FURTHER DETAILS REGARDING MAIN TOPICS OF PROGRAMME No. 12/2020 (Item No: 05)

LECTURER GRADE I – RURAL ENGINEERING

RURAL DEVELOPMENT

Category Numbers: 68/2015

Part I (a): Technical Mathematics

1. Matrices – Identification of Matrices, matrix operations, adjoint and inverse.

2. Determinants – Evaluation of second and third order, minors and cofactors, solutions of simultaneous linear equation in three unknown using Cramer's rule.

3. Binomial Series – Expansions using Binomial theorem.

4. Trigonometric functions – Signs of functions in each quadrant. Trigonometric values of angles, properties of trigonometric functions, applications of the identities sin (A ± B), cos (A ± B) and tan (A ± B).

5. Coordinate geometry – Equations to a straight line – slope-intercept form, intercept form, Angle between two lines, condition for two lines to be perpendicular, parallel.

6. Differentiation – Limits and continuity, derivatives of functions, equation to tangents and normals. Maxima and minima of functions of one variable.

7. Integration of functions – Integration of different types of functions.

8. Applications of integration – Area bounded by a curve and X or Y axis, solutions of differential equations using the method of variable separable, solutions of linear differential equations of first order.

Part I (b): Basic Civil Engineering

Materials: Brick – varieties and strength, characteristics of good brick. Cement – varieties and grade of cement and its uses. Steel – types of steel for reinforcement bars, steel structural sections. Aggregates – types & requirements of good aggregates. Concrete – grades of concrete as per IS code, water cement ratio. Workability, mixing, batching, compaction and curing.

Construction: Parts of building – foundation – types of foundations – spread footing, isolated footing, combined footing, Raft, pile and well foundations. Masonry – types rubble masonry, brick masonry, English bond and Flemish bond. (One brick wall).

Surveying: Chain surveying – principles, instruments, ranging, and chaining survey lines, field work and field book, selection of survey stations, units of land area.

Levelling: Levelling instruments, different types, bench mark, reduced level of points, booking of field notes, reduction of levels by height of collimation method (simple problem). Modern survey – instruments – Total station, Electronics theodolite, Distomat.

Part I (c): Basic Mechanical Engineering

The importance of IC Engines: Definition, classification – two stroke engines, four stroke engines, working of two stroke engines and four stroke engines with the help of line sketches, comparison between two stroke and four stroke engines, comparison between petrol and diesel engines, function of fly wheel, clutch, gearbox, propeller shaft and differential in power transmission, explain with sketch the working of differential, briefly explain power transmission of 4 wheel vehicle with line diagram.

The importance of Power Plants: Introduction, classification of power plants – working of hydroelectric power plant with schematic sketches – working of thermal (Steam and Diesel) power plant with schematic sketches – working of nuclear power plant with schematic sketches.

Part I (d): Basic Electrical Engineering

Review with discussion of electric current, potential difference, power, EMF, resistance and its laws, Ohms law and series parallel circuit, electromagnetism, generation of AC and DC supply.

Idea of Basic electrical circuit: Electrical supply and load and its functioning, division of voltage and current in a parallel and series circuit – simple problems, units of power and energy, solution of DC circuit with calculation of energy consumption in an installation.

Circuit parameters: Resistance, Capacitance and inductance. AC circuit with R, L, C. Simple solution of typical AC circuit with resistance, impedance, power and power factor.

Electrical circuit of an installation: Earthing, lightning protection.

Part I (e): Essentials of Electronics Engineering

Active and passive devices – review only. LED – working, applications, comparison of LED lighting and CFL lighting. Full wave rectifier – diagram and explanation, 5 V power supply – with bridge rectifier and 7805. SMPS – block diagram and advantages. Integrated circuits. SMDs – advantages. Static electricity – precautions in handling electronic circuits.

Switches: ON / OFF, push to ON, push to OFF, push to ON / OFF, SPST, SPDT, DPDT. Working and application of limit switches, proximity switches, relays.

Microcontrollers: Simple block diagram of 8 bit microcontrollers – application.

Mobile technology: CDMA and GSM. Compare – 2G and 3G technologies.

Inverter & UPS: Block diagram. Compare – inverter and UPS. Online and off line UPS – differentiate. Battery selection for UPS and inverter.

E-waste: Health hazards of e-waste.

Civil Engineering

I ***Construction Engineering***

Structural Building Materials: Stone – classification – geological, physical and chemical classification – characteristics of good building stone – varieties of stones – granite – trap – basalt – sand stone – Laterite. Values of load bearing capacity of stones. Quarrying of stones – methods – wedging and blasting – explosives used. Dressing of stones. Clay products
Bricks : Raw materials used – composition of brick earth, manufacturing methods – IS specifications of bricks – characteristics of good brick used for building purpose.
Tiles: Types of tiles – characteristics – uses – Porcelain and glazed tiles
Earthenware and stoneware pipes – uses – qualities
Lime: Sources of lime – Classification – methods of manufacturing (Description only)
Cements: Composition, Compounds present, manufacturing methods – characteristics of cement, Types of cement – properties of each – characteristics of cement – Tests on cement – consistency test, fineness test, Specific Gravity test, setting time test, Soundness test.
Puzzolana – definition – common Puzzolanas used as admixtures in cement
Aggregates: Sand: Sources of sand – River sand, Sea sand and pit sand – Limitations of mining of sand from rivers and sea shore – M-sand, alternatives of sand.
Coarse aggregates: Materials generally used, requirements of good coarse aggregates, commonly, used sizes for different applications.
Cement Concrete: Plain concrete – Water cement ratio – Ingredients and proportioning methods characteristics – preparation – workability – Tests on Cement concrete – Laboratory tests and field tests – Slump test, compaction factor test – Qualities of water used for mixing, Reinforced cement concrete – qualities of materials – Types of reinforcement used – Characteristics of reinforcing material – waterproofing compounds.
Mortar: Preparation of lime and cement mortar – Proportions of mortar for various items of work – tests on cement mortar.
Timber and wood products: Structural classification – soft wood and hard wood – defects in timber – seasoning of timber – preservation of timber
Metals: Ferrous metals – Wrought iron, Cast iron, Mild steel – Special steels – High carbon steel, High tensile steel and stainless steel (Properties and uses only) – Non ferrous metals: Aluminium, Copper, Lead, Zinc and titanium – important alloys – Properties and uses.

Ornamental Materials for Finishing: Paints and Varnishes: Types – Constituents – Preparation – characteristics and application.
Plastics: Types - characteristics and properties of PVC – uses – limitations of using plastics
Rubber: Characteristics and properties, uses.
Aluminium: Aluminium sections used for building construction – Hand rail and baluster.
Doors and windows, Panelling and false ceiling, building façade.
Glass – Types – Uses and properties. Glass used for Structural applications.
Miscellaneous: Abrasives – Adhesives – asbestos – asphalt – bitumen – cork – Plaster of Paris – insulating materials – fibre glass – thermo Cole wood products – veneers, ply wood, particle board – fibre board, hard board, etc.

Construction Technology: Masonry: Classification – Stone masonry – Brick masonry – Laterite masonry – composite masonry. Different types of stone masonry – General principles and specifications for stone masonry as per relevant codes.
Brick masonry: Different types of bonds for walls, piers and junctions of walls for equal and unequal thickness – English, Flemish (Single and Double Flemish) – Specification for brick masonry as per relevant codes.

Hollow block masonry: Types of hollow blocks used in construction and methods of construction – Advantages and Disadvantages with reference to other types of masonry. Solid block masonry and inter locking block masonry.
Partition walls – Types – materials – requirements.
Modern methods of constructions – Framed – Prefabricated – Earthquake resistant
Damp proof courses: Definition of dampness – causes and effects – methods of prevention – surface treatment – internal water proofing courses.
Pre-stressed concrete: Principle of pre-stressing – Types – Internal & External and different methods – pre-tensioning & post tensioning.
Form work: Functions – materials used – requirements of good form work – modern trends in material & technology – slip forms.
Scaffolding, shoring and under pinning: Definition – purpose and function – requirements – materials used
Plastering and Pointing: Materials and proportion – Functions – general specifications – type

Building Components: Different components of building from foundation to roof and their functions
Foundations: Functions, Classification, Shallow-deep, Types – spread footing – raft-mat-column footing – pile foundation – well foundation.
Flooring: Requirements of a good floor – materials used for flooring, Floor finishes – Types – Mosaic, Marble, Granite, Ceramic tiles, Vitrified tiles, Glass, Wooden, and other types of modern floor finishes.
Doors and Windows: Positioning of Doors and windows with respect to lighting and ventilation – Types and Size – Special types of doors – Flush, Revolving, and collapsible, Rolling and Sliding – Windows – Different types – Ventilator Different types – Fittings for doors and windows.
Lintels and sunshades: Types of lintels – Wooden, Stone, brick, RCC and RSJ lintels – Sunshades – Canopy and sun breakers.
Arches – Types, terms used.
Vertical Transportation: Staircases, Lifts and Escalators – Planning and location – component
Parts of staircase and lift – Types of staircase
Ceiling: Materials used for Ceiling – False ceiling.
Roof: Definition – importance of roofing with respect to climatic conditions – classification – pitched and flat – Coupled, closed coupled and collar roof. Different types of trusses for pitched roof – wood and steel trusses – roof covering for pitched roof – AC sheets, GI corrugated sheets.
Aluminium sheets – PVC sheets – method of arranging and fixing to the battens rafters and purlins – RCC roof – slab with beams – flat and sloped slabs – Flat slab construction – weather proof course to flat roof.
Requirements of good floor finish, Selection of materials
Ceiling: Types, Requirements of good ceiling, selection of materials
Stairs and staircases: Location – types – standards for staircase as per KBR – Tread, Rise, Going, Riser, Nosing – width of stair – Head room – Flight – Landing – Hand rails.
Lift and escalators – Component parts and requirements as per NBC

Introduction to Construction Management: Need for construction management – factors involved in Construction management.
Preliminary planning and organizational aspects importance of planning – site investigation – Feasibility report – collection of data and preparation of project report – different organizations – Engineering department organizational structure of PWD – and responsibilities – Role of various officers – (over seer, AE, A Ex E, EE, SE, CE)
Estimates – preliminary estimate – detailed estimate – budget provision – Administrative sanction and technical sanction – powers of sanction

Construction Planning: Construction stages – construction operation – schedule – procurement of labour, material and equipment – programme of work – objectives of programming – job layout – bar chart and flow process chart – work study – critical path method – preparation of network diagram – critical path and calculation of Float times. Scheduling by PERT. Comparison between PERT and CPM.

Execution of Works: Permanent and work charged establishments – specifications – enforcement of specifications – inspection by officials – quality control – supervision – sampling and testing of materials. Regulation of departmental labour muster roll and causal labour roll – out turn – plant capacities and hire charges

Contracts: Legality of contracts, types of contracts - piecework contracts, lump sum contracts, item rate contract, percentage contract – negotiated rates – departmental execution of works – piecework system – merits and demerits of each contract system.

Tender and Tender notices: Necessity of tenders – sealed tenders – tender notice, tender document – Earnest money and security deposit – opening of tenders – scrutiny of tenders – comparative statements – selection of contractors – negotiation, acceptance of tender, work order – contract agreement – conditions of contract.
Measurement of Works – Measurement book – Rules to be followed in recording measurements – pre-measurements and check measurements – contractor's acceptance of measurement.

Payment of Bills: Types of bills – first and final bills – preparation of bills – running account bills – modes of payment – hand receipts – checking of bills – recoveries to be made from bill – contractors ledger – imprest account – works register – works account and abstract

Human Resource Management: Definition – Difference between selection, appointment and recruitment – training of employees – managing men – labour welfares – trade unions

Stores: Classification of stores – materials – heavy plant and machinery – material handling – transport vehicles – inspection of vehicles – tools and plants – materials at site – borrowing and lending of tools and plants – safe custody of stores – procedure of taking delivery from station yards, demurrage – issue of stores materials – indent stock register – periodical inspection of stores verification and accounting of shortage and surplus – write off.

Materials Management: Definition – selection of materials as per standards – Optimum use of materials.

Construction Machinery: Earth moving equipments – crawler and wheel tractors – bulldozers – uses – operation of power shovels – selection – output of power shovel – Drag-lines – types – operations – output of Drag lines – output of hoes.
Concrete Machinery – concrete mixers – classification – ready mix plants – compaction machinery – vibrators – Lifting and hoisting machineries – pumps – types – uses.

Principles of Safety in Construction: Causes, effects and prevention of accidents, safety practices in construction – Site Engineers / Supervisor's role – safety through legislation – precautions during handling of materials occupational hazards and basic guidelines for safety in construction industry.

Entrepreneurship and Management: Entrepreneurship – concept – definition, role and expectation – Entrepreneurship in construction related activities. Technocrats – managers – Entrepreneurial Motivation and Development – advantages and disadvantages – List the institutions supporting entrepreneurship and their role.

Small Scale Industry: Growth – its role in economic development - Understands the requirements of a licensed supervisor, surveyor and contractor - Understand statutory requirements of small scale industry - List the different agencies promoting small scale industries – Assistance Programme for small enterprises.

Quality Management: Introduction to quality control and quality assurance system – elements of quality – ISO 9000 and T.Q.M. – Quality systems – Definitions of quality policy, quality management quality system – Indian standards on quality system – ISO 9000 – Merits and demerits.

Environmental Hazards & Disasters:

(a) Meaning of Environmental hazards, Environmental Disasters and Environmental Stress.
(b) Concept of Environmental hazards, Environmental stress & Environmental Stress & Environmental Disasters.

Types of Environmental hazards & Disasters: (a) Natural hazards and disasters (b) Man induced hazards and Disasters - Causes and Environmental consequences of the flowing natural HAZARDS – Droughts and Floods, Volcanic Eruption, Earthquakes, Landslides, Cyclones, Lightning, Tsunami.
Chemical hazards/disasters: Causes and consequences of release of toxic chemicals, nuclear explosion. Case studies – Minamata tragedy, Bhopal disaster, Chernobyl disaster.
Emerging approaches in Disaster Management – Three Stages.

9. Pre-disaster stage (preparedness) : (a) Preparing hazard zonation maps, Predictability / forecasting & warning. (b) Preparing disaster preparedness plan (c) Land use zoning (d) Preparedness through (IEC) Information, education & Communication.

Pre-disaster stage (mitigation): (a) Disaster resistant house construction (b) Population reduction in vulnerable areas (c) Awareness

10. Emergency Stage (a) Rescue training for search & operation at national & regional level (b) Immediate relief (c) Assessment surveys.

11. Post Disaster stage – rehabilitation: (a) Political (b) administrative aspect (c) Economic aspect (d) Environmental aspect

II ***Surveying & Quantity Surveying***

Compass survey – purpose and principles of compass survey – description and working of prismatic compass – concept of meridian – bearing of a line – True bearing and magnetic bearing. Magnetic dip and declination. Field work in compass survey – booking of field notes - Reduced and whole circle bearings - Calculations of included angles in compass traverse. Sources of errors in compass surveying – local attraction – detection and correction. Plotting of compass traverse – closing error and adjustments.

Levelling – Purpose of levelling – Errors in levelling – Curvature and refraction corrections, distance to visible horizon – problems.

Classification of levelling – fly levelling, profile levelling, cross sectioning, checks levelling, reciprocal levelling and contouring. Contouring – characteristics – methods of contouring, plotting by interpolation – tracing contour gradient – uses. Marking alignments of road, railway and canal in a contour map. Capacity of reservoirs using contour maps. Longitudinal sectioning and cross sectioning – plotting – working profile for roads. Permanent adjustments of dumpy level.

Quantity Surveying and Valuation: Definition of quantity surveying – essential requirements – quantity surveyor – duties and qualities – definition and elements of estimate – types – rough cost, plinth area, cubical content and service unit method – detailed estimate.
Units of measurements for different items as per standard – accuracy of measurements – explain the terms – sundries, Lump sum, Lead and lift, contingencies, unforeseen items, work charged establishment. Earth work computation – Trapezoidal – Mid ordinate and Prismoidal formula for computing volumes – Taking out quantities from Longitudinal section and Cross section in cutting and filling.

Different methods of taking out measurements – Centre line – in to in and out to out – Crossing methods.

Taking out quantities of all items of the following – Below roof level excluding finishing items

1. A compound wall
2. Computation of the capacity of reservoir from a contour map
3. One roomed building (RCC roof – Flat & Sloped)
4. Two roomed building (RCC roof – Flat & Sloped)
5. A residential building with RCC roof – Flat & Sloped
6. An office building with RCC roof – Flat & Sloped
7. Doors, windows, ventilators etc.

Taking out quantities of all items of the following – above roof level and finishing items including water supply and sanitary fittings.

1. One roomed building (RCC roof – Flat & Sloped)
2. Two roomed building (RCC roof – Flat & Sloped)
3. A residential building with RCC roof – Flat & Sloped
4. An office building with RCC roof – Flat & Sloped
5. Masonry Well.
6. Ground level RCC water tank.
7. Road estimate – Method of taking quantities of a W.B.M. road.

Definition – cost of materials – at source and at site – conveyance charges – standard data book – schedule of rates – Lump sum items – Rules of measurements – rules regarding tolerance of wastage of materials and extra labour.
Preparation of data – categories of labour and labour charge – cost of materials – over head charge including establishment – incidental, lead and lift – exercises. Methods of preparing abstract estimate – exercises.

Detailed and abstract estimate preparation for building with gabled roof, building with hipped roof, building with valley, two storied building (residential and office) Septic Tank and soak pit and steel roof truss.

Detailed and abstract estimate of Slab Culvert, Pipe culvert, Single span T-beam bridge, Pier of a bridge, Detailed estimate of an RCC well and RCC retaining wall.

Detailed estimate of RCC beam, slab, column etc and preparation of bar bending schedule.
Detailed estimate of Aqueduct.
Detailed specifications for various items of work of Earth work excavation, Foundation concrete, Masonry work, DPC, Form work, RCC, Plastering, Pointing, Flooring, Painting and Polishing. IRC specifications for WBM road. Preparation of Plan, Estimate and other documents for submission.

Definition of Valuation, meaning, purpose – Factors governing valuation – Life of structure – type location – Maintenance – legal control – Scrap value – salvage value – market value – book value – sinking fund annuity and depreciation.
Methods of valuation – Rental method – direct comparison with cost – Based on profit – Development method of valuation – depreciation method. Calculation of depreciation by different methods. Land valuation – Problems.

III *Irrigation Fluid Mechanics and Environmental Engineering*

Nature and Scope of Irrigation Engineering: Definitions – necessity of irrigation – advantages and disadvantages – perennial and Inundation irrigation – flow and lift irrigation – direct and storage irrigation.

Water requirement of Crop: (a) Principle Crops – Kharif and Rabi Crops in India & Kerala – Dry and wet crops – Crop period (b) Duty – different methods of expressing duty – base period – relationship between duty and delta – Factors affecting duty – requirements for precise statement of duty – duty figures for principal crops – Simple problems on duty.

Hydrology:

(a) Rainfall – Types of rain gauges – precautions in setting and maintaining rainfall records – rainfall cycle – average annual rainfall of an area – Methods of estimating average rainfall over a catchment – Thiessen's polygon method.
(b) Catchment basin and catchment area – free catchment, intercepted catchment – runoff – factors affecting runoff – nature of catchment, runoff coefficient – methods of estimating runoff – empirical formulae.
(c) River gauging – importance – site selection – open gauge well – measurement of velocity by surface floats, velocity rods and current meter.
(d) Maximum flood discharge from rainfall records Ryves and Dicken's formulae, H.F.L. marks, Gauge reading.

Head Works:

(a) Classification of head works – storage and diversion head works – their suitability under different conditions – suitable site for diversion works – general layout of diversion works – brief description of component parts of a weir.
(b) Barrage and weirs
(c) Head Regulator – scouring sluice – flood banks and other protective works
(d) Percolation – percolation gradient – up lift pressure, effect of percolation on irrigation works, up lift pressure and exit velocity – scour – protective works – solid and loose aprons.

(a) Dams – types – selection of site – site investigations – capacity of reservoirs from contours – dead storage – live storage
(b) Evaporation – Evaporation losses in reservoirs
(c) Dams – rigid and non-rigid dams – main types – gravity dams – failure of gravity dams and remedial measures – elementary profile – limiting height of dam – low dam and high dam – free board and top width – practical profiles of low dam – drainage gallery – spill ways.
(d) Earth dams – situations suitable for earth dams – types of earth dams – causes of failure of earth dams and precautions – saturation gradient and (phreatic) line – drainage arrangements
(e) Tank sluices – tower head type – regulating arrangements.
(f) Tank surplus works – necessity – suitable site – flush escapes – weirs.

Distribution works:

(a) Canals – classification – typical cross section of canal in cutting, embankment, partial cutting and embankment – berms – standard dimensions – balancing depth of cutting – canal lining – types – maintenance of canals.
(b) Canal regulation – sluice – drops – escapes
(c) Cross drainage works – necessity – general description of aqueducts – super passage, under tunnel – siphon – level crossing – inlet and outlet.
(d) Soil erosion – methods of prevention of soil erosion.

Methods of irrigation: Border irrigation – check-basin irrigation – furrow irrigation – sprinkler irrigation – drip irrigation.

Fluid Mechanics: Scope of hydraulics in engineering – definition of density, specific volume, specific gravity, viscosity, Kinematics & dynamic viscosity, compressibility, vapour pressure, cohesion, adhesion, surface tension and capillarity.
Intensity of pressure at a point – pressure head – units of pressure – Pascal's law – Atmospheric pressure – Gauge pressure – Absolute pressure – vacuum pressure – problems – Measurements of atmospheric pressure – simple mercury barometers – pressure measuring devices – piezometer tubes, manometers – u-tube – simple differential and inverted tubes only – mechanical gauge – Bourdon tube pressure gauge.
Pressure on plane surfaces immersed in liquid. Total pressure and center of pressure on horizontal, vertical and inclined surfaces immersed in liquids. Pressure on lock, gates, sluice gate – problems.

Flow of Fluid: Types of flow – uniform, non uniform, $dv/dt = 0$, $dv/dt \neq 0$, Streamline turbulent, steady, unsteady flow, compressible & incompressible flow – Definitions and mathematical expression, $dv/dt = 0$, $dv/dt \neq 0$, $dv/ds = 0$, $dv/ds \neq 0$
Equation of continuity of flow – problems. Types of energy need – static, pressure and velocity energy need – total energy of flowing liquid. Expressions for energy metre/kg & height liquid column. Bernoulli's theorem – statement and proof (only 2 - dimensional) – problems – assumptions & limitations - application – venturimeter, orifice meter and Pitot tube – problems

Flow through orifices & Mouth Pieces: Definition of orifice, types of orifices (based size, shape flow condition) – definition of vena contracta – hydraulic coefficients – Cv, Cc, Cd – experimental determination – problems.
Submerged and partially submerged orifices. Large rectangular orifice – expression for discharge – derivation. Time for emptying a prismatic tank through an orifice at bottom or in the side – head loss due to sudden enlargement and sudden contraction at the entrance of pipe from large vessel, at the exit of a pipe line, obstruction in a pipe line derivation of expression for head loss due to enlargement & contraction – problems. Mouth piece – different types – external and internal – cylindrical – formula discharge through them and problems.

Pumps: Centrifugal pumps, reciprocating pumps – working principle – description of propeller pumps, jet and air lift pumps, deep well pumps, diaphragm pumps – description and application.

Turbines: Classification – impulse and reaction turbines – Pelton Wheel – description and working, Description of reaction turbines – Francis and Kaplan turbines – Draft tube – purpose

Notches: Definition, types of notches – rectangular, triangular and trapezoidal notches.
Discharge over rectangular, triangular and trapezoidal notches. Derivations of expressions and problems. Advantages of triangular notches.

Weirs: Classifications – definition – discharge over rectangular weir, end contraction in weir effect of end contraction over discharge – Francis formula and Bazin's formula for end contraction – problems – velocity of approach – problems broad crested weir – problems submerged weir description and problems.

Hydro-electric Installation: Layout – intake works, pressure tunnel, penstock, surge tank, action of surge tank anchor blocks and tailrace.
Flow through Pipes.
Frictional loss in pipes – Chezy's and Darcy's formulae – Derivation and problems Hydraulic gradient and total energy line – Water hammer and its effect Syphon – problems.
Flow through Channels Wetter perimeter Hydraulic mean depth – uniform and non-uniform flow – Chezy's formula – derivations / and problems.
Kutters, Mannings and Bazin's formula – Most economical section of channel – condition for rectangular and trapezoidal – derivation – problems.

Water Supply Engineering: General importance of water supply – Development of water supply – Different systems of water supply – Need for protect water supply – Estimating water requirement – Total quantity of water for a town, per capita demand and factors affecting demand – water requirements for domestic purposes, industrial use, fire fighting, commercial and industrial needs, public use – variation in demand – Peak demand during day, month and year – Forecasting population by arithmetical, geometrical and incremental increase method (problems)
Sources of Water: Surface source – lakes, streams, rivers and impounded reservoirs, Yield from surface source – Underground sources – springs, wells, infiltration wells and galleries – Yield from wells – test for yield. Conveyance of water : Types of Intakes – Reservoir intake – River intake – Canal intake, Conveyance of water – open channels, aqueduct pipes – List of pipe materials – C. I. pipes, steel pipes, concrete pipes, A. C. pipes, G. I. pipes, plastic and P. V. C. pipes, high density polythene pipes, merits and demerits of each type (brief description only). Pipe joints – spigot and socket joint, flange joint, expansion joint for C. I. pipe, joints for concrete and asbestos cement pipe, methods of leak detection – prevention – rectification – pipe corrosion – causes and prevention.

Purification of Water: Quality of Water – Impurities of water – need for laboratory test. Sampling and Testing of water – physical, chemical and bacteriological tests – various standards of water such as pH value, colour, taste, hardness, odour – for potable water.
Flow diagram of different treatment units for both surface and ground sources – reservoir / pond and well
Aeration – methods of aeration – Sedimentation – plain sedimentation and sedimentation by coagulation.
Filtration – construction and operation of slow sand, rapid sand and pressure filters
Disinfections of water – necessity and method, chlorination, pre-chlorination, break point chlorination, super chlorination - Removal of Taste, colour, odour and hardness.

Distribution System: General requirements, system of distribution, gravity system, combined system, direct pumping – Methods of supply – intermitted and continuous – advantages & disadvantages
Layout of distribution system – Types – dead end, grid, radial and ring system their merits and demerits and their suitability.

Appurtenances in Distribution System: Uses of Sluice valves, Check valves or reflux valves, Air valves. Drain valves or blow-off valves, Scour valves, Fire hydrants and Water meters

Water Supply Arrangements in Building: Definition of terms – water main, service pipe, communication pipe, supply pipe, distribution pipe, air gap. General layout of water supply arrangements for single and multi-storied building as per I. S. Code of practice general principles and precautions in laying pipe line with in the premises of a building – Connection from water main to building.

Sanitary Engineering: Objects of providing sewerage works – Definition of terms – sewage, sewerage, sewer, refuse, garbage, sullage etc. – Systems of sewage disposal – conservancy and water carriage Systems – Types of sewerage systems and their suitability – separate, combined and partially separate – Quantity of Sewage – Quantity of discharge in sewers, dry weather flow, variability of flow, limiting velocities of sewers – Use of nomograms I.S. 1742 – Determination of storm water flow – run-off coefficient – time of concentration, empirical formulae for run-off – Surface drainages – requirements, shapes.
Different shapes of cross section for sewers – rectangular, circular, egg shaped – merits and demerits of each. Brief description and choice of types of sewers – stone ware, cast iron, cement concrete, pre cast sewers - AC pipe
Sewer appurtenances – location, function and construction of Man holes, Drop man holes, Catch basins, Flush tanks and inverted siphon
Necessity of pumping sewage – location and component parts of pumping station
Sewage characteristics – Strength of sewage, sampling of sewage, characteristics of sewage – physical, chemical and biological – significance of the following tests for – Solids, Oxygen demand, BOD, COD, pH-value , Chlorides

Sewage Treatment and Disposal: Preliminary treatment – brief description and functions of Screens, Skimming tanks and Grit chambers
Primary treatment – brief description and functions of plain sedimentation.
Secondary treatment – brief description of Trickling filters, Activated sludge process, Secondary clarifier and Sludge digestion, drying, disposal
Miscellaneous treatment – septic tank – Imhoff tank
Calculation of dimension of a septic tank from a given data.
Sewage disposal – dilution, disposal on lands, oxidation ponds, oxidation ditch, aerated lagoons, anaerobic lagoons.
Solid waste disposal – Methods of disposal – uncontrolled dumping, sanitary landfill, incineration and composting. Drainage and Sanitation in Buildings. Sanitary fittings – traps, water closets, flushing cisterns, urinals, inspection chambers, anti syphonage pipe
Rural sanitation and sanitary latrines, brief description of operational details of bio-gas plants using cow dung, night soil and agricultural wastes.

IV *Transportation and Geotechnical Engineering*

Road Engineering: Importance of roads, IRC classification of roads, Classification of urban roads

Investigation for Road Project: Different types of road surveys – Fixing the alignment of road – Factors affecting alignment – Drawings required for road project – key map, index map, preliminary and detailed location survey plan - Longitudinal and cross section.

Geometric Design of Highways: Road structure – subsoil, sub grade, foundation course – base and wearing course – highway width for different classification of road – Kerbs, road margin, road formation, right of way – camber-purpose and types – super elevation – definition, formula, minimum and maximum values. Sight distance – different types – gradient – different

types – curves – necessity, types – horizontal, vertical and transition – widening of roads on curves, Road drainage – surface drainage and subsurface drainage. Typical cross sections of a national highway in cutting and embankment

Highway Construction: Pavement – objectives, structure, function, types.
Earthen Roads – borrow pits, spoil bank, lead and lift, balancing of earth work, construction procedure.
Water bound macadam roads – materials used – consistent parts – construction – maintenance Bituminous roads – bitumen, asphalt, emulsion, cut back, tar common grades for construction – types of bituminous surface – prime coat, tack coat, seal coat. Construction and maintenance of Surface dressing – Grouted macadam – Premixed macadam – asphalt concrete – bituminous carpet with pre-coated chips. Hill roads – parts and functions – types of curves – drainage structures.

Traffic Engineering: Traffic volume study – traffic control devices – road signs – signals – traffic islands.
Road intersections at grade – grade separators – trumpet and cloverleaf patterns.

Introduction: Importance of railways – classification of railways based on gauges

Permanent way: Component parts of permanent way – types of Rails – Rail joints – types requirements of good joint, fixtures and fastening – simple type of fish plates, coning of wheel, adzing of sleepers, sleepers – definition – materials used. Ballast – function – materials used. Cross section of a BG single and double line in cutting and embankment.

Laying and Maintenance: Plate laying – definition, Methods

Points and Crossings: Points, crossings, turn out, diamond crossing.

Station Yards: Station yard – marshalling yard – goods yard – shunting yard – loco yard.

Signalling and Interlocking: Objectives of signalling, signals types only - modern signalling methods – multiple aspect signalling system – two, three, four aspect system – drooping signals principles of interlocking.

Introduction: Surveys, plans and documents for bridge project – IRC classification of bridges. Selection of site – Alignment of bridge – economical span – determination of water way – afflux and vertical clearance – permissible velocities – scour depth, depth foundation.

Sub Structure: Different types of piers – abutments (different types) – different types of wing walls – different types of approaches.

Super Structure: Descriptive study of different types of bridges – deck, through and semi through bridges – RCC beam bridges – plate girder bridges - steel trussed bridges – arch and bow string girder.

Tunnel Engineering: Necessity of tunnels – typical section of tunnels for a national highway and a single and double broad gauge railway track.

Airport Engineering: Classification of airport – layout of an airport and locational requirements – airport components – Runway, aprons and taxy way – pattern and layout of runways – selection of site for airport.

Docks and Harbours: Requirement and classification – break waters – types, uses – docks.

Geotechnical Engineering: Nature of soil and fundamental relationship – Introduction of soil mechanics – soil Engineering – scope of soil engineering – History of development of soil mechanics – Soil types – residual and transported – soil as a three phase system – water content – unit weight of soil mass – bulk unit weight, dry unit weight, unit weight of solids, saturated unit weight, submerged unit weights – specific gravity – void ratio – porosity – degree of saturation – percentage air voids – air content – density index – functional relationships – problems.

Determination of index properties – water content by oven drying method – specific gravity using pycnometer and specific gravity bottle – particle size distribution – sieve analysis, hydrometer method – particle size distribution curve – consistency of soils – liquid limit, plastic limit, shrinkage limit, plasticity index, consistency index – determination of liquid limits, plastic limit & shrinkage limit – shrinkage ratio – field density by sand replacement method and the core cutter method, classification of soils Necessity – I. S. classification.

Soil water – classification – absorbed water – capillary water – stress condition in soil: Effective and neutral pressures – problems.
Permeability of soil – Darcy's law – discharge velocity and seepage velocity – factors affecting permeability – determination of coefficient of permeability – constant head permeability test – falling head permeability test – problems.
Compaction of soil – Definition and objectives of compaction – Standard Proctor test and modified proctor test – concept of O.M.C and maximum dry density – Zero air voids line – field compaction methods – factors affecting compaction.

Site investigation and sub-soil exploration – objectives – site recognaissance – site exploration – depth of exploration – number and disposition of pits and boring – general exploration – detailed exploration – methods of site exploration – open excavations – boring methods – auger boring – auger and shell boring – wash boring – percussion boring – rotary boring – soil samples and samplers – disturbed sampling – undisturbed sampling – Standard Penetration Test – Geophysical.
Bearing capacity – ultimate bearing capacity, safe bearing capacity and allowable bearing pressure – general and local shear failure – Terzaghi's theory of bearing capacity – effect of water table – plate load test – limitations.

Foundations – different types of foundations – proportioning of foundations – rectangular and trapezoidal combined footings – strap footing – Raft foundation.
Deep foundations – Pile foundation – necessity of pile foundation – classification of piles according to materials, mode of transfer of loads, method of installation, use and displacement of soil. Well foundations – shapes of wells and component parts – sell sinking – tilts and shifts – measures for rectification of tilts and shifts.

V ***Analysis and Design of Structures***

Forces and Moments: Definition of force – conditions of Equilibrium of forces – Resolution of forces – Principles of resolution – Resultant of a number of coplanar forces acting at a point.
Moment of force – types of moments – principle of moments – Determination of reactions of simply supported beams and overhanging beams with point loads and uniformly distributed loads.

Centre of Gravity: Definition of centre of gravity (C.G.) – C. G. of plane in the same straight line and those distributed over a plane – Centroid of plane figures – C. G. of solids.
Determination of centroid of compound areas and reminders – C. G. of combination of simple solids.

Moment of Inertia: Definition of rectangular moment of inertia and polar moment of inertia – radius of gyration, parallel axis theorem and perpendicular axis theorem M. I of simple sections, rectangle, triangle, circle, M. I. of composite areas and remainders.

Friction: Static, dynamic and limiting friction – Laws of friction – Angle of friction – coefficient of friction, angle of repose. Equilibrium of a body on inclined rough surface.

Simple Stresses and strains: Stress and strain – types of stresses – Elasticity – Hook's law – Young's modulus – stresses and strains in uniform sections of same and composite materials.
Mechanical properties of materials – Elasticity, stiffness, plasticity, toughness, brittleness, ductility, malleability and hardness – Tensile test on ductile material (mild steel bar) and stress strain curve – Compression test on brittle material (cement concrete) and stress strain curve – limit of Proportionality, elastic limit, yield point – ultimate stress – breaking stress – working stress and factor of safety.

Temperature Stresses: Elongation and contraction due to temperature change – temperature stress when deformation is fully or partially prevented – temperature stress in composite sections. Linear strain and lateral strain – Poisson's ratio – volumetric strain – Bulk modulus – modulus of rigidity – relationship between Elastic constants – simple problems.

Strain Energy: Resilience – proof resilience – modulus of resilience – stress and strain when load is applied gradually, suddenly and with impact.

Torsion of circular shafts: Theory of pure torsion – derivation of formula – problems, Power transmitted by circular shafts – problems.

Beams and bending: Classification of beams – cantilever, simply supported, fixed, overhanging and continuous.
Types of loading – concentrated, uniformly distributed and uniformly varying load.
Shear force and bending moment – definition and sign conventions.
Calculation of SF and BM for Cantilever, simply supported and overhanging beams and sketching of SF and BM diagrams. Relation between SF and BM. Maximum BM – point of contraflexure.

Thin Cylinders: Failure of thin cylindrical shell due to internal pressure – circumferential and longitudinal stresses – Changes in dimension and volume of thin cylinders due to internal pressure.

Columns and Struts: Strut, column – failure of strut, short and long columns – types of end conditions. Euler's formula for columns of different end conditions – slenderness ratio – limitations of Euler's formula – applications. Derivations of Rankine's formulae from Euler's formulae – Rankine's constant for different materials – applications

Analysis of Trusses: Analysis of truss, determine the magnitude and type of forces in various members of the truss due to loading, using methods of joints – simple problems.

Introduction to method of sections. Introduction to method of resolution of forces by graphical method – Graphical representation of vectors – Bow's notation.

Theory of simple Bending: Theory of simple bending, Explain the terms 'Neutral axis', 'moment of resistance' and 'section modules'. Apply the theory of simple bending to simple and compound sections to calculate stress, section modulus and moment of resistance. Calculate shear stress distribution in rectangular and I Sections.

Direct and Bending Stresses: Eccentric loading of symmetrical columns (about one axis only) – maximum and minimum stress Limit of eccentricity.

Dams and Retaining Walls: Trapezoidal dam with vertical water face – forces acting, intensity of pressure at base, conditions of Stability, minimum base width. Retaining wall (trapezoidal with earth face vertical without surcharge) – Rankine's formulae for earth pressure (proof not required) – conditions of stability – minimum base width.

Fixed Beams: Fixed beams – advantages, method of finding fixing moments (derivations) BM and SF diagrams for fixed beams under point load and u.d. load (for Symmetrical loading only).

Deflection of Beams: Strength and stiffness of beam – curvature, slope and deflection – derivation of the differential equation.
Double integration method (Macaulay's method) of slope and deflection of – cantilever with point load, cantilever with u. d. load, simply supported beam with point load, S. S. Beam with u. d. load – Problems in cantilever and simply supported beams with combinations of point and u.d. load. Calculation of fixed beam with central point load; fixed beam with UD load over whole span using double integration method.
Moment area method for slope and deflection of beams – Mohr's theorems – application of the method to problems in cantilever beams with point load, UD load, and combinations of point and U. D. Load.

Application of the method to problems in simply supported beam with point load, UD load; and combinations of point and UD Load (Symmetrical load only.)

Continuous Beams: Continuous beams – statement of the theorem of three moments – BM and SF diagrams for simple, concentrated and u.d. loads.

Moment distribution method: Hardy cross methods of moment distribution – stiffness factor – carry over moment – distribution factor – application to continuous beams and simple portal frames – sketching the SFD and BMD.

Design: The subject of RCC and steel are to be taught in SI units and according to the latest IS Codes eg. IS 456-2000, and SP 16, IS 800-2007, IS 875, IS 801 – 1975 and Steel Tables.

Properties of materials of RCC as per the latest IS codes – materials for concrete – Grading of aggregate, proportioning and mixing of concrete, bulking of sand, water cement ratio and placing and compaction of concrete and removal of forms – Grades of concrete and their strength – types of steel used in RCC – the permissible stresses in concrete and steel – The concept of Limit State Design, Partial safety factors in Limit State method of Design, values of Partial safety factors with reference to latest IS codes, Principles of Limit State Design, Characteristic load and characteristic strength, stress-strain curve of concrete and steel, assumptions made in the Limit State method of design, neutral axis depth, limiting value of NA, design a simply supported beam and cantilever beams for different loading conditions for flexure, Design doubly Reinforced rectangular beams under different loading conditions. Design of lintels under different loading conditions. Design of flanged beams under different loading conditions (Use S P16).

Check for stiffness as per IS code, Basic i/d ratio, Modification factor, reduction factor for flanged beams, check the deflection of singly reinforced, doubly reinforced and flanged beams, the shear and torsional behaviour in RCC members, Nominal shear stress, maximum shear stress in concrete, permissible shear stress in concrete, Design beams under different loading conditions for shear, bond and anchorage, calculation of development length, check for curtailment of bars in beams, code provisions for lap length.
Study the behaviour of slabs. Design of one way slabs simply supported, continuous, cantilever and sunshade, Design of two way slab, simply supported, restrained and different end condition (Design of two way slab by using S P 16 only). Design of staircases under different loading and end conditions. Theory on design of columns, behaviour of short and long columns, Slenderness limit for columns as per IS code, Design the short column for direct load, Design the column for uniaxial bending using SP 16, study of slender columns, Theory of column footing, Design of isolated column footing (SP 16). Introduction on combined footing.

Design of Steel structures – Introduction to steel design – use of IS: 800, steel tables – strength of bolted and welded connections – Design of members using bolted and welded connection.
Design of Tension members – General – Net sectional area of Tension members – effective sectional area of angles / T-sections connected by one leg / flange (welded connections only) – Design of ties using single / Double angles, T-sections and channels. Design of compression members – general – effective length – slenderness ratio reference to IS code.

Design compressive stress and strength – discontinuous single / double angle struts – continuous angle struts Design of columns using rolled steel sections with / without cover plates – Lacing and battens – requirements – Description only – (Design of Lacing or battens not necessary).

Design of Steel beams – Plastic moment carrying capacity of section – classification of cross-section Bending strength, shearing strength and deflection limit of laterally supported beam.
Fundamentals of Plate Girder – parts and function.
Design of Roof truss – Elements of roof truss – Loads acting with reference to IS code – Design of elements of Roof truss. Design of angle purlins.

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.