REDLINES INDICATE CHANGES FROM PREVIOUS SYLLABUS

Chemical engineering examinations

2023 SYLLABUS

Group A - Compulsory examinations (six required)

23-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.

Textbooks (most recent edition is recommended):

- J.M. Smith, H.C. Van Ness, M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, latest edition. McGraw-Hill.
- R.W. Felder, R.W. Rousseau, Elementary Principles of Chemical Processes, latest edition. John Wiley.

23-Chem-A2 Unit Operations and Separation Processes

Incompressible and compressible fluid flow. Flow through packed beds, fluidization. Particle size distribution. Mechanical operations such as mixing and blending, filtration and sedimentation. Thermal operations such as evaporation and crystallization. Application of equilibrium theory and rate considerations for absorption, adsorption, distillation, drying, extraction, membrane separation, leaching.

Textbooks (most recent edition is recommended):

- C.J. Geankoplis, Transport Processes and Unit Operations, latest edition. Prentice Hall.
- W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, latest edition. McGraw-Hill.
- F.P. Incropera, D.P. DeWitt, Fundamentals of Heat and Mass Transfer, latest edition. John Wiley.

23-Chem-A3 Heat and Mass Transfer

Theory and practice of conductive, convective, and radiative heat transfer; design of heat exchangers; heat transfer involving phase change. Diffusion and permeability; mass transfer through stagnant and moving films; the concept of equilibrium stages; estimation and use of overall heat and mass transfer coefficients in the design of process equipment.

Textbooks (most recent edition is recommended):

- R.E. Treybal, Mass Transfer Operations, latest edition. McGraw-Hill.
- P.H. Wankat, Equilibrium Staged Separations. Elsevier.
- J.D. Seader, E.J. Henley, Separation Process Principles. John Wiley.
- W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, latest edition. McGraw-Hill.

23-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.

Textbooks (most recent edition is recommended):

- H.S. Fogler, Elements of Chemical Reaction Engineering, latest edition. Prentice Hall.

23-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. The use of heuristics in

design of chemical processes.
Textbooks (most recent edition is recommended):

- M.S. Peters, K.D. Timmerhaus, R.E. West, Plant Design and Economics for Chemical Engineers, latest edition. McGraw-Hill.
- W.D. Seider, J.D. Seader, D.R. Lewin, Process Design Principles: Synthesis, Analysis and Evaluation. John Wiley.
- R. Turton, R.C. Bailie, W.B. Whiting, J.A. Shaeiweitz, Analysis, Synthesis, and Design of Chemical Processes, latest edition, Prentice Hall.

23-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.

Textbooks (most recent edition is recommended):

- D.E. Seborg, T.F. Edgar, D.A. Mellichamp, Process Dynamics and Control. John Wiley, latest edition.
- T. Marlin, Process Control, Designing Processes and Control Systems for Dynamic Performance, latest edition. McGraw-Hill.
- B.W. Bequette, Process Control: Modeling, Design and Simulation. Prentice Hall.
- C.A. Smith, A.B. Corripio, Principles and Practice of Antomatic Process Control, latest edition John Wiley.

Group B - Optional examinations (three required)

23-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.

Textbooks (most recent edition is recommended):

- R.S. Brodkey, H.C. Hershey, Transport Phenomena: A Unified Approach. McGraw-Hill.
- R.B. Bird, W.E. Stewart, E.N. Lightfoot, Transport Phenomena. latest edition, John Wiley.

23-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, electrodialysis, 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.

Textbooks (most recent edition is recommended):

- G. Kiely, Environmental Engineering. McGraw-Hill Ryerson.

23-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.

Textbooks (most recent edition is recommended):

- S.M. Walas, Modelling with Differential Equations in Chemical Engineering. Butterworth-Heinemann.
- D. Basmadjian, The Art of Modeling in Science and Engineering. Chapman & Hall.
- B.W. Beqette, Process Dynamics: Modeling, Analysis and Simulation. Prentice Hall (first 12 chapters and all modules).

- P. Venkataraman, Applied Optimization with Matlab Programming. John Wiley.
- T.F. Edgar, D.M. Himmelblau, L.S. Lasdon, Optimization of Chemical Processes. Latest edition. McGraw-Hill.

23-Chem-B4 Biochemical Engineering

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

MINOR EDIT

Textbooks (most recent edition is recommended):

- J.E. Bailey, D.F. Ollis, Biochemical Engineering Fundamentals, latest edition. McGraw-Hill.

23-Chem-B5 Pulp and Paper Technology

Papermaking raw materials: wood anatomy and chemistry. Pulping processes: mechanical pulping, chemi-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.

Textbooks (most recent edition is recommended):

- J.P. Casey, Pulp and Paper: Chemistry and Chemical Technology, latest edition, Volumes 1 and 2. Wiley Interscience.
- G.A. Smook, Handbook for Pulp and Paper Technologists, latest edition, Angus Wilde Publ, Inc.

23-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.

Textbooks (most recent edition is recommended):

- J.H. Gary, G.E. Handwerk, Petroleum Refining, Technology and Economics, latest edition. Marcel Dekker.
- J.G. Speight, The Chemistry and Technology of Petroleum, latest edition. Marcel Dekker.

23-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.

Textbooks (most recent edition is recommended):

- T. Rosenqvist, Principles of Extractive Metallurgy, latest edition. McGraw-Hill.
- C. Bosworth, The Extraction and Refining of Metals. CRC Press.

23-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.

Textbooks (most recent edition is recommended):

- A. Rudin, The Elements of Polymer Science and Engineering, latest edition. Academic Press.
- J. Fried, Introduction to Polymer Science and Technology. Prentice Hall.

23-Chem-B9 Advanced Materials

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

Textbooks (most recent edition is recommended):

- No Referenced Textbooks

23-Chem-B10 Life Cycle Assessment (LCA)

Concepts of life cycle assessment. Applications to energy utilization, environment, sustainable development and process analysis and optimisation.

Textbooks (most recent edition is recommended):

- No Referenced Textbooks

23-Chem-B11 Nuclear and Nuclear Chemical Processes

The properties of actinides; radioactivity; processes of mining, refining and enrichment of uranium; reactor materials and design; reprocessing chemistry; waste management.

Textbooks (most recent edition is recommended):

- No Referenced Textbooks

TOTAL EXAMINATION PROGRAM

PEO Syllabus of Examinations, 2016 Edition

CHEMICAL ENGINEERING

PROFESSIONAL EXAMS – SPECIFIC TO CHEMICAL ENGINEERING

GROUP A

16-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.

16-Chem-A2 Unit Operations and Separation Processes *(formerly Mechanical and Thermal operations)*

REWRITTEN

Incompressible and compressible fluid flow. Flow through packed beds, fluidization. Particle size distribution. Mechanical operations such as mixing and blending, filtration and sedimentation. Thermal operations such as evaporation and crystallization. Application of equilibrium theory and rate considerations for absorption, adsorption, distillation, drying, extraction, membrane separation, leaching.

16-Chem-A3 Heat and Mass Transfer

REWRITTEN

Theory and practice of conductive, convective, and radiative heat transfer; design of heat exchangers; heat transfer involving phase change. Diffusion and permeability; mass transfer through stagnant and moving films; the concept of equilibrium stages; estimation and use of overall heat and mass transfer coefficients in the design of process equipment.

16-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.

16-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. The use of heuristics in design of chemical processes.

16-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

16-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.

16-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, electrodialysis, 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.

16-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.

16-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.

16-Chem-B5 Pulp and Paper Technology

Papermaking raw materials: wood anatomy and chemistry. Pulping processes: mechanical pulping, chemi-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.

16-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.

16-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.

16-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.

16-Chem-B9 Advanced Materials

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

16-Chem-B10 Life Cycle Assessment (LCA)

Concepts of life cycle assessment. Applications to energy utilization, environment, sustainable development and process analysis and optimisation.

16-Chem-B11 Nuclear and Nuclear Chemical Processes NEW

The properties of actinides; radioactivity; processes of mining, refining and enrichment of uranium; reactor materials and design; reprocessing chemistry; waste management.

16-Chem-B12 Corrosion and Oxidation PEO ONLY (12-MTL-B11/10-MET-A7)

Basic corrosion theory. Electrochemical corrosion theory. Metallurgical cells. Environmental cells. Stress assisted corrosion. Materials selection. Protective coatings. Corrosion inhibitors. Cathodic and anodic protection. Oxidation.

16-Chem-B13 Ceramic Materials PEO ONLY (21-MAT-B6/10-MET-B8)

Bonding in ceramics. Ceramic structures. Effect of chemical forces and structure on physical properties. Defects in ceramics. Diffusion and electrical conductivity. Phase equilibria. Sintering and grain growth. Mechanical properties: fast fracture, creep, slow crack growth and fatigue. Thermal stresses and thermal properties. Dielectric properties.

16-Chem-B14 Nanomaterials PEO ONLY (12-MTL-B14)

Physical chemistry of solid surfaces, zero, one and two dimensional nanostructures, special nanomaterials, nanostructures fabricated by different physical techniques. Characterization and properties of nanomaterials in electronics, biology, catalysis, quantum devices, energy and environment.

2016 PEO CHEMICAL ENGINEERING EXAMINATIONS TEXTBOOKS REFERENCE LIST

NOTE: Please feel free to use the most recent edition of textbooks referenced in this list

16-Chem-A1 Process Balances and Chemical Thermodynamics

J.M. Smith, H.C. Van Ness, M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, latest edition. McGraw-Hill.

R.W. Felder, R.W. Rousseau, Elementary Principles of Chemical Processes, latest edition. John Wiley.

16-Chem-A2 Unit Operations and Separation Processes (formerly Mechanical and Thermal Operations)

C.J. Geankoplis, Transport Processes and Unit Operations, latest edition. Prentice Hall.

W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, latest edition. McGraw-Hill.

F.P. Incropera, D.P. DeWitt, Fundamentals of Heat and Mass Transfer, latest edition. John Wiley.

16-Chem-A3 Heat and Mass Transfer

R.E. Treybal, Mass Transfer Operations, latest edition. McGraw-Hill.

P.H. Wankat, Equilibrium Staged Separations. Elsevier.

J.D. Seader, E.J. Henley, Separation Process Principles. John Wiley.

W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, latest edition. McGraw-Hill.

16-Chem-A4 Chemical Reactor Engineering

H.S. Fogler, Elements of Chemical Reaction Engineering, latest edition. Prentice Hall.

16-Chem-A5 Chemical Plant Design and Economics

M.S. Peters, K.D. Timmerhaus, R.E. West, Plant Design and Economics for Chemical Engineers, latest edition. McGraw-Hill.

W.D. Seider, J.D. Seader, D.R. Lewin, Process Design Principles: Synthesis, Analysis and Evaluation. John Wiley.

R. Turton, R.C. Bailie, W.B. Whiting, J.A. Shaeiweitz, Analysis, Synthesis, and Design of Chemical Processes, latest edition, Prentice Hall.

16-Chem-A6 Process Dynamics and Control

D.E. Seborg, T.F. Edgar, D.A. Mellichamp, Process Dynamics and Control. John Wiley, latest edition.

T. Marlin, Process Control, Designing Processes and Control Systems for Dynamic Performance, latest edition. McGraw-Hill.

B.W. Bequette, Process Control: Modeling, Design and Simulation. Prentice Hall.

C.A. Smith, A.B. Corripio, Principles and Practice of Antomatic Process Control, latest edition John Wiley.

16-Chem-B1 Transport Phenomena

R.S. Brodkey, H.C. Hershey, Transport Phenomena: A Unified Approach. McGraw-Hill.

R.B. Bird, W.E. Stewart, E.N. Lightfoot, Transport Phenomena. latest edition, John Wiley.

16-Chem-B2 Environmental Engineering

G. Kiely, Environmental Engineering. McGraw-Hill Ryerson.

16-Chem-B3 Simulation, Modelling, and Optimization

S.M. Walas, Modelling with Differential Equations in Chemical Engineering. Butterworth-Heinemann.

D. Basmadjian, The Art of Modeling in Science and Engineering. Chapman & Hall.

B.W. Beqette, Process Dynamics: Modeling, Analysis and Simulation. Prentice Hall (first 12 chapters and all modules).

P. Venkataraman, Applied Optimization with Matlab Programming. John Wiley.

T.F. Edgar, D.M. Himmelblau, L.S. Lasdon, Optimization of Chemical Processes. Latest edition. McGraw-Hill.

16-Chem-B4 Biochemical Engineering

J.E. Bailey, D.F. Ollis, Biochemical Engineering Fundamentals, latest edition. McGraw-Hill.

16-Chem-B5 Pulp and Paper Technology

J.P. Casey, Pulp and Paper: Chemistry and Chemical Technology, latest edition, Volumes 1 and 2. Wiley Interscience.

G.A. Smook, Handbook for Pulp and Paper Technologists, latest edition, Angus Wilde Publ, Inc.

16-Chem-B6 Petroleum Refining and Petrochemicals

J.H. Gary, G.E. Handwerk, Petroleum Refining, Technology and Economics, latest edition. Marcel Dekker.

J.G. Speight, The Chemistry and Technology of Petroleum, latest edition. Marcel Dekker.

16-Chem-B7 Extractive Metallurgy

T. Rosenqvist, Principles of Extractive Metallurgy, latest edition. McGraw-Hill.

C. Bodsworth, The Extraction and Refining of Metals. CRC Press.

16-Chem-B8 Polymer Engineering

A. Rudin, The Elements of Polymer Science and Engineering, latest edition. Academic Press.

J. Fried, Introduction to Polymer Science and Technology. Prentice Hall.

16-Chem-B9 Advanced Materials

16-Chem-B10 Life Cycle Assessment (LCA)

Green Engineering, Environmentally Conscious Design of Chemical Processes; EPA (ISBN 0-13-061908-6) Latest Edition.
Supplementary Resources for this text available on the EPA website.

16-Chem-B11 Nuclear and Nuclear Chemical Processing

16-Chem-B12 Ceramics Materials PEO ONLY

Barsoum, M.W., Fundamentals of Ceramics. IOP Publishing, Bristol, 2003. ISBN #0 07503 0902 4. Chapters 1-4, 6-8, and 10-14.
Kingery, W.D., H.K. Bowen, and D.R. Uhlmann, Introduction to Ceramics. (2nd edition) Wiley, New York, 1976. ISBN 0471478601.

16-Chem-B13 Corrosion and Oxidation PEO ONLY

Bradford SA, Corrosion Control (2nd edition), Casti Publishing, Edmonton. ISBN 1-894038-58-4. Chapters 1-6, 9-12, 14.

Metals Handbook Volume 13A - Corrosion: Fundamentals, Testing and Protection. 2003.
Metals Handbook Volume 13B - Corrosion: Materials. 2005.

Metals Handbook Volume 13C - Corrosion: Environments and Industries. 2006.

16-Chem-B14 Nanomaterials PEO ONLY

Cao, G, and Wang, Y., Nanostructure and Nanomaterials: Synthesis, Properties and Applications, 2nd Edition, Ed. World Scientific, 2011, Chap. 2-9.

(24-PET-A5)

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

APEGA ONLY

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.

(24-PET-A3)

16-Chem-B13 Fundamental Reservoir Engineering – (98-Pet-A3)

APEGA ONLY

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.

4.3. INTRODUCTION

Nineteen engineering disciplines are included in the Examination Syllabus issued by the Canadian Engineering Qualifications Board of the Canadian Council of Professional Engineers.

Each discipline examination syllabus is divided into two examination categories: compulsory and elective. A full set of Chemical Engineering examinations consists of nine, three-hour examination papers. Candidates will be assigned examinations based on an assessment of their academic background. Examinations from discipline syllabi other than those specific to the candidates' discipline may be assigned at the discretion of the constituent Association/Ordre.

Before writing the discipline examinations, candidates must have passed, or have been exempted from, the Basic Studies Examinations.

The constituent Association/Ordre will supply information on examination scheduling, textbooks, materials provided or required, and whether the examinations are open or closed book.

4.3.1 CHEMICAL ENGINEERING EXAMINATIONS

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

MINOR EDITS (DELETIONS)

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, 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.

ADD

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.

ADD

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, electrodialysis, 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, chemi-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 NEW

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

04-Chem-B10 Life Cycle Assessment (LCA) NEW

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

04-Chem-A1 - Process Balances and Chemical Thermodynamics

J.M. Smith, H.C. Van Ness, M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, sixth edition. McGraw-Hill, 2001.

R.W. Felder, R.W. Rousseau, Elementary Principles of Chemical Processes, third edition. John Wiley, 2000.

04-Chem-A2 - Mechanical and Thermal Operations

C.J. Geankoplis, Transport Processes and Unit Operations, third edition. Prentice Hall, 1993.

W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, sixth edition. McGraw-Hill, 2001.

F.P. Incropera, D.P. DeWitt, Fundamentals of Heat and Mass Transfer, fifth edition. John Wiley, 2001.

04-Chem-A3 - Mass Transfer Operations

R.E. Treybal, Mass Transfer Operations, third edition. McGraw-Hill, 1980.

P.H. Wankat, Equilibrium Staged Separations. Elsevier, 1988.

J.D. Seader, E.J. Henley, Separation Process Principles. John Wiley, 1998.

W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, sixth edition. McGraw-Hill, 2001.

04-Chem-A4 - Chemical Reactor Engineering

H.S. Fogler, Elements of Chemical Reaction Engineering, third edition. Prentice Hall, 2002.

04-Chem-A5 - Chemical Plant Design and Economics

M.S. Peters, K.D. Timmerhaus, R.E. West, Plant Design and Economics for Chemical Engineers, fifth edition. McGraw-Hill, 2003.

W.D. Seider, J.D. Seader, D.R. Lewin, Process Design Principles: Synthesis, Analysis and Evaluation. John Wiley, 1999.

R. Turton, R.C. Bailie, W.B. Whiting, J.A. Shaeiweitz, Analysis, Synthesis, and Design of Chemical Processes, second edition, Prentice Hall, 2003.

04-Chem-A6 - Process Dynamics and Control

D.E. Seborg, T.F. Edgar, D.A. Mellichamp, Process Dynamics and Control. John Wiley, second edition, 2003.

T. Marlin, Process Control, Designing Processes and Control Systems for Dynamic Performance, second edition. McGraw-Hill, 2000.

B.W. Bequette, Process Control: Modeling, Design and Simulation. Prentice Hall, 2003.

C.A. Smith, A.B. Corripio, Principles and Practice of Antomatic Process Control, John Wiley, second edition, 1997.

04-Chem-B1 - Transport Phenomena

R.S. Brodkey, H.C. Hershey, Transport Phenomena: A Unified Approach. McGraw-Hill, 1988.

R.B. Bird, W.E. Stewart, E.N. Lightfoot, Transport Phenomena. Second edition, John Wiley, 2002.

04-Chem-B2 - Environmental Engineering

G. Kiely, Environmental Engineering. McGraw-Hill Ryerson, 1996.

04-Chem-B3 - Simulation, Modelling, and Optimization

S.M. Walas, Modelling with Differential Equations in Chemical Engineering. Butterworth-Heinemann, 1991.

D. Basmadjian, The Art of Modeling in Science and Engineering. Chapman & Hall, 1999.

B.W. Beqette, Process Dynamics: Modeling, Analysis and Simulation. Prentice Hall, 1998 (first 12 chapters and all modules).

P. Venkataraman, Applied Optimization with Matlab Programming. John Wiley, 2002.

T.F. Edgar, D.M. Himmelblau, L.S. Lasdon, Optimization of Chemical Processes. Second edition. McGraw-Hill, 2001.

04-Chem-B4 - Biochemical Engineering

J.E. Bailey, D.F. Ollis, Biochemical Engineering Fundamentals, second edition. McGraw-Hill, 1986.

04-Chem-B5 - Pulp and Paper Technology

J.P. Casey, Pulp and Paper: Chemistry and Chemical Technology, third edition, Volumes 1 and 2. Wiley Interscience, 1980.

G.A. Smook, Handbook for Pulp and Paper Technologists, third edition, Angus Wilde Publ, Inc., 2002

04-Chem-B6 - Petroleum Refining and Petrochemicals

J.H. Gary, G.E. Handwerk, Petroleum Refining, Technology and Economics, fourth edition. Marcel Dekker, 2001.

J.G. Speight, The Chemistry and Technology of Petroleum, third edition. Marcel Dekker, 1999.

04-Chem-B7 - Extractive Metallurgy

T. Rosenqvist, Principles of Extractive Metallurgy, second edition. McGraw-Hill, 1983.

C. Bodsworth, The Extraction and Refining of Metals. CRC Press, 1994.

04-Chem-B8 - Polymer Engineering

A. Rudin, The Elements of Polymer Science and Engineering, second edition. Academic Press, 1998.

J. Fried, Introduction to Polymer Science and Technology. Prentice Hall, 1995

04-Chem-B9 Advanced Materials

04-Chem-B10 Life Cycle Assessment (LCA)

CHEMICAL ENGINEERING EXAMINATION
SYLLABUS

GROUP A

COMPULSORY EXAMINATIONS (6 REQUIRED)

98-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.

98-Chem-A2 Mechanical and Thermal Operations

Fluid statics and decanting. Incompressible and compressible flow of fluids in piping. Sizing of pumps, metering. Flow through packed beds, fluidization, settling. Mixing and blending. Solids handling, screening, comminution, 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.

98-Chem-A3 Mass Transfer Operations

Application of equilibrium theory and rate considerations to theory and practice of absorption, adsorption, blending, distillation, drying, liquid-liquid extraction, mixing, settling; handling solids, screening, comminution, filtration.

98-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.

98-Chem-A5 Chemical Plant Design and Economics

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

protection.

98-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, proportional, integral, derivative, and combinations of these control actions. 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 (3 REQUIRED)

98-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.

98-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, electrodialysis, reverse osmosis. Sources and dispersion of atmospheric pollutants. Control methods for particulates, gases, and vapours. Photochemical reactions, noxious pollutants, and odour control. Measurement techniques.

98-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.

98-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.

98-Chem-B5 Pulp and Paper Technology

Papermaking raw materials: wood anatomy and chemistry. Pulping processes: mechanical pulping, chemi-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.

98-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.

98-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.

98-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.

Recommended Text List

** **NOTE TO CANDIDATES, THE LISTED TEXTBOOKS BELOW ARE ONLY SUGGESTED. THE LIST DOES NOT DEFINE OR LIMIT THE SYLLABUS**

98-Chem-A1 - Process Balances and Chemical Thermodynamics

J.M. Smith, H.C. Van Ness, M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 5th edition. McGraw-Hill, 1996.

R.W. Felder, R.W. Rousseau, Elementary Principles of Chemical Processes, third edition. John Wiley, 1986.

98-Chem-A2 - Mechanical and Thermal Operations

Christie J. Geankoplis, Transport Processes and Unit Operations, 3rd edition. Prentice Hall, 1993. ISBN # 013-93043-98.

W.L. McCabe, J.C. Smith, Unit Operations of Chemical Engineering, fifth edition. McGraw-Hill, 1993.

F.P. Incropeia, D.P. DeWitt, Fundamentals of Heat and Mass Transfer, fourth edition. John Wiley, 1996.

98-Chem-A3 - Mass Transfer Operations

R.E. Treybal, Mass Transfer Operations, third edition. McGraw-Hill, 1980.

P.H. Wankat, Equilibrium Staged Separations. Elsevier, 1988.

98-Chem-A4 - Chemical Reactor Engineering

H.S. Fogler, Elements of Chemical Reaction Engineering, third edition. Prentice Hall, 1991.

98-Chem-A5 - Chemical Plant Design and Economics

M.S. Peters, K.D. Timmerhaus, Plant Design and Economics for Chemical Engineers, 4th edition. McGraw-Hill, 1990.

98-Chem-A6 - Process Dynamics and Control

D.E. Seborg, T.F. Edgar, D.A. Mellichamp, Process Dynamics and Control. John Wiley, 1989.

98-Chem-B1 - Transport Phenomena

Christie J. Geankoplis, Transport Processes and Unit Operations. 3rd Edition, Prentice-Hall, 1993. ISBN # 013-93043-98

98-Chem-B2 - Environmental Engineering

G. Kiely, Environmental Engineering. McGraw-Hill Ryerson, 1996.

98-Chem-B3 - Simulation, Modelling, and Optimization

M. Walas, Modelling with Differential Equations in Chemical Engineering. Butterworth-Heinemann, 1991.

T.F. Edgar, D.M. Himmelblau, Optimization of Chemical Processes. McGraw-Hill, 1987.

98-Chem-B4 - Biochemical Engineering

J.E. Bailey, D.F. Ollis, Biochemical Engineering Fundamentals, second edition. McGraw-Hill, 1986.

98-Chem-B5 - Pulp and Paper Technology

J.P. Casey, Pulp and Paper: Chemistry and Chemical Technology, third edition, Volumes 1 and 2. Wiley Interscience, 1980.

98-Chem-B6 - Petroleum Refining and Petrochemicals

J.H. Gary, G.E. Handwerk, Petroleum Refining, Technology and Economics, third edition. Marcel Dekker, 1993.

J.G. Speight, The Chemistry and Technology of Petroleum, second edition. Marcel Dekker, 1991.

98-Chem-B7 - Extractive Metallurgy

T. Rosenquist, Principles of Extractive Metallurgy, second edition. McGraw-Hill, 1983.

J.D. Gilchrist, Extraction Metallurgy, third edition. Pergamon, 1989.

98-Chem-B8 - Polymer Engineering

A. Rudin, The Elements of Polymer Science and Engineering, second edition. Academic Press, 1998.

Updated: July 2001