

# DETAILED SYLLABUS FOR THE POST OF ASSISTANT ENGINEER IN KERALA WATER AUTHORITY

(Cat.Nos.: 137/2022, 138/2022)

(Total Marks – 100)

## 1. Mechanics of Solids and Structural Analysis (7 Marks)

Concept of stress and strain, relationship between elastic Constants, strain energy and complementary energy-strain energy due to tension. Bending moment and shear force, Stresses in beams, beams of uniform strength - beams of two materials – strain energy due to bending - shearing stresses in beams.

Stress on inclined planes for axial and biaxial stress fields - principal stresses - Mohr's circle of stress. Thin and Thick Cylinders, Torsion of solid and hollow circular shafts. Springs: Close coiled and open coiled helical springs. Deflection of beams, Theory of columns, Truss analysis, Displacement response of statically determinate structural systems using energy methods, Principle of virtual work, Statically indeterminate structures, Strain Energy methods, Moving loads and influence lines, Arches. Slope Deflection Method, Moment Distribution Method, Clapeyrons Theorem (Three Moment Equation).

## 2. Fluid Mechanics and Water Resources Engineering (10 Marks)

Fluid Statics- Fluid pressure, Buoyancy and floatation, Fluid Kinematics, Dynamics of fluid flow, Flow through orifice and notches, Flow through pipes, Boundary layer, Drag and Lift on immersed bodies. Hydraulic machines- flow through vanes (moving and stationary) Impulse and reaction Turbines, Centrifugal Pumps, Open channel flow, Uniform flow, Hydraulic Jump, Gradually varied flow, Dimensional analysis and model testing.

Hydrologic cycle, Precipitation, Infiltration and Evaporation-measurement and data analysis. Runoff-components and computation, Hydrograph, Unit Hydrograph and S-Hydrograph. Irrigation types and methods-Soil water plant relationships, Frequency of irrigation, Computation of crop water requirement. Stream flow measurement -Stage-discharge curve. Meandering of rivers, river training works. Surface water systems: diversion and storage systems, reservoir - estimation of storage capacity and yield of reservoirs - reservoir sedimentation -useful life of reservoir. Groundwater - Aquifer types and properties - Steady radial flow into a well. Estimation of yield of an open well.

## 3. Surveying and Levelling, Quantity Surveying and Valuation (7 Marks)

Basics of Surveying, Levelling and Contouring, Area and Volume Computation, Theodolite Survey, Mass Diagram. Principles, Linear, angular and graphical methods, Survey stations, Survey lines- ranging, Bearing of survey lines, Local attraction, Declination, Dip, Latitude and Departure, Methods of orientation, Principle of resection. Principles of levelling- Dumpy level, booking and reducing levels, Methods- simple,

differential, reciprocal leveling, profile levelling and cross sectioning. Digital and Auto Level, Errors in leveling. Triangulation, Theory of Errors, Electronic Distance Measurement, Total Station Survey, Global Positioning Systems, Remote Sensing, Geographical Information System. Contouring: Characteristics, methods, uses

Analysis of rates - Data book and schedule of rates, Analysis of rates for various items of work, Detailed specification. Types of Estimate. Detailed estimate including quantities, abstract and preparation of various items of works, Preparation of bar bending schedules for various RCC works. Valuation- Methods of valuation, Depreciation, Fixation of rent.

#### **4. Building materials, Construction Technology, Construction Management (7 Marks)**

Construction Materials – Timber, Mortar, Iron and Steel, Structural steel, Modern materials. Concrete–Admixtures, Making of concrete, Properties of concrete, Mix proportioning.

Building construction- Cost-effective construction, Masonry, Lintels and arches. Floors and flooring, Roofs and roof coverings, Doors, windows and ventilators, Finishing works.

Tall Buildings – Steel and Concrete frame, Prefabricated construction, Slip form construction. Vertical transportation – Stairs, Elevators, Escalators and Ramps. Building failures and Retrofitting, failures in RCC and Steel structures.

Construction Planning and Scheduling, Construction disputes and settlement, Ethics in Construction, Construction safety, Principles of materials management, Quality management practices, Construction procedures.

#### **5. Environmental Engineering (10 Marks)**

Water sources and demand, Quantity estimation, Population forecasting, Factors affecting consumption-Fluctuations in demand . Quality of water. Drinking water standards - Physical, chemical and biological analysis. Water treatment- Physical methods, Chemical methods. Design of sedimentation tank, flocculator, clariflocculator, filters, Membrane treatment techniques. Disinfection methods. Distribution of water, Pumps, Hardy Cross method of analysis

Working and Design of Rapid and Slow sand filters. Loss of head in filters, Pressure filters. Disinfection of water - Methods, Chlorination-Types, Factors affecting - Chlorine demands. Miscellaneous treatment-Ion exchange, Lime-soda process, Electro dialysis - Colour, Taste and Odour removal-Adsorption-Aeration-Fluoridation-Defluoridation

Waste water- Sources, Characteristics, Oxygen demand. Design of sewers, Sewer appurtenances-Man holes, Catch basin, flushing devices, Inverted siphon. Ventilation of sewers. Sewage, Sewerage, Systems of sewerage, Sewage characteristics- Physical, chemical and biological parameters, Biological oxygen demand, first stage BOD, Chemical oxygen demand, Relative stability, Population equivalent.

Treatment of sewage-Preliminary and Primary treatment - design of Screen, Grit chamber, Detritus chamber, Flow equalization tank and Sedimentation tank. Contact bed, Intermittent sand filter, design of Trickling filter, Activated sludge process, Trickling filter-High rate, standard. Rotating biological contactor. Design of Septic tank and Imhoff tank, Principle and working of Oxidation ditch and oxidation ponds. Aerated lagoons, Design of upflow anaerobic sludge blanket reactors.

Upflow anaerobic sludge blanket reactors, Sludge digestion, Sludge drying bed. Air pollution- sources, effects on human, Control of air pollutants, Air quality legislations.

## **6. Design of Structures (7 Marks)**

Properties of concrete and reinforcing steel. Limit state method of design, Analysis of reinforced rectangular beams, Design of shear reinforcement, Bond and development length, Curtailment of reinforcement, Design for torsion, Design of singly and doubly reinforced beams, one way slab, Cantilever slab, Continuous slab (detailing only), Two way slabs, Limit state of serviceability, Deflection, Cracking, Stair cases -design & detailing. Columns-effective length-design of axially loaded short columns with rectangular ties and helical reinforcement.

Columns under compression - effective length- short column - long column - reinforcement-IS specifications regarding columns- design of columns under uniaxial bending. Design of slender columns.

Design of rectangular footings-uniform thickness and sloped, Combined footings (design principles only)- analysis of combined footings-rectangular and trapezoidal. Fundamentals of Pre-stressed concrete, Concept of prestressing, materials and methods of prestressing systems, losses of pre-stress, Analysis of pre-stressed beams (rectangular sections).

Steel and steel structures – Bolted and welded connections, Tension members, Compression members, Beams, Roof trusses, Purlins. Timber structures- columns, composite beams (concepts only)

## **7. Geotechnical Engineering (8 Marks)**

Three phase representation system of soil and relationships, index properties, soil structure (single grained, honey comb, flocculent and dispersed structures), basic structural units in clay mineralogy, Permeability of soils, laboratory and field permeability test, Principle of effective stress, seepage pressure, basic definitions and simple computations in flow nets. Stresses in elastic half space due to concentrated loads (Boussinesq equation), contact pressure distribution below foundations.

Consolidation and Compaction. Shear characteristics of soil, Lateral earth pressure-Rankine's theory

Bearing capacity of soil, Terzaghi's equation (bearing capacity factors to be provided in the problems), effect of water table, Settlement of soil, immediate and consolidation settlement- computation of, Pile foundations, static equation, dynamic equation

(engineering news formula only), under reamed piles, vertical and uplift capacity of pile foundations. Geotechnical investigations, need of investigations, site reconnaissance and its significance, planning of investigations, drilling and sampling, in-situ tests including Standard Penetration Test, vane shear test, pile load test and Plate load test,

### **8. Transportation Engineering and Urban Planning (4 Marks)**

Classification and alignment of highways, Geometric design of highways, Properties and testing of pavement materials, CBR method of flexible pavement design, Construction and maintenance of pavements, Design of runways, taxiways and aprons. Traffic characteristics. Site selection, Desirable properties and testing of road aggregates, bituminous materials and sub grade soil. Flexible and rigid pavements, Factors influencing the design of pavements, CBR method and IRC guidelines for flexible pavements. Types and causes of failures in flexible and rigid pavements, Highway drainage. Traffic characteristics, Traffic studies and their applications. Influencing factors and preventive measures for traffic accidents, Railways- geometric design of tracks, Maintenance. Alignment, Ventilation and drainage of tunnels, Types of harbours and docks.

Definitions in town and country planning; Goals and objectives of planning; Components of planning; Benefits of planning - urbanization, industrialization and urban development;; migration trends and impacts on urban and rural development - rural-urban fringes - city region - area of influence and dominance. regional planning: definition, need and importance, function, objective, concept of region, types of regions, delineation of regions - Types and contents of regional planning for block, district, state, nation, NCR, resource region, agro-climatic region, topographic region and sectoral planning, major regional problems and their solutions. Theories of urbanization. Spatial standards for residential, industrial, commercial and recreational areas, space standards for facility areas and utilities, Provisions of Town Planning Act, zoning, subdivision practice, metro region concept.

## **MECHANICAL ENGINEERING**

### **MODULE – I (ENGINEERING MECHANICS) (3 Marks)**

Statics: Fundamental concepts and laws of mechanics, Rigid body, principle of transmissibility of forces, Coplanar force systems, moment of a force, principle of moments, resultant of force and couple system, Equilibrium of rigid body, free body diagram, conditions of equilibrium in two dimensions, two force and three force members.

### **MODULE – II (MATERIALS AND MECHANICS OF SOLIDS) (4 Marks)**

Pure materials, crystal structures, Metals, alloys, composites, phase diagrams, and TTT curves. Material behavior, uniaxial tension test, stress-strain diagrams, concepts of orthotropy, anisotropy and inelastic behavior, Hooke's law for linearly elastic isotropic material under axial and shear deformation, Definition of stress and strain at a point

(introduction to stress and strain tensors and its components only), Poisson's ratio, biaxial and triaxial deformations, Bulk modulus, Relations between elastic constants.

**MODULE – III (MECHANICS AND DYNAMICS OF MACHINERY) (6 Marks)**

Gears, terminology of spur gears, law of Gearing, involute spur gears involutometry, contact ratio, interference, backlash, gear standardization, interchangeability, centre distance modification, modes of gear tooth failures, theory and details of bevel, helical and worm gearing. (3)

Introduction to vibrations, free vibrations of single degree freedom systems, Energy Method, Undamped and damped free vibrations, viscous damping, critical damping, logarithmic decrement, Coulomb damping, harmonically excited vibrations, Response of an undamped and damped system, transmissibility. (3)

**MODULE – IV (FLUID MECHANICS AND HEAT TRANSFER) (6 Marks)**

Fluids and continuum, Physical properties of fluids, density, specific weight, vapour Pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Energy equation and continuity equations. Flow through pipes, loss due to friction, flow measurement devices in pipe flow and open flow. Hydraulic machines: impulse and reaction turbines, roto-dynamic and positive displacement pumps, specific flow, specific speed, pen stock, water hammer. (3)

Modes of Heat Transfer, Conduction, Fourier law of heat conduction, Thermal conductivity of solids, liquids and gases, Factors affecting thermal conductivity, Most general heat conduction equation in Cartesian, cylindrical and spherical coordinates, One dimensional steady state conduction with and without heat generation, conduction through plane walls, cylinders and spheres, variable thermal conductivity, conduction shape factor, heat transfer through corners and edges. Critical radius of insulation. (3)

**MODULE – V (INDUSTRIAL AND PRODUCTION ENGINEERING) (6 Marks)**

Management of Human Relations in Organisations: Ethics and fair treatment at work, ethics and the law, ethical behaviour at work, individual factors, organizational factors, the boss's influence, ethics policies and codes, the organization's culture, role of HR in fostering ethics and fair treatment. Type of management, organizational structures, span of control, budgeting. (3)

Sand Casting: Sand Molds, Types of Molding Sands and Testing. Type of patterns, Pattern Materials, Cores, Types and applications, Sand Molding Machines Gating System, Riser, Shell Mold Casting, Ceramic Mold Casting, Investment Casting, Vacuum Casting, Slush Casting, Pressure Casting, Die Casting, Centrifugal Casting, Defects in Castings. Machine tools: principles of milling, turning, grinding, shaping, drilling, and welding. Tool properties for these processes. Principle of indexing. TIG and MIG welding. Computer numeric control of machines, (3)

# DETAILED SYLLABUS OF CHEMICAL ENGINEERING

## **MODULE 1 (5 marks)**

### **PARTICLE TECHNOLOGY**

Filtration: applications, classification of filters, Filter operation – effect of pressure – constant pressure and constant volume filtration. Centrifugation, classification of centrifuges

Size Reduction: Nature of the materials to be crushed – hardness, structure, moisture content, crushing, Types of crushing equipments, coarse crushers – Intermediate crushers – fine grinders, Laws of crushing – Kick's law – Rittinger's law – Bonds law – Jaw crusher – gyratory – Average particle size – specific surface of mixture, volume surface mean diameter.

Size Separation: Screens: Tyler and U. S. standard screens, Screen analysis: efficiency and capacity of screens, Types of screening equipment – grizzlies – trammels, shaking screens, vibrating screens. Air separation methods: cyclone separator – air separator – bag filter, Electrostatic precipitator. Fluidization: Mechanism of fluidization – conditions for fluidization – batch fluidization –boiling effect. Sedimentation : Sedimentation – application Principle of froth floatation cells - froth floatation cells – simple flow sheet for floatation plant.

Agitation and Mixing: Purpose of agitation – agitation equipment – propellers, paddles and turbines - Flow pattern in agitated vessels – prevention of swirling – draft tubes and baffles – their power consumption in agitated vessels.

Storage and Transportation of Solids, Gases and Liquids: Storage of solids – Hoppers – bins – angle of repose. Devices for discharge of solids – Conveyor types – belt conveyor – chain conveyor – scraper conveyor – apron conveyor – screw conveyors pneumatic conveyors – pneumatic conveying system auxiliary equipments. Storage of liquid – storage tanks, Storage of volatile liquids – floating roof. Storage of gases: Horton sphere – pressure cylinders – gas holders – wet and dry specifications.

## **MODULE 2 (6 marks)**

### **STOICHIOMETRY, INSTRUMENTATION & PROCESS CONTROL**

Units and dimensions: conversion of units, dimensionless group. Gas Laws and Their Applications: Ideal gases – gas laws (derivation is not required), simple problems involving single gas, Gas mixtures – Dalton's Law, Amagat's law, Concept of mole, weight percent, mole percent, normality, molarity, molality, vapour pressure. Material Balances – Not involving chemical reactions. Material Balances involving Chemical Reactions: Chemical reactions, complete and incomplete reactions, stoichiometric proportions of reactants.

Principles of measurement – Instruments for indication, recording and remote control.

Temperature – filled system thermometers – bimetallic – thermocouples – resistance

Pressure and vacuum – manometers – diaphragm gauges, bellow gauges, strain gauges.

Different flow meters and level measuring instruments, Specific gravity, Humidity & Instrumental methods of analysis: Specific gravity,- Off line and on line measurement – Humidity - Dew point method, wet bulb method, hygrometry, electrical type - Moisture content in different products - Chromatographic analysis – flame photometry, spectrophotometry.

Process Control: Recorders, timers – transducers - Characteristics of measuring elements and process control system – open and closed loop systems, Computerized Control and

Instrumentation Diagrams: - Heat exchangers, Distillation plant, Control room – panels and control room functions, Control valves- types, P, PI and PID Controllers - basic principles and transfer functions

### MODULE 3 (2 marks)

#### MASS TRANSFER

Mass Transfer: Molecular diffusion – molar flux – Fick's law – steady state diffusion  
Absorption: Mechanism of Absorption – conditions of equilibrium between gas and liquid  
Adsorption: Types of adsorption, adsorbents, adsorption isotherms. Humidification: General mechanism of diffusional processes – Definitions and mathematical expressions for Adiabatic saturation temperature – wet bulb temperature, types cooling towers. Drying: Purpose and industrial applications – Mechanism of drying – Rate of drying. Distillation: Boiling-point diagram and equilibrium curves -application of Raoult's law, -relative volatility – Types of distillations- Simple distillation, steam distillation Azeotropic distillation, extractive distillation and fractional distillation. Leaching: applications - batch and continuous leaching, factors affecting rate of leaching.

### MODULE 4 (2 marks)

#### POLYMER TECHNOLOGY

Introduction to polymers: Speciality Thermoplastic / Thermosetting plastics - Plastics – Rubber – Fibre – adhesive – coatings, Important sources of monomers and manufacturing of the following: Ethylene, Propylene, Vinyl Chloride, Styrene. Types of polymerisation reaction: Addition polymerisation, Step polymerisation, Chain polymerisation, Anionic and cationic polymerisation, Polymerisation by condensation Different types of co-polymers – Random, block, graft co-polymer, Characteristic features and applications of co-polymerisation – polycondensation, Manufacture of thermoplastics: Commodity plastics, Manufacture of Man made Fibres – Nylon, Viscous Rayon, Polyester

**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.**