

## Plan of Study: Bachelor of Science in Chemical Engineering

Year I		
Fall Semester		18 Credits
Code	Course Title	Credit Hours
CMPS 100B	Introduction to Technical Computing for the Sciences	3
ENGL 101	Basic Academic English I	3
MATH 199	Calculus I	3
CHEM 130	Chemical Principles I	3
CHEM 130L	Introductory Chemistry Laboratory	1
ENGR 105	Engineering Graphics	2
ENTR 200	Introduction to Entrepreneurship	3
Spring Semester		16 Credits
Code	Course Title	Credit Hours
EECE 130	Computers and Programming I	3
ENGL 102E	English for Engineering and Sciences I	3
ENGR 100	Introduction to Engineering	3
MATH 200	Calculus II	3
CHEM 170	Chemical Principles II	3
ENGR 110	Engineering Workshop	1
Summer Semester		9 Credits
Code	Course Title	Credit Hours
ENGL 203E	English for Engineering and Sciences II	3
MATH 205	Calculus III	3
SOCS 102	Omani Society	3

Year II		
Fall Semester		18 Credits
Code	Course Title	Credit Hours
PHYS 170	Fundamentals of Physics I	3
CHEM 260	Analytical Chemistry	3
CHEE 270	Fluid Mechanics	3
CHEE 275	Thermodynamics	3
CHEE 201	Principles of Chemical Engineering	3
CHEM 210	Organic Chemistry I	3
Spring Semester		17 Credits
Code	Course Title	Credit Hours
ARAB 101	Academic Writing in Arabic	3
CHEE 270L	Fluid Mechanics Laboratory	1
CHEM 250	Organic Chemistry II	3
CHEM 250L	Organic Chemistry Laboratory	1
CHEM 370	Physical Chemistry	3
CHEE 208	Instrumentation	3
CHEE 280	Mass Transfer	3

Year III		
Fall Semester		15 Credits
Code	Course Title	Credit Hours
MATH 335	Mathematics for Science and Engineering	3
CHEE 300	Computational Methods	3
CHEE 310	Reactive Process Engineering	3

MATH 210	Differential Equations	3
ENGL 204	Advanced English for Academic Purposes and Research	3
<b>Spring Semester</b>		<b>16 Credits</b>
<b>Code</b>	<b>Course Title</b>	<b>Credit Hours</b>
ENGL 305	Advanced English Language and Communication Skills	3
CHEE 380	Heat Transfer	3
CHEE 470	Chemical Process Dynamics and Control	3
ENGR 300	Engineering Economy	3
CHEM XXX	Major Elective	3
XXX	Elective Laboratory	1
<b>Summer Semester</b>		<b>0 Credits</b>
<b>Code</b>	<b>Course Title</b>	<b>Credit Hours</b>
CHEE 400	Practical Training	0
<b>Year IV</b>		
<b>Fall Semester</b>		<b>16 Credits</b>
<b>Code</b>	<b>Course Title</b>	<b>Credit Hours</b>
CHEE 401	Final Year Project I	0
CHEE 410	Separation Processes	3
CHEE 420	Chemical Engineering Process Design	3
CHEE 430	Materials Science	3
CHEE 440	Introduction to Biotechnology	3
XXX	Science Elective	3
XXX	Elective Laboratory	1
<b>Spring Semester</b>		<b>13 Credits</b>
<b>Code</b>	<b>Course Title</b>	<b>Credit Hours</b>
CHEE 402	Final Year Project II	3
CHEM XXX	Major Elective	3
CHEM XXX	Major Elective	3
XXX	General Elective	3
XXX	Elective Laboratory	1

## Course Description

### **CHEM 260 Analytical Chemistry (3 crs)**

This course covers the fundamentals and techniques of analytical chemistry including solution equilibria, titrations, spectroscopic fundamentals and techniques, electrochemical fundamentals and techniques, and statistical analysis. Prerequisite: CHEM 170.

### **CHEM 370 Physical Chemistry (3 crs)**

The course covers surface phenomena (surface tension, adsorption, electrical double layers, colloids), transport properties (thermal conductivity, viscosity, diffusion coefficients, and porous media), chemical kinetics (rate laws, mechanisms, catalysis, reaction rates, heterogeneous reactions, photochemistry), and extraction. Prerequisites: CHEM 170.

### **CHEE 201 Principles of Chemical Engineering (3 crs)**

The course covers the fundamentals of chemical engineering including balancing, introduction to the design of industrial processes, survey of unit operations, systems of units, first and second laws of thermodynamics, flow processes, heat engines, relationships between thermodynamic properties, and property estimation techniques. Prerequisite: MATH 205, CHEM170.

### **CHEE 208 Instrumentation (3 crs)**

The course covers the instrumentation of different chemical analysis techniques including: Chromatography (HPLC, GC, and TLC), UV-Visible spectroscopy, IR- and FTIR spectroscopy, X-ray spectrometry, and Atomic Absorption Fluorescence spectroscopy. Prerequisite: CHEM 260.

**CHEE 270                 Fluid Mechanics   (3 crs)**

The course covers the concepts of density, volume, mass, weight, viscosity, gravitational force, fluid statics, buoyancy, balance equation, first law of thermodynamics, Bernoulli's equation, fluid friction and momentum balance. Prerequisites: MATH 205, CHEM 170.

**CHEE 275                 Thermodynamics   (3 crs)**

The course covers the basic concepts of thermodynamics, the three laws of thermodynamics, system and control volume analysis of thermodynamic processes, irreversibility, relations for ideal gas mixtures, Carnot Cycle, and the thermodynamic properties of chemical reactions ( $\Delta U$ ,  $\Delta H$ ,  $\Delta S$ ,  $\Delta G$ ,  $\Delta A$ ). Prerequisites: ENGR 100, MATH 205, CHEM 370.

**CHEE 280                 Mass Transfer   (3 crs)**

The course covers an introduction to mass transfer phenomena as relevant to the chemical and process industry, theories of mass transfer, the flux laws for mass transfer, diffusion of the gases, diffusion in liquid and solid, mass transfer coefficient, dimensional analysis, convective mass transfer, multi direction diffusion, and design principles for mass transfer equipment. Prerequisites: CHEE 201, MATH 205.

**CHEE 300                 Computational/Numerical Methods in Chemical Engineering   (3 crs)**

linear and nonlinear equations, derive mathematical model from actual data, Differential equations and integration. Use of MATLAB software for interpolation, extrapolation, Newton method, Euler, Trapezoidal rule, Runge-Kutta methods, Mid points and curve fitting. Prerequisites: CMPS 100B, CHEE 201; Corequisites MATH 335.

**CHEE 310                 Reactive Process Engineering   (3 crs)**

The course covers the numerical solutions including: root finding, numerical differentiation and integration, series expansions and approximation, finite difference methods, solution of first-order ordinary differential equations, nonlinear systems. The students will learn the basics of structural programming and numerical analysis techniques. MATLAB will be used as a basic tool together with a dedicated CAD. Prerequisites: CHEM370, CHEE275, co-requisite: CHEE300

**CHEE 380                 Heat Transfer   (3 crs)**

Modes of heat transfer: conduction, convection and radiation. Thermal conductivity. Steady and unsteady state heat conduction. Convective heat transfer coefficients, external flow, internal flow, free convection, heat transfer with laminar and turbulent flows, design of heat exchange equipment: double-pipe, shell- and-tube heat exchangers, condensers and re-boilers. Radiation heat transfer. Prerequisites: CHEE 280, Co-requisite: CHEE300.

**CHEE 400                 Practical Training (BS Students)   (0 crs)**

This course requires eight weeks of practical training in chemical engineering with an established firm.

**CHEE 401                 Final Year Project I   (0 crs)**

A supervised project, normally in groups of three students, aimed at providing practical experience in some aspects of chemical engineering. Students are expected to complete a literature survey, project specification, critical analysis, and to acquire the necessary material needed for their intended end product.

**CHEE 402                 Final Year Project II   (3 crs)**

The course teaches students the skill to integrate the knowledge gained in different courses, by asking them to deliver a product that has passed through the design, analysis, testing and evaluation stages. It includes production of a professional report, design process and outcome, implementation and testing, verification and validation, and critical appraisal of the project. Prerequisite: CHEE 401.

- CHEE 410 Separation Processes (3 crs)**  
The course covers basic concepts of separation processes, equilibrium-based processes with staging and continuous contacting, distillation, evaporation, liquid-liquid extraction, leaching, membrane based separations. Prerequisites: CHEE 208, CHEM 370, and co-requisite: CHEE 380.
- CHEE 420 Chemical Engineering Process Design (3 crs)**  
The course covers design of equipment, processes and systems of interest in chemical engineering through application of scientific, technological, economic principles. Emphasis is placed on problem formulation and the conceptual, analytical, and decision aspects of open-ended design situations. The work integrates knowledge and skills gained in previous and concurrent courses. Prerequisite: CHEE 310, CHEE 410.
- CHEE 430 Materials Science (3 crs)**  
The course covers structure/property relationship for metals, ceramics, polymers and composite materials, atomic and molecular structure, bonds, electronic band structure and semi-conductors, order in solids, crystal structure, disorders, solid phases, mechanical properties and fracture, physico-chemical properties, and design. Prerequisite: CHEM 370, MATH 335.
- CHEE 440 Introduction to Biotechnology (3 crs)**  
The course covers introduction to biochemistry, enzyme kinetics, proteins, carbohydrates, other biochemicals, industrially significant microbes, introduction to genetic engineering, cell structure and metabolism. Prerequisites: CHEM 250.
- CHEE 450 Materials Engineering (3 crs)**  
The course covers processes for forming and producing engineering materials such as amorphous, semi-crystalline, textured and crystal-oriented substances and composites, effect of processing variables on the properties of the finished article, process of blending and alloying, shaping and joining operations, vessel equipment design for chemical engineering applications. Prerequisite: CHEE 430.
- CHEE 460 Computational Engineering (3 crs)**  
The course covers Monte Carlo integration; data analysis: plotting and interpretation of data, extraction of physical parameters; probability and statistics: simulation of distributions, histograms, calculation of moments, random walk problem; error analysis: sources of error, propagation of error; logistic map, and chaos. Prerequisite: CHEE 300.
- CHEE 470 Chemical Process Dynamics and Control (3 crs)**  
The course covers introduction to modeling, control of dynamic chemical processes, the development of first-principles models, linearization and state space form, input-output (transfer function) form, design and tuning of PID controllers, model-based control, frequency response for robustness analysis, case studies in multivariable control, numerical analysis and simulation. Prerequisites: MATH 335, CHEE 300, CHEE 310.
- CHEE 475 Chemical Reactor Design (3 crs)**  
The course covers principles of kinetics, reactor design, analysis for both homogeneous and heterogeneous (catalytic) systems, the design for multiple reaction networks (optimum selectivity), analysis of simple reactor combinations, the design of isothermal, adiabatic, and optimum temperature profile reactor. Prerequisites: CHEE 300, CHEE 310, CHEE 320.
- CHEE 480 Biochemical Engineering (3 crs)**  
The course covers engineering aspects of microbial processes, conversions with immobilized enzymes, mixed-culture processes, sterilization, aseptic techniques, mass transfer, bioprocess control, product isolation, enzyme technology, bioprocess development. There are heavy emphases on continuous fermentation and on chemicals from biomass. Prerequisite: CHEE 440.
- CHEE 485 Fuel Cell Technology (3 crs)**  
The course covers the basics of fuel cell, various types of fuel cells; cell equilibrium, standard potentials, Nernst

equation, transport and adsorption in proton-exchange membranes and supported liquid electrolytes, kinetics and catalysis, the Butler-Volmer equation, reaction routes, mechanisms; applications of fuel cells. Prerequisite: CHEE 275, CHEE 430.

**CHEE 487                      Polymer Engineering                      (3 crs)**

The course covers polymer processing operations with emphasis on the application of polymer rheology and transport phenomena to predict performance, polymer rheology and constitutive equations, mixing, extrusion, injection molding, coating flows, fiber spinning, film blowing, blow molding, compression molding, thermoforming and composites processing. Prerequisite: CHEM 250, CHEE 430.

**CHEE 488                      Instrumentation and Process Control                      (3 crs)**

The course covers principles of control theory and their application to chemical processes, single-loop feedback and feed forward control; laboratory sessions cover measurement fundamentals, signal transmission, dynamic testing, control system synthesis, implementation and adjustment. Prerequisite: CHEE 470.

**CHEE 489                      Pharmaceutical Biotechnology                      (3 crs)**

The course covers introduction to biotechnology, pharmaceuticals, therapeutic products derived from living organisms (e.g., proteins, peptides, DNA, RNA) and from the production plant, the challenges of keeping these products "active" as they are stored, shipped, and administered to patients. Prerequisite: CHEE 440.

**CHEE 490                      Renewable Energy                      (3 crs)**

The course covers energy conversion, utilization and storage for renewable technologies such as wind, solar, biomass, fuel cells and hybrid systems, energy supply from renewable resources as a result of solar power (such as direct solar radiation, and indirect forms such as bioenergy, water and wind power), geothermal energy, and modern technologies used in renewable energy. Prerequisite: CHEE 275, CHEE 430.

**CHEM 250L                      Organic Chemistry Laboratory                      (1 crs)**

The laboratory covers experiments that include, the synthesis, separation, purification, and characterization of organic compounds, characterization techniques (IR and UV visible absorbance, NMR, mass spectrometry, and chemical tests), unknown compounds and mixtures of unknown compounds will be separated and identified by chemical and spectroscopic techniques. Co-requisite: CHEM 250.

**CHEE 270L                      Fluid Mechanics Laboratory                      (1 crs)**

The laboratory covers experiments that include the basic principles of fluid mechanics. The course helps students to combine elements of theory and practice. During the course of this laboratory several experiments will be conducted that covers the course CHEE 270. Co-requisite: CHEE 270.

**CHEE 311L                      Reactive Process Engineering Laboratory                      (1 crs)**

The laboratory covers exercises in the design, operation and implementation of various types of simple chemical reactors. Co-requisite: CHEE 310.

**CHEE 411L                      Separation Processes Laboratory                      (1 crs)**

The laboratory covers exercises in techniques and instrumentation in separation processes. Co-requisite: CHEE 410.

**CHEE 441L                      Biotechnology Laboratory                      (1 crs)**

The laboratory covers exercises in techniques and instrumentation in biotechnology. Co-requisite: CHEE 440.

**CHEE 421L                      Chemical Engineering Process Design Laboratory                      (1 crs)**

The laboratory covers exercises in chemical engineering process design.  
Co-requisite: CHEE 420.

**CHEE 476L                      Chemical Reactor Design Laboratory                      (1 crs)**

The laboratory covers exercises in advanced chemical reactor design.

Co-requisite: CHEE 475.

**CHEE 486L          Fuel Cell Laboratory          (1 crs)**

The laboratory covers modern techniques for the design and assessment of fuel cells, and the deployment in hybrid electric systems. Co-requisite: CHEE 485.

**CHEE 487L          Polymer Engineering Laboratory          (1 crs)**

The laboratory covers experimental techniques to measure rheological and physical properties of various polymers. Co-requisite: CHEE 487.