



. **Chem. Eng. Dep. - B.Sc. Course Description**

0905201 Computer Applications in Chemical Engineering (2 Credit Hours)

Prerequisite: (1900100)

An applied course focusing on use of Internet resources and computer packages to equip the students with the essentials of using computers in chemical engineering. Internet: Use of Web search engines; Useful chemical engineering links and databases; World Wide Virtual Libraries. Computer Packages: Getting started with some available packages used in typical modern chemical engineering textbooks, e.g., EZ-Solve, Polymath, and Matlab. Students will undertake a number of assignments involving solving problems utilizing Internet acquired information as well as the numerical, symbolic and graphical capabilities of the computer packages.

0905202 Physical Chemistry (3 Credit Hours)

Prerequisite: (0303101)

Behaviour and properties of gases. First law of thermodynamics: ideal gas relationships, thermochemistry. Second and third laws of thermodynamics: entropy and entropy changes, free energy functions. Chemical equilibrium for homogenous and heterogeneous systems, shifts of equilibrium, effects of temperature and pressure. Phase equilibria for one component systems. Solutions of electrolytes: theories of strong and weak electrolytes, molar and ionic conductivities. activity coefficients and ionic equilibria for dilute solutions. Surface chemistry and colloids.

0905211 Chemical Engineering Principles (1) (3 Credit Hours)

Prerequisite: (0303101)

The role of the chemical engineer. Units and dimensions. Conversion of units. Systems of units. Dimensional homogeneity. Process data representation. Processes and process variables. Degrees of freedom analysis. Elementary mathematical tools for solving balance equations. Material balances for non reactive and reactive systems. Material balance on single phase and multiphase systems.



0905212 Chemical Engineering Principles (2) (3 Credit Hours)

Prerequisite: (0905211)

The first law of thermodynamics. Energy balance on closed system. Energy balance on open systems at steady state. Energy balances on non reactive and reactive systems. Material and energy balances. Balances on transient systems.

0905231 Mathematical Methods in Chemical Engineering (3 Credit Hours)

Prerequisite: (0301201)

Concepts of differential equations. First, second and higher order ordinary differential equations. System of ordinary differential equations. Eigenvalues and eigenvectors. Solution of ordinary differential equations using various analytical techniques including series and Laplace transform methods and application in chemical engineering.

Partial differential equations, types, solutions of first order partial differential equation and applications in chemical engineering.

0905241 Fluid Mechanics (3 Credit Hours)

Prerequisite: (0905211)

Introduction of fluid mechanics. Physical properties of fluids. Types of fluids. Fluid statics: Basic hydrostatic equation, Buoyancy and manometers. Bernouli's equation. Fluid flow measurements. Fluid friction in steady flow. Macroscopic momentum balances. Open channel flow. Pumping of fluids and pump selection, fluid mixing.

0905301 Numerical Methods in Chemical Engineering (3 Credit Hours)

Prerequisite: (0905201)

Introduction to floating point arithmetic and error analysis. Numerical solution of nonlinear algebraic equations. Solution of linear and nonlinear systems of algebraic equation. Fitting and interpolating polynomials. Numerical differentiation and integration. Numerical solutions of ordinary and partial differential equations. Solution of different applications in chemical engineering using MATLAB.

0905322 Thermodynamics (1) (3 Credit Hours)

Prerequisite: (0905202, 0905211)

Introduction to engineering thermodynamics. Analytical and generalized equations of state. Applications of the first law of thermodynamics: conservation of energy, flow and non-flow processes, work calculations. Applications of the second law of thermodynamics: reversible and irreversible processes, entropy relations. Departure functions based on analytical and generalized relationships. Thermodynamic cycles for common energy systems



0905323 Thermodynamics (2) (3 Credit Hours)

Prerequisite: (0905322)

Relationships among thermodynamic properties: equations, tables, diagrams. Estimation of auxiliary physical properties. Properties of mixtures and solutions : fugacity of gases and liquids, ideal and non-ideal solutions, activity and standard states, Gibbs-Duhem equation. Physical equilibria among phases: phase rule, vapor-liquid equilibria for various systems. Equilibrium phase diagrams. Chemical reactions equilibria.

0905331 Process Modeling by Statistical Methods (3 Credit Hours)

Prerequisite: (0905231)

Introduction to stochastic and deterministic modeling of simple chemical engineering processes. Essential probability and statistical methods: probability laws, random variables and distributions. Descriptive statistics, estimation and tests of hypotheses, regression and correlation analysis.

0905341 Transport Phenomena (3 Credit Hours)

Prerequisite: (0905241)

Momentum Transfer: viscosity and mechanism of momentum transfer. Velocity distribution in laminar flow (steady-state). Energy Transfer: thermal conductivity and mechanism of heat transfer by conduction and convection. Introduction to radiation. Mass transfer: diffusivity and mechanism of mass transfer. Interphase mass transfer and mass transfer coefficient.

0905342 Solid Particulates (3 Credit Hours)

Prerequisite: (0905241)

Characterisation of solids: solid properties, size analysis, solids in bulk, handling and flow of solids, size reduction. Fluid particle systems: packings and packed columns, filtration, centrifugation, mixing, flotation, fluidization.

0905343 Process Heat Transfer (3 Credit Hours)

Prerequisite: (0905341)

Design of heat exchangers: double-pipe heat exchanger, shell-and-tube heat exchanger. Effectiveness-NTU method, and crossflow heat exchanger. condensation and boiling heat transfer. Design of condensers. Radiation heat transfer and design of fired heaters.



0905381 Strength of Materials and Equipment Design (3 Credit Hours)

Prerequisite: (Dept. approval)

Introduction to material properties. Stresses and strains, shearing force and moment diagram, stresses due to bending, deflection, torsion, buckling, analysis of thin and thick cylindrical shells and spherical shells. Theories of failure. Welding. General design considerations for flat bottomed cylindrical vessels, cylindrical vessels with formed closures under internal and external pressure. Design of tall vertical vessels. Design of supports.

0905401 Management for Chemical Engineering (3 Credit Hours)

Prerequisite: (Dept. approval)

Theories of management, Forecasting, Organisation of chemical engineering projects, Breakeven analysis, project evaluation and cashflow diagrams. Critical path method, Decision trees and alternatives, Inventory control.

0905421 Chemical Reaction Engineering (1) (3 Credit Hours)

Prerequisite: (0905323)

Rate equations and conservation equation applied to homogeneous reaction system in batch, continuous stirred tank and tubular reactors. Conversion, yield and selectivity for isothermal reactors with multiple reactions: Choice of reactor for various reactions. Non-ideal flow reactors. Residence time distributions and measurement. Effects of micromixing. Design of single phase reactor configurations.

0905422 Chemical Reaction Engineering (2) (3 Credit Hours)

Prerequisite: (0905421)

Introduction to multiphase reaction systems. Non-catalytic fluid solid reactions and reactors. Gas/liquid and liquid/liquid reactions, concept of rate controlling step. Catalysis and kinetic-catalytic models. Mass transfer and reaction in porous solids. Catalytic heterogeneous reactors-packed and fluidized bed types. Thermal characteristics. Design techniques.

0905423 Biochemical Engineering (3 Credit Hours)

Prerequisite: (0905421)

Introduction to Biotechnology. Elementary Biochemistry and Microbiology. Major metabolic pathways. Introduction to genetic engineering. Kinetics and mechanism of enzymatic reactions, enzyme inhibition, and enzyme immobilization. Kinetics of microbial growth, substrate utilization and product formation. Methods of cell cultivation (batch, continuous and fed batch). Transport phenomena in bioprocesses. Design, analysis and scale-up of biochemical reactors.



0905431 Process Analysis and Simulation (3 Credit Hours)

Prerequisite: (0905301)

Techniques for analysis, modeling and simulation of typical process equipment and integrated processes, both continuous and non-continuous. Application of necessary analytical and numerical mathematical algorithms to selected cases.

0905441 Mass Transfer Operations (3 Credit Hours)

Prerequisite: (0905323)

Interphase mass transfer, equilibrium stage concept. Vapor-liquid processes. Distillation: equilibrium data, batch, flash, binary, steady state, multicomponent, steam, azeotropic and extractive distillation. Gas absorption: equilibrium data, multistage continuous contacting, non isothermal, multicomponent, design of packed column. Solvent extraction: phase equilibria, stage-wise calculations, transfer units, tower design, mixer-settler, design of stirred vessel systems. Leaching: equilibrium relations, stage wise calculations.

0905442 Heat and Mass Transfer Operations (3 Credit Hours)

Prerequisite: (0905343, 0905441)

Humidification : equilibrium data, adiabatic and non-adiabatic operations, evaporative cooling, drought towers. Drying: definitions, batch, mechanism of drying, drying at low temperature, continuous drying, material and enthalpy balances, design of driers. Crystallization: theory, batch and continuous, equilibrium enthalpy balances, design of different types of crystallizers. Evaporation: single and multiple effects, and flow arrangements, heat pumps, barometric condensers. Adsorption and ion-exchange: stagewise adsorption, continuous adsorption, design using LUB concept and regeneration. Dialysis and reverse osmosis.

0905451 Local Chemical Industries (3 Credit Hours)

Prerequisite: (0303102, 0905212)

Studying the basic principles, raw materials and process description for a number of industries such as, industrial gases, inorganic acids, sodium, potassium and phosphates industries. Cement; Ceramic; Glass; Oil and Fat; Soap and Detergents; Surface coating industries; Specifications and Standards. Local Regulations.



0905452 Petroleum Refining Engineering (3 Credit Hours)

Prerequisite: (0905441)

Origin and occurrence of petroleum, and its constituents. Refining feedstocks and refining products. Industrial use of refinery products and the need for refining operations. Crude oil distillation. Chemical reactions and refinery operations of: delayed coking, catalytic reforming and isomerization, catalytic cracking, hydrotreating, catalytic hydrocracking, alkylation. Product blending and production of lubricating oil. Asphalt technology. Supporting processes. Cost estimation and economic evaluation.

0905461 Chemical Engineering Laboratory (1) (1 Credit Hour)

Prerequisite: (0905241, 0905323)

Selected experiments drawn from (0905241), (0905322), (0905323). For example pumps, fans, jets, pressure drops in closed and open conduits, flow measurements and refrigeration, stirling cycle, air conditioning, vapor-liquid equilibrium, liquid-liquid equilibrium.

0905462 Chemical Engineering Laboratory (2) (1 Credit Hour)

Prerequisite: (0905342, 0905343)

Selected experiments drawn from (0905342) and (0905343). For example crushing and grinding, screening, sedimentation, flotation, fluidization, filtration, mixing and heat conduction, free and forced convection, plain and finned exchangers, fluidized beds, two-phase heat transfer.

0905463 Chemical Engineering Laboratory (3) (1 Credit Hour)

Prerequisite: (0905442 or concurrently)

Selected experiments drawn from (0905441), (0905442). For example: Wetted wall column, ion exchange, absorption, air-water simulator, distillation, extraction, cooling tower performance, tray drier, evaporation, crystallization, and adsorption.

0905471 Fuel and Energy (3 Credit Hours)

Prerequisite: (0905343)

Energy classification, sources and utilization. Non-renewable Energy: Fossil fuels, Nuclear energy, hydrogen fuel. Fossil-fuel systems and applications, waste heat recovery systems. Renewable Energy: solar energy, wind power, tidal power, geothermal energy, and Biofuels. Energy storage: chemical storage, thermal storage and fuel cells. Energy and the Environment.



0905473 Process Safety Engineering (2 Credit Hours)

Prerequisite: (4th year level)

Safe handling of hazardous chemicals and toxic materials. Theories of ignition, flames, fire and explosion. Methods of protection and prevention of hazards: containment, suppression, explosion relief, inerting. Safety codes and check lists considerations in design and operation. Case studies.

0905474 Engineering Materials Science (3 Credit Hours)

Prerequisite: (Dept. approval)

Structure of solid phases. Crystal geometry. Structural disorder. Solid solutions and phase diagrams. Types of materials. Mechanical and thermal behavior of materials. Stability of materials in service. Corrosion and material selection. Phase diagrams and phase changes, thermal treatment.

0905475 Corrosion and Electrochemical Engineering (3 Credit Hours)

Prerequisite: (Dept. approval)

Fundamental, principles and laws of electrochemistry. Thermodynamics and kinetics of electrochemical cells. Heat and Mass transfer in electrochemical reactors. Theory and applications of electrodeposition of metals. Theory of corrosion. Types and mechanisms of corrosion processes. Corrosion control by preventative methods, chemical additives, and electrical techniques.

0905481 Process Design (3 Credit Hours)

Prerequisite: (0901420, 0905441)

Process synthesis and analysis. Development of a conceptual design: batch versus continuous arrangements, flow configurations, structure of flowsheet. Separation and heat exchanger networks and their optimization. Computer aided design software.

0905509 Selected Topics in Chemical Engineering (3 Credit Hours)

Prerequisite: (Dept. approval)

Coverage of the various aspects of a special topic of interest to chemical engineers. The title of the topic to be covered at each offering of the course will be pre-announced by the Department. As a guideline, topics could include one of the following: water desalination, food engineering, experimental design, mixing, project engineering, applied surface chemistry, process instrumentation and measurements, analysis and simulation of chemical processes, mineral processing, process catalysis.



0905531 Process Optimization (3 Credit Hours)

Prerequisite: (0905301)

Structure and formulation of optimization problems in chemical engineering. Optimality criteria, single and multivariable methods for unconstrained optimization. Linear programming. Optimality criteria and techniques for constrained optimization. Selected applications in chemical engineering.

0905541 Separation Processes (3 Credit Hours)

Prerequisite: (0905441)

Multicomponent distillation. Azeotropic and extractive distillation. Liquid-Liquid separation processes. Membrane separation processes including reverse osmosis and ultrafiltration. Dialysis, chromatography etc...

0905551 Extractive Metallurgy (3 Credit Hours)

Prerequisite: (0905342)

Scope of extractive metallurgy. Ores and mineral: natural resources in Jordan, beneficiation and products. Application of thermodynamics and reaction kinetics in metal extraction. Hydrometallurgical processes. Industrial applications in production of common ferrous and nonferrous metals, including the iron blast furnace, theory and practice and modern iron-ores direct reduction technologies. Hydro- and electrometallurgy. Applications from the production of copper, aluminum, manganese, magnesium and uranium industries.

0905553 Polymers and Plastics Engineering (3 Credit Hours)

Prerequisite: (0905421)

Raw materials. Types of polymers. Role of polymer and plastics industries. Polymer reaction engineering. Polymer properties. Analysis of polymer processing in terms of elementary steps and shaping methods. Transport phenomena. Polymer melt rheology. Extrusion. Injection molding. Blow molding. Film blowing. Calendering.

0905554 Fertilizer Technology (3 Credit Hours)

Prerequisite: (0905441)

Nature, purpose and function of fertilizers. The new trends in fertilizer manufacturing including new or modified fertilizer products and new techniques. Preparation of raw materials. Fundamentals and design of processes common to fertilizer industries (phosphatic, potash and nitrogenous fertilizers). Pollution and corrosion problems and the use of waste streams.



0905561 Chemical Engineering Laboratory (4) (1 Credit Hour)

Prerequisite: (0905422, 0905571)

Selected experiments drawn from (0905421), (0905422), (0905571). For example: determination of reaction kinetics, use of plug flow and continuous flow stirred tank reactors, measurement of residence time distributions. Gas absorption with chemical reaction. Selected experiments on temperature, pressure, level and pH control. Simulation and analogue computing, servomechanisms, and instrumentation.

0905571 Process Dynamics and Control (3 Credit Hours)

Prerequisite: (0905231, 0905441)

Introduction to control systems. Modelling of dynamic behavior of chemical processes. Transfer functions. Dynamic behavior of first and second order systems. Analysis and design of control systems: types of controllers, closed loop response, stability, design of feedback controllers. Analysis of frequency response of linear systems. Design using frequency response techniques.

0905572 Environmental Engineering (3 Credit Hours)

Prerequisite: (0905342)

Concepts and terminology. Sources and impacts of water pollutants. Conventional water and wastewater treatment processes: Sedimentation, flocculation, softening, filtration, disinfection and biological systems. Sources and impacts of air pollutants. Air pollution control through gas cleaning devices: cyclones and wet scrubbers. Solid waste classification, handling and ultimate disposal.

0905582 Chemical Plant Design (3 Credit Hours)

Prerequisite: (0905441, 0905451)

Principles of Engineering Economy. Estimation of capital and manufacturing costs. Profitability and feasibility analysis. Process conception and definition. Process flowsheet preparation, including symbols, piping and instrumentation diagram. Materials of construction and corrosion. Selection of equipment: alternatives, and capacity; and cost considerations. Utilities. Plant location and layout. Safety considerations. Case study. Introduction to engineering optimization.

0905597 Practical Project (3 Credit Hours)

Prerequisite: (5th year level)

An individually chosen project. This project should allow an element of original work by each student, and will be drawn from the facilities available in the Department. A full report covering all aspects of the work must be submitted.



0905598 Project (1) (1 Credit Hour)

Prerequisite: (Results in 121 Cr. Hrs., 0905481 or concurrently)

A group of students perform flowsheet synthesis and/or selection for a chemical process including material and energy balances for the selected process.

0905599 Project (2) (2 Credit Hours)

Prerequisite: (0905598)

Each student performs a detailed study of a chemical engineering problem from the selected process chosen in project (1). The final report submitted by the group should include mass and energy balances, process flow diagram and detailed design of one or more items of equipment and other equivalent tasks.