

APPENDIX-I

SCHEME AND SYLLABUS OF EXAMINATION FOR THE PURPOSE OF FILLING UP THE POST OF JUNIOR ENGINEER (CIVIL) UNDER VARIOUS DEPARTMENT

I The written examination will consist of 02 (two) Papers: -

PAPER	SUBJECT	MARKS	TIME ALLOWED
I	GENERAL ENGLISH/ GENERAL KNOWLEDGE (MCQ/ CONVENTIONAL)	100	2:00 HOURS
II	MAIN PAPER (MCQ/ CONVENTIONAL)	300	3 HOURS

II SYLLABUS: -

1. PAPER I: -

(a) General English: -

The question will be designed to test the candidate's understanding and command of the English Language.

The pattern of the questions would be broadly as follows: -

- i. Comprehension of a given passage,
- ii. Grammer,
- iii. Usages and Vocabulary,
- iv. Report writing, essay writing and precis writing.

(b) GENERAL KNOWLEDGE: -

The question will be designed to test the candidates knowledge of current events of local, national and international importance and of such matter of everyday observation and experience as may be expected of any educated person who has not made a special study of the subject.



PR. CHIEF ENGINEER TO THE GOVT OF SIKKIM
ROADS AND BRIDGES DEPARTMENT

[Handwritten signature]
19/04/2024

SYLLABUS FOR RECRUITMENT OF JUNIOR ENGINEER CIVIL**INDEX**

1	Units and Measurements
2	Construction Materials
3	Basic Surveying
4	Mechanics of Materials
5	Building Construction
6	Concrete Technology
7	Geotechnical Engineering
8	Hydraulics
9	Advanced Surveying
10	Theory of Structure
11	Building Planning and Drawing
12	Water Resources Engineering
13	Transportation Engineering
14	Design of Steel and RCC structures
15	Estimating and Costing
16	Public Health Engineering
17	Precast and Prestressed Concrete
18	Construction Management
19	Rural Construction Technology
20	Traffic Engineering
21	Solid Waste Management
22	Advanced Construction Technology
23	Pavement Design & maintenance
24	Green Building and Energy Conservation
25	Building Services and Maintenance
26	Repairs and Maintenance of Structures
27	Advanced Design of Structures
28	Tendering and Accounts

1 **Units and Measurements**

Physical quantities, fundamental and derived, Units and systems of units (FPS, CGS and SI units), Dimensions and dimensional formulae of physical quantities, Principle of homogeneity of dimensions, Dimensional equations and their applications (conversion from one system of units to other, checking of dimensional equations and derivation of simple equations), Limitations of dimensional analysis. Measurements: Need, measuring instruments, least count, types of measurement (direct, indirect), Errors in measurements (systematic and random), absolute error, relative error, error propagation, error estimation and significant figures.

Concept and units, examples of zero work, positive work and negative work

2 **Construction Materials**

Scope of construction materials in Building Construction, Transportation Engineering, Environmental Engineering, Irrigation Engineering (applications only).

Selection of materials for different civil engineering structures on the basis of strength, durability, Eco friendly and economy.

Broad classification of materials – Natural, Artificial, special, finishing and recycled.

Natural Construction Materials

Requirements of good building stone; general characteristics of stone; quarrying and dressing methods and tools for stone.

Structure of timber, general properties and uses of good timber, different methods of seasoning for preservation of timber, defects in timber, use of bamboo in construction.

Asphalt, bitumen and tar used in construction, properties and uses.

Properties of lime, its types and uses.

Types of soil and its suitability in construction.

Properties of sand and uses

Classification of coarse aggregate according to size

Artificial Construction Materials

Constituents of brick earth, Conventional / Traditional bricks, Modular and Standard bricks, Special bricks – fly ash bricks, Characteristics of good brick, Field tests on Bricks, Classification of burnt clay bricks and their suitability, Manufacturing process of burnt clay brick, fly ash bricks, Aerated concrete blocks.

Flooring tiles – Types, uses

Manufacturing process of Cement - dry and wet (only flow chart), types of cement and its uses. field tests on cement.

Pre-cast concrete blocks- hollow, solid, pavement blocks, and their uses.

Plywood, particle board, Veneers, laminated board and their uses.



Types of glass: soda lime glass, lead glass and borosilicate glass and their uses.

Ferrous and non-ferrous metals and their uses.

Special Construction Materials

Types of material and suitability in construction works of following materials:

Water

proofing, Termite proofing; Thermal and sound insulating materials.

Fibers – Types – Jute, Glass, Plastic Asbestos Fibers, (only uses).

Geopolymer cement: Geo-cement: properties, uses.

Processed Construction Materials

Constituents and uses of POP (Plaster of Paris), POP finishing boards, sizes and uses.

Paints- whitewash, cement paint, Distempers, Oil Paints and Varnishes with their uses. (Situations where used).

Industrial waste materials- Fly ash, Blast furnace slag, Granite and marble polishing waste and their uses.

Agro waste materials - Rice husk, Bagasse, coir fibres and their uses.

Special processed construction materials; Geosynthetic, Ferro Crete, Artificial timber, Artificial sand and their uses.

3 Basic Surveying

Survey- Purpose and Use.

Types of surveying- Primary and Secondary, Classification: Plane, Geodetic, Cadastral, Hydro- graphic, Photogrammetry and Aerial.

Principles of Surveying.

Scales: Engineer's scale, Representative Fraction (RF) and diagonal scale.

Chain Surveying

Instruments used in chain survey: Metric Chain, Tapes, Arrow, Ranging rod, Line ranger, Off- set rod, Open cross staff, Optical square.

Chain survey Station, Base line, Check line, Tie line, Offset, Tie station.

Ranging: Direct and Indirect Ranging.

Methods of Chaining, obstacles in chaining.

Errors in length: Instrumental error, personal error, error due to natural cause, random error.

Principles of triangulation.

Types of offsets: Perpendicular and Oblique.

Conventional Signs, Recording of measurements in a field book.

Compass Traverse Survey

Compass Traversing- open, closed.

Technical Terms: Geographic/ True Magnetic Meridians and Bearings, Whole Circle Bearing system and Reduced Bearing system and examples on conversion of given bearing to another bearing (from one form to another), Fore Bearing and Back Bearing, Calculation of internal and external angles from bearings at a station, Dip of Magnetic needle, Magnetic Declination.

Components of Prismatic Compass and their Functions, Methods of using Prismatic Com- pass- Temporary adjustments and observing bearings.

Local attraction, Methods of correction of observed bearings - Correction at station and correction to included angles.

Methods of plotting a traverse and closing error, Graphical adjustment of closing error.

Levelling and Contouring

Basic terminologies: Level surfaces, Horizontal and vertical surfaces, Datum, Bench Marks- GTS, Permanent, Arbitrary and Temporary, Reduced Level, Rise, Fall, Line of collimation, Station, Back sight, Fore sight, Intermediate sight, Change point, Height of instruments.

Types of levels: Dumpy, Tilting, Auto level, Digital level, Components of Dumpy Level and its

fundamental axes, Temporary adjustments of Level.

Types of Levelling Staff: Self-reading staff and Target staff.

Reduction of level by Line of collimation and Rise and Fall Method.

Levelling Types: Simple, Differential, Fly, Profile and Reciprocal Levelling.

Contour, contour intervals, horizontal equivalent.

Uses of contour maps, Characteristics of contours, Methods of Contouring: Direct and indirect.

Measurement of Area and Volume

Components and use of Digital planimeter.

Measurement of area using digital planimeter.

Measurement of volume of reservoir from contour map.

4 Mechanics of Material

Moment of Inertia

Moment of inertia (M.I.): Definition, M.I. of plane lamina, Radius of gyration, section mod- ulus, Parallel and Perpendicular axes theorems (without derivations), M.I. of rectangle, square, circle, semi-circle, quarter circle and triangle section (without derivations).

M.I. of symmetrical and unsymmetrical I-section, Channel section, T-section, Angle section, Hollow sections and built-up sections about centroidal axes and any other reference axis.

Polar Moment of Inertia of solid circular sections.

Simple Stresses and Strains

Definition of rigid, elastic and plastic bodies, deformation of elastic body under various forces, Definition of stress, strain, elasticity, Hook's law, Elastic limit, Modulus of elasticity.

Type of Stresses-Normal, Direct, Bending and Shear and nature of stresses i.e. Tensile and Compressive stresses.

Standard stress strain curve for tor steel bar under tension, Yield stress, Proof stress, Ultimate stress, Strain at various critical points, Percentage elongation and Factor of safety.

Deformation of body due to axial force, forces applied at intermediate sections, Maximum and minimum stress induced, Composite section under axial loading. Concept of temperature stresses and strain, Stress and strain developed due to temperature variation in homogeneous simple bar (no composite section) Longitudinal and lateral strain, Modulus of Rigidity, Poisson's ratio, Biaxial and tri-axial

stresses, volumetric strain, change in volume, Bulk modulus (Introduction only). Relation between modulus of elasticity, modulus of rigidity and bulk modulus (without derivation).

Shear Force and Bending Moment

Types of supports, beams and loads.

Concept and definition of shear force and bending moment, Relation between load, shear force and bending moment (without derivation).

Shear force and bending moment diagram for cantilever and simply supported beams subjected to point loads, uniformly distributed loads and couple (combination of any two types of loading), point of contra flexure.

Bending and Shear Stresses in beams

Concept and theory of pure bending, assumptions, flexural equation (without derivation), bending stresses and their nature, bending stress distribution diagram.

Concept of moment of resistance and simple numerical problems using flexural equation.

Shear stress equation (without derivation), relation between maximum and average shear stress for rectangular and circular section, shear stress distribution diagram.

Shear stress distribution for square, rectangular, circle, hollow, square, rectangular, circular, angle sections, channel section, I-section, T section. Simple numerical problems based on shear equation.

Columns

Concept of compression member, short and long column, Effective length, Radius of gyration, Slenderness ratio, Types of end condition for columns, Buckling of axially loaded columns.

Euler's theory, assumptions made in Euler's theory and its limitations, Application of Euler's equation to calculate buckling load.

Rankine's formula and its application to calculate crippling load.

Concept of working load/safe load, design load and factor of safety.

5 Building Construction

Building Components

Classification of Buildings as per National Building Code Group A to I, as per Types of Constructions- Load Bearing Structure, Framed Structure, Composite Structure.

Building Components - Functions of Building Components, Substructure - Foundation, Plinth.



Superstructure – Walls, Partition wall, Cavity wall, Sill, Lintel, Doors and Windows, Floor, Mezzanine floor, Roof, Columns, Beams, Parapet.

Construction of Substructure

Job Layout: Site Clearance, Layout for Load Bearing Structure and Framed Structure by Center Line and Face Line Method, Precautions.

Earthwork: Excavation for Foundation, Timbering and Strutting, Earthwork for embankment, Material for plinth Filling, Tools and plants used for earthwork.

Foundation: Functions of foundation, Types of foundation – Shallow Foundation, Stepped Footing, Wall Footing, Column Footing, Isolated and Combined Column Footing, Raft Foundation, Grillage Foundation. Deep Foundation - Pile Foundation, Well foundation and Caissons, Pumping Methods of Dewatering, Deep wells, Well points, Cofferdams (Introduction only).

Construction of Superstructure

Stone Masonry: Terms used in stone masonry- facing, backing, hearting, Through stone, corner stone, cornice. Types of stone masonry: Rubble masonry, Ashlar Masonry and their types. Joints in stone masonry and their purpose. Selection of Stone Masonry, Precautions to be taken in Stone Masonry Construction.

Brick masonry: Terms used in brick masonry- header, stretcher, closer, quoins, course, face, back, hearting, bat bond, joints, lap, frog line, level and plumb. Bonds in brick masonry header bond, stretcher bond, English bond and Flemish bond. Requirements of good brick masonry. Junctions in brick masonry and their purpose and procedure. Precautions to be observed in Brick Masonry Construction. Comparison between stone and Brick Masonry. Tools and plants required for construction of stone and brick masonry. Hollow concrete block masonry and composite masonry.

Scaffolding and Shoring: Purpose, Types of Scaffolding, Process of Erection and Dismantling. Purpose and Types of Shoring, Underpinning. Formwork: Definition of Formwork, Requirements of Formwork, Materials used in Formwork, Types of Formworks, Removal of formwork.

Building Communication and Ventilation

Horizontal Communication: Doors –Components of Doors, Full Panelled Doors, Partly Panelled and Glazed Doors, Flush Doors, Collapsible Doors, Rolling Shutters, Revolving Doors, Glazed Doors. Sizes of Door recommended by BIS.

Windows: Component of windows, Types of Windows - Full Panelled, Partly Panelled and Glazed, wooden, Steel, Aluminium windows, Sliding Windows, Louvered Window, Bay window, Corner window, clear-storey window, Gable and Dormer window, Skylight. Sizes of Windows recommended by BIS. Ventilators. Fixtures and fastenings for doors and windows- Material used and functions of Window Sill and Lintels, Shed / Chajja.

Vertical Communication: Means of Vertical Communication- Stair Case, Ramps, Lift, Elevators and Escalators. Terms used in staircase-steps, tread, riser, nosing, soffit, waist slab, baluster, balustrade, scotia, hand rails, newel post, landing, headroom, winder. Types of staircases (On the basis of shape): Straight, dog-legged, open well, Spiral, quarter turn, bifurcated, three quarter turn and Half turn, (On the basis of Material): Stone, Brick, R.C.C., wooden and Metal.

Building Finishes

Floors and Roofs: Types of Floor Finishes and its suitability- Kota, Marble, Granite, Ceramic Tiles, Vitrified, Chequered Tiles, Paver Blocks, Concrete Floors, wooden Flooring, Skirting and Dado. Process of Laying and Construction, Finishing and Polishing of Floors, Roofing Materials RCC, Mangalore Tiles, AC Sheets, G.I. sheets, Corrugated G.I. Sheets, Plastic and Fibre Sheets. Types of Roofs: Flat roof, Pitched Roof-King Post truss, Queen Post Truss, terms used in roofs.

Wall Finishes: Plastering – Necessity of Plastering, Procedure of Plastering, Single Coat Plaster, Double Coat Plaster, Rough finish, Neeru Finishing and Plaster of Paris (POP). Special Plasters- Stucco plaster, sponge finish, pebble finish. Plaster Board and Wall Claddings. Pre- cautions to be taken in plastering, defects in plastering. Pointing – Necessity, Types of pointing and procedure of Pointing. Painting –Necessity, Surface Preparation for painting, Methods of Application.

Concrete Technology

Concrete: Different grades of concrete, provisions of IS 456.

Duff Abraham water cement (w/c) ratio law, significance of w/c ratio, selection of w/c ratio for different grades, maximum w/c ratio for different grades of concrete for different exposure conditions as per IS 456.

Properties of fresh concrete: Workability: Factors affecting workability of concrete. Determination of workability of concrete by slump cone, compaction factor, Vee-Bee Consistometer. Value of workability requirement for different types of concrete works. Segregation, bleeding and preventive measures. Properties of Hardened concrete: Strength, Durability, Impermeability.

Concrete Mix Design and Testing of Concrete

Concrete mix design: Objectives, methods of mix design, study of mix design as per IS 10262

Testing of concrete, determination of compressive strength of concrete cubes at different ages, interpretation and co-relation of test results.

Non- destructive testing of concrete: Rebound hammer test, working principle of rebound hammer and factor affecting the rebound index, Ultrasonic pulse velocity test as per IS13311 (part 1 and 2), Importance of NDT tests.

Quality Control of Concrete

Concreting Operations: Batching, Mixing, Transportation, Placing, Compaction, Curing and Finishing of concrete.

Forms for concreting: Different types of form work for beams, slabs, columns, materials used for form work, requirement of good form work. Stripping time for removal of form works per IS 456.

Waterproofing: Importance and need of waterproofing, methods of waterproofing and materials used for waterproofing.

Joints in concrete construction: Types of joints, methods for joining old and new concrete, materials used for filling joints.

Chemical Admixture, Special Concrete and Extreme Weather concreting

Admixtures in concrete: Purpose, properties and application for different types of admixtures such as accelerating admixtures, retarding admixtures, water reducing admixtures, air entraining admixtures and super plasticizers.

Special Concrete: Properties, advantages and limitation of following types of Special concrete: Ready mix Concrete, Fiber Reinforced Concrete, High performance Concrete Self-compacting concrete and light weight concrete.

Cold weather concreting: effect of cold weather on concrete, precautions to be taken while concreting in cold weather condition.

Hot weather concreting: effect of hot weather on concrete, precautions to be taken while concreting in hot weather condition.

Geotechnical Engineering

Introduction of Geology, Branches of Geology, Importance of Geology for civil engineering structure and composition of earth, Definition of a rock: Classification based on their genesis (mode of origin), formation. Classification and engineering uses of igneous, sedimentary and metamorphic rocks.

Importance of soil as construction material in Civil engineering structures and as foundation bed for structures.

Field application of geotechnical engineering for foundation design, pavement design, design of earth retaining structures, design of earthen dam.

Physical and Index Properties of Soil

Soil as a three-phase system, water content, determination of water content by oven drying method as per BIS code, void ratio, porosity and degree of saturation, density index. Unit weight of soil mass – bulk unit weight, dry unit weight, unit weight of solids, saturated unit weight, submerged unit weight. Determination of bulk unit weight and dry unit weight by core cutter and sand replacement method, Determination of specific gravity by pycnometer.

Consistency of soil, Atterberg limits of consistency: Liquid limit, plastic limit and shrinkage limit. Plasticity index.

Particle size distribution test and plotting of curve, Determination of effective diameter of soil, well graded and uniformly graded soils, BIS classification of soil.

Permeability and Shear Strength of Soil

Definition of permeability, Darcy's law of permeability, coefficient of permeability, factors affecting permeability, determination of coefficient of permeability by constant head and falling head tests, simple problems to determine coefficient of permeability. Seepage through earthen structures,



seepage velocity, seepage pressure, phreatic line, flow lines, application of flow net, (No numerical problems).

Shear failure of soil, concept of shear strength of soil. Components of shearing resistance of soil – cohesion, internal friction. Mohr-Coulomb failure theory, Strength envelope, strength equation for purely cohesive and cohesion less soils. Direct shear and vane shear test –laboratory methods.

Bearing Capacity of Soil

Bearing capacity and theory of earth pressure. Concept of bearing capacity, ultimate bearing capacity, safe bearing capacity and allowable bearing pressure. Introduction to Terzaghi's analysis and assumptions, effect of water table on bearing capacity.

Field methods for determination of bearing capacity – Plate load and Standard Penetration Test. Test procedures as per IS:1888 & IS:2131.

Definition of earth pressure, Active and Passive earth pressure for no surcharge condition, coefficient of earth pressure, Rankine's theory and assumptions made for non-cohesive Soils.

Compaction and stabilization of soil

Concept of compaction, Standard and Modified proctor test as per IS code, Plotting of Compaction curve for determining: Optimum moisture content (OMC), maximum dry density (MDD), Zero air voids line. Factors affecting compaction, field methods of compaction – rolling, ramming and vibration. Suitability of various compaction equipment-smooth wheel roller, sheep foot roller, pneumatic tyred roller, Rammer and Vibrator, Difference between compaction and consolidation.

Concept of soil stabilization, necessity of soil stabilization, different methods of soil stabilization. California bearing ratio (CBR) test - Meaning and Utilization in Pavement Construction

Necessity of site investigation and soil exploration: Types of exploration, criteria for deciding the location and number of test pits and bores. Field identification of soil – dry strength test, dilatancy test and toughness test.

8 Hydraulics

Pressure measurement and Hydrostatic pressure

Technical terms used in Hydraulics –fluid, fluid mechanics, hydraulics, hydrostatics and hydrodynamics - ideal and real fluid, application of hydraulics. Physical properties of fluid – density-specific volume, specific gravity, surface tension, capillarity, viscosity-Newton's law of viscosity.

Various types of pressure – Atmospheric Pressure, Gauge Pressure, Absolute Pressure, Vacuum Pressure. Concept of Pressure head and its unit, Pascal's law of fluid pressure and its uses.

Measurement of differential Pressure by different methods.



Variation of pressure with depth, Pressure diagram, hydrostatic pressure and center of pressure on immersed surfaces and on tank walls.

Determination of total pressure and center of pressure on sides and bottom of water tanks, sides and bottom of tanks containing two liquids, vertical surface in contact with liquid on either side

Fluid Flow Parameters

Types of flow – Gravity and pressure flow, Laminar, Turbulent, Uniform, Non-uniform, Steady, Unsteady flow. Reynolds number.

Discharge and its unit, continuity equation of flow.

Energy of flowing liquid: potential, kinetic and pressure energy.

Bernoulli's theorem: statement, assumptions, equation.

Flow through pipes

Major head loss in pipe: Frictional loss and its computation by Darcy's Weisbach equation, Use of Moody's Diagram and Nomograms.

Minor losses in pipe: loss at entrance, exit, sudden contraction, sudden enlargement and fittings.

Flow through pipes in series, pipes in parallel and Dupuit's equation for equivalent pipe.

Hydraulic gradient line and total energy line.

Water **hammer in pipes: Causes and Remedial measures.**

Discharge measuring device for pipe flow: Venturi meter - construction and working.

Discharge measurement using Orifice, Hydraulic Coefficients of Orifice.

Flow through Open Channel

Geometrical properties of channel section: Wetted area, wetted perimeter, hydraulic radius for rectangular and trapezoidal channel section.

Determination of discharge by Chezy's equation and Manning's equation.

Conditions for most economical rectangular and trapezoidal channel section.

Discharge measuring devices: Triangular and rectangular Notches.

Velocity measurement devices: current meter, floats and Pitot's tube.

Specific energy diagram, Froudes' Number

Hydraulic Pumps

Concept of pump, Types of pumps - centrifugal, reciprocating, submersible.

Centrifugal pump: components and working

Reciprocating pump: single acting and double acting, components and working.

Suction head, delivery head, static head, Manometric head

Power of centrifugal pump.

Selection and choice of pump.

9 **Advance Surveying**

Plane Table Surveying

Principles of plane table survey.

Accessories of plane table and their use, Telescopic alidade.

Setting of plane table; Orientation of plane table - Back sighting and Magnetic meridian method, True Meridian Method.

Methods of plane table surveys- Radiation, Intersection and Traversing.

Merits and demerits of plane table survey.

Theodolite Surveying

Types and uses of Theodolite, Components of transit Theodolite and their functions, Reading the Vernier of transit Theodolite.

Technical terms- Swinging, Transiting, Face left, Face right.

Fundamental axes of transit Theodolite and their relationship

Temporary adjustment of transit Theodolite.

Measurement of horizontal angle- Direct and Repetition method, Errors eliminated by method of repetition.

Measurement of magnetic bearing of a line, Prolonging and ranging a line, deflection angle.

Measurement of vertical Angle.

Theodolite traversing by Included angle method and Deflection angle method.

Checks for open and closed traverse, Calculations of bearing from angles.

Traverse computation-Latitude, Departure, Consecutive coordinates, independent coordinates, balancing the traverse by Bowditch's rule and Transit rule, Gale's Traverse table computation.

Tacheometric surveying and Curve setting

Principles of Tacheometry, Tacheometer and its component parts, Anallatic lens. Tacheometric formula for horizontal distance with telescope horizontal and staff vertical.

Field method for determining constants of tacheometer, Determining horizontal and vertical distances with tacheometer by fixed hair method and staff held vertical, Limitations of tacheometry.

Types of curves used in roads and railway alignments. Designation of curves. Setting simple circular curve by offsets from long chord and Rankine's method of deflection angles.

Advanced surveying equipment

Principle of Electronic Distance Meter (EDM), its component parts and their Functions, use of EDM.

Use of micro-optic Theodolite and Electronic Digital Theodolite.

Use of Total Station, Use of function keys.

Measurements of Horizontal angles, vertical angles, distances and coordinates using Total

Station, Traversing, Profile Survey and Contouring with Total Station.

Remote sensing, GPS and GIS

Remote Sensing – Overview, Remote sensing system, Applications of remote sensing in Civil engineering, land use / Land cover, mapping, disaster management.

Use of Global Positioning System (G.P.S.) instruments.

36

Geographic Information System (GIS): Over view, Components, Applications, Software for GIS.
Introduction to Drone Surveying.

10 Theory of structures

Direct and Bending Stresses in vertical members

Introduction to axial and eccentric loads, eccentricity about one principal axis only, nature of stresses, Maximum and minimum stresses, resultant stresses and distribution diagram.

Condition for no tension or zero stress at extreme Fiber, Limit of eccentricity, core of section for rectangular and circular cross sections, Middle third rule.

Chimneys of circular cross section subjected to wind pressure, Maximum and minimum

stresses, resultant stresses and distribution diagram at base.

Analysis of dams subjected to horizontal water pressure, conditions of stability, Maximum

and minimum stresses, resultant stresses and distribution diagram at base.

Slope and Deflection

Concept of slope and deflection, stiffness of beams, Relation among bending moment, slope, deflection and radius of curvature, (no derivation). Double integration method to find slope and deflection of cantilever and simply supported beams subjected to concentrated load and uniformly distributed load on entire span.

Macaulay's method for slope and deflection, application to cantilever and simply supported beam subjected to concentrated and uniformly distributed load on entire span.

Fixed and Continuous Beam

Concept of fixity, effect of fixity, advantages and disadvantages of fixed beam over simply supported beam. Principle of superposition, Fixed end moments from first principle for beam subjected to point load, UDL over entire span.

Application of standard formulae in finding end moments, end reactions and drawing S.F. and B.M. diagrams for a fixed beam.

Definition, effect of continuity, nature of moments induced due to continuity, concept of deflected shape, practical examples.

Clapeyron's theorem of three moments (no derivation), Application of Clapeyron's theorem maximum up to three spans and two unknown support moment only, Support at same level spans having same and uniform moment of inertia subjected to concentrated loads and uniformly distributed loads over entire span.

Drawing SF diagrams showing point of contraflexure, shear and BM diagrams showing net BM and point of contraflexure for continuous beams.

Moment distribution method

Introduction to moment distribution method, sign convention, Carry over factor, stiffness factor, distribution factor.

Application of moment distribution method to various types of continuous beams subjected to concentrated loads and uniformly distributed load over entire span having same or different moment of inertia, supports at same level, up to three spans and two unknown support moments only.

Introduction to portal frames – Symmetrical and unsymmetrical portal frames with the concept of Bays and stories.

Simple trusses

Types of trusses (Simple, Fink, compound fink, French truss, pratt truss, Howe truss, North light truss, King post and Queen post truss)

Calculate support reactions for trusses subjected to point loads at joints

Calculate forces in members of truss using Method of joints and Method of sections.

11 Building Planning and Drawing

Conventions and Symbols

Conventions as per IS 962, symbols for different materials such as earthwork, brickwork, stonework, concrete, woodwork and glass.

Graphical symbols for doors and windows, Abbreviations, symbols for sanitary and electrical installations.

Types of lines-visible lines, centre line, hidden line, section line, dimension line, extension line, pointers, arrow head or dots. Appropriate size of lettering and numerals for titles, sub-titles, notes and dimensions.

Types of scale- Monumental, Intimate, criteria for Proper Selection of scale for various types of drawing.

Sizes of various standard papers/sheets.

Reading and interpreting readymade Architectural building drawing (To be procured from Architect, Planning Consultants, Planning Engineer).

Planning of Building

Principles of planning for Residential and Public building- Aspect, Prospect, Orientation, Grouping, Privacy, Elegance, Flexibility, Circulation, Furniture requirements, Sanitation, Economy.

Space requirement and norms for minimum dimension of different units in the residential and public buildings as per IS 962.

Rules and bye-laws of sanctioning authorities for construction work.

Plot area, built up area, super built-up area, plinth area, carpet area, floor area and FAR (Floor Area Ratio).

Line plans for residential building of minimum three rooms including water closet (WC), bath and staircase as per principles of planning.

Line plans for public building-school building, primary health centre, restaurant, bank, post office, hostel, Function Hall and Library.

Drawing of Load Bearing Structure

Drawing of Single storey Load Bearing residential building (2 BHK) with staircase.



Data drawing –plan, elevation, section, site plan, schedule of openings, construction notes with specifications, area statement, Planning and design of staircase- Rise and Tread for residential and public building.

Working drawing – developed plan, elevation, section passing through staircase or WC and bath.

Foundation plan of Load bearing structure.

Drawing of Framed Structure

Drawing of Two storeyed Framed Structure (G+1), residential building (2 BHK) with stair- case.

Data drawing – developed plan, elevation, section, site plan, schedule of openings, construction notes with specifications, area statement. Planning and design of staircase- Rise and tread for residential and public building.

Working drawing of Framed Structure – developed plan, elevation, section passing through staircase or WC and bath.

Foundation plan of Framed Structure.

Details of RCC footing, Column, Beam, Chajjas, Lintel, Staircase and slab.

Drawing with CAD- Draw commands, modify commands, layer commands.

Perspective Drawing

Definition, Types of perspective, terms used in perspective drawing, principles used in perspective drawing, Two Point Perspective of small objects only such as steps, monuments, pedestals.

12 Water Resources Engineering

Introduction to Hydrology

Hydrology: Definition and Hydrological cycle

Rain Gauge: Symons rain gauge, automatic rain gauge,

Methods of calculating average rainfall: Arithmetic mean, Isohyetal, and Thiessen polygon method.

Runoff, Factors affecting Run off, Computation of run-off.

Maximum Flood Discharge measurement: Rational and empirical methods, Simple numerical problems.

Yield and Dependable yield of a catchment, determination of dependable yield.

Crop water requirement and Reservoir Planning

Irrigation and its classification.

Crop Water requirement: Cropping seasons, Crop period, base period, Duty, Delta, CCA, GCA, intensity of irrigation, factors affecting duty, Problems on water requirement and capacity of canal.

Methods of application of irrigation water and its assessment.

Surveys for irrigation project, data collection for irrigation project. Area capacity curve.

Silting of reservoir, Rate of silting, factors affecting silting and control measures.

Control levels in reservoir, Simple numerical problems on Fixing Control levels.

Dams and Spillways

Dams and its classification: Earthen dams and Gravity dams (masonry and concrete).

Earthen Dams – Components with function, typical cross section, seepage through embankment and foundation and its control.

Methods of construction of earthen dam, types of failure of earthen dam and preventive measures.

Gravity Dams – Forces acting on dam, Theoretical and practical profile, typical cross section, drainage gallery, joints in gravity dam, concept of high dam and low dam.

Spillways-Definition, function, location, types and components, Energy dissipaters.

Minor and Micro Irrigation

Bandhara irrigation: Layout, components, construction and working, solid and open bandhara.

Percolation Tanks – Need, selection of site.

Lift irrigation Scheme-Components and their functions, Lay out.

Drip and Sprinkler Irrigation- Need, components and Layout.

Well irrigation: types and yield of wells, advantages and disadvantages of well irrigation.

Diversion Head Works & Canals

Weirs – components, parts, types, K.T. weir – components and construction

Diversion head works – Layout, components and their function.

Barrages – components and their functions. Difference between weir and Barrage.

Canals – Classification according to alignment and position in the canal network, Cross section of canal in embankment and cutting, partial embankment and cutting, balancing depth, Design of most economical canal section.

Canal lining - Purpose, material used and its properties, advantages.

Cross Drainage works- Aqueduct, siphon aqueduct, super passage, level crossing.

Canal regulators- Head regulator, Cross regulator, Escape, Falls and Outlets

13

Transportation Engineering

Overview of Highway Engineering

Role of transportation in the development of nation, Scope and Importance of roads in India and its' Characteristics.

Different modes of transportation – land way, waterway, airway. Merits and demerits of roadway and railway;

General classification of roads.

Selection and factors affecting road alignment.

Geometric Design of Highway

Camber: Definition, purpose, types as per IRC – recommendations.

Kerbs: Road margin, road formation, right of way.

Design speed and various factors affecting design speed as per IRC – recommendations.

Gradient: Definition, types as per IRC – Recommendations.

Sight distance (SSD): Definition, types IRC – recommendations, simple numerical.

Curves: Necessity, types: Horizontal, vertical curves.

Extra widening of roads: numerical examples.

Super elevation: Definition, formula for calculating minimum and maximum Super elevation and method of providing super-elevation.

Standards cross-sections of national highway in embankment and cutting.

Construction of Road Pavements

Types of road materials and their Tests – Test on aggregates-Flakiness and Elongation Index tests, Angularity Number test, test on Bitumen- penetration, Ductility, Flash and Fire point test and Softening point test.

Pavement – Definition, Types, Structural Components of pavement and their functions Construction of WBM road. Merits and demerits of WBM & WMM road.

Construction of Flexible pavement / Bituminous Road, Types of Bitumen and its proper- ties, Emulsion, Cutback, Tar, Terms used in BR-prime coat, tack coat, seal coat, Merits and Demerits of BR.

Cement concrete road -methods of construction, Alternate and Continuous Bay Method, Construction joints, filler and sealers, merits and demerits of concrete roads. Types of joints.

Track geometrics, Construction and Maintenance

Alignment- Factors governing rail alignment.

Track Cross sections – standard cross section of single and double line in cutting and embankment. Important terms-permanent land, formation width, side drains,

Railway Track Geometrics: Gradient, curves- types and factors affecting, grade compensation, super elevation, limits of Super elevation on curves, cant deficiency, negative cant, coning of wheel, tilting of rail.

Branching of Tracks, Points and crossings, Turn out- types, components, functions and inspection. Track junctions: crossovers, scissor cross over, diamond crossing, track triangle.

Station -Purpose, requirement of railway station, important technical terms, types of railway station, factors affecting site selection for railway station.

Station yard: Classification- Passenger, goods, locomotive and marshalling yards. Function & drawbacks of marshalling yards.

Track Maintenance- Necessity, Classification, Tools required for track maintenance with their functions, Organisation of track maintenance, Duties of permanent way inspector, gang mate and key man



Design of Steel Tension and Compression Members (Limit State Method)

Types of sections used for Tension members.

Strength of tension member by- yielding of section, rupture of net cross-section and block shear.

Design of axially loaded single angle and double angle tension members with bolted and welded connections.

Types of sections used as compression member, Calculation of effective length, Radius of gyration and slenderness ratio, Permissible values of slenderness ratio as per IS 800, Design compressive stress.

Introduction to built up sections, lacing and battening (Meaning and purpose), Diagrams of single and double lacing and battening system. (No numerical problems).

Design of axially loaded single and double angle struts connected by bolted and welded connections with gusset plate.

Design of Steel beams (Limit State Method)

Standard beam sections, Bending stress calculations.

Design of simple I and channel section.

Check for shear as per IS 800.

Design of Reinforced Concrete Beams by Limit State Method

Concept of Limit state, Stress block diagram, Introduction to singly and doubly reinforced sections, IS 456

Design of singly reinforced beam, concept of under reinforced, over reinforced and balanced section, Simple numerical problem on ultimate moment of resistance and design of beam section

Design of doubly reinforced sections, stress and strain diagrams, depth of neutral axis, simple numerical problems on ultimate moment of resistance of reinforced beam, Calculation of A_{st} and A_{sc} .

Shear, Bond and Development length in Design of RCC member

Nominal shear stress in RCC section, Design shear strength of concrete, Design of shear reinforcement, Minimum Shear Reinforcement, Provisions of IS 456, forms of shear reinforcement

Type of bond, Bond stress, check for bond stress, Determination of Development length in tension and compression members and check as per codal provisions, Anchorage value of 90D hook, Lapping of bars.

Simple numerical on: Shear reinforcement, Adequacy of section for shear.

Introduction to serviceability limit state check.

Design of axially loaded RCC Column

Definition and classification of column, Limit state of compression members, Effective length of column.

Provisions of IS 456 for minimum steel, cover, maximum steel, spacing of ties etc.



Design of axially loaded short column - Square, Rectangular, and Circular only.

15 **Estimating and Costing**

Fundamentals of Estimating and Costing

Estimating and Costing – Meaning, purpose, administrative approval, Technical Sanction and Budget provision.

Types of estimates – Approximate and Detailed estimate.

Types and Uses of Estimates: Revised estimate, Supplementary estimate, Repair and maintenance estimate, renovation estimate.

Roles and responsibility of Estimator.

Checklist of items in load bearing and framed structure.

Standard formats of Measurement sheet, Abstract sheet, Face sheet.

Modes of measurement and desired accuracy in measurements for different items of work as per IS:1200.

Rules for deduction in different category of work as per IS:1200.

Description / specification of items of building work as per PWD /DSR.

Approximate Estimates

Approximate estimate- Definition, Purpose.

Methods of approximate estimate - Service unit method, Plinth area rate method, Cubical content method, Typical Bay method, Approximate quantity method (with simple numericals)

Approximate estimate for roads, Railways, bridges/culvert, irrigation projects and water supply projects.

Detailed Estimate

Detailed Estimate- Definition and Purpose, Data required for detailed estimate - Civil cost, GST, Contingencies, Supervision charges, Agency charges, Procedure for preparation of de- tailed estimate- Taking out quantities and Abstracting.

Methods of Detailed Estimate- Unit quantity method and total quantity method (with simple numericals)

Long wall and short wall method, Centre line method.

Bar bending schedule for footing, column, beam, Lintel, chajja and slab elements

Provisions in detailed estimate: contingencies, work charged establishment, percentage charges, water supply and sanitary Charges and electrification charges etc.

Prime cost, Provisional sum, Provisional quantities, Bill of quantities, Spot items or Site items.

Estimate for Civil Engineering Works

Earthwork - Quantities for roads, Embankment and canal by – Mid sectional area method, mean sectional area method, Prismoidal and trapezoidal formula method.

Detailed estimate for septic tank, Community well.

Use of computer / softwares / programmes for detailed estimate Preparation of Civil Engineering Works.

Rate Analysis

Rate Analysis: Definition, purpose and importance.

Lead (Standard and Extra), lift, overhead charges, water charges and contractors' profit,

Procedure for rate analysis.

Task work- Definition, types. Task work of different skilled labour for different items.

Categories of labours, their daily wages, types and number of labours for different items of work.

Transportation charges of materials - Lead and Lift, Hire charges of machineries and equipments.

Preparing rate analysis of different items of work pertaining to buildings and roads.

16

Public Health Engineering

Sources, Demand and Quality of water

Water supply schemes - Objectives, components,

Sources of water: Surface and Subsurface sources of water, Intake Structures, Definition and types, Factors governing the location of an intake structure, Types of intakes.

Demand of water: Factors affecting rate of demand, Variations of water demands, forecasting of population, Methods of forecasting of population, (Simple problems on forecasting of population), Design period, estimating of quantity of water supply required for city or town.

Quality of water: Need for analysis of water, Characteristics of water- Physical, Chemical and Biological, testing of water for Total solids, hardness, chlorides, dissolved Oxygen, pH, Fluoride, Nitrogen and its compounds, Bacteriological tests, E coli, B coli index, MPN, Sampling of water, Water quality standards as per IS 10500.

Purification of water

Purification of Water: Objectives of water treatment, Aeration- objects and methods of aeration, Plain sedimentation, Sedimentation with coagulation, principles of coagulation, types of coagulants, Jar Test, process of coagulation, types of sedimentation tanks, Clariflocculator.

Filtration - mechanisation of filtration, classification of filters: slow sand filter, rapid sand filter, pressure filter. Construction and working of slow sand filter and rapid sand filter, operational problems in filtration. Disinfection: Objects, methods of disinfection, Chlorination- Application of chlorine, forms of chlorination, types of chlorination practices, residual chlorine and its importance, Flow diagram of water treatment plants.

Miscellaneous water Treatments: Introduction to water softening, Defluoridation techniques.

Conveyance and Distribution of water

Conveyance: Types of Pipes used for conveyance of water, choice of pipe material, Types of joints & Types of valves- their use, location and function on a pipeline.

Distribution of water: Methods of distribution of water- Gravity, pumping, and combined system, Service reservoirs - functions and types, Layouts of distribution of Water-Dead end system, grid iron system, circular system, radial system; their suitability, advantages and disadvantages.

Domestic sewage and System of Sewerages

Building Sanitation: Necessity of sanitation, Necessity to treat domestic sewage, Definitions - Sewage, sullage, types of sewage. Definition of the terms related to Building Sanitation-Water pipe, Rain water pipe, Soil pipe, Sullage pipe, Vent pipe. Building Sanitary fittings-Water closet - Indian and European type, flushing cistern, wash basin, sinks, Urinals. Traps- types, qualities of good trap. Systems of plumbing - one pipe, two pipe, single stack, choice of system. Principles regarding design of building drainage, inspection and junction chambers, their necessity, location, size and shape.

Systems of Sewerage and Sewer Appurtenances: Types of Sewers, Systems of sewerage, self-cleansing velocity and non-scouring velocity, Laying, Testing and maintenance of sew- ers, Manholes and Drop Manhole-component parts, location, spacing, construction details, Sewer Inlets, Street Inlets.

Characteristics and treatment of Sewage

Analysis of sewage: Characteristics of sewage, B.O.D., C.O.D. and its significance., Central Pollution Control Board Norms for discharge of treated sewage, Objects of sewage treatment and flow diagram of conventional sewage treatment plant. Treatment of Sewage: Screening, Types of screens, Grit removal, Skimming, Sedimentation of sewage, Aerobic and anaerobic process, Sludge digestion, trickling filters, Activated sludge process, Disposal of sewage, Oxidation pond, Oxidation ditch. Septic tank, Recycling and Reuse of domestic waste.

17 Precast and Prestressed Concrete

Precast concrete Elements

Advantages and disadvantages of precast concrete members

Non-structural Precast elements - Paver blocks, Fencing Poles, Transmission Poles, Man- hole Covers, Hollow and Solid Blocks, kerb stones as per relevant BIS specifications

Structural Precast elements - tunnel linings, Canal lining, Box culvert, bridge panels, foundation, sheet piles

Testing of Precast components as per BIS standards

Prefabricated building

Precast Structural Building components such as slab panels, beams, columns, footings, walls, lintels and chajjas, staircase elements,

43

Prefabricated building using precast load bearing and non-load bearing wall panels, floor systems - Material characteristics, Plans & Standard specifications
Modular co-ordination, modular grid, and finishes

Prefab systems and structural schemes and their classification including design considerations

Joints – requirements of structural joints and their design considerations, Manufacturing, storage, curing, transportation and erection of above elements, equipment needed

Introduction to Prestressed Concrete

Principles of pre-stressed concrete and basic terminology.

Applications, advantages and disadvantages of prestressed concrete

Materials used and their properties, Necessity of high-grade materials

Types of Pre-stressing steel -Wire, Cable, tendon, Merits-demerits and applications

Methods and systems of prestressing

Methods of prestressing – Internal and External pre-stressing, Pre and Post tensioning, applications, Systems for pre tensioning – process, applications, merits and demerits - Hoyer system

Systems for post-tensioning - process, applications, merits and demerits - Freyssinet system, Magnel Blaton system, Gifford Udall system.

Prestressing force in Cable, Loss of prestress during the tensioning process - loss due to friction, length effect, wobbling effect and curvature effect, (Simple Numerical problems to determine loss of pre-stress), Loss of pre-stress at the anchoring stage.

Loss of pre-stress occurring subsequently: losses due to shrinkage of concrete, creep of concrete, elastic shortening, and creep in steel, (Simple Numerical problems to determine loss of pre-stress).

BIS recommendations for percentage loss in case of Pre and Post tensioning.

Analysis and design of Prestressed rectangular beam section

Basic assumptions in analysis of pre-stressed concrete beams.

Cable Profile in simply supported rectangular beam section – concentric, eccentric straight and parabolic

Effect of cable profile on maximum stresses at mid span and at support.

Numerical problems on determination of maximum stresses at mid spans with linear (con- centric and eccentric) cable profiles only.

Simple steps involved in Design of simply supported rectangular beam section (No numerical problems)

18 Construction Management

Construction industry and management

Organization-objectives, principles of organization, types of organization: government/public and private construction industry, Role of various personnel in construction organization Agencies associated with construction work-owner, promoter, builder, designer, architects

Role of consultant for various activities: Preparation of Detailed Project Report (DPR), monitoring of progress and quality, settlement of disputes.

Site Layout

Principles governing site layout.

Factors affecting site layout.

Preparation of site layout.

Land acquisition procedures and providing compensation.

Planning and scheduling

Identifying broad activities in construction work & allotting time to it, Methods of Scheduling, Development of bar charts, Merits & limitations of bar chart.

Elements of Network: Event, activity, dummy activities, Precautions in drawing Network, Numbering the events.

CPM networks, activity time estimate, Event Times by forward & backward pass calculation, start and finish time of activity, project duration. Floats: Types of Floats-Free, independent and total floats, critical activities and critical path, Purpose of crashing a network, Normal Time and Cost, Crash Time and Cost, Cost slope, Optimization of cost and duration.

Material Management- Ordering cost, inventory carrying cost, Economic Order Quantity

Store management, various records related to store management, inventory control by ABC technique, Introduction to material procurement through portals (e.g. www.inampro.nic.in)

Construction Contracts and Specifications

Types of Construction contracts

Contract documents, specifications, general special conditions

Contract Management, procedures involved in arbitration and settlement (Introduction only)

Safety in Construction

Safety in Construction Industry—Causes of Accidents, Remedial and Preventive Measures.

Labour Laws and Acts pertaining to Civil construction activities (Introduction only)

Rural Construction Technology

Rural Development and Planning

Scope; development plans; various approaches to rural development planning.

Significance of rural development.

Rural development programme/projects.

Rural Housing

Low-cost construction material for housing

Composite material- ferro-cement & fly ash, autoclaved calcium silicate bricks and soil-stabilized un-burnt brick; Plinth protection of mud walls.

Water-proof and fire-retardant roof treatment for thatch roofs. Pre-cast stone masonry, rat-trap bond for walls; Panels for roof, ferro-cement flooring/roofing units.

Biomass - types of fuels such as firewood, agricultural residues, dung cakes.

Renewable energy and integrated rural energy program - Objectives, Key elements, Implementation, financial provisions, sources of renewable energy.

Working of gobar gas and bio gas plants.

Water Supply and Sanitation for Rural Areas

Sources of water: BIS & WHO water standards.

Quality, Storage and distribution for rural water supply works.

Hand pumps-types, installation, operation, and maintenance of hand pumps.

Conservation of water - rainwater harvesting, drainage in rural areas.

Construction of low-cost latrines: Two pit pour flush water seal, septic tank etc.

Low-cost community and individual Garbage disposal systems, Ferro-cement storage tanks.

Low-Cost Rural Roads

Broad categories of Pavement Layers, types of Granular Sub-Bases and Bases.

Guidelines for Surfacing of Rural Road as per relevant IRC codes.

Pradhan Mantri Gram Sadak Yojna (PMGSY)- Highlights of Scheme.

Low-Cost Irrigation

Design consideration and construction of tube-well, drip & sprinkler irrigation systems.

Watershed and catchment area development -problems and features of watershed management.

Watershed management structures - K. T. weir, Gabian Structure, Cement Plug, Contour Bunding, Farm Pond, Bandhara system.

20

Traffic Engineering

Fundamentals of Traffic Engineering.

Traffic engineering- Definition, objects, scope

Relationship between speed, volume and density of traffic

Road user's characteristics-physical, mental, emotional factors.

Vehicular characteristics-width, length, height, weight, speed, efficiency of breaks.

Road characteristics - gradient, curve of a road, design speed, friction between road and tyre surface.

Reaction time - factors affecting reaction time. PIEV Theory.

Traffic Studies

Traffic volume count data- representation and analysis of data.

Necessity of Origin and Destination study and its methods.

Speed studies - Spot speed studies, and its presentation.

Need and method of parking study.

Road Signs and Traffic Markings

Traffic control devices –definition, necessity, types.

Road signs - definition, objects of road signs.

Classification as per IRC: 67-Mandatory or Regulatory, Cautionary or warning, informatory signs, Location of cautionary or warning sign in urban and non-urban areas, Points to be considered while designing and erecting road signs.

Traffic markings- definition, classification, carriage way, kerb, object marking and reflector markers.

Traffic Signals and Traffic Islands

Traffic signals- Definition, Types, Traffic control signals, pedestrian signals.

Types of traffic control signals - Fixed time, manually operated, traffic actuated signals and location of signals.

Compute signal time by fix time cycle, Webster's and IRC method and sketch timing diagram for each phase.

Traffic islands –Definition, advantages and disadvantages of providing islands.

Types of traffic islands - rotary or central, channelizing or Refuge Island.

Road intersections or junctions - Definition, Types of road intersection.

Intersection at grade- Types, basic requirements of good intersection at grade.

Grade separated intersection- advantages and disadvantages, types - flyovers- partial and full Cloverleaf pattern, Diamond intersection, Trumpet type, underpass.

Road Accident Studies and Arboriculture

Road Accidents-Definition, types and causes for collision and non-collision accidents.

Measures to prevent road accidents.

Collision and condition diagram.

Street lighting –definition, necessity, types-luminaire, foot candle, lumen, factors affecting their utilization and maintenance.

Arboriculture- definition, objectives, factors affecting selection of type of trees.

Maintenance of trees-protection and care of road side trees.

21 Solid Waste Management

Introduction

Definition of solid waste, different solid waste – domestic Waste, commercial waste, industrial waste, market waste, agricultural waste, biomedical waste, E-waste, hazardous waste, institutional waste, etc.

Sources of solid waste, Classification of solid waste – hazardous and non-hazardous waste.

Physical and chemical characteristics of municipal solid waste.

Storage, Collection and Transportation of Municipal Solid Waste

Collection, segregation, storage and transportation of solid waste.

Tools and Equipment-Litter Bin, Broom, Shovels, Handcarts, Mechanical Road sweepers, Community bin - like movable and stationary bin.

Transportation vehicles with their working capacity -Animal carts, Auto vehicles, Tractors or Trailers, Trucks, Dumpers, Compactor vehicles. Transfer station-meaning, necessity, location.

Role of rag pickers and their utility for society.

Composting of Solid Waste

Concept of composting of waste, Principles of composting process. Factors affecting the composting process.

Methods of composting – Manual Composting – Bangalore method, Indore Method, Mechanical Composting – Dano Process, Vermi composting.

Techniques for Disposal of Solid Waste

Solid waste management techniques – solid waste management hierarchy, waste prevention and waste reduction techniques

Land filling technique, Factors to be considered for site selection, Land filling methods-Area method, Trench method and Ramp method, Leachate and its control, Biogas from landfill, Advantages and disadvantages of landfill method, Recycling of municipal solid waste

Incineration of waste: Introduction of incineration process, Types of incinerators - Flash, Multiple chamber Incinerators, Products of incineration process with their use, Pyrolysis of waste – Definition, Methods

Biomedical and E-waste management

Definition of Bio medical Waste.

Sources and generation of Biomedical Waste and its classification

Bio medical waste Management technologies.

Definition, varieties and ill effects of E- waste,

Recycling and disposal of E- waste.

22

Advanced Construction Technology

Fibres: Use and properties of steel, polypropylene, carbon and glass fibres.

Plastics: Use and properties of PVC, RPVC, HDPE, FRP, GRP.

Miscellaneous Materials: Properties and uses of acoustics materials, wall claddings, plaster boards, micro-silica, waterproofing materials, adhesives.

Use of waste products and industrial by products in bricks, blocks, concrete and mortar.

Advanced Concreting Methods and Equipment

Ready Mix Concrete: Necessity and use of ready-mix concrete. Products and equipments for ready mix concrete plant. Conveying of ready-mix concrete, transit mixers.

Vibrators for concrete consolidation: Internal, needle, surface, platform and form vibrators.

Underwater Concreting: Procedure and equipments required for Tremie method, Drop bucket method. Properties, workability and water cement ratio of the concrete.

Special concrete: procedure and uses of special concretes: Roller compacted concrete,
Self-compacting concrete (SCC), Steel fibre reinforced concrete, Foam concrete, shotcreting.

Advanced Technology in Constructions

Construction of bridges and flyovers: Equipments and machineries required for foundation and super structure.

Construction of multi-storeyed Building: Equipments and machinery required for construction of multi-storeyed building such as use of lifts, belt conveyers, pumping of concrete.

Prefabricated construction: Methods of prefabrication, Plant fabrication and site fabrication, All prefabricated building elements such as wall panels, slab panels, beams, columns, door and window frames etc. Equipments and machineries used for placing and Jointing of prefabricated elements.

Strengthening of embankments by soil reinforcing techniques using geo-synthetics

Hoisting and Conveying Equipments

Hoisting Equipments: Principles and working of Derrick-Pole, Gin Pole, Crane, Power driven scotch derrick crane, Hand operated crane, Locomotive crane, Tower crane, Lattice Girder, Winches, Elevators, ladders. Crawler cranes, Truck mounted cranes, Gantry cranes, Mast cranes.

Conveying Equipments: Working of belt conveyers, types of belts and conveying mechanism. Capacity and use of dumpers, tractors and trucks.

Miscellaneous Machineries and Equipments

Excavation Equipments: Use, working and output of following machinery – bull dozers, scrapers, graders, Clam Shell, trenching equipment, Tunnel boring machine, Wheel mount- ed belt loaders, power shovels, JCB, and drag lines.

Compacting Equipments: Output of different types of rollers such as plain rollers, ship foot- ed rollers, vibratory, pneumatic rollers rammers.

Miscellaneous Equipments: Working and selection of equipments: Pile driving equipments, Pile hammers, Hot mix bitumen plant, bitumen paver, grouting equipment, guniting equipments, floor polishing and cutting machine selection of drilling pattern for blasting, Bentonite/mud slurry in drilling, Explosives for blasting, Dynamite, process of using explosives.

23 Pavement Design and Maintenance

Basics of pavement Design

Types of pavements - Flexible, Rigid and Semi Rigid

Comparison of Rigid and flexible pavement according to Design precision, life maintenance, initial cost, stages of construction, availability of materials, surface characteristic, penetration of water in the pavement, utility location, glare and night visibility.

Functions and characteristics of pavement.

Factors affecting selection of type of pavement.

Fundamentals of pavement design

Factors affecting pavement design-design wheel load, Traffic factors, Environmental factors, Road geometry and material, Characteristics of soil and Drainage situation

Design overview of Flexible and Concrete pavement

Methods of flexible pavement design-Theoretical method, Empirical method with and with- out soil strength test.

IRC37 guidelines for design of flexible pavement (overview only)

Factors affecting design of concrete pavement.

IRC58 guidelines for design of concrete pavement (overview only)

Joints-Need, Types, requirements, spacing of joints

Pavement evaluation

Definition and purpose of pavement evaluation

Methods of Pavement evaluation –Visual rating, Pavement serviceability index, Roughness measurements, Benkelman Beam deflection method

Pavement Maintenance

Types of pavement maintenance - routine, periodic, and special. Need for inspection and maintenance schedule. Causes of pavement failure and remedial measures. Typical flexible and rigid pavement failures

Types and causes of damages in flexible pavement, surface defects, cracks. Deformations

Rutting, fatigue, settlement and upheaval. Disintegration- loss of aggregate, stripping, pothole. Remedial measures - slurry seal, liquid seal, fog seal, patching, ready mix patch.

Types of damages to rigid pavement - cracking, spalling, slab rocking, settlement, joint seal- ant failure. Methods of repair - repair of spalled joints, full depth reconstruction, replacement of dowel bars.

24 **Green Building and Energy Conservation**

Introduction to Green Building and Design Features

Definition of Green Building, Benefits of Green building, Components/features of Green Building, Site selection, Energy Efficiency, Water efficiency, Material Efficiency, Indoor Air Quality.

Site selection strategies, Landscaping, building form, orientation, building envelope and fenestration, material and construction techniques, roofs, walls, fenestration and shaded finish- es, advanced passive heating and cooling techniques, waste reduction during construction

Energy Audit and Environmental Impact Assessment (EIA)

Energy Audit: Meaning, Necessity, Procedures, Types, Energy Management Programs

Environmental Impact Assessment (EIA): Introduction, EIA regulations, Steps in environ- mental impact assessment process, Benefits of EIA, Limitations of EIA, Environmental clearance for the civil engineering projects.

Energy and Energy conservation

Renewable Energy Resources: Solar Energy, Wind Energy, Ocean Energy, Hydro Energy, Bio- mass Energy

Non-renewable Energy Resources: Coal, Petroleum, Natural Gas, Nuclear Energy, Chemical Sources of Energy, Fuel Cells, Hydrogen, Biofuels.

Energy conservation: Introduction, Specific objectives, present scenario, Need of energy conservation, LEED India Rating System and Energy Efficiency.

Green Building

Introduction: Definition of Green building, Benefits of Green building,

Principles: Principles and planning of Green building

Features: Salient features of Green Building, Environmental design (ED) strategies for building construction.

Process: Improvement in environmental quality in civil structure

Materials: Green building materials and products- Bamboo, Rice husk ash concrete, plastic bricks, Bagasse particle board, Insulated concrete forms. reuse of waste material-Plastic, rubber, Newspaper wood, Nontoxic paint, Green roofing

Rating System

Introduction to (LEED) criteria,

Indian Green Building council (IGBC) Green rating,

Green Rating for Integrated Habitat Assessment. (GRIHA) criteria

Heating Ventilation Air Conditioning (HVAC) unit in green Building

Functions of Government organization working for Energy conservation and Audit(ECA)-

National Productivity council (NPC)

Ministry of New and Renewable Energy (MNRE)

Bureau of Energy efficiency (BEE)

25 **Building Services and Maintenance**

Overview of Building Services

Introduction to building services, Classification of buildings as per National Building code, Necessity of building services, Functional requirements of building, Different types of building services i.e. HVAC (Heat, Ventilation and Air Conditioning), Escalators and lifts, fire safety, protection and control, plumbing services, rain water harvesting, solar water heating system, lighting, acoustics, sound insulation and electric installation etc.

Role and responsibility of Building Service Engineer, Introduction to BMS (Building Management Services), Role of BMS, concept of smart building.

Modes of vertical communication

Objectives and modes of vertical communication in building.

Lifts: Different types of lifts and its uses, Component parts of Lift- Lift Well, Travel, Pit, Hoist Way, Machine, Buffer, Door Locks, Suspended Rope, Lift Car,

Landing Door, Call Indicators, Call Push etc., Design provisions for basic size calculation of space enclosure to accommodate lift services, Safety measures.

Escalators: Different Types of Escalators and its Uses, Components of escalators, Design provisions for basic size calculation of space enclosure to accommodate escalator services, Safety measures.

Ramp: Necessity, design consideration, gradient calculation, layout and Special features re- quired for physically handicapped and elderly.

Fire Safety

Fire protection requirements for multi-storeyed building, causes of fire in building, Fire detecting and various extinguishing systems, Working principles of various fire protection systems.

Safety against fire in residential and public buildings (multi-storeyed building), National Building Code provision for fire safety, Fire resisting materials and their properties, Fire resistant construction, procedures for carrying out fire safety inspections of existing buildings, Provisions for evacuation.

Plumbing Services

Importance of plumbing, AHJ (Authority Having Jurisdiction) approval, Plumbing Terminology and fixtures: Terms used in plumbing, Different types of plumbing fixtures, shapes/ sizes, capacities, situation and usage, Traps, Interceptors.

System of plumbing for building water supply: storage of water, hot and cold-water supply system.

System of plumbing for building drainage: Types of drainage system such as two pipe system, one pipe system, types of Vents and purpose of venting, Concept of grey water and reclaimed water.

Different pipe materials, and jointing methods, fittings, hanger, supports and valves used in plumbing and their suitability.

Lighting, Ventilation and Acoustics

Concept of SWH (Solar water heating), component parts of SWH, various system of SWH (heat transfer, propulsion, passive direct system, active direct system, Do-it-yourself), installation and maintenance.

Concept of lighting, types of lighting (natural and artificial), factors influencing the bright- ness of room, factors affecting selection of artificial lighting, installation of light (direct, half-direct, indirect, half-indirect and direct-indirect), types of light control (manual switch, remote switch, timer switch and photo-electric cell switch), types of lamps (incandescent, tungsten halogen and electric discharge), Lamp selection as per room sizes.

Concept of ventilation, necessity and Types of ventilation.

Building Acoustic, Objectives, acoustic Control in a building, acoustic material (porous absorber and cavity resonator)

26 Repairs and Maintenance of Structures

Basics of maintenance

Types of Maintenances - repair, retrofitting, re-strengthening, rehabilitation and restoration.

Necessity, objectives and importance of maintenance.

Approach of effective management for maintenance.

Periodical maintenance: check list, maintenance manual containing building plan, reinforcement details, material sources, maintenance frequency, corrective maintenance procedures and sources. Pre- and post- monsoon maintenance.

Causes and detection of damages

Causes of damages due to distress, earthquake, wind, flood, dampness, corrosion, fire, deterioration, termites, pollution and foundation settlement.

Various aspects of visual observations for detection of damages.

Load test and non-destructive tests (brief description). NDT tests on damaged structure such as rebound hammer, ultrasonic pulse velocity, rebar locator, crack detection micro- scope, digital crack measuring gauge.

Chemical test - Chloride test, sulphate attack, carbonation test, pH measurement, resistivity method, Half-cell potential meter (Introduction and demonstration only).

Materials for maintenance and repairs

Types of repair material, material selection.

Essential parameters for maintenance and repair materials such - bond with substrate, durability.

Waterproofing materials based on polymer modified cement slurry, UV resistant acrylic polymer, ferro-cement.

Repairing materials for masonry: plastic/ aluminium nipples, non-shrink cement, polyester putty or 1:3 cement sand mortar, galvanized steel wire fabrics and clamping rods, wire nails, ferro-cement plates.

Repairing materials for RCC: epoxy resins, epoxy mortar, cement mortar impregnated with polypropylene, silicon, polymer concrete composites, sealants, fiber reinforcement concrete, emulsions and paints.

Maintenance and repair methods for masonry Construction

Causes of cracks in walls - bulging of wall, shrinkage, bonding, shear, tensile, vegetation.

Probable crack location: junction of main and cross wall, junction of slab and wall, cracks in masonry joints.

Repair methods based on crack type - For minor & medium cracks (width 0.5 mm to 5mm): grouting and for major cracks (width more than 5mm): fixing mesh across cracks, RCC band, installing ferro-cement plates at corners, dowel bars, propping of load bearing.

Remedial measures for dampness & efflorescence in wall.

Maintenance and repair methods for RCC Construction



Repair stages such as concrete removal and surface preparation, fixing suitable formwork, bonding/passive coat and repair application, various methods of surface preparation.

Repair options such as grouting, patch repairs, carbonated concrete, cleaning the corroded steel, concrete overlays, latex concrete, epoxy bonded mortar and concrete, polymer concrete, corrosion protection such as jacketing.

Building cracks and its prevention, common methods for dormant crack repairs such as Epoxy injection, grooving and sealing, stitching, grouting and guniting/shotcreting.

Strengthening methods for live cracks such as addition of reinforcements, Jacketing, brackets, collars, supplementary members i.e. shoring, underpinning and propping of framed structure.

27

Advanced Design of Structures

Design of connections in steel structures

Types of rivets, Riveted connections, Strength of riveted joints, Design of riveted joints for axially loaded members.

Types of weld, welded connections, Permissible stresses in weld, Strength of weld. Advantages and disadvantages of weld, Design of fillet weld and butt weld for axial load.

Design of column bases for axially loaded columns only.

Steel Beams

Different steel sections, Simple and built-up sections, Permissible bending stresses,

Design of built-up sections (symmetrical I section with cover plates only), check for shear and deflection

Introduction to plate girder: Components and functions (no numericals)

Design of RC flanged beam

General features of T and L beams, Advantages, Effective width as per BIS 456

Design of singly reinforcement T beam, Stress and Strain diagram, Depth of neutral axis, Moment of resistance, T and L beams with neutral axis in flange only.

Simple numericals on location of neutral axis, Effective width of flange.

Design of slab

Design of simply supported one-way slab for flexure, shear and deflection and checks, as per the provisions of BIS 456

Design of one-way cantilever slab, Chajjas, Flexure including checks for Development length and Shear stress.

Design of two-way simply supported slab,

Introduction to design of dog-legged staircases.

Design of RCC Column and Footing design: Uni-axial bending

IS 456 provisions, Column with uniaxial moment, Effective length calculations, Minimum eccentricity

Design of footing for axially loaded column only.

28 **Tendering and Accounts****Procedure to execute the work**

Administrative approval, technical sanction, budget provision, expenditure sanction.

Methods for carrying out works- contract method, departmental method -rate list method, piece work method, day's work method, employing labours on daily wages basis.

Contracts

Definition of contract, objects of contract, requirements of contract, overview of Indian Contract Act.

Types of engineering contract with advantages, disadvantages and their suitability - Lump sum contract, item rate contract, percentage rate contract, cost plus percentage, cost plus fixed fee, cost plus variable percentage and cost-plus variable fee contract, labour contract, demolition contract, target contract, negotiated contract, Engineering Procurement Construction Contract (EPC), Annuity Contract.

Introduction of FIDIC Conditions of contract.

Classification of contractor on basis of financial limits, Requirement of documents for registration of contractor.

Build Operate Transfer (BOT) Project, BOT Toll contract, BOT (Annuity) contract, Design, Build, Finance, Operate and Transfer (DBFOT) contract, Hybrid Annuity contract, Operate Maintain and Transfer (OMT) contract, Operation & Maintenance contract (Introduction only).

Tender and Tender Documents

Definition of tender, necessity of tender, types of tenders- Local, Global, Limited. E -Tendering System - Online procedure of submission and opening of bids (Technical and Financial).

Notice to invite tender (NIT)- Points to be included while drafting tender notice, Drafting of tender notice.

Procedure of submitting filled tender Documents (Two envelope system), procedure of opening tender, comparative statement, scrutiny of tenders, award of contract, letter of award.

Meaning of terms - Earnest Money Deposit (EMD), Performance Security Deposit, Validity period, corrigendum to tender notice and its necessity, Unbalanced bid.

Tender documents - Index, tender notice, general instructions, special instructions, Schedule A, Schedule B, Schedule C etc.

Terms related to tender documents - contract conditions- time limit, time extension, penalty, defective material and workmanship, termination of contract, suspension of work, subletting of contract, extra items, price variation clause(escalation), defect liability Period, liquidated Damages.

Arbitration- Meaning, Qualification of an arbitrator, Appointment, Dispute and Settlement of disputes, Arbitration and Conciliation Act, Arbitration award.

Accounts

Various account forms and their uses – Measurement Books, E- Measurement book (E-MB), Nominal Muster Roll (NMR), Imprest Cash, Indent, Invoice, Bill, Vouchers, Hand receipt Cash Book, Temporary Advance. Heads of Accounts. Mode of Payment to the contractor and its necessity -Interim Payment, Advance Payment Secured Advance, Petty advance, Mobilization advance, Running account bill, Final bill, Retention money, E - payment.

Introduction to Valuation

Definition and purpose of Valuation, role of valuer. Definition - Cost, Price and Value, Characteristics of Value, Factors Affecting Value.

Types of Value - Book Value, Scrap Value, Salvage Value, Speculative Value, Distress Value, Market Value, monopoly Value, Sentimental Value. Factors affecting value.

Depreciation, Obsolescence, Sinking Fund, Methods of Calculation of Depreciation – Straight Line Method, Sinking Fund Method, Constant Percentage Method.

Fixation of rent, Lease – types of lease, lease hold property and free hold property. Mortgage - Mortgage deed, precautions to be taken while making mortgage.

