Canal outlets: non-modular, semi-modular and modular outlets. Water logging: causes, effects and remedial measures. Lining of canals- economics of lining, types of lining. Drainage of irrigated lands: necessity, methods.

Module 6: Canal structures- Surface and sub-surface flow considerations for design of canal structures: hydraulic jump, seepage forces, uplift forces. Canal falls, cross regulator, distributory head regulator, canal escapes: types, components and design considerations
6.3 Cross drainage works: need, types, design considerations.

Module 7: Canal head works- Weir and barrage, different units of head works, types of weirs, sediment control in canals, river training for canal head works.Theories of seepage for design of weirs: Bligh"s creep theory, Lane"s weighted creep theory, Khosala"s method of independent variables.

Module 8: Dams and spillways-Embankment dams: Classification, selection of site for dam, design considerations, estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical

profile, structural joints, keys and water seals, galleries, outlets. Arch and buttress dams- types. Spillways: components of spillways, types, terminal structures, types of gates for spillway crests; Reservoirs- Types, capacity of reservoirs, yield of reservoir, reservoir regulation, sedimentation, economic height of dam, selection of suitable site, flood routing.

Construction Project Management

Module 1: Construction- Unique features of construction, construction project, types and features, phases of a project, agencies involved and their methods of execution.
Module 2: Construction project planning- Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, estimating durations, sequence of activities, activity utility data
Module 3: Techniques of planning- Bar charts, Networks: basic terminology, types of precedence relationships: finish to start, start to start, finish to finish, start to finish, preparation of CPM networks: activity on link and activity on node representation, analysis of single relationship (finish to start) networks, computation of float values, critical and semi- critical paths, calendering networks.
Module 4: Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts, resource aggregation, allocation, smoothening and leveling.
Module 5: PERT- Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion.
Module 6: Planning and organizing construction site and resources- Site: site layout, developing site organization, record keeping at site, Manpower: planning, organizing, staffing, motivation, Materials: concepts of planning, procurement and inventory control, Equipment: basic concepts of planning and organizing, Funds: cash flow, sources of funds.
Module 7: Construction costs- Classification of costs, time cost trade-off in construction projects, compression and decompression
Module 8: Monitoring & control-Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for

quality control, role of inspection, basics of statistical quality control. Safety and health on project sites: accidents; their causes and effects, costs of accidents, occupational health problems in construction, organizing for safety and health.

Foundation Engineering

Module 1: Lateral Earth Pressures Theories- Introduction: applications of earth pressure theories, different types of earth pressure at rest, active and passive pressure. Rankine"s Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal and inclined backfill including the direction of failure Planes for cohesion-less and cohesive soils. Coulomb"s Wedge Theory: Coulomb"s active pressure in cohesion-less soils, expression For active pressure, Coulomb"s passive earth pressure. Rebhann"s Construction for Active Pressure, Culmann"s graphical solutions for active soils, Wedge Method, passive pressure by friction circle method for cohesion-less and cohesive soils.
Module 2: Earth Retaining Structures- Rigid and flexible retaining structures, stability analysis of retaining walls, cantilever retaining Walls, construction details, drainage and wall joints.
Module 3: Bearing Capacity of Shallow Foundation- Definitions of ultimate bearing capacity, gross, net and safe pressures, allowable bearing pressure, types of shallow foundations modes of failures. Bearing capacity theories: Rankine"s approach, Prandtl"s approach and Terzaghi"s approach, concept behind derivation of equation, general bearing capacity equation, bearing capacity equations for square and circular footings, factors influencing bearing capacity, performance of footings in different soils, Vesic"s chart, ultimate bearing capacity in case of local shear failure. Plate load test in detail with reference to IS1888 and its applications and estimation of settlements, bearing capacity based on Standard Penetration Test.
Module 4: Axially Loaded Pile Foundations: 4.1 Introduction to pile foundations, necessity of pile foundation, classification of piles, construction methods of bored piles, concrete bored piles, driven cast in-situ piles. Pile capacity based on static analysis, piles in sand, piles in clay, dynamic methods and their limitations, in- situ penetration tests and pile load test as per IS 2911 specifications, negative skin friction. Pile groups ultimate capacity of groups, settlement of pile groups in sand and in clay as per IS 2911 and critical depth method.
Module 5: Underground Conduits- Classes of underground conduits, load on a ditch conduit, settlement ratio, ditch condition and projection condition, imperfect ditch conduit.
Module 6: Open Cuts: Difference in open cuts and retaining walls, apparent pressure diagrams, average apparent pressure diagrams for sand and stiff clay, estimation of loads on struts.

Structural Dynamics

Module 1: Introduction to structural dynamics, definition of basic problem in dynamics, static versus dynamic loads, different types of dynamic loads.

Module 2: Introduction to single degree of Freedom (SDOF) systems- Un-damped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement, forced vibration, response to periodic loading, response to periodic loading, response to pulsating forces, dynamic load factors, response of structure subjected to general dynamic load, Dulhamel"s integral, numerical evaluation of dynamics response of SDOF systems, response of structure in frequency domain subjected to general periodic and non-periodic/impulsive forces of short duration, use of complex frequency response function, use of Fourier Series for periodic forces, introduction to vibration isolation, distributed mass system idealized as SDOF system, use of Rayleigh"s method, response of SDOF system subjected to ground motion.
Module 3: Generalized Single Degree of Freedom System-Generalized properties: Assemblages of Rigid Bodies, Systems with distributed mass and elasticity, expressions for generalized system properties.
Module 4: Lumped mass multi degree of freedom (MDOF) system- Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods. Energy methods and use of Lagrange"s method in writing equations of motions, decoupling of equations of motion,

modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, application to multi-storey rigid frames subjected to lateral dynamic loads.

Module 5: Structure with distributed mass system- Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads.
Module 6: Random Vibrations-Random processes, stationary and ergodic processes, autocorrelation function, power spectral density function, relationship between power spectral and autocorrelation functions, power spectral density and autocorrelation functions for derivatives of processes, superposition of stationary processes, stationary Gaussian processes, stationary white noise, probability distribution for maxima and extreme values.

Module 7: Stochastic Response of Linear SDOF Systems- Transfer functions, relationship between input and output autocorrelation functions, relationship between input and output power spectral density functions, response characteristics for narrowband systems.

Experimental determination of frequency of vibration and damping coefficient using simple displacement pickups.

Earthquake Engineering

Module 1: Definitions of basic problems in dynamics, static versus dynamic loads, different types of dynamic loads, un-damped vibration of SDOF system, natural frequency and periods of vibration, damping in structure, response to periodic loads, response to general dynamic load, response of structure subject to gravitational motion, use of Fourier series for periodic forces.
Module 2: Direct determination of frequencies and mode shapes, orthogonality principle, approximate methods for determination of frequencies and mode shapes, modal error of forced vibration of MDOF system, modal analysis, applications to multistoried rigid frames subject to lateral dynamic loads.
Module 3: Seismological background: Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, Richter scale, measurement of ground motion, seismogram.
Module 4: Characterization of ground motion: earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics.
Module 5: Deterministic earthquake response: types of earthquake excitation, lumped SDOF elastic systems, translational excitation, lumped MDOF elastic systems, translational excitation time history analysis, multistoried buildings with symmetric plans, multistoried buildings with unsymmetric plans, torsional response of symmetric plan building, distributed-parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a single mode, SRSS and CQCC combination of modal responses.

Module 6: I. S. code method of seismic analysis: seismic co-efficient method and its limitation, response spectrum method, I. S. code provision for seismic analysis of buildings and water towers.
Module 7: Review of damages during past earthquakes and remedial measures, seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints.

Advanced Design of Steel Structures

Module 1: Moment Resistant Beam End Connections- Design of moment resistant riveted and welded beam end connections.
Module 2: Round tubular structural members- Properties of steel tubes. Design of tension and

compression members, Design of welded connections. Design of flexural members. Analysis and design of tubular trusses including purlins and supports.
Module 3: Elevated steel tanks and stacks- Loads acting on tanks including wind and earthquake. Design of circular tanks with conical bottom, supporting ring beam, staging for circular tanks. Design of rectangular steel tanks. Design of foundation for columns.
Module 4: Gantry Girder - Loads acting on gantry girder. Analysis & design of gantry girder.
Module 5: Lattice Tower-Loads acting on lattice towers. Analysis and design of lattice tower including welded or riveted connections for members.
Module 6: Steel Chimney:-Forces acting on chimney. Design of self supporting welded chimney including design of foundation.

1. Design of tubular trusses.
2. Design of elevated circular tank with conical bottom or rectangular steel tank.
3. Design of lattice tower or steel chimney.

The drawings to be made with pencil only on minimum of A-1 size drawing sheets. Each student to appear for at least one written test during the term. The graded answer paper of the test to be submitted as *Term Work.*

Advanced Design of R.C.C. Structures

Module 1: Design of Flat Slabs- Modes of failure of flat slabs. I.S code Provisions for the design of simple and continuous flat slabs. Special detailing requirements of flat slabs.
Module 2: Large Span Roofs- Folded Plate Roofs - Whitney"s Method , Simpson"s Method and Design of single and multi-bay folded plate roofs, design based on IS codes of practice.
Module 3: Circular Cylindrical Shell Roofs-Beam theory of cylindrical shells, single and multiple bays with various edge conditions.
Module 4: Silos and Bunkers-Lateral Pressures in bunkers as per Rankine"s and Coulomb theories, Lateral pressures in silos as per Janssen"s and Airy"s theories , design considerations for square, rectangular and circular shapes of silos , design of hoppers and supporting structures of bins. I. S. Code Provisions for design of Silos and Bunkers.
Module 5: Design OF Deep Foundations- Design considerations for piles and pile groups. Codal provisions for the design of pile caps, Rectangular, circular and triangular pile caps for group of piles. Truss Analogy method for the analysis of pile caps.
Module 6: Design Of R.C.C, Chimney- I.S. Code provisions, principles of design under various types of loadings, behaviour of chimneys and stack structures under wind.
Module 7: Design of Cooling Towers-Principles of design of various types of cooling towers.
I.S. Code provisions for the design, analysis and design umder wind and earthquake loads.

Pre-stressed Concrete

Module 1: Introduction to pre-stressed concrete: basic concept and general principles, materials used and their properties, methods and techniques of pre-stressing, pre-stressing systems, loss of pre-stress
Module 2: Analysis of pre-stressed concrete sections: loading stages and computation of section properties, critical sections under working load for pre-tensioned and post-tensioned members, load balancing method of analysis of pre-stressed concrete beams.
Module 3: Design of pre-stressed concrete sections for flexure: general philosophy of design, design approaches in working stress method and limit stress method, critical conditions for design, limit state of collapse in flexure, permissible stresses in concrete and steel, kern points, choice and efficiency of sections, cable profiles and layouts, cable zone, deflections of pre-stressed concrete members.
Module 4: Design for shear: calculation of principle tension under working load, permissible principle tension, shear strength calculation under limit state of collapse for both sections cracked and un-cracked in flexure.
Module 5: End zone stresses in pre-stressed concrete members: pretension transfer bond, transmission length, end block of post-tensioned members

Module 6: Design of pre-stressed concrete beams: design of simply supported pre-tensioned and post tensioned slabs and beams, introduction to application of pre-stressing to continuous beams, linear transformation and concordancy of cables.

Term Work:

This shall include a project report on design of a post tensioned prestressed concrete beam with one A1 size drawing sheet on design.

Soil Dynamics

Module 1: Vibration of elementary system, Degrees of freedom, Analysis of system with one degree of freedom, spring-mass system, harmonic vibration, uniform circular motion, natural frequency, free and forced vibrations with and without damping, types of damping.
Module 2: Wave propagation in elastic rods, in an elastic infinite medium, and in semi- elastic half space, wave generated by surface footing.
Module 3: Liquefaction of soils, criterion and factor affecting liquefaction of soil, laboratory and field studies on liquefaction, liquefaction studies in oscillatory simple shear, evaluation of liquefaction potentials, liquefaction of clay.*Module 4:* Principles of machine foundation, design criteria for satisfactory machine foundation, degrees of freedom of a block foundation analysis of vertical and sliding vibration of a machine foundation, mass of soil participating in vibration.
Module 5: Vibration isolation and screening methods, improvement of distressed machine foundation.
Module 6: Field and laboratory tests for evaluation of dynamic properties of soil under vertical vibration, coefficient of elastic uniform compression, coefficient of elastic uniform shear, spring constant damping modulus of elasticity typical values of soils.
Module 7: IS code method of design and IS code provisions for dynamic analysis of buildings.

Advanced Foundation Engineering

Module 1: Planning of subsurface investigation- Purpose and scope, Influence of soil conditions and type of foundation on exploratory programme, Subsurface soundings – static and dynamic methods, Planning of subsurface investigations, Type and sequence of operations, Lateral extent and depth of exploration, Interpretation of field and laboratory data
Module 2: Consolidation: Terzaghi"s theory of one-d consolidation – derivation of equation (solution in detail need not be covered), Estimation of Cc and Cv from laboratory tests, Estimation of Pc by various methods, Field consolidation curves, Quasi pre-consolidation and secondary consolidation, practical applications
Module 3: Stress and strain behavior of soil: Triaxial test - drained and un-drained behavior of sand and clays, Failure criteria in soils – only Mohr – Coulomb"s criteria, Ideal, plastic and real soil behavior, Shear strength of sand and clays.
Module 4: Estimation of stresses: Boussinesq"s theory, Westergard"s theory, Newmarks charts.
Module 5: Bearing capacity and settlement analysis of shallow foundations: Modes of failure, Failure criteria, Prandtl Reissner solutions, Buisman – Terzaghi solution, Assumptions in estimates of ultimate loads, Effect of shape, embedment of footing, eccentricity in loading, compressibility (including critical rigidity index), Choice of factor of safety, Settlement of foundations on sand – Schmertmann method, Foundations on

collapsing and swelling soils, non-uniform soils, compressible soils and on rock, R.C.C. design of isolated and combined footings.
Module 6: Pile foundations: Use of load tests, Estimation of single pile capacity by static and dynamic methods, Group capacity, Separation of skin friction and end bearing capacity, Settlement of single and group of piles.
Module 7: Ground improvement: Improvement of deep cohesionless soils and cohesive soils (including stone columns), geological properties of reinforced soils, Instrumentation – mainly pore pressure gauges and settlement gauges and their applications.

Geographic Data Analysis and Applications

Module 1: Basic concepts of GIS- Information systems, spatial and non-spatial information, geographical concepts and terminology, advantages of GIS, basic components of GIS, commercially available GIS hardware and software, organization of data in GIS.
Module 2: GIS data- Field data, statistical data, Maps, aerial photographs, satellite data, points, lines and areas features, vector and raster data, advantages and disadvantages, data entry through keyboard, digitizers and scanners, digital data, preprocessing of data- rectification and registration, interpolation techniques.
Module 3: Data management- DBMS, various data models, run-length encoding, quadtrees, data analysis-data layers, analysis of spatial and non-spatial data, data overlay and modeling, data processing: raster based and vector based, data presentation –hardcopy devices, softcopy devices.
Module 4: Remote sensing and GIS integration- Principles of electromagnetic remote sensing, imaging characteristics of remote sensing systems, extraction of metric and descriptive information from remotely sensed images, integration of remote sensing and GIS.
Module 5: Applications of GIS- Map revision, land use, agriculture, forestry, archaeology, municipal geology, water resources, soil erosion, land suitability analysis, change detection

Term Work:

Each student to appear for at least one written test during the semester. At least 10 assignments based on above syllabus and the graded answer paper for the semester test to be submitted.

Concrete Technology

Module 1: Properties of Ingredients-Properties of coarse and fine aggregates and their influence on concrete, types of cement and their use, physical properties of 33 Grade, 43 Grade, 53 Grade ordinary Portland cement, Portland pozzolana cement, rapid hardening Portland cement, hydrophobic cement, low heat Portland cement and sulphate resisting Portland cement as per relevant I.S. codes. Stone types and properties, preservative treatments, stone aggregates.
Module 2: Grades of concrete- Concrete for ordinary work, light weight concrete, high density concrete, workability, durability and strength requirements, effect of w/c ratio, acceptability criteria, laboratory testing of fresh and hardened concrete.
Module 3: Concrete mix design-Mix design for compressive strength by I.S. methods, road note method and British method, mix design for flexural strength.
Module 4: High performance concrete-Constituents of high grade concrete, various tests and application of high performance concrete.
Module 5: Admixtures-Plasticizers, retarders, accelerators and other admixtures, test on admixtures, chemistry and compatibility with concrete.
Module 6: Ready mix concrete: requirements of ready mix concrete, transit mixer details, mix design of RMC.
Module 7: Concrete for repairs and rehabilitation of structures-Polymer concrete, fiber reinforced concrete, polymer impregnated concrete, polymer modified cement concrete and Ferro cement, different tests.
Module 8: Non-Destructive testing of concrete-hammer test, ultrasonic pulse velocity test, load test, carbonation test, half cell potentio-meter, corrosion of steel, core test and relevant provision of I.S. codes.

(a) Effect of w/c ratio o workability (slump cone, compaction factor, V-B test, flow table)
(b) Effect of w/c ratio on strength of concrete,
(c) Mix design in laboratory
(d) Non destructive testing of concrete – some applications (hammer, ultrasonic)
(e) Secant modulus of elasticity of concrete & indirect tensile test on concrete.
(f) Study of admixtures & their effect on workability and strength of concrete.
(g) Modulus of rupture of concrete.

(h) Permeability test on concrete.
(i) Tests on polymer modified mortar / concrete.
(j) Tests on fiber-reinforced concrete.
(k) Flexure test on beam (central point load and two point load) (plotting of load deflection curve and finding value of E)

Advanced Construction Materials

Module 1: Recent developments in construction materials for Cladding, Waterproofing, Tiles, Paints, Formwork, Decorative interiors etc.
Module 2: Specifications: their properties, methods of use, benefits and limitations.

Module 3: Economic analysis of using new materials, recycling and reuse.
Module 4: Specific precautions to be taken while using new materials.

Construction Equipment and Materials

Module 1: Large and heavy engineering projects- characteristics and complexities, methods statement for major activities like excavation, concreting, steel fabrication and erection for projects like earthen dams, hydropower projects, nuclear power plant, refineries and other industrial projects,
Module 2: Excavation for heavy engineering projects- Excavation in various types of soils, selection of equipment, safety measures in excavation, drainage in excavation.
Module 3: Concrete construction for heavy engineering projects-Selection of equipment for batching, mixing, transporting, placing and compacting for various types of jobs, safety measures during concreting, Special concretes and mortars-preplaced aggregate concrete, roller compacted concrete, grouting
Module 4: Prefabricated construction- Planning for pre-casting, selection of equipment for fabrication, transport and erection, quality measures, safety measures during erection.
Module 5: Steel construction-Planning for field operations, selection of equipment and erection tools, tools and methods of welding, tools and methods of cutting and joining, bridge erection, quality measures, safety measures during fabrication and erection.
Module 6: Specific issues related to planning, site layouts, equipment selection and pre- project activities for large size construction projects like earthen dams, concrete dams, thermal power stations, nuclear power stations, light houses, airports and ports, bridges.
Module 7: Information related to special equipments and their applications to off-shore construction, underground utility construction.
Module 8: New materials and equipment for construction; Case studies of heavy construction projects.

Building Maintenance and Repairs

Module 1: General-Quality Assurance for concrete construction as Built Concrete property Strength, Permeability, Thermal Properties and Cracking.
Module 2: Influence on Serviceability and Durability-Effects due to climate, Temperature, Chemicals, Wear and Erosion, Design and Construction errors, Corrosion Mechanism, Effects of Cover thickness and Cracking, Methods of Corrosion protection, Corrosion Inhibitors, Corrosion Resistant Steels, Coatings, Cathodic Protection.
Module 3: Maintenance and Repair Strategies-Definitions-Maintenance, repair and rehabilitation, Facets of Maintenance, Importance of Maintenance, Preventive Measures on Various Aspects, Inspection, Assessment Procedure for Evaluating for Damaged Structures, Causes of Deterioration, Testing Techniques.
Module 4: Materials for Repair-Special Concretes and Mortar, Concrete chemicals, Special Elements for accelerated strength gain, Expansive cement, Polymer Concrete, Sulphur Infiltrated Concrete, Ferro Cement, Fiber Reinforced Concrete.

Module 5: Techniques for Repair-Rust Eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and shotcrete, Epoxy Injection, Mortar Repairs for cracks, shoring and underpinning.
Module 6: Examples of Repair to Structures-Repairs to overcome low member strength, deflection, cracking, chemical disruption, weathering wear, fire, leakage, marine exposure.
Module 7: Engineered demolition techniques for dilapidated structures – case studies.

Water Resource Systems

Module 1: Planning for water resources development, levels of planning and objectives, project formulation and evaluation. System analysis in planning, trends in water resources development.
Module 2: Objectives and evaluation criteria: Technological objectives, social benefit-cost analysis, practical project appraisal, environmental - ecological objectives and evaluation criteria, Multi-objective analysis.
Module 3: Hydrologic input analysis: surface sub-system (watershed) functional analysis, hydrograph and IUH, wash and Clark model, hydrologic forecasting computer simulation of basin. Soil sub-system analysis, ground water sub-system, stream flow generation.
Module 4: Demand analysis: categories of demand, demand projections and policy formulation for various demands.
Module 5: System elements and sub-system planning, water conveyance and distribution systems, reservoir systems, conjunctive surface and ground water development.
Module 6: Multipurpose developmental issues- flood management, conjunctive flood mitigation and water resources enhancement, hydro-electric development and the power sector, inland water transportation, micro-level planning, erosion and sedimentation, water shed management, conjunctive use of surface water and ground water, rainwater harvesting

Pavement Management System

Module 1: Pavement distresses Distresses in flexible/rigid pavements causes and remedies. Visual Surface distress survey procedures and techniques. Serviceability Indicators for roads. Measurement of Serviceability Indicators using various equipments like Bump Indicator, Skid tester, Distress surveys & Benkelman Beam.Functional evaluation of pavements- Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Roughness Measurements, Skid Resistance, Roughness, and Safety Aspects. Inventory System.

Module 2: Maintenance operations/alternatives- Classification of maintenance operations, Routine, Periodic, Special. Common types of maintenance: Potholes, Cracked surface, Ruts & undulations, Resurfacing, Interface treatments, Bituminous Thin Surface Courses- Seal
..Coat, Surface Dressing, Premixed carpet, Mixed seal surfacing, Micro asphalt concrete
(MAC), Bituminous Surface Courses: Semi-Dense Bituminous Concrete, Bituminous Concrete, and Bitumen Mastic. Road maintenance in high rainfall areas. Choice of materials. Modified bitumen & geo-fabrics. Maintenance alternatives including recycling.
Module 3: Pavement Management/ Maintenance Management System-Components of PMS and their Activities, Major Steps in Implementing PMS, Inputs, Design, Construction and Maintenance, Rehabilitation and Feedback Systems, Examples of HDM package, Highway Financing, Fund Generation, Evaluating Alternate Strategies and Decision Criteria.
Module 4: Prediction Deterioration Models- Factors that affect performance, Types of prediction models, Prediction deterioration model development, Method to assess the precision and accuracy of the developed model.
Module 5: Pavement Structural Design and Economic Analysis; Emerging Technology in Pavement Management Systems.

Bridge Engineering

Module 1: Introduction-Types of bridges, economic spans, aesthetics, selection of suitable type of bridge,
Module 2: Design loads and their distribution-IRC loads, railway loading, analysis of deck slab and IRC loads, load distribution among longitudinal beams of a bridge.

Module 3: Design of superstructures- Design of balanced cantilever concrete bridge, introduction to design of RC arch bridge, pre-stressed concrete and box girder bridge. Design of lattice girder rail way bridge.
Module 4: Design of substructure-Different types of foundations, their choice and method of construction, design of well foundation, design of piers and abutments, various types of bearings and their design.
Module 5: Construction methods-Erection of bridge superstructures, cantilever construction.

Traffic Planning and Design

Module 1: Traffic Engineering and control-Review of various traffic surveys and traffic Studies; Statistical methods for traffic engineering and their applications - Distributions, sampling theory and Significance testing, Regression and Correlation; Intersection design- Principles, various available alternatives, rotary design, mini roundabout, traffic signals: types of traffic signals, advantages, determination of optimal cycle time and signal setting for an intersection with fixed time signals, co-ordination of signals, types, area traffic control, delay at signalized intersection. Accident and road safety: accident causes, recording system, analysis and preventive measures, accident cost, alternative methodologies for calculation. Traffic management- various measures and their scope, relative merits and demerits. Highway capacity: passengers car units, level of service, factor affecting capacity and level of service, influence of mixed traffic.
Module 2: Transportation Planning and management-Introduction to the process of urban transport planning. Travel demand forecasting=Trip generation analysis, trip classification, multiple regression analysis, category analysis. Modal split analysis: introduction, earlier modal split models, modal split models with behavioral basis.Trip distribution analysis: introduction, methods of trip distribution, uniform and average factor method, Fratar method, Furness method, The Gravity model, Intervening and competing, Linear programming approach to trip distribution. Traffic Assignment: purpose of traffic assignment, traffic flow characteristics, Assignment techniques=All or nothing assignment, Multiple route assignment, Capacity restraint assignment, Diversion curves. Rout building algorithms. Land- use transport models: Introduction, selection of Land-use transport models, The Lowry model, Grain – Lowry model, Applications of Lowry model.
Module 3: Theory of traffic flow- Scope, definitions and basic relationship, review of flow density speed studies, hydrodynamic analogies, Application of hydrodynamic analogy, Car- following theory and its application to traffic engineering, probabilistic description of traffic flow, an introduction to queuing theory as applied to traffic flow problems for study state conditions, simulation studies.
Module 4: Transport Economics-Economic evaluation of highway schemes, need for economic evaluation, cost and benefits of transportation projects, basic principles of economic evaluation, Net present value method, benefit/cost ratio method, internal rate of return method. Vehicle operating costs, Value of travel time saving, Accident costs.
Module 5: Public Transportation-Mass transit systems: Bus and rail transit, characteristic capacities.
Module 6: Introduction to intelligent transportation systems, Introduction to advanced computational techniques for transportation planning.

Solid and Hazardous Waste Management

Module 1: Solid Wastes – sources, types, composition, physical, chemical, and biological properties of solid wastes / sources and types of hazardous and infectious wastes in municipal solid wastes.
Module 2: Solid waste generation and collection, Handling, Storage, Processing, Transportation.
Module 3: Disposal of Solid waste – materials separation and processing, thermal conversion, biological and chemical conversion, recycling of material in municipal solid wastes, Land-filling, Composting, gas generation, closure of land-fills.
Module 4: Hazardous Wastes – Fundamentals, fate, and Transport of contaminants, Toxicology origin, quantity and quality parameters.
Module 5: Biomedical / infectious Waste: Composition, Collection, Handling and Disposal.
Module 6: Legal aspects of Hazardous Waste Management: Collection, Conveyance, Treatment and Disposal.
Module 7: Hazardous Waste Management Practices: Environmental Audits, Pollution Prevention.
Module 8: Treatment and Disposal Methods; Physicochemical processes, Biological Methods, Stabilization & Solidification, Thermal Methods, Land Disposal.
Module 9: Site Remediation- Site & Subsurface Characterization, Remedial Technologies.

Environmental Impact Assessment *(EIA)* and Audit

Module 1: Environmental Impact-Environmental inventories, Environmental assessment, evaluation.
Module 2: Socioeconomic Impact Assessment-Financing of capital expenditure, increase in user charges, sociological impacts.
Module 3: Role of EIA in Planning and Decision making Processes, Rapid EIA.
Module 4: Environmental Impact Statement.

Module 5: Environmental Auditing-Post Audit reviews of EIA.

Module 6: Case studies.

Term Work:

This shall include a project report on at least one aspect of EIA.

Construction and Law

Module 1: Indian Contract Act 1972 – Valid Contract, Voidable Contract, Void – Sections related to these. Definitions, Interpretation.
Module 2: Arbitration and Conciliation Act of 1996- Arbitration agreement, Arbitrator tribunal, Qualifications of Arbitrator, Arbitration Proceedings Award. Conciliation agreement, proceedings, settlement.
Module 3: Provisions of various labor laws-Workmen's Compensation Act 1923; Disablement, Total Permanent disablement, Temporary disablement, Formula for compensation; Minimum wages act, 1948; Payment of bonus Act, 1965; Weekly holidays Act, 1942; Payment of Wages Act, 1936; Inter-State Migrant Labor Act, 1979; Employees Insurance Act, 1948.
Module 4: The building and other construction workers (regulation of employment and conditions of service) Act, 1996 and Rules 1998.

Systems Approach to Civil Engineering

Module 1: Concept of systems approach: system, boundaries of system, goals and objectives,

optimality, mathematical models, objective function and constraints, problem solving mechanism, types of problems, modeling / problem formulation, sub-optimization, solution techniques, sensitivity analysis

Module 2: Basic concepts of probability and probability distributions, regression and curve fitting.

Module 3: Decision theory: classification of decision situations, decision tables and decision tree, criteria for decision making under certain, uncertain and risk conditions.

Module 4: Index numbers: basic requirements of index numbers, constructing index numbers: using relatives, using aggregates.

Module 5: Linear programming: general nature of problem, graphical method of solution, simplex method, dual, sensitivity analysis.

Module 6: Distribution models: transportation and assignment problems and their solutions.

*Module 7:*Queuing models: various situations, queue discipline and customer behavior, single server model.

Module 8: Simulation: general approach, Monte Carlo simulation, simple problems using hand calculations.

Risk & Value Management

Module 1: Project Risks- Definition, dynamic and static risk, uncertainty and risk, Risk and construction project time, money and technology, the people and the risks, processes and risks, risks and clients, consultants and contractors, risk allocation in contracting.

Module 2: Human Aspects-Personnel attitude towards risk, perceptions and risks, individuals and groups , communication in risk management, concept of utility and risks.

Module 3: Risk management system- Risk identification, sources of risks, risk classification, types, impact and consequences of risk, risk analysis, Sensitivity analysis, breakeven analysis ,scenario analysis, risk response: retention, reduction, transfer, avoidance

Module 4: Qualitative and quantitative methods in risk management-Qualitative risk assessment, risk register, probability – Impact matrix, project appraisal, cost benefit analysis, Monte- Carlo technique, portfolio theory, Delphi method, influence diagrams, decision trees.

Module 5: Disasters-Natural and manmade, possible effects, Disaster recovery plan.

Module 6: Value Engineering-Value, Reasons of poor value in constructed facilities, habits, road blocks and attitudes.

Module 7: Value management-Value Engineering job plan, function analysis, purpose and implications of life cycle costs, Impact of energy on cost of constructed facilities, managing value engineering study.

Module 8: Disaster recovery plan: basic requirements, documenting disaster recovery plan, rehearsing the disaster recovery plan, example disaster recovery plan.

Note: The above syllabus is indicative and not exhaustive

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