DETAILED SYLLABUS FOR THE POST OF ASSISTANT ENGINEER IN KERALA STATE POLLUTION CONTROL BOARD

(Cat.No. : 124/2021)

Marks Distribution to be followed for the above exam

From

MODULE I - 10 Marks
MODULE II - 15 Marks
MODULE III - 15 Marks
MODULE IV - 35 Marks
MODULE V - 25 Marks

SYLLABUS	
Module	**Contents**
I	**Matrices:** Rank, eigen values, eigen vectors. **Partial Differentiation:** Partial derivatives, Euler's theorem on homogeneous functions, Taylor's series (one and two variables) – Maxima and minima of functions of two variables – Lagrange' s method. **Vector Differentiation:** Scalar and vector functions, differentiation of vector functions – velocity and acceleration – scalar and vector fields – operator ⊸ – Gradient – Directional derivative – Divergence – Curl – irrotational and solenoidal fields – scalar potential. **Laplace Transforms:** Transforms of elementary functions, solution of ordinary differential equations with constant coefficients using Laplace transforms. **Ordinary Differential Equations:** First Order ordinary differential equations, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients. **Complex Analysis:** Analytic functions, conformal mappings, bilinear transformations, complex integration, Cauchy's integral theorem and formula, Taylor and Laurent's series, residue theorem **Fourier Series:** Fourier series of periodic functions of period 2 π and 2 ℓ, odd and even functions, Half range expansions.

II	**Mechanics** – statistics – Coplanar forces – conditions of equilibrium. Support reactions – Simply supported and overhanging beams. Friction – Laws of friction – applications. Centre of gravity and moment of inertia of plane areas. Dynamics – rectilinear motion – Newton's laws of motion – curvilinear motion. Concept of stress and strain, Bending moment and shear force, Stresses in beams, 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), Kani's method of analysis. **Plain and Reinforced concrete**- Properties of concrete and reinforcing steel- Objectives of design-Different design philosophies- Working Stress and Limit State methods-Limit State method of design-Introduction to latest BIS code- Types of limit states-characteristic and design values-partial safety factors-types of loads and their factors. Limit State of Collapse in Bending-assumptions-stress-strain relationship of steel and concrete- analysis of singly reinforced rectangular beams-balanced-under reinforced-over reinforced sections-moment of resistance codal provisions.Design of Singly Reinforced Beams- basic rules for design- design example of simply supported beam- design of cantilever beam-detailing Analysis and design of doubly reinforced beams –detailing, T-beams- terminology- analysis of T beams- examples - Design for torsion- IS code approach. **Introduction to steel structures**, properties of steel, structural steel sections. Introduction to design: Design loads and load combinations, limit state design concepts. Connections bolted and welded (direct loads) Tension members-Types of sections – net area- design of tension members- concept of shear lag-use of lug angle-connections in tension members. Compression members-design of struts- solid and built up columns for axial loads-- design of lacings and battens-column bases- slab base – gusseted base. Design of beams-laterally restrained and unrestrained – simple and compound beams- plate girders subjected to uniformly distributed loads – design of stiffeners. **Building materials** – common building materials – stone, brick, cement, steel, aggregate, timber, mortar, modern materials – properties, IS specification. Concrete–Admixtures, Making of concrete, Properties of concrete, Mix proportioning. **Building construction**- Foundations, 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 Management-** CPM,PERT,Valuation of buildings, Construction disputes and settlement, Ethics in Construction, Construction safety, Principles of materials management, Quality management practices, Construction procedures. **Analysis of rates** - Data book and schedule of rates, Analysis of rates for various items of work, Detailed specification. Types of Estimate. Detailed

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	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.
III	**Surveying –** principle of surveying – linear measurements using chain – levelling work – reduced levels , Levelling and Contouring, Area and Volume Computation, Theodolite Survey, Mass Diagram, Triangulation, Theory of Errors, Electronic Distance Measurement, Total Station Survey, Global Positioning Systems, Remote Sensing, GIS applications. **Fluid Mechanics -** 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. **Water Resources Engineering -**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, Duty, Delta, 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. **Geotechnical Engineering -** Major soil deposits of India, Classification and three phase system of soil, Permeability of soils, Principle of effective stress, Shear characteristics of soil, Consolidation (Terzaghi's theory of one-dimensional consolidation only) and Compaction. Stability of finite slopes-Swedish Circle Method and Friction circle method, Stresses in subsoil due to loaded areas of various shapes, Boussinesq's formula, Newmark's chart Lateral earth pressure-Rankine's and Coulomb' theories. Bearing capacity of soil, Estimation of magnitude of settlement, Site investigation, Standard Penetration Test and Plate load test,Pile load test, Design of shallow, deep and machine foundations, Ground improvement techniques. **Transportation Engineering and Urban Planning-** 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- Traffic studies and analysis, Traffic control devices. Airport characteristics- Aircraft component parts. Site selection, Terminal area planning- Airport marking and lighting. Traffic regulation rules, Highway capacity, Traffic safety, Influencing factors and preventive measures for traffic accidents, Basic diagrams of traffic flow theory. Railways- geometric design of tracks, railway operation control, Maintenance. Alignment, Ventilation and drainage of tunnels, Types of harbours and docks. Goals and objectives of

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	Urban planning; Components of planning, Regional planning, Theories of urbanization, Study of Urban Forms, Zoning, Development of new towns, Town Development Plan, Town planning acts.
IV	**Water** sources and demand, Quantity estimation, Population forecasting, Quality of water. Water treatment methods - Design of sedimentation tank, flocculator, clariflocculator, filters, Membrane treatment techniques. Disinfection methods. Miscellaneous treatment techniques, Lay out of water distribution network , Distribution of water, Pumps, Hardy Cross method of analysis,Equivalent method,Pipe appurtenances,Plumbing systems. -Hardy cross method-Equivalent pipe method-Pipe appurtenances.Plumbing systems. IS 10500:2012 BIS Drinking water standards. **Wastewater**- Sources, Characteristics, Oxygen demand. Design of sewers, Circular sewers, Partial flow and full flow conditions. Sewer appurtenances, Disposal of wastewater, Streeter Phelps equation, Oxygen sag curve, Treatment methods, Aerobic and anaerobic methods, Design of various treatment units-Screening, Grit chamber, Sedimentation tank, Activated Sludge process, Trickling filter, Rotating biological contactor, Septic tanks, Imhoff tanks, Oxidation ditches, Oxidation ponds, Upflow anaerobic sludge blanket reactors, Sludge digestion, Sludge drying bed. Effluent discharge standards followed in India. **Industrial wastewater management** – CETP,Effluent characteristics and treatment methodologies for Dairy industry, Pulp and paper industry, Tannery industry, Sugar industry, Distillery industry and Thermal power plant **Air pollution:** Sources and effects – Nature of air pollution classification, properties and sources of pollutants, acid rain – Green house effect – Ozone depletion –Global warming & climate change, Global Warming Potential, Effects of man, animal, vegetation and material dangers, atmospheric stability, lapse rates, inversions, plume behaviour and theory of pollutant dispersion, Dispersion models. Air quality criteria and standards, NAAQS, Air Quality Index, methods of pollutant sampling and measurement. Control methods for particulate emissions and gaseous pollutants – design aspects of Cyclone separator, Electrostatic precipitator – Bag house filter – Scrubbers – Different types – Indoor Air pollution control- Box model approach. **Solid Waste Management** (SWM) : Sources, generation rate, classification and microbiology of solid waste, solid waste characteristics – health aspects, methods of collection and disposal, solid waste processing and recovery – composting, thermal processes, regeneration and recycling, waste segregation and storage –case studies under Indian conditions – source reduction of waste – Reduce, Reuse and Recycle. SWM Heirarchial Triangle, Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor–Dumpsite Rehabilitation. 2016 Municipal solid waste (M&H) rules. E-waste management.

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	Nuclear waste: Sources and nature of nuclear waste, Radiation measurement and pathways of transmission, storage technology and disposal of liquid, solid and gaseous (radio active) wastes. **Noise Pollution** - Noise control measures, noise rating system, Hearing mechanism, acoustical absorptive materials. **Pollution types** - Eutrophication, Heavy metal pollution, Marine pollution, Plastic Pollution etc. **Environmental Management**: ISO 14001 standards- Environmental Management System – Kyoto protocol – Montreal Protocol –Kigali Agreement-International summits on Environmental protection-CoP- IPCC reports- Carbon foot Print- Environmental Impact assessment – Environmental Auditing - Life cycle Assessment – Industrial Ecology- Industrial Symbiosis. Environmental law enforcing agencies - Legislative aspects including water (Prevention and control of pollution) Act 1974, Air (prevention and control of pollution) Act 1981, Environmental Protection Act 1986. **Sustainable Development**, Cleaner production**, Green technologies**- Renewable energy sources, Bio- fuels, Eco labeling, Green buildings and its rating system, Organic farming, bio-pesticides, bio-fertilisers, Phytoremediation, Carbon credit, Carbon trading and Carbon sequestration.
V	**Process Calculations -** Units and dimensions, conversion of units, dimensional analysis, conversion of empirical equations, mole concept and mole fraction, weight fraction and volume fraction, concentration of liquid solutions – molarity, molality, normality, ppm, density and specific gravity, specific gravity scales, use of mole concept in chemical reaction stoichiometry, ideal gases and gas mixtures, various gas laws, average molecular weight and density of gases, critical properties and compressibility of gases. **Material balances** with and without chemical reactions, material balance in unit operations such as evaporation, crystallization, drying, absorption, distillation etc. Energy balances: Heat capacity, specific heat and enthalpy, heat capacities of gases and gaseous mixtures, estimation of heat capacity – relevant rules and laws, calculation of enthalpy changes, Estimation of latent heat of vaporization, heat balance calculations in processes without chemical reaction, heat of reaction, standard heats of formation, combustion and reaction, heat of solution and heat of mixing, adiabatic and non-adiabatic reactions, theoretical and actual flame temperatures. **Vapour Pressure:** vapour pressure of pure liquids and immiscible liquids, ideal solutions and Raoult's law, non-volatile solutes, humidity: Humidity and saturation: various term associated with humidity and saturation. Material and energy balance problems involving vaporization and condensation, fuels and combustion, heating value of fuels, proximate and ultimate analysis, Orsat analysis of flue gases. **Thermodynamics:** Fundamental concepts and definitions – various systems – intensive and extensive properties – Zeroth law of thermodynamics – First law of thermodynamics – applications – limitations. Second law of

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thermodynamics – general statements of second law – concept of entropy – calculation of entropy changes – Carnot's principle-Clausius inequality – entropy and irreversibility – statistical explanation of entropy-Third law of thermodynamics. Thermodynamic properties of pure fluids – Gibbs free energy, work function – Joule- Thomson coefficient – Gibbs-Helmholtz equation – method of Jacobians – thermodynamic diagrams – fugacity and activity of pure fluids Compressors – single-stage and multistage compression – refrigeration and liquefaction – COP – various refrigeration cycles – general properties of refrigerant – Joule-Thomson expansion and liquefaction processes – power cycles – steam-power plant cycles – internal combustion engine cycles – gas-turbine power plant cycle.

Properties of solutions – partial molar properties and methods of determination – Lewis-Randall rule – Raoult's law – Henry's law – activity and activity coefficients in solutions – effect of temperature and pressure on activity coefficients – Gibbs-Duhem equations, property changes on mixing – heat effects of mixing processes.

Chemical reaction equilibria – reaction stoichiometry – equilibrium constant – standard free energy change – standard state – feasibility of reaction – effect of temperature on equilibrium constant – presentation of free energy data – evaluation of K – equilibrium conversion in gas-phase reactions – effect of pressure and other parameters on conversion – liquid-phase and heterogeneous reaction – reactions in solutions – pressures of decomposition in gas-solid reaction – simultaneous reactions- phase-rule for reacting systems.

Chemical Reaction Engineering: Overview of chemical reaction engineering, classification of chemical reactions, variables affecting the rate of reaction, definition of reaction rate, kinetics of homogeneous reaction, pseudo steady state hypothesis (PSSH), searching for a mechanism, General considerations, hydrogen bromide reaction, polymerisation – steps in free radical polymerisation, evaluation of rate equation by integral and differential analysis for constant volume and variable volume system. Introduction to reactor design, classification of reactors, design of single and multiple reactions – size comparison of single and multiple reactors, auto catalytic reactions, design of evaluation of laboratory reactors, Integral (fixed bed) reactor, stirred batch reactor, stirred contained solid reactor (SCSR), differential reactors: continuous stirred tank reactor (CSTR), Laminar flow reactor, stirred through transport reactor, re-calculating transport reactor.

Heterogeneous Reactions: Catalysis and catalytic reactors: Catalysts, types of catalysts, catalyst properties, steps in a catalytic reaction, Heterogeneous data analysis for reactor design, catalyst deactivation, deactivation mechanisms, diffusion and reaction in porous catalysts, Thiele Modulus, internal effectiveness factor, overall effectiveness factor, estimation of diffusion and reaction limited regimes – Weisz – Prater criterion for internal diffusion, Mears criterion for external diffusion. **Fluid-Fluid reactions:** Rate equations, kinetic regimes for mass transfer and reactions, rate equation for instantaneous and fast and slow reactions, two film theory, film conversion parameters, pressure drop in reactors, accounting the pressure drop in the rate law, flow through a packed bed, pressure drop in

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	pipes, simultaneous reactions and separations. **Process Instrumentation** : Introduction – definition of instrumentation – concept of an instrument – functional elements and functions of an instrument – classification of instruments, performance characteristics of an instrument like static and dynamic type, temperature measurement – electrical, non-electrical, contact and non-contact methods. Pressure measurement – manometers of U-tube type, well type and inclined type, Prandtl and air type micro-manometers, Barometer method for atmospheric pressure measurement, low pressure measurement by Pirani gauge, McLeod gauge, thermal conductivity gauge, Transducers of electrical mechanical type, density measurement using constant volume hydrometer and, air pressure balance method, gas density detector and gas specific gravity measuring system. Flow measurements – Liquid and gas flow measurements, ways of measuring liquids and gas flow, direct volume measurements, open channel flow measurements, turbine type flow meters strain gauge flow meters mass flow meter, measuring flow of dry materials, Thermal analysis – differential thermal analysis, thermo gravimetric, conductimetric analysis Chromatography and application, PH control temp control, heat exchangers, distillation column, reaction system etc. Moisture content and humidity definition, moisture content determination by thermal drying, Instruments for measuring humidity like hygrometer, psychrometer, dew point apparatus, pH measurement using calomel electrode, composition analysis using spectroscopic methods like absorption, emission and mass spectrometers, analysis of solids by X-ray diffraction, Gas analysis by thermal conductivity, polarography & chromatography.

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.

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