

Tamil Nadu Public Service Commission
Syllabus
Chemical and Mechanical Engineering (Degree Standard)

Code: 528

Unit I: Chemical Technology, Chemical Process Calculations, Mechanical Operations (20 Questions)

Fertilizers, Cement, Glass, Ceramic and Refractories, Fermentation Products, Oils, Soaps and Detergents, Pulp and paper, Dyes, sugar, leather and rubber, polymer, pharmaceutical and food industries, Marine chemicals.

Properties of gases, liquids and solids, Humidity and saturation, Gas laws, steady and unsteady state material balance - involving recycle, by-pass and purge systems, Material with reactions, use of tie components, Gibbs Phase rule and degree of freedom analysis.

Laws of size Reduction, Mixing and agitation, Filtration, Sedimentation and Conveying of solids. Materials of construction for chemical Industries - Metallic, Non-metallic, Polymeric and composite materials, Nano and biomaterials. Corrosion - prevention and control.

Unit II: Thermodynamics, Fluid Mechanics and Heat transfer (20 Questions)

Thermodynamics functions - Chemical and Phase Equilibrium - Ideal and non-ideal gases and solutions – Equation of state and residual properties, compression of fluids, Second law of Thermodynamics and entropy, Chemical potential, properties of mixtures- fugacity, partial molar properties, excess properties and activity coefficient. Predicting Vapour Liquid Equilibrium (VLE) of systems, Free Energy Change and Chemical Reaction Equilibrium.

Fluid Statics, Newtonian and Non-Newtonian fluids, Types of Manometers, Equation of continuity, Equation of motion, Bernoulli equation, Friction Factor, Dimensional analysis and similitude, Flow through pipes, velocity profiles, flow through fixed and fluidized beds, flow meters.

Thermal boundary layer and heat transfer coefficient. Design of heat exchangers- Double pipe, Shell and tube, single and multiple effect evaporators.

Unit III: Mass Transfer, Separation Processes and Process Control (20 Questions)

Fick's Laws, Diffusion, Mass Transfer Coefficient and theories of Mass Transfer, Momentum, Heat and Mass transfer analogies, Inter phase Mass transfer operations, Transfer Unit concepts, Design of equipment - Distillation, Extraction, Absorption, Drying. Crystallization and Membrane separation processes, Ion Exchange chromatography and electrodialysis, Separations involving pervaporation and permeation techniques for solids, liquids and gases, supercritical fluid extraction.

Sensitivity analysis, Constrained and unconstrained NLP, Newton's method, Quasi-Newton's method, Cost estimation, Plant utilities, pinch technology, Laplace transformation, application to solve Ordinary Differential Equation (ODEs). Open-loop systems, first order systems, first order systems in series, second order systems and their dynamics; transportation lag. Closed loop control systems, feed-back control systems, BODE diagram, stability criterion, frequency response.

Unit IV: Chemical reaction Engineering and Computational methods (20 Questions)

Reaction rates - homogeneous and heterogeneous reactions, single and multiple reactions in ideal reactors. Residence time distribution. Design of reactors - Isothermal and non-isothermal

fixed bed reactors and fluidized bed reactors. Kinetics of heterogeneous catalytic reactions. Diffusion effects in catalysis- rate and performance equations, Catalyst deactivation.

Numerical solutions of linear and non-linear algebraic equations, solution of initial and boundary values, Integration of Simpson rule. Solution of partial differential equations. Eigen value problems - Theorem for Eigen values and Eigen functions.

Unit V: Environmental Engineering, Occupational Safety and Health in Chemical Industry (20 Questions)

Air, Water, Soil pollution and Noise control. Wastewater treatment by various methods: Chemical, biochemical and advanced oxidation process. Industrial hygiene, occupational safety & health in chemical industries, Industrial safety principles, plant layout, chemical hazards identification and classification, Safety in operations and processes, fire safety, hazard identification techniques, disposal of hazardous and toxic wastes, onsite and offsite emergency preparedness plan, safety audit, work permit system, roles and responsibilities of safety officers and welfare officers, occupational diseases.

Kohlberg's theory – Gilligan's theory - Safety and Risk – Assessment, Risk Benefit Analysis and Reducing Risk, Respect for Authority, Collective Bargaining, Confidentiality, Conflicts of Interest, Occupational Crime, Professional Rights, Employee Rights. Intellectual Property Rights (IPR), Employee Discrimination. Multinational Corporations, Environmental Ethics & legislation – Engineers as Managers, Expert Witnesses and Advisors. Moral Leadership, Code of Conduct, Corporate Social Responsibility

Unit VI: Engineering Mechanics (20 Questions)

Statics of Particles, Equilibrium of Rigid bodies, Mechanism of Deformable Bodies, Properties of Surfaces and Solids, Centroid, Centre of Gravity, Dynamics of Particles, Elements of Rigid Body Dynamics, Basics of Mechanisms, Kinematics of mechanisms, Friction in Machine Elements, Force Analysis, Balancing, Single Degree Free Vibration, Forced Vibration, mechanisms for Vibration Control, Effect of Damping, Vibration Isolation.

Stress, Strain and Deformation of Solids, Combined Stresses, Theories of Failures, Transverse Loading on Beams, Stresses in Beams, Torsion, Deflection of Beams, Fundamentals of Design for Strength and Stiffness of Machine Members, Design of Shafts and Couplings, Design for Static and Dynamic Loading, Design of Fasteners and Welded Joints, Reverted Joints.

Unit VII: Fluid Mechanics and Machinery (20 Questions)

Fluid properties, manometry, buoyancy of mass, momentum and energy, fluid acceleration, differential equations of continuity and momentum, viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, head losses in pipes, bends. Turbo machinery: Pelton wheel, Francis and Kaplan turbines - impulse and reaction principles – pumps and its applications-Valves and Types - Online Continuous Flow Monitoring System.

Unit VIII: Thermal Engineering (20 Questions)

Basic concepts, Zeroth, Thermodynamic system and processes, Carnot cycle. Behaviour of ideal and real gases, thermodynamic relations, properties of pure substances, calculation of work and heat in ideal processes, analysis of thermodynamic cycles related to energy conversion, Fuel and combustion, Fuels Characteristics, Emissions and Controls, Renewable sources of Energy.

Modes of heat transfer - one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins dimensionless parameters - Free and forced convective heat transfer, effect of turbulence, radiative heat transfer, black and grey surfaces, heat exchanger performance, LMTD and NTU methods. Basic Concepts of Mass transfer, Diffusion Mass Transfer, Steady state Molecular diffusion, Convective Mass Transfer, Radiative Heat Transfer.

Unit IX: Materials and Manufacturing Technology (20 Questions)

Constitution of alloys and phase diagrams, Iron – Iron Carbide Phase Diagram - steels, cast iron, phase transformations- diffusion-TTT diagram, ferrous and nonferrous alloys, heat treatment of ferrous and non-ferrous metal, surface modification techniques, powder metallurgy, non-metallic materials, mechanical properties and testing, nano-materials.

Foundry Technology- types of pattern, cores, moulding and casting methods, Solidification, design of castings, defects, Melting Furnaces, Metal Forming Processes - Metal joining processes, Thermo Setting and Thermo Plastic Products, Metal cutting, Cutting Tool Nomenclature, Machine Tool Types and its machining operations - Unconventional machining processes, CNC machine tools.

Limits, Fits and Tolerance, Linear and angular measurements, Interferometry, laser interferometers - Computer Aided Inspection, CMM – Types of CMM, Machine vision, Form measurement – Straightness - Flatness, Roundness, Surface finish measurement, Measurement of power, flow and temperature. Statistical quality control, control charts, acceptance sampling, reliability, TQM, 5S, ISO standards.

Unit X: CAE and Industrial Engineering (20 Questions)

Fundamentals of CIM, Production Planning and Control, Computer Aided Process Planning, Cellular Manufacturing, Flexible Manufacturing System and Automated Guided Vehicle System, Group Technology, Production Flow Analysis, Industrial Robotics, Additive Manufacturing, Just in Time (JIT), lean manufacturing, One Dimensional Problems in FEA, Two Dimensional Scalar Variable Problems, Two dimensional vector variable problems, Isometric Parametric Formulation.

Work study - Techniques, Method study and work measurements - machine loading and scheduling, inventory control - E O Q - ABC Analysis material handling systems, operations research, Linear Programming, simplex method, Transportation model, Assignment model CPM and PERT, Management theory and practice, planning - Decision making, Organising, staffing, Motivation, Leadership, controlling, control techniques, Industrial Safety - Standards – OSHA.

Dated: 25.03.2025