B.Sc. Chemical Engineering
Session 2015 and Onwards

Detail of Courses
(Alphabetical listing of course codes)

ChE-101: Industrial Stoichiometry – I

(1) Units and dimensions, conversion of units, and dimensional analysis (2) Stoichiometric and composition relations (3) Concept of an ideal gas (4) Study of non-ideal behavior of gases and related calculations (5) Vapor pressure saturation and humidity as applied to material balance calculations (6) Introduction to material and energy balance computations

Recommended Books:

1. "Basic Principles and Calculations in Chemical Engineering" by D. M. Himmelblau, and J. B. Riggs
2. "Chemical Process Principles — Part 1: Material and Energy Balances" by O. A. Hougen, and K. M. Watson
3. "Elementary Principles of Chemical Processes" by R. M. Felder, and R. W. Rousseau
4. "Introduction to Material and Energy Balances" by G. V. Reklaitis, and D. R. Schneider
5. "Handbook of Chemical Engineering Calculations" by T. G. Hicks, and N. P. Chopey

ChE-102: Fluid Mechanics

(1) Characteristics of fluids and laws of fluid mechanics (2) Hydrodynamic behavior of fluids (3) Stress in a fluid (4) Newton's law of viscosity (5) Fluid statics (6) Concept of pressure and pressure gradient (7) Manometry (8) Basic physical laws in fluid mechanics (9) Conservation of mass, momentum, and energy (10) The Bernoulli's equation and its application (11) Dimensional analysis (12) Viscous flow in pipes (13) Concept of laminar and turbulent flow (14) Concept of friction and pressure drop in flowing fluids (15) Friction factor in laminar and turbulent flows in pipes (16) Concept of equivalent diameter (17) Flow measuring devices (a) Bernoulli devices (b) variable area meters (18) Concept of boundary layer and its importance in fluid mechanics (19) A brief introduction to external flows

Recommended Books:

1. "Unit Operations of Chemical Engineering" by W. L. McCabe, J. C. Smith, and P. Harriott
2. "Coulson and Richardson's Chemical Engineering — Volume 1: Fluid Flow, Heat Transfer and Mass Transfer" by J. M. Coulson, J. F. Richardson, J. R. Backhurst, and J. H. Harker
3. "Fluid Flow for Chemical Engineers" by F. A. Holland, and R. Bragg
4. "Fluid Mechanics" by F. M. White
5. "Fluid Mechanics for Chemical Engineers" by N. de Nevers

ChE-103: Chemical Process Industries

(1) Introduction to process flowsheeting, process flow diagrams, and standard symbols (2) Detailed study of the following group of industries: (a) Water treatment (b) Silicate industries (cement, glass, ceramics) (c) Agro-based industries (pulp and paper, soap and detergent, oil and ghee, sugar) (d) Acid industries (hydrochloric acid, sulfuric acid, nitric acid, phosphoric acid) (e) Alkali industries (soda ash, caustic soda, ammonia) (f) Fertilizer industries (NPK based fertilizers) (g) Classified chemical (insecticides, explosives, surface coating industries) (h) Petrochemicals

Recommended Books:

1. "Shreve's Chemical Process Industries" by G. T. Austin
2. "A Textbook of Chemical Technology" by G. N. Pandey
3. "Chemical Process Technology" by J. Moulijn, M. Makkee, and A. van Diepen
4. "Riegel's Handbook of Industrial Chemistry" by J. A. Kent

ChE-201: Industrial Stoichiometry – II

(1) Material balances involving multiple reactions and multiple units (2) Material balances involving recycle, bypass and purge streams (3) Material balances involving phase change (4) General energy balance with and without chemical reactions (5) Combined material and energy balance in chemical process industries

Recommended Books:

1. "Basic Principles and Calculations in Chemical Engineering" by D. M. Himmelblau, and J. B. Riggs
2. "Chemical Process Principles — Part 1: Material and Energy Balances" by O. A. Hougen, and K. M. Watson
3. "Elementary Principles of Chemical Processes" by R. M. Felder, and R. W. Rousseau
4. "Introduction to Material and Energy Balances" by G. V. Reklaitis, and D. R. Schneider
5. "Handbook of Chemical Engineering Calculations" by T. G. Hicks, and N. P. Chopey

ChE-202: Fluid Dynamics

(1) Introduction to fluid dynamics (2) Pipes, fittings, and valves (3) Transportation of fluids (4) Fluid moving machinery (5) Measurement of flowing fluids (6) Friction in flow through bed of solids (7) Motion of particles through fluids (8) Agitation of fluids and agitators (9) Blending and mixing (10) Suspension of solid particles (11) Dispersion operations

Recommended Books:

1. "Unit Operations of Chemical Engineering" by W. L. McCabe, J. C. Smith, and P. Harriott
2. "Coulson and Richardson's Chemical Engineering — Volume 1: Fluid Flow, Heat Transfer and Mass Transfer" by J. M. Coulson, J. F. Richardson, J. R. Backhurst, and J. H. Harker
3. "Fluid Flow for Chemical Engineers" by F. A. Holland, and R. Bragg
4. "Fluid Mechanics" by F. M. White
5. "Fluid Mechanics for Chemical Engineers" by N. de Nevers

ChE-203: Particle Technology

(1) Importance of particle technology in chemical industries (2) Characterization of the particles (3) Detailed study of the following unit operations: (a) Screening (b) Mixing (c) Size reduction (d) Crystallization (e) Filtration (f) Sedimentation (4) Different types of screening equipment, mixers, centrifuges, filters, size reduction equipment, and crystallizers with emphasis on the following: (a) Mechanical construction (b) Operation and the working principle (c) Design and the controlling parameters (d) Efficiency (e) Economic evaluation (f) Applications and the selection criteria (5) Role of different mechanical separation techniques in chemical industry

Recommended Books:

1. "Unit Operations of Chemical Engineering" by W. L. McCabe, J. C. Smith, and P. Harriott
2. "Coulson and Richardson's Chemical Engineering — Volume 2: Particle Technology & Separation Processes" by J. F. Richardson, J. H. Harker, and J. R. Backhurst
3. "Fundamentals of Particle Technology" by R. G. Holdich
4. "Introduction to Particle Technology" by M. Rhodes
5. "Particle Technology" by H. Rumpf

ChE-204: Chemical Engineering Thermodynamics – I

(1) Scope of thermodynamics, fundamental quantities, terminologies, and related parameters (2) First law of thermodynamics and its applications to chemical engineering processes (3) PVT behavior of pure fluids (4) Equations of state (5) Heat effects (6) Concept of entropy and second law of thermodynamics (7) Thermodynamic properties of fluids (8) Generalized correlation for gases (9) Thermodynamics of flow processes

Recommended Books:

1. "Introduction to Chemical Engineering Thermodynamics" by J. M. Smith, H. G. van Ness, and M. M. Abbott

2. “Chemical Engineering Thermodynamics” by T. E. Daubert
3. “Chemical and Engineering Thermodynamics” by S. I. Sandler
4. “Thermodynamics: An Engineering Approach” by Y. A. Cengel, and M. Boles
5. “Applied Thermodynamics: For Engineering Technologists” by T. D. Eastop, and A. McConkey
6. “Fundamentals of Engineering Thermodynamics” by M. J. Moran, and H. N. Shapiro

ChE-205: Heat Transfer Fundamentals

(1) Introduction to heat transfer (2) Applications and importance of heat transfer (3) Modes of heat transfer (4) Steady state one-dimensional conduction including heat sources and convective boundary conditions (5) Extended surfaces (6) Transient conduction: lumped capacity method (7) Free and forced convection under various flow patterns (8) Dimensional analysis (9) Importance of temperature in mechanism of heat transfer (10) Calculation of caloric and wall temperature (11) Momentum and heat transfer analogies (12) Boiling and condensation (13) Principles of radiation heat transfer (14) Introduction to heat transfer equipment and their configurations

Recommended Books:

1. “Unit Operations of Chemical Engineering” by W. L. McCabe, J. C. Smith, and P. Harriott
2. “Process Heat Transfer” by D. Q. Kern
3. “Process Heat Transfer” by G. F. Hewitt, G. L. Shires, and T. R. Bott
4. “Heat Transfer: A Practical Approach” by Y. A. Cengel
5. “Heat Transfer” by J. P. Holman
6. “Introduction to Heat Transfer” by F. P. Incropera, D. P. DeWitt, T. L. Bergman, and A. S. Lavine
7. “Coulson and Richardson’s Chemical Engineering — Volume 1: Fluid Flow, Heat Transfer and Mass Transfer” by J. M. Coulson, J. F. Richardson, J. R. Backhurst, and J. H. Harker

ChE-206: Mass Transfer Fundamentals

(1) Introduction to mass transfer and its applications (2) Mass conservation equations for single and multicomponent mixture (3) Principles of diffusion transfer between phases (4) Fick’s law (5) Analogies with momentum and heat transfer (6) Steady state diffusion in gases and liquids (7) Transient diffusion (8) Mass transfer theories (9) Mass transfer coefficients through various geometries and flow patterns (10) Equilibrium stage operations (11) Equipment for stage contacts (12) Distillation: (a) Flash distillation (b) Continuous distillation with reflux (13) Design of plate and packed columns

Recommended Books:

1. “Unit Operations of Chemical Engineering” by W. L. McCabe, J. C. Smith, and P. Harriott
2. “Fundamentals of Heat and Mass Transfer’’ by F. P. Incropera, D. P. DeWitt, T. L. Bergman, and A. S. Lavine
3. “Separation Process Principles” by J. D. Seader, and E. J. Henley
4. “Principles of Mass Transfer and Separation Processes” by B. K. Dutta
5. “Mass Transfer Operations” by R. E. Treybal
6. “Principles of Unit Operations” by A. S. Foust, L. A. Wenzel, C. W. Clump, L. Maus, and L. B. Andersen
7. “Coulson and Richardson’s Chemical Engineering — Volume 1: Fluid Flow, Heat Transfer and Mass Transfer” by J. M. Coulson, J. F. Richardson, J. R. Backhurst, and J. H. Harker
8. “Coulson and Richardson’s Chemical Engineering — Volume 2: Particle Technology & Separation Processes” by J. F. Richardson, J. H. Harker, and J. R. Backhurst

ChE-207: Engineering Materials

(1) Significance of materials in engineering equipment design and fabrication (2) Fundamental concepts of stress and strain, their estimation and applications (3) Chemical engineering design (4) Mechanical and thermal properties and the applications of the following materials of construction: (a) Iron and steel (b) Stainless steel (c) Nickel (d) Hastelloy (e) Copper alloys (f) Aluminum and its

alloys (g) Lead (h) Titanium and tantalum (5) Phase equilibrium diagrams of stainless steel (6) Polymeric materials (7) Composite materials (8) Glass, stoneware, acid-resistant bricks and tiles (9) Selection of materials of construction (10) Introduction to corrosion and its types

Recommended Books:

1. "Science of Engineering Materials" by C. M. Srivastava, and C. Srinivansan
2. "Introduction to Engineering Materials" by V. John
3. "Principles of Materials Science and Engineering" by W. F. Smith
4. "Engineering Materials and Their Applications" by R. A. Flinn, and P. K. Trojan

ChE-301: Chemical Reaction Engineering

(1) Fundamentals of chemical reaction engineering and its importance (2) Rate of reaction, rate equation, molecularity, and order of reaction (3) Kinetic models and mechanism for non-elementary reactions (4) Analysis of rate data: integral and differential methods of analysis for single irreversible and reversible reactions for constant and variable volume reactors (5) Ideal reactors for single reactions: design equations for homogeneous batch and flow reactors (6) Holding time and space time for flow reactors (7) Comparison of reactors (8) Multiple reactors system: reactors of equal and different sizes used in series and/or parallel (9) Determining best setup for given conversion (10) Recycle reactors (11) Autocatalytic reactions

Recommended Books:

1. "Chemical Reaction Engineering" by O. Levenspiel
2. "Elements of Chemical Reaction Engineering" by H. S. Fogler
3. "Chemical Engineering Kinetics" by J. M. Smith
4. "Introduction to Chemical Reaction Engineering and Kinetics" by R. W. Missen, C. A. Mims, and B. A. Saville
5. "Chemical Reactor Design, Optimization, and Scaleup" by E. B. Nauman

ChE-302: Chemical Engineering Mathematics

(1) Application of the following to chemical engineering problems: (a) Ordinary differential equations (b) Simultaneous differential equations (c) Partial differential equations (d) Series solution (e) Laplace transformation

Recommended Books:

1. "Mathematical Methods in Chemical Engineering" by V. G. Jenson, and G. V. Jeffreys
2. "Applied Mathematical Methods for Chemical Engineers" by N. W. Loney
3. "Applied Mathematics and Modeling for Chemical Engineers" by R. G. Rice, and D. D. Do
4. "Basic Principles and Calculations in Chemical Engineering" by D. M. Himmelblau, and J. B. Riggs

ChE-303: Unit Processes

(1) Industrial application of the following unit processes with emphasis on their kinetic behavior and economic importance: (a) Nitration (b) Esterification (c) Amination (d) Halogenation (e) Sulfonation (f) Oxidation (g) Hydrogenation (2) Introduction to biochemical engineering processes

Recommended Books:

1. "Shreve's Chemical Process Industries" by G. T. Austin
2. "A Textbook of Chemical Technology" by G. N. Pandey
3. "Chemical Process Technology" by J. Moulijn, M. Makkee, and A. van Diepen
4. "Riegel's Handbook of Industrial Chemistry" by J. A. Kent
5. "Unit Processes in Organic Synthesis" by P. H. Groggins

ChE-304: Chemical Engineering Thermodynamics – II

(1) Power cycles, refrigeration and liquefaction (2) Concept of equilibrium (3) Phase rule (4) Vapor–liquid equilibrium at low to moderate pressure (5) Simple models for vapor–liquid equilibrium and

modified Raoult's law (6) Vapor–liquid equilibrium from K-value correlations (7) Solution thermodynamics (8) Fundamental property relation (9) Maxwell equations (10) Chemical potential and phase equilibria (11) Partial properties (12) Ideal gas mixture (13) Fugacity (14) Fugacity coefficient for pure species and for a species in solution (15) Generalized correlation for fugacity coefficients (16) Ideal solutions (17) Excess properties (18) Liquid phase properties from vapor–liquid equilibrium data (19) Models for excess Gibbs energy (20) Property changes of mixing (21) Heat effects of mixing process (22) Chemical reaction equilibrium (23) Chemical reaction equilibrium for homogeneous and heterogeneous systems

Recommended Books:

1. "Introduction to Chemical Engineering Thermodynamics" by J. M. Smith, H. G. van Ness, and M. M. Abbott
2. "Chemical Engineering Thermodynamics" by T. E. Daubert
3. "Chemical and Engineering Thermodynamics" by S. I. Sandler
4. "Thermodynamics: An Engineering Approach" by Y. A. Cengel, and M. Boles
5. "Applied Thermodynamics: For Engineering Technologists" by T. D. Eastop, and A. McConkey
6. "Fundamentals of Engineering Thermodynamics" by M. J. Moran, and H. N. Shapiro

ChE-305: Process Heat Transfer

(1) Importance of industrial heat transfer (2) Heat transfer equipment for process industries (3) Selection and performance evaluation criterion (4) Process and mechanical design of concentric tube, shell-and-tube, air coolers, compact, and finned heat exchangers (5) Correction factors for different heat exchangers (6) Optimum design of heat exchangers and performance evaluation (7) Design of heat exchangers with phase change (8) Condensers, evaporators, boilers, and reboilers (9) Fundamental of design of furnace (10) Introduction to pinch technology (11) Computer applications to design of heat transfer equipment

Recommended Books:

1. "Unit Operations of Chemical Engineering" by W. L. McCabe, J. C. Smith, and P. Harriott
2. "Process Heat Transfer" by D. Q. Kern
3. "Process Heat Transfer" by G. F. Hewitt, G. L. Shires, and T. R. Bott
4. "Heat Transfer: A Practical Approach" by Y. A. Cengel
5. "Heat Transfer" by J. P. Holman
6. "Introduction to Heat Transfer" by F. P. Incropera, D. P. DeWitt, T. L. Bergman, and A. S. Lavine
7. "Coulson and Richardson's Chemical Engineering — Volume 1: Fluid Flow, Heat Transfer and Mass Transfer" by J. M. Coulson, J. F. Richardson, J. R. Backhurst, and J. H. Harker

ChE-306: Separation Processes

(1) Introduction to separation techniques (2) Selection of separation techniques (3) Separation operations (4) Gas absorption (a) Packing and packed tower design (b) Principles of absorption (c) Absorption from rich gases (d) Mass transfer correlations (e) Absorption with chemical reaction (5) Leaching (a) Leaching equipment (b) Principles of continuous counter current leaching (6) Liquid–liquid extraction (a) Extraction equipment (b) Principles of extraction (c) Special extraction techniques (7) Membrane separation processes(a) Separation of gases (b) Membrane structure (c) Pressure drop and mass transfer effects (d) Membranes for liquid–liquid extraction (8) Pervaporation (9) Reverse osmosis (10) Electrostatic separation

Recommended Books:

1. "Unit Operations of Chemical Engineering" by W. L. McCabe, J. C. Smith, and P. Harriott
2. "Fundamentals of Heat and Mass Transfer'' by F. P. Incropera, D. P. DeWitt, T. L. Bergman, and A. S. Lavine
3. "Separation Process Principles" by J. D. Seader, and E. J. Henley
4. "Principles of Mass Transfer and Separation Processes" by B. K. Dutta
5. "Mass Transfer Operations" by R. E. Treybal

6. “Principles of Unit Operations” by A. S. Foust, L. A. Wenzel, C. W. Clump, L. Maus, and L. B. Andersen
7. “Coulson and Richardson’s Chemical Engineering — Volume 1: Fluid Flow, Heat Transfer and Mass Transfer” by J. M. Coulson, J. F. Richardson, J. R. Backhurst, and J. H. Harker
8. “Coulson and Richardson’s Chemical Engineering — Volume 2: Particle Technology & Separation Processes” by J. F. Richardson, J. H. Harker, and J. R. Backhurst

ChE-307: Transport Phenomena

(1) Viscosity and the mechanism of momentum transport (2) Velocity distributions in laminar flow (3) The equations of change for isothermal systems (4) Velocity distribution with more than one independent variable (5) Thermal conductivity and the mechanism of energy transport (6) Temperature distribution in solids and in laminar flow (7) The equations of change for non-isothermal systems (8) Diffusivity and the mechanism of mass transport (9) Concentration distribution in solids and in laminar flow (10) The equations of change for multicomponent systems

Recommended Books:

1. “Transport Phenomena” by R. B. Bird, W. E. Stewart, and E. N. Lightfoot
2. “Momentum, Heat, and Mass Transfer” by C. O. Bennett, and J. E. Myers
3. “Fundamentals of Momentum, Heat, and Mass Transfer” by J. R. Welty, C. E. Wicks, R. E. Wilson, and G. Rorrer
4. “Transport Phenomena: A Unified Approach” by R. S. Brodkey, and H. C. Hershey

ChE-308: Energy Engineering

(1) Introduction to energy, types of energy, and sources of energy (2) Introduction to fuels in solid, liquid, and gaseous state (3) Renewable and non-renewable energy resources (4) Introduction to hydropower, solar energy, wind energy, tidal energy, geothermal energy, nuclear energy, and fossil fuels (5) Extraction, advantages, and limitations of each energy resource (6) Availability of these energy resources in Pakistan (7) Environmental impacts of energy resources (8) Fuel processing: (a) Carbonization (b) Combustion (c) Gasification (d) Fuel upgradation (9) Energy from biomass

Recommended Books:

1. “Fuel and Energy” by J. R. Backhurst, and J. H. Harker
2. “Fuels and Combustion” by M. L. Smith, and K. W. Stinson
3. “Flame and Combustion” by J. F. Griffiths, and J. A. Bernard
4. “An Introduction to Combustion: Concepts and Applications” by S. R. Turns
5. “Synthetic Fuels” by R. F. Probstein, and R. E. Hicks

ChE-309: Chemical Engineering Economics

(1) Importance of economics in engineering (2) Market and process surveys in relation to feasibility analysis (3) Plant location (4) Estimation of capital investment (5) Physical plant cost (6) Manufacturing cost (7) General expenses (8) Interest, taxes, insurance, and depreciation (9) Sales and profit (10) Cost accounting (11) Alternative investments and replacements (12) Marketing

Recommended Books:

1. “Plant Design and Economics for Chemical Engineers” by M. S. Peters, K. D. Timmerhaus, and R. E. West
2. “Chemical Engineering Economics” by D. E. Garrett
3. “Chemical Engineering Process Design and Economics: A Practical Approach” by G. D. Ulrich, and P. T. Vasudevan
4. “Process Engineering Economics” by J. R. Couper

ChE-401: Chemical Reactor Design

(1) Temperature and energy effects for single reactions (2) Heat of reaction and equilibrium constant (3) Design equations for batch and flow reactors derived from mass and energy balance equations (4) Adiabatic and non-adiabatic operations (5) Introduction to heterogeneous reaction system

(6) Fluid–particle reaction kinetics (7) Rate controlling step in shrinking and non-shrinking spherical particles (8) Catalysis (9) Adsorption isotherms: B.E.T. equation (10) Kinetics of solid-catalyzed reactions (11) Experimental methods for finding rates (12) Integral and differential reactors (13) Design for gas–solid catalytic reactors

Recommended Books:

1. "Chemical Reaction Engineering" by O. Levenspiel
2. "Elements of Chemical Reaction Engineering" by H. S. Fogler
3. "Chemical Engineering Kinetics" by J. M. Smith
4. "Introduction to Chemical Reaction Engineering and Kinetics" by R. W. Missen, C. A. Mims, and B. A. Saville
5. "Chemical Reactor Design, Optimization, and Scaleup" by E. B. Nauman

ChE-402: Simultaneous Heat and Mass Transfer

(1) Multicomponent distillation (2) Azeotropic and extractive distillation (3) Equipment evaluation and design (4) Drying mechanisms (5) Humidification, dehumidification and equipment design (6) Fixed-bed operations:(a) Adsorption (b) Ion exchange

Recommended Books:

1. "Unit Operations of Chemical Engineering" by W. L. McCabe, J. C. Smith, and P. Harriott
2. "Fundamentals of Heat and Mass Transfer'' by F. P. Incropera, D. P. DeWitt, T. L. Bergman, and A. S. Lavine
3. "Separation Process Principles" by J. D. Seader, and E. J. Henley
4. "Principles of Mass Transfer and Separation Processes" by B. K. Dutta
5. "Mass Transfer Operations" by R. E. Treybal
6. "Principles of Unit Operations" by A. S. Foust, L. A. Wenzel, C. W. Clump, L. Maus, and L. B. Andersen
7. "Coulson and Richardson's Chemical Engineering — Volume 1: Fluid Flow, Heat Transfer and Mass Transfer" by J. M. Coulson, J. F. Richardson, J. R. Backhurst, and J. H. Harker
8. "Coulson and Richardson's Chemical Engineering — Volume 2: Particle Technology & Separation Processes" by J. F. Richardson, J. H. Harker, and J. R. Backhurst
9. "Transport Processes and Separation Process Principles" by C. J. Geankoplis

ChE-403: Chemical Engineering Plant Design

(1) Introduction to process design and development (2) General design considerations (3) Optimal design (4) Materials of fabrication and their selection (5) Material transfer handling and equipment design (6) Heat transfer equipment design (7) Mass transfer equipment design (8) Application of computer aided design software

Recommended Books:

1. "Plant Design and Economics for Chemical Engineers" by M. S. Peters, K. D. Timmerhaus, and R. E. West
2. "Ludwig's Applied Process Design for Chemical and Petrochemical Plants" by A. K. Coker
3. "Chemical Process Equipment: Selection and Design" by J. R. Couper, W. R. Penney, J. R. Fair, and S. M. Walas
4. "Equipment Design Handbook: For Refineries and Chemical Engineers" by F. L. Evans
5. "Chemical Process: Design and Integration" by R. Smith
6. "The Art of Chemical Process Design" by G. L. Wells, and L. M. Rose
7. "Coulson and Richardson's Chemical Engineering — Volume 6: Chemical Engineering Design" by R. K. Sinnott

ChE-404: Instrumentation and Control

(1) Fundamentals of electrical technology and digital logic employed in measurement (2) Review of scientific principles employed in instruments (3) Parts of instruments: sensor, modifier, and recorder (4) Dynamic and static properties of instruments (5) Selection and calibration of

instruments(6) Instrument identification and line symbols (7) Available technology of instrumentation for (a) Temperature (b) Flow (c) Level (d) Weight (e) Load (f) Pressure (g) Composition (8) Transducers (9) Advanced measurement devices employing piezoelectric current, ultrasonic, laser, microwave (10) Installation and installation costs (11) Instrumentation case studies (12) Introduction and significance of control (13) Feedback and feed forward control (14) Design and hardware elements of control (15) Dynamics of first and second order systems (16) Overall transfer function testability (17) Controllers (P, PI, PID, etc.) and final control elements (18) Representation of control systems (19) Multiple control loops (20) Cascade, ratio, over-riding control (21) Introduction to stability of chemical processes (22) Introduction to frequency response techniques (23) Routh's criterion and Bode plots (24) Nyquist method (25) Computer control (26) Introduction to distributed control systems (27) Case study: development of control scheme of complete plant

Recommended Books:

1. "Chemical Process Control: An Introduction to Theory and Practice" by G. Stephanopoulos
2. "Process Dynamics, Modeling, and Control" by B. A. Ogunnaike, and W. H. Ray
3. "Process Systems Analysis and Control" by D. R. Coughanowr, and L. B. Koppel
4. "Principles and Practice of Automatic Process Control" by C. A. Smith, and A. Corripio
5. "Essentials of Process Control" by W. L. Luyben, and M. L. Luyben
6. "Process Control: Instrumentation Technology" by C. D. Johnson
7. "Process Control: Designing Processes and Control Systems for Dynamic Performance" by T. E. Marlin

ChE-405: Maintenance Engineering

(1) Types of maintenance and their applications (2) Maintenance management (3) Maintenance of pumps, machines, and piping (4) Lubrication programs (5) Forms of corrosion, prevention, and inhibition (6) Design considerations: layout and construction (7) Overall safety of plant and personnel (8) Fire and explosion (9) Health hazard (10) Accident prevention (11) Government regulations for industrial safety

Recommended Books:

1. "Engineering Maintenance: A Modern Approach" by B. S. Dhillon
2. "Maintenance Fundamentals" by R. K. Mobley
3. "Rules of Thumb for Maintenance and Reliability Engineers" by R. Smith, and R. K. Mobley
4. "Maintenance Engineering Handbook" by R. K. Mobley, L. R. Higgins, and D. J. Wikoff

ChE-406: Environmental Engineering

(1) Introduction to ecology of environment (2) Impact of technology on ecology of system (3) The effects of industrial pollutants on human environments (4) Environmental impact assessment and sustainable development (5) Air pollution and its control (6) Water pollution and its control (7) Industrial wastewater and its control (8) Industrial noise pollution and its control (9) Future requirements for process industries and developments under the constraints of diminishing world resources and ecological demands of human environment

Recommended Books:

1. "Introduction to Environmental Engineering" by M. L. Davis, and D. A. Cornwell
2. "Introduction to Environmental Engineering" by P. A. Vesilind, S. M. Morgan, and L. G. Heine
3. "Environmental Engineering" by R. F. Weiner, and R. A. Matthews
4. "Principles of Environmental Science and Technology" by K. Saravanan, S. Ramachandran, and R. Baskar
5. "Handbook of Water and Wastewater Treatment Technologies" by N. P. Cheremisinoff

ChE-407: Process Modeling and Simulation

(1) Computer simulation in process engineering (2) Steps in simulation approach (3) Architecture of flowsheeting software (4) Selection of simulation software (5) Steady state flowsheeting (6) Dynamic simulation (7) Introduction to various design and simulation software, e.g., Aspen Plus, Aspen

HYSYS, ChemCAD, etc. (A particular software may be selected to cover the rest of course contents) (8) A review of capabilities and limitations of the design and simulation software (9) Defining process streams and use of fluid packages (10) Adding common unit operations in the flowsheet (11) Drawing simple process flow diagram (PFD in Aspen HYSYS) (12) Steady state material and energy balances using graphical user interface and work sheet (13) Adding instrumentation and control components (14) Simple transient calculations

Recommended Books:

1. "Process Modeling, Simulation, and Control for Chemical Engineers" by W. L. Luyben
2. "Process Dynamics: Modeling, Analysis and Simulation" by B. W. Bequette
3. "Plantwide Dynamic Simulators in Chemical Processing and Control" by W. L. Luyben

ChE-408: Engineering Management

(1) Resources and management processes (2) Environment of engineering organization and managers (3) Social, ethical, global, and multicultural environment (4) Elements of planning and decision making (5) Decision making and its types (6) Managing strategy and strategic planning (7) Elements of an organization (8) Organization design, change, and innovation (9) Human resource management (10) Managing motivation and performance (11) Managing workgroups and teams (12) Organization communication and interpersonal relations in engineering organizations (13) Types of control (14) Managing operation, quality, and productivity of an engineering organization

Recommended Books:

1. "Engineering Project Management: An Introductory Text" by O. Faniran
2. "Management" by S. P. Robbins, and M. Coulter
3. "Project Management: A Systems Approach to Planning, Scheduling, and Controlling" by H. R. Kerzner
4. "Process Engineering Economics" by J. R. Couper

ChE-411: Plant Design Project – I

Plant design project is the practical demonstration of a student's theoretical knowledge. In plant design project, a group of students is assigned a project that includes process selection, capacity selection, overall material and energy balance, design of different units or equipment, instrumentation and control, economic analysis of plant, hazard assessment and HAZOP study, etc. Students are required to present their project in front of class and faculty in a seminar to help improve their interpersonal and communication skills.

ChE-412: Plant Design Project – II

Same as ChE-411: Plant Design Project – I.

ChE-421: Gas Engineering

(1) Introduction to natural gas industry (2) Phase behavior of natural gas systems (3) Properties of natural gas and volatile hydrocarbon liquids (4) Gas hydraulics (5) Compressor station (6) Pipe loops vs. compression (7) Gas distribution network (analysis and simulation) (8) Gas purification by low temperature processes (9) Sweetening and dehydration of crude gas (10) Corrosion protection of gas pipelines (11) Pipeline economics

Recommended Books:

1. "Handbook of Natural Gas Engineering" by D. L. Katz
2. "Surface Production Operations — Volume 2: Design of Gas Handling Systems and Facilities" by K. Arnold, and M. Stewart
3. "Acid and Sour Gas Treating Processes" by S. A. Newman
4. "Handbook of Natural Gas Transmission and Processing" by S. Mokhatab, W. A. Poe, and J. G. Speight
5. "Gas Pipeling Hydraulics" by E. S. Menon

ChE-422: Biochemical Engineering

(1) Introduction to chemical engineering and biotechnology (2) Cells, cell structure, and cell types (3) Lipids, saccharine, RNA, DNA, amino acids, and proteins (4) Enzyme production and kinetics (5) Substrate and its utilization (6) Biomass production and product formation (7) Experimental techniques (8) Immobilization materials and techniques (9) Biochemical reactors (10) Downstream processing (11) Applications and future of biotechnology

Recommended Books:

1. "Biochemical Engineering Fundamentals" by J. E. Bailey, and D. F. Ollis
2. "Bioprocess Engineering: Basic Concepts" by M. L. Shuler, and F. Kargi

ChE-423: Nanotechnology in Chemical Engineering

(1) Introduction to nanotechnology and its importance in chemical engineering (2) Nanoengineering basics (effect of length scale and properties of nanomaterials) (3) Types of nanomaterials (4) Nanofabrication (5) Nanoparticle design and assembly (6) Characterization of nanoscale structures and surfaces (7) Nanobiomaterials (8) Nanomaterial safety

Recommended Books:

1. "Nanotechnology for Chemical Engineers" by S. S. Elnashaie, F. Danafar, and H. H. Rafsanjani
2. "Introduction to Nanotechnology" by C. P. Poole, and F. J. Owens
3. "Textbook of Nanoscience and Nanotechnology" by B. S. Murty, P. Shankar, B. Raj, B. B. Rath, and J. Murday

ChE-424: Nuclear Engineering

(1) Radioactive decay (2) Nuclear reactions and artificial radioactivity (3) General properties (4) Neutrons and neutron flux (5) Fission and chain reactions (6) Separation of isotopes (7) Uses of stable isotopes (8) Nuclear reactor principles (9) Reactor startup and operations (10) Materials of construction (11) Design of gas cooled enriched uranium reactors (12) Processing methods of nuclear materials (13) Radiation hazards (14) Shielding (15) Detection and control instruments (16) Waste disposal

Recommended Books:

1. "Introduction to Nuclear Engineering" by J. R. Lamarsh, and A. J. Baratta
2. "Nuclear Chemical Engineering" by M. Benedict, T. H. Pigford, and H. W. Levi

ChE-425: Computer Aided Design

(1) Modeling of chemical engineering design problems (2) Using spreadsheet software for design calculations (3) User-defined functions, formulas, and data replication (4) Iterative and selective structures implementation (5) Macro application (6) Graphical output (7) Flowsheeting fundamentals (8) Flowsheeting codes (9) Representing a design problem in flowsheeting codes (10) Using flowsheeting software for solving design problems (11) Physical property estimation (12) Cost estimation (13) Heat and mass balances computations (14) Degree of freedom and thermodynamic properties calculations (15) Size determination (16) Regression analysis and graphical output of results using flowsheeting software

Recommended Books:

1. "Integrated Design and Simulation of Chemical Processes" by A. C. Dimian, C. S. Bildea, and A. A. Kiss
2. "Chemical Process Design: Computer-Aided Case Studies" by A. C. Dimian, and C. S. Bildea
3. "Chemical Engineering: Modeling, Simulation, and Similitude" by T. G. Dobre, and J. G. Sanchez-Marcano

ChE-426: Process Analysis and Optimization

(1) Importance and hierarchy of optimization (2) Significance of optimization in chemical engineering (3) Classification and model development (4) Solution and interpretation of optimization models (5) Economic and time value of objective functions (6) Linear programming application to chemical processes with multi-variant situations (7) Unconstrained functions with one-dimensional search (8) Nonlinear mixed integer optimization (9) Application of optimization in heat transfer and energy

conservation (10) Optimal design and operation of conventional mass transfer operations (11) Optimal design of fluid flow in pipes with and without pumping and compressing devices (12) Optimization of medium scale plants along with integrated planning and control in process industries

Recommended Books:

1. "Optimization of Chemical Processes" by T. F. Edgar, D. M. Himmelblau, and L. S. Lasdon
2. "Chemical Reactor Design, Optimization, and Scaleup" by E. B. Nauman
3. "Operations Research: An Introduction" by H. A. Taha
4. "Process Plant Simulation" by B. V. Babu

CS-101: Computing Fundamentals

Course details are to be provided by the owner department.

CY-142: Physical and Analytical Chemistry

(1) Dalton's law, Henry's law, and Raoult's law (2) Antoine equation (3) Relative volatility (4) Electrochemistry, including fuel cells (5) Colloidal chemistry, reaction kinetics and equilibrium (6) Introduction to instrumental techniques involving (a) potentiometery (b) pH-metery (c) Liquid solid chromatography (d) high performance liquid chromatography (e) Ion exchange (f) Gas chromatography (g) Plane chromatography (7) Spectroscopy: basics of spectroscopy (8) UV and visible spectroscopy

Recommended Books:

1. "Principles of Physical Chemistry" by H. Kuhn, H. D. Försterling, and D. H. Waldeck
2. "Analytical Chemistry: Principles and Techniques" by L. G. Hargis
3. "Analytical Chemistry" by G. D. Christian, P. K. Dasgupta, and K. A. Schug
4. "Fundamentals of Analytical Chemistry" by D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch
5. "Applied Colloid and Surface Chemistry" by R. M. Pashley, and M. E. Karaman

CY-221: Inorganic and Organic Chemistry

(1) Overview of periodic table (2) Molecular orbital theory (3) Chemistry of solutions (4) Chemistry of transition metals, coordination compounds, and radioactive elements (5) Crystalline state of metals and lattice structure (6) Industrial inorganic chemistry (7) Qualitative and group theory of inorganic chemistry (8) Functional groups (9) Interconversion of functional groups (10) Unit processes: reaction mechanism of (a) Sulfonation (b) Nitration (c) Hydrogenation (d) Amination (e) Halogenation (f) Oxidation (g) Polymerization

Recommended Books:

1. "Unit Processes in Organic Synthesis" by P. H. Groggins
2. "Inorganic Chemistry" by G. L. Miessler, P. J. Fischer, and D. A. Tarr

EE-199: Basic Electrical and Electronics Engineering

Course details are to be provided by the owner department.

HU-111: Communication Skills

Course details are to be provided by the owner department.

HU-221: Technical Writing and Presentation Skills

Course details are to be provided by the owner department.

IS-101: Islamic and Pakistan Studies – I

Course details are to be provided by the owner department.
Subject is compulsory for Muslim students.
Alternatively, HU-101: Ethics and Pakistan Studies – I is compulsory for non-Muslim students.

IS-201: Islamic and Pakistan Studies – II
Course details are to be provided by the owner department.
Subject is compulsory for Muslim students.
Alternatively, HU-201: Ethics and Pakistan Studies – II is compulsory for non-Muslim students.

MA-113: Calculus and Analytic Geometry

(1) A review of differentiation (a) Geometrical interpretation of a derivative (b) Infinitesimal (c) Differential coefficient (d) Derivatives of higher order (e) Indeterminate forms and L'Hopital's rule (f) Asymptotes (g) Curvature (h) Approximation and error estimates (2) Further techniques of integration (a) Integration by reduction formula (b) Fundamental theorem of integral calculus (c) Definite integral and its properties (d) Area enclosed between curves (e) Arc length (f) Volume of a solid (g) Volume of a solid of revolution (h) Area of surface of revolution (i) Moments (j) Centroids (3) Cartesian, cylindrical, and spherical coordinates (a) The ratio formula (b) Equations of a straight line in R3 (c) Direction ratios and direction cosines (d) Angle between two straight lines (e) Distance of a point from a line (f) Equations of a plane (g) Angle between two planes (h) The sphere (i) Directional derivatives (4) The concept of limit, continuity, and differentiation in functions of several variables (a) Geometric interpretation of partial derivatives (b) Total differential (c) Chain rule (d) Implicit differentiation (e) Maxima and minima of functions of two independent variables (f) Taylor's and Maclaurin's series for functions of two variable (5) Double integration (a) Fubini's theorems (b) Change of order (c) Geometrical interpretation of double integral (d) Applications to find volumes and areas

Recommended Books:

1. "Mathematics for Engineers and Scientists" by M. I. Bhatti, and M. N. Chaudhari
2. "Calculus and Analytic Geometry" by G. B. Thomas, and R. L. Finney
3. "Advanced Engineering Mathematics" by E. Kreyszig
4. "Calculus" by H. Anton, I. C. Bivens, and S. Davis
5. "Calculus" by E. W. Swokowski, M. Olinick, and D. D. Pence

MA-118: Applied Mathematics and Statistics

(1) Product and quotient of complex numbers in polar form (2) Properties of complex numbers (3) Logarithm of a complex number (4) De Moivre's theorem (5) The nth roots of a number (6) Solution of equations (7) A review of matrices (a) Determinants and finding inverse of a matrix through elementary row operations (b) Solution of the system of linear equations (c) Eigenvalues and eigenvectors (8) Formation of differential equations (a) Solution of various types of first order differential equations (b) Orthogonal trajectories (c) Application in physical problems (d) Linear differential equations of second order (e) Complementary function and particular integral (9) Formation of partial differential equations (10) Solution of equations reducible to ordinary differential equations (11) Periodic functions (a) Even and odd functions (b) Fourier series of functions of period 2 (c) Arbitrary period (d) Half range series (12) Scalar and vector triple products (a) Scalar and vector point functions (b) Differentiation and integration of vector point functions (c) Motion along a straight line with uniform acceleration (d) Motion along a curved path (e) Tangential and normal components of acceleration (f) Simple harmonic motion (13) Introduction and role of statistics in engineering (a) Frequency distributions (b) Measures of central tendency and dispersion (c) Regression (d) Probability with basic theory of distributions (e) Nomograms

Recommended Books:

1. "Mathematics for Engineers and Scientists" by M. I. Bhatti, and M. N. Chaudhari
2. "Advanced Engineering Mathematics" by E. Kreyszig
3. "Applied Statistics for Engineers and Scientists" by J. L. Devore, N. R. Farnum, and J. A. Doi
4. "Elements of Complex Variables" by L. L. Pennisi
5. "Vector and Tensor Analysis" by N. A. Shah

MA-233: Applied Mechanics

(1) Experimental work related to the following core areas of mechanics: (a) Inertia and moment of inertia of flywheel (b) Determination of coefficient of friction for different systems (c) Basiler suspension (d) Mechanics of Weston differential pulley (e) Performance evaluation of tie-and-jib and force analysis (f) Mechanical advantages and applications (g) Estimation of efficiency losses for various systems and study of techniques to improve efficiency

Recommended Books:

1. "Engineering Mechanics" by S. Timoshenko, D. H. Young, and J. V. Rao

MA-240: Numerical Analysis

(1) Basic concepts: (a) Round-off errors (b) Floating point arithmetic (c) Convergence (2) Solution of nonlinear equations: (a) Simple iterations (b) Bisection method (c) Newton's method (d) Secant method (e) Method of false position (3) Solution of linear simultaneous equations: (a) Jacobi's method (b) Gauss–Seidel method (4) Finite differences: (a) Difference operators and tables (b) Newton's interpolating techniques for equally spaced data (c) Newton divided difference table and interpolation (d) Lagrange's formulation of interpolation (5) Numerical differentiation: approximating the derivative (6) Numerical integration: (a) Review of integration concepts and their physical significance for engineering (b) Trapezoidal and Simpson's rules (7) Solution of differential equations: (a) Euler's methods (b) Runge–Kutta methods(8) Computations: numerical techniques in context of engineering applications and solutions of problems by using MATLAB

Recommended Books:

1. "Numerical Methods for Engineers" by S. Chapra, and R. Canale
2. "Numerical Methods using MATLAB" by J. H. Mathews, and K. K. Fink
3. "Applied Numerical Methods for Engineering using MATLAB" by H. A. Schilling, and S. L. Harris
4. "Numerical Methods for Engineers and Scientists" by J. D. Hoffman, and S. Frankel
5. "A First Course in Numerical Analysis with Fortran and C" by S. A. Bhatti

ME-100L: Workshop Practice

Course details are to be provided by the owner department.

ME-122L: Engineering Drawing

Course details are to be provided by the owner department.

PHY-113: Applied Physics

(1) Sound (a) Sound waves (b) Properties, sources, and types of sound waves (c) Vibrating systems (d) Beats (e) Doppler's effect (2) Thermodynamics (a) Temperature and heat (b) Thermal expansion (c) The absorption of heat by solids and liquids (d) Laws of thermodynamics (e) Heat transfer mechanisms (f) Ideal gases (g) Translational kinetic energy (h) The distribution of molecular speeds (i) The molar specific heats (j) Entropy (3) Magnetism (a) Magnetic field (b) Crossed fields (c) Discovery of electron (d) The Hall effect (e) A circulating charged particle (f) Magnetic forces (g) Torque on a current loop (h) Ampere's law (i) Solenoids and toroids (j) Magnetic dipoles(k) Maxwell's equations (4) Atomic physics(a) Properties of atoms (b) Electron spin (c) Angular momenta and magnetic dipole moments (d) The Stern–Gerlach experiment (e) Magnetic resonance (f) The Pauli exclusion principle (g) Periodic table (h) X-rays (i) Lasers (j) Spectroscopy (5) Nuclear physics (a) Discovering the nucleus (b) Nuclear properties (c) Radioactive decay (d) Alpha decay (e) Beta decay (f) Radioactive dating

Recommended Books:

1. "Fundamentals of Physics" by D. Halliday, R. Resnick, and J. Walker
2. "Sears and Zemansky's University Physics" by H. D. Young, R. A. Freedman, T. R. Sandin, and A. L. Ford
3. "Physics for Scientists and Engineers with Modern Physics and Mastering Physics" by D. C. Giancoli