Tamil Nadu Public Service Commission

Syllabus
Industrial Safety and Health
(Degree Standard)

Code: 515

Unit I: Chemical Technology, Chemical Process Calculations, Thermodynamics, Fluid Mechanics and Mechanical Operations (20 questions)

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

Properties of gases, liquids and solids, Humidity and saturation, Gas laws, Material balance involving recycle, by-pass and purge systems with and without chemical reactions and Energy balances. Material and Energy balance with reactions, Gibbs Phase rule.

Thermodynamics and its applications, thermodynamic functions, compressibility factors, entropy, Chemical Reaction Equilibrium.

Fluid Statics, Newtonian and Non-Newtonian fluids, Equation of continuity, Navier Stroke equation, Friction Factor, Dimensional analysis, Flow though pipes, flow through fixed and fluidized beds, flow meters.

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

Unit II: Heat Transfer, Mass Transfer, Chemical Reaction Engineering and Process Design, Instrumentation and Control (20 questions)

Modes of Heat transfer, Heat transfer with phase change, heat transfer coefficient. Design of heat exchangers - Double pipe, Shell and Tube. Evaporators - Single and Multiple effect.

Fick's Laws, Diffusion, Mass Transfer Coefficient and theories of Mass Transfer, Momentum, Heat and Mass transfer analogies, Inter phase Mass transfer operations, HTU, NTU and HETP concepts, Design of equipment - Distillation, Extraction, Absorption, Drying. Crystallization and Membrane separation processes.

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.

Sensitivity analysis, Constrained and unconstrained NLP, Newton's method, Quasi-Newton's method, Cost estimation, Plant utilities, pinch technology, Laplace transformation, application to solve 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 III: Environmental Engineering, Occupational Safety and Health in Chemical Industry, Mechanics of Machinery and Management in Textile 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).

Drive transmission, clutches and brakes in textile machinery, design of machine elements – cams, cone drums, drafting rollers; calculations – sley eccentricity, beat-up force; application of industrial engineering in garment industry; costing of yarn, fabric and garment; maintenance of light, temperature and humidity, and ergonomic aspects in textile industry, interpretation of financial statements; investment appraisal techniques; application of TQM tools.

Unit IV: Textile Manufacturing (20 questions)

Classification and identification of fibres; structure and properties of fibres; Production of synthetic fibres – raw materials, wet, dry, melt, dry- jet spinning.

Objectives, principle of working and calculations – ginning, blow room, carding, draw frame, comber preparatory, comber, roving frame, ring frame, ring doubling, TFO, rotor, air-jet, air-vortex, friction, core and wrap spinning machines; helical geometry and packing density of yarn, yarn contraction, yarn twist vs. strength, structure-property relations of yarns.

Objectives, principle of working and calculations – winding, warping, sizing; principle of fabric formation in shuttle looms, rapier, air-jet, and projectile looms; Basic woven fabric structures and its derivatives; Pierce geometry of plain woven fabrics, structure-property relationship of fabrics.

Objectives, principle of working and calculations – circular, flat and warp knitting; basic weft and warp knitted structures; production of nonwovens – needle punch, spun lace, spun bond and melt blown. Safety measures in fibre, yarn and fabric manufacturing industry.

Unit V: Chemical Processing of Textiles and Quality Assurance (20 questions)

Objectives and principles of desizing, singeing, scouring, bleaching and mercerizing machines; dyeing of different types of fibres, yarns and fabrics and the machines used; types and methods of printing; colour and fastness measurement.

Principles and methods for shrink-proof, raising and calendaring, crease resistance, water-proof, water-repellent, flame retardant, soil release, UV resistance, anti-microbial, anti-static, softening, stiffening, elastomeric, self-cleaning finishes; eco-friendly processing, eco standards and eco labels, characteristics of effluent and effluent treatment.

Measurement of length, strength, fineness, maturity and trash of the cotton fibres; measurement of count, twist, strength and elongation, unevenness, imperfections and hairiness of the yarn; determination of construction parameters, tensile, tear, and bursting strength, air permeability, bending, drape, crease and wrinkle recovery, thickness, pilling and abrasion resistance and shrinkage of the fabrics; yarn defects analysis – diagram, spectrogram, Variance-length curve; fabric defects analysis.

Garment manufacturing – pattern making, marker planning, spreading, cutting, sewing and finishing; types of stitches and seams; garment inspection; fibre, yarn and fabric requirement for industrial, automotive, geo, agro, medical, protective and sports textiles.

Safety measures in chemical processing industry.

Unit VI: Electrical Engineering (20 questions)

Circuit elements – Kirchoff's Laws – Mesh and Nodal Analysis – Network Theorems and Applications for DC and AC circuits: Thevenin's Theorem, Norton's Theorem, Superposition Theorem, Maximum Power Transfer Theorm. Three phase Circuits, Star – delta transformation.

Coulomb's Law, Gauss's Law, Magnetic Circuits – Magnetomotive force- Reluctance – Faraday's laws – Lenz's law – Biot – Savart's law – Ampere's law – Fleming's left and Right Hand Rule - Lorentz force – Inductance – Self and Mutual Inductance – Dot Convention – Coupled Circuits.

D.C, Machines, Generators and Motors – Starting, Speed Control and braking – Testing Losses and Efficiency. Transformers – Types – Construction and Operation – Testing. Induction Machines Starting, Speed Control and braking Synchronous Machines, permanent magnet brushless DC motor, stepper motors

Circuit Breakers- protection; transformer, generator, motor, bus bars and transmission line – AC and DC Distribution – deregulation- energy conservation and energy auditing.

Unit VII: Measurements, Control Systems and Power Electronics (20 questions)

Measurement of Current, Voltage, Power, Power factor; Energy – Indicating instruments – Multi meters, Transducers and their applications to the Measurement of Non-Electrical Quantities like Temperature, Pressure, Flow-rate, Displacement, Acceleration, Noise level- Data Acquisition Systems – A/D and D/A converters – Data Transmission Systems – PLC – smart meters.

Control systems; Mathematical Modelling of Physical Systems, Transfer function, block diagram, signal flow graph and the reduction, PI, PD and PID Controllers –state. Semiconductor Devices

Power Semiconductor devises – single and Three Phase AC to DC Converters, Speed Control of DC Drives speed control of AC drives, induction motor drives.

Unit VIII: Electrical Power Generation and Thermal Engineering (20 questions)

Power Generation Types – Hydro, Thermal and Nuclear Stations, Co- generation, Renewable Energy, Solar energy, Wind Energy, smart grid – electric vehicles – V2G and G2V – Fuel cells – Batteries – types and characteristics – Super Capacitors.

Thermal engineering - basic concepts, Zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, Emissions and Controls. I.C. Engines Refrigeration and air-conditioning: Vapour refrigeration cycle, heat pumps, gas refrigeration. Heat exchanger performance.

Unit IX: Mechanical Engineering (20 questions)

Properties of Surfaces and Solids, Centre of Gravity, Gears and Gear Trains, Fly Wheels and Governors, Balancing of Rotating and Reciprocating Masses, Friction in Machine Elements, Force Analysis, mechanisms for Vibration Control. Stress, Strain and Deformation of Solids, Fundamentals of Design for Strength and Stiffness of Machine Members, Spur Gears and Parallel Axis Helical Gears, Bevel Gears, Worm Gears and Crossed Helical Gears. Fluid properties, Bernoulli's equation, Pelton wheel, Francis and Kaplan turbines - pumps and its applications - Valves and Types

Production Flow Analysis, Industrial Robotics, lean manufacturing. Work study - Techniques, Method study - ABC Analysis material handling systems, Management theory and practice, planning - Decision making, Organising, staffing, Motivation, Leadership, controlling, control techniques, Industrial Safety - Standards – OSHA.

Unit X: Production Engineering (20 questions)

Constitution of alloys and phase diagrams, heat treatment of ferrous and non-ferrous metal, surface modification techniques, powder metallurgy, non-metallic materials, mechanical properties and testing, crystal defects and strengthening mechanisms, Engineering ceramics, Engineering and commodity polymers, composites, nano-materials. Foundry Technology- Sheet Metal Operation welding defects, Casting, Welding Inspection (NDT), Machinability machine tools - CNC machine tools. Limits, Fits and Tolerance, Computer Aided Inspection, Machine vision, Measurement of power, flow and temperature. Statistical quality control, control charts, acceptance sampling, reliability, TQM, 5S, ISO standards. Fundamentals of Computer Graphics, Geometric Modeling, Production Planning and Control, Computer Aided Process Planning, Cellular Manufacturing, Flexible Manufacturing System and Automated Guided Vehicle System.

Note: The medium of instruction is English only

Dated: 20.02.2025