Harcourt Butler Technical University, Kanpur

Syllabus of Written Test to the post of Assistant Professor in "Paint Technology"

Section 1: Engineering Mathematics

Linear Algebra: Matrix algebra, systems of linear equations, eigen values and eigen vectors.
Differential Equations: First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.
Numerical Methods: Numerical solutions of linear and non-linear algebraic equations; integration by trapezoidal and Simpson's rules; single and multi-step methods for differential equations.

Section 2: Process Calculations and Thermodynamics

Steady and unsteady state mass and energy balances including multiphase, multi-component, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis.
First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Section 3: Fluid Mechanics and Mechanical Operations

Fluid statics, surface tension, Newtonian and non-Newtonian fluids, transport properties, shell balances including differential form of Bernoulli equation and energy balance, equation of continuity, equation of motion, equation of mechanical energy, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, velocity profiles, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop.
Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

Section 4: Heat Transfer

Equation of energy, steady and unsteady heat conduction, convection and radiation, thermal boundary layer and heat transfer coefficients, boiling, condensation and evaporation; types of heat exchangers and evaporators and their process calculations; design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

Section 5: Mass Transfer

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts; design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption, membrane separations (micro-filtration, ultra-filtration, nanofiltration and reverse osmosis).

Section 6: Surface Coatings and their Raw Materials

Classification of surface coatings, sources and composition of glyceride oils; molecular structure of tri-glyceride oils; constitution and molecular structure of fatty acids; evaluation & characterization of oils – physical and chemical; fatty acid composition and characteristics of

individual oils; drying, semi drying and non-drying oils; properties and uses of glyceride oils. Deficiencies in oil films; chemical modifications of oils.

Constitution of coating Driers; active & auxiliary, primary and secondary; surface & through driers; properties and uses of individual driers; mechanism of drier action; manufacture of driers; evaluation of driers; combination of driers; drier dosage.

General classes of solvents, properties of solvents e.g. solvent (cutting) power, rate of evaporation, boiling point, distillation range, flash point, toxicity, aromatic content etc.

Section 7: Resins and Polymers

Resinous State, Classification of Resins, Classification of Natural Resins, Sources, availability, processing and properties, and modifications of Natural Resins: Rosin, Shellac. Natural polymers and their modifications: cellulosic polymers, rubber resins.
Introduction to Synthetic Polymers: Functionality of molecules and its determination; Degree of polymerization and molecular weight; Non-convertible and Convertible film-formers, Thermoplastic and Thermosetting Resins. Raw materials, Manufacture, Properties, Applications in Surface Coatings of various Synthetic Resins: Alkyds, Polyesters, Epoxies, Polyurethanes, Vinyl and Acrylic resins, Silicone resins.

Definition and classification of pigments. General methods of manufacturing, properties and applications of natural and synthetic inorganic pigments and extenders; applications, merits and demerits of Nano pigments and extenders. Functional and effect pigments. Properties of pigments. Color Phenomena, Industrial Organic Pigments, High Performance and Miscellaneous Pigments

Coating Additives: Definition, nomenclature, role, scope of incorporation, dosage, side/adverse effects of use of additives

Section 8: Formulation and Manufacture of Coatings

Prerequisites, Mathematics & Steps; PVC, CPVC, LCPVC, RCPVC, % Volume solids, Relationship between PVC and film properties, Theoretical Covering Capacity, P/B ratio.
Steps in Paint manufacturing, Phenomenon of Mixing, Soaking, wetting, grinding, dispersion and Stabilization. Thinning, Dilution shock and Filtration, Dispersion processes. Equipment used in paint manufacture and their functioning.

Section 9: Testing of raw materials and paints

Testing of Pigments, Extenders, Oils, Resins, and Solvents. Testing of Liquid Paints. Evaluation of Paint films for physical, mechanical and optical properties. Chemical resistance, Corrosion resistance, Weather resistance and aging properties of paints.

Section 10: Surface Preparation and Coating Applications

Different Steps involved in Mechanical and Chemical pretreatment of surfaces. Different application techniques: Conventional Air-spray, Airless and Electrostatic Spray, Electro deposition. Common paint defects their prevention & cure. Recent trends in surface coatings and application techniques. Safety & health hazards in Paint industry.