



CHEMICAL ENGINEERING

SYLLABUS OF EXAMINATIONS

2004 Edition

For textbook information please refer to the **Textbooks** section on page 3 of the document entitled **Information for Students and Examinations Candidates**.

GROUP A

COMPULSORY EXAMINATIONS (six required)

04-Chem-A1 Process Balances and Chemical Thermodynamics

The analysis of industrial and chemical processes; mass conservation and energy conservation; thermochemistry; properties of pure substances; properties of solutions; energy and the first law of thermodynamics; the second law of thermodynamics and entropy; applications of the laws of thermodynamics to problems in the behaviour of fluids, flow processes, power cycles, refrigeration and heat pumps, phase equilibria and chemical reaction equilibria.

04-Chem-A2 Mechanical and Thermal Operations

Fluid statics. Incompressible and compressible flow of fluids in piping. Sizing of pumps, metering. Flow through packed beds, fluidization, settling. Mixing and blending. Solids handling, screening, and filtration. Thermal operations such as evaporation and crystallization. Theory and practice of conductive, convective, and radiative heat transfer; design of heat exchangers; temperature measurement.

04-Chem-A3 Mass Transfer Operations

Application of equilibrium theory and rate considerations to theory and practice of absorption, adsorption, distillation, drying, liquid-liquid extraction, solid liquid extraction, membrane separation. Mass transfer at the molecular level.

04-Chem-A4 Chemical Reactor Engineering

Application of the principles of chemical kinetics and other rate phenomena to the design of chemical reactors. Dynamics in chemical systems, including chemical kinetics, catalysis and transport processes. Theory of idealized isothermal reactors including batch, plug flow, and continuous stirred tank reactors for single and multiple reactions. Residence time distributions and their effect on conversion. Simple adiabatic and non-isothermal reactors with homogeneous and heterogeneous reactions; thermal run-away reactions.

04-Chem-A5 Chemical Plant Design and Economics

Structure of chemical process systems and systematic methods for capital and operating cost calculations. Economic factors in design, economic balances, capital and operating cost estimation techniques, assessment of alternative investments and replacements, and application of compound interest calculations. Simple optimization theory. Evaluation of process alternatives. Equipment and materials selection. Factors such as energy, safety, hygiene, and

environmental protection. Familiarity with computer process simulation. Intrinsically safe design. Risk analysis.

04-Chem-A6 Process Dynamics and Control

Concept of transfer functions. Response of simple chemical processes to step, ramp, and sinusoidal inputs. Transient response of interacting elements in series. Frequency response analysis of simple systems. On-off control, cascade control, ratio control, proportional, integral, derivative, and combinations of these control actions, single-input/single-output control and multiple-input/multiple-output control. Closed-loop response. Feedback and feedforward control. Controller tuning and algorithms. Simple stability analysis. Dynamics and control of common chemical process units such as heat exchangers, simple reactors, and agitated vessels. Hardware implementation, analog and digital, of simple control algorithms and designs.

GROUP B

ELECTIVE EXAMINATIONS (three required)

04-Chem-B1 Transport Phenomena

The application of integral and differential techniques for solving problems involving mass, energy and/or momentum transport through solids and within fluids. Steady and unsteady state processes. Molecular transport. Convective transfer of heat and mass involving laminar and turbulent fluid flows.

04-Chem-B2 Environmental Engineering

Engineering aspects of air and water pollution abatement and effluent treatment. Characterization of water contaminants and their measurement, biological oxygen demand, sedimentation, flotation, aeration, and activated sludge processes, pH control, ion exchange, oxidation-reduction, electro dialysis, reverse osmosis. Sources and dispersion of atmospheric pollutants. Control methods for particulates, gases, and vapours. Photochemical reactions, noxious pollutants, and odour control. Contaminated soil remediation. Measurement techniques.

04-Chem-B3 Simulation, Modelling, and Optimization

The analysis and modelling of chemical processes using either a mechanistic or an empirical input/output approach. Subsystem modelling to reduce complex processes to simpler component parts. Linearization of non-linear processes. Optimization methods; direct search, climbing and elimination techniques, linear and non-linear programming.

04-Chem-B4 Biochemical Engineering

Basic microbiology and chemistry of cells, biochemical kinetics, enzymes, metabolic pathways, energetics, transport phenomena and reactor design as applied to biochemical reactors, scale-up, fermentation technology.

04-Chem-B5 Pulp and Paper Technology

Papermaking raw materials: wood anatomy and chemistry. Pulping processes: mechanical pulping, chemo-thermo-mechanical processes, chemical pulping (sulphite, Kraft). Pulp treatment: refining and bleaching. Papermaking equipment and processes. Environmental protection. Structure and properties of paper and paperboard.

04-Chem-B6 Petroleum Refining and Petrochemicals

The composition and classification of petroleum. Crude oil evaluation in relation to product quality. Refinery products: properties, specifications, and testing. The petroleum refinery: crude oil distillation, catalytic cracking, alkylation, hydrogen production, catalytic reforming, hydrotreating, amine processes, sulphur production, isomerization, polymerization, oxygen compounds. Lubricating oil and asphalt manufacturing. Synthesis of primary products; ethylene, methanol, glycols, aromatics.

04-Chem-B7 Extractive Metallurgy

Thermodynamics and reaction kinetics of extractive metallurgical processes. Electrolytic reduction of molten salts. Metal refining processes. Heat transfer, mass transfer, and materials preparation in the metallurgical industry. Comparison of processes. Equipment selection and operation.

04-Chem-B8 Polymer Engineering

Basic polymer structures and characterization of polymer physical, chemical, and mechanical properties. Polymerization reactions and kinetics; chain formation and co-polymerization. Polymerization processes: bulk, suspension, solution, and emulsion polymerizations. Polymer flow behaviour describing non-Newtonian and visco-elastic effects. Polymer processing including extrusion, moulding and film production. Polymer systems: additives, blends, composites, and fibre reinforcement.

04-Chem-B9 Advanced Materials

Properties, production of and uses of composites, engineered plastics, biopolymers, special coatings, and nanostructured materials with emphasis on structure property relationships.

04-Chem-B10 Life Cycle Assessment (LCA)

Concepts of LCA. Applications to energy utilization, environment, sustainable development and process analysis and optimisation.

04-Chem-B11 Fundamental Reservoir Engineering – (98-Pet-A3)

Physical properties and flow of fluids through porous media. Porosity, fluid saturations, permeability, interfacial tension, wettability, capillary pressure, effective and relative permeability, steady and unsteady state fluid flow. An introduction to oil and gas material balance equations, drive indices. An introduction to performance prediction techniques.

04-Chem-B12 Petroleum Production Operations – (98-Pet-A5)

Overall view of important steps involved in Petroleum Production Engineering. Inflow performance relationships. Two-phase vertical flow. Decline curve analysis. Other steps include importance of reservoir description, role of effective communication between the reservoir and the well bore, oil and gas separation, well bore damage, fluid movements and vigor of excluding undesirable fluids, workover and stimulation methods, oil well cementing and through tubing logging. Surface facility: storage, separators, emulsions, flow measurement and gas hydrates.

Revised: April 2005