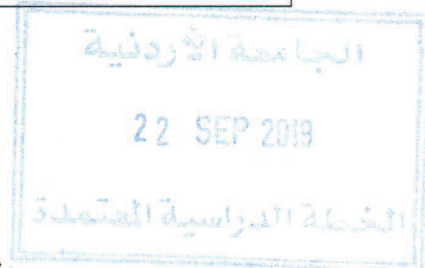| 1.	School	Engineering
2.	Department	Chemical
3.	Program title (Arabic)	بكالوريوس في الهندسة الكيميائية
4.	Program title (English)	B.Sc. in Chemical Engineering

5. Components of Curriculum:

The curriculum for the bachelor's degree in Chemical Engineering consists of (165) credit hours distributed as follows:

Number	Type of Requirement	Credit Hours
First	University Requirements	27
Second	Faculty Requirements	27
Third	Department Requirements	111
Total		**165**

6. Numbering System:

A- Department Number

Number	Department
1	Civil Engineering
2	Architectural Engineering
3	Electrical Engineering
4	Mechanical Engineering
5	Chemical Engineering
6	Industrial Engineering
7	Computer Engineering
8	Mechatronics Engineering

B- Course Number

Domain Number	Domain Title
0	Miscellaneous
1	Chemical Engineering Principles
2	Thermodynamics and Chemical Reaction Engineering
3	Material Engineering
4	Transport Phenomena
5	Unit Operations and Separations
6	Laboratories
7	Industrial Safety and Environment
8	Process Design, Control and Management
9	Projects and Practical Training

C- Course Number consists of 7 digits

School		Department		Level	Specialty	Serial
0	9	0	5	2	3	1

Preparation Program Requirements

All students admitted to the university must apply for a degree examination in Arabic and English and the computer is prepared or approved by the university to determine their level. Based on the results of the examinations, either the student will study one or more of the requirements of the preparatory program

(0 - 15 Credit Hours)

No.	Course Title	Course No.	Credit Hours	Prerequisite	Notes
1	Basics of Arabic	3201099	3	3201098	Pass/Fail
2	Arabic Language Skills	3201100	3	3201098,3201099	Pass/Fail
3	Basics of English	3202099	3	3202098	Pass/Fail
4	English Language Skills	3202100	3	3202098,3202099	Pass/Fail
5	Basics of Computing	1932099	3	1902098	Pass/Fail

First: University Requirements

	Compulsory Requirements				
	(18 Credit Hours)				
No.	Course Title	Course No.	Credit Hours	Prerequisites	Notes
1	Military Science	2200100	3		
2	National Culture	3400100	3		
3	Learning & Research Skills	3400101	3	3202099 3201099 1932099	
4	Communication Skills	3400102	3	3400101	
5	Introduction to Philosophy and Critical Thinking	3400103	3	3400101	
6	Human Civilization	3400104	3		

Electives

(9 Credit Hours)

Elective courses: (9) credit hours to be chosen from the first, second and third groups mentioned below. The student has to choose one course from each of the groups.

(First Group)

No.	Course Title	Course No.	Credit Hours	Prerequisite	Notes
1	Great Books	3400107	3		
2	Islam and Current Issues	0400101	3		
3	Arab-Islamic Civilization	2300101	3		
4	Jordan: History and Civilization	2300102	3		
5	Jerusalem	3400108	3		

Electives

(Second Group)

No.	Course Title	Course No.	Credit Hours	Prerequisite	Notes
1	Legal Culture	1000102	3		
2	Environmental Culture	0300102	3		
3	Physical Fitness Culture	1100100	3		
4	Islamic Culture	0400102	3		
5	Health Culture	0720100	3		

     Study Plan-Bachelors

		Electives				
		(Third Group)				
No.	Course Title	Course No.	Credit Hours	Prerequisite	Notes	
1	Entrepreneurship & Creativity	3400109	3			
2	Foreign Language	2200103	3			
3	Electronic Commerce	1600100	3			
4	Social Media	1900101	3			
5	Appreciation of Arts	2000100	3			
6	Special Subject	3400106	3			
7	Management Skills	1601105	3			

Second: School Courses: distributed as follows:

    A. **Obligatory School Courses: (27) credit hours.**
    B. **Elective School Courses: (Zero) credit hours.**

    A. **Obligatory School Courses: (27) credit hours:**

Course No.	Course Title	Contact Hours		Credit Hours	Prerequisite
		Theoretical	Practical		
0301101	Calculus (1)	3	-	3	-
0301102	Calculus (2)	3	-	3	0301101
0301201	Calculus (3)	3	-	3	0301102
0302101	General Physics (1)	3	-	3	-
0302111	Practical Physics (1)	-	3	1	0302101 or Co-requisite
0302102	General Physics (2)	3	-	3	0302101
0302112	Practical Physics (2)	-	3	1	0302102 or Co-requisite
0901420	Engineering Economy	3	-	3	90 Cr. Hours
0904131	Engineering Graphics and Descriptive Geometry	2	2 Drawing 2 Computer	3	-
0966111	Engineering Workshops	-	3	1	-
0907101	Computer Skills for Engineers	3	-	3	1902098, 1932099

Third: Specialty courses: (111) credit hours distributed as follows:

A. **Obligatory specialty courses: (99) credit hours**
B. **Elective specialty courses: (12) credit hours**

A. **Obligatory specialty courses: (99) credit hours:**

Course Number	Course Title	Contact Hours		Credit Hours	Prerequisite
		Theoretical	Practical		
0303101	General Chemistry (1)	3	0	3	-
0303102	General Chemistry (2)	3	0	0	0303101
0333109	Experimental General Chemistry For Non Chemistry Majors	0	3	1	0303101 or Co-requisite
0333211	Analytical Chemistry	3	0	3	0303102
0303216	Experimental Analytical Chemistry	0	3	1	0333109, 0333211
0333233	Organic Chemistry For Non Chemistry Majors	3	0	3	0303101
0303239	Practical Organic Chemistry For Non Chemistry Majors	0	3	1	0333233 or Co-requisite
0303241	Physical Chemistry(1)	3	0	3	0301102, 0303102
0903203	Electrical Engineering	3	0	3	0302102
0915201	Mathematical Methods in Chemical Engineering	3	0	3	0301201
0905211	Chemical Engineering Principles (1)	3	0	3	0303101
0905212	Chemical Engineering Principles (2)	2	2	3	0905211
0905241	Fluid Mechanics	3	0	3	0905211
0935301	Numerical Methods in Chemical Engineering	3	0	3	0907101,0915201
0905302	Process Analysis by Statistical Methods	3	0	3	0301102
0915321	Chemical Engineering Thermodynamics (1)	3	0	3	0303241, 0935212
0915322	Chemical Engineering Thermodynamics (2)	3	0	3	0915321
0915331	Materials Science and Engineering	3	0	3	0333233,0303241

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0915341	Transport Phenomena (1)	3	0	3	0905241
0915342	Transport Phenomena (2)	2	0	2	0915341
0905343	Process Heat Transfer	3	0	3	0915341
0915351	Unit Operations of Particulate Solids	3	0	3	0905241
0915361	Chemical Engineering Lab. (1)	0	3	1	0915341,0905241
0905421	Chemical Reaction Engineering (1)	3	0	3	0915322,0935301
0915422	Chemical Reaction Engineering (2)	3	0	3	0905421
0915451	Separation Processes (1)	3	0	3	0915342
0915452	Separation Processes (2)	3	0	3	0915451,0905343
0915461	Chemical Engineering Lab. (2)	0	3	1	0915322,0905351
0915471	Environmental Engineering	3	0	3	0905351
0915481	Chemical Process Technology	2	0	2	0915451
0905482	Process Dynamics and Control	3	0	3	0905421
0915561	Chemical Engineering Lab. (3)	0	3	1	0915452
0905562	Chemical Engineering Lab. (4)	0	3	1	0905482,0905421
0915571	Chemical Process Design	3	0	3	0905482
0915581	Process Safety Engineering	3	0	3	0915571
0935582	Chemical Plant Design	3	0	3	0915571
0915591	Practical Project	1	-	1	0915452
0905500	Practical Training	-	-	3	Student should pass 115 credit hours
0975598	Graduation Project (1)	1	-	1	0905500
0975599	Graduation Project (2)	2	-	2	0975598

* Project duration is two regular semesters, where project mark is registered once at the semester where project (2) is finished.

B. Elective Specialty Courses: (12) Credit Hours:

Course Number	Course Title	Contact Hours		Credit Hours	Prerequisite
		Theoretical	Practical		
	Energy				
0915323	Fuel and Energy Engineering	3	0	3	0915321
0915453	Petroleum Refining Engineering	3	0	3	0915451
0905483	Energy Conservation and Management	3	0	3	0905343
0915423	Biofuel	3	0	3	0915451,0905421
	Bioengineering				
0905424	Biochemical Engineering	3	0	3	0915342,0905421
0915551	Food Technology	3	0	3	0915452,0915351
0905454	Pharmaceutical Technology	3	0	3	0915341,0915351
	Environmental				
0915572	Waste Water Treatment	3	0	3	0915471
0915573	Air pollution and Control	3	0	3	0915471
0915552	Water Desalination	3	0	3	0915452
0905574	Hazardous Waste Management	3	0	3	0915471
	Engineering Management				
0905491	Project Management	3	0	3	0901420
0915381	Management for Chemical Engineering	3	0	3	3rd year level
0905583	Quality Control in Engineering	3	0	3	0915481,0905302
	Technology				
0905425	Corrosion Engineering	3	0	3	0905421,0915331
0905455	Extractive Metallurgy	3	0	3	0905343,0915351
0905456	Fertilizer Technology	3	0	3	0915451
0905431	Polymers Engineering	3	0	3	0915421,0915331
0915531	Nanotechnology	3	0	3	0915452

		Theoretical	Practical		
	Process Design				
0905584	Process Optimization	3	0	3	0905302,0915571
0905484	Process Modelling and Simulation	3	0	3	0905421,0915451
0905586	Chemical Product Design	3	0	3	0915571
	Special Topics				
0915401	Selected Topics in Chemical Engineering	3	0	3	4th year level
0915501	Special Topics in Chemical Engineering	3	0	3	5th year level

Fourth: Courses offered by other faculties and departments

Course Number	Course Title	Contact Hours		Credit Hours	Prerequisite
		Theoretical	Practical		
0301101	Calculus (1)	3	-	3	-
0301102	Calculus (2)	3	-	3	0301101
0301201	Calculus (3)	3	-	3	0301102
0302101	General Physics (1)	3	-	3	-
0302111	Practical Physics (1)	-	3	1	0302101 or Co-requisite
0302102	General Physics (2)	3	-	3	0302101
0302112	Practical Physics (2)	-	3	1	0302102 or Co-requisite
0901420	Engineering Economy	3	-	3	90 Cr. Hours
0904131	Engineering Graphics and Descriptive Geometry	2	2 Drawing 2 Computer	3	-
0966111	Engineering Workshops	-	3	1	-
0907101	Computer Skills for Engineers	3	-	3	1902098,1932099
0303101	General Chemistry (1)	3	0	3	-
0303102	General Chemistry (2)	3	0	0	0303101
0333109	Experimental General Chemistry For Non Chemistry Majors	0	3	1	0303101 or Co-requisite
0333211	Analytical Chemistry	3	0	3	0303102
0303216	Experimental Analytical Chemistry	0	3	1	0333109, 0333211
0333233	Organic Chemistry For Non Chemistry Majors	3	0	3	0303101

0303239	Practical Organic Chemistry For Non Chemistry Majors	0	3	1	0333233 or Co-requisite
0303241	Physical Chemistry (1)	3	0	3	0301102, 0303102
0903203	Electrical Engineering	3	0	3	0302102

Fifth : Advisory Study Plan
First Year

First Semester			Second Semester		
Course Number	Course Title	Credit Hours	Course Number	Course Title	Credit Hours
0301101	Calculus (1)	3	0301102	Calculus (2)	3
0302101	General Physics (1)	3	0302102	General Physics (2)	3
0302111	Practical Physics (1)	1	0904131	Engineering Graphics and Descriptive Geometry	3
0303101	General Chemistry (1)	3	0303102	General Chemistry (2)	3
0333109	Experimental General Chemistry For Non Chemistry Majors	1	0907101	Computer Skills for Engineers	3
0966111	Engineering Workshops	1	0302112	Practical Physics (2)	1
	University Requirement	3			
Total		15	**Total**		16

Second Year

First Semester			Second Semester		
Course Number	Course Title	Credit Hours	Course Number	Course Title	Credit Hours
0905211	Chemical Engineering Principles (1)	3	0915201	Mathematical Methods in Chemical Engineering	3
0301201	Calculus (3)	3	0905241	Fluid Mechanics	3
0333211	Analytical Chemistry	3	0905212	Chemical Engineering Principles (2)	3
0303216	Experimental Analytical Chemistry	1	0303241	Physical Chemistry (1)	3
0333233	Organic Chemistry For Non Chemistry Major	3	0903203	Electrical Engineering	3
0303239	Practical Organic Chemistry For Non Chemistry Majors	1		University Requirement	3
	University Requirement	3			
Total		17	**Total**		18

Third Year

First Semester			Second Semester		
Course Number	**Course Title**	**Credit Hours**	**Course Number**	**Course Title**	**Credit Hours**
0935301	Numerical Methods in Chemical Engineering	3	0915322	Chemical Engineering Thermodynamics (2)	3
0915321	Chemical Engineering Thermodynamics (1)	3	0915342	Transport Phenomena (2)	2
0915341	Transport Phenomena (1)	3	0905343	Process Heat Transfer	3
0915331	Materials Science and Engineering	3	0915361	Chemical Engineering Lab (1)	1
0915351	Solid Particulate Operation	3	0905302	Process Analysis by Statistical Methods	3
	University Requirement	3		University Requirement	3
Total		**18**	**Total**		**15**

Fourth Year

First Semester			Second Semester		
Course Number	**Course Title**	**Credit Hours**	**Course Number**	**Course Title**	**Credit Hours**
0901420	Engineering Economy	3	0915452	Separation Processes (2)	3
0915451	Separation Processes (1)	3	0915471	Environmental Engineering	3
0905421	Chemical Reaction Engineering (1)	3	0915422	Chemical Reaction Engineering (2)	3
0915461	Chemical Engineering Lab. (2)	1	0915481	Chemical Process Technology	2
	Department Elective	3	0905482	Process Dynamics and Control	3
	University Requirement	3		University Requirement	3
Total		**16**	**Total**		**17**

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Fifth Year

First Semester			Second Semester		
Course Number	**Course Title**	**Credit Hours**	**Course Number**	**Course Title**	**Credit Hours**
0915571	Chemical Process Design	3	0905562	Chemical Enginecring Lab. (4)	1
0915561	Chemical Engineering Lab. (3)	1	0935582	Chemical Plant Design	3
	Department Elective	3		Department Elective	3
0975598	Graduation Project (1)	1	0935581	Process Safety Engineering	3
0915591	Practical Project	1	0975599	Graduation Project (2)	2
	University Requirement	3		University Requirement	3
	Department Elective	3			3
Total		**15**	**Total**		**15**

0301101   **Calculus (1)**   **(3 Credit Hours)**
          Prerequisite: (None)
Functions: domain, operations on functions, graphs of functions, trigonometric functions, limits: meaning of a limit, computational techniques, limits at infinity, infinite limits, continuity, limits and continuity of trigonometric functions, the derivative: techniques of differentiation, derivatives of trigonometric functions, the chain rules, implicit differentiation, differentials, Roll's Theorem, the mean value theorem, the extended mean value theorem, L'Hopital's rule, increasing and decreasing functions, concavity, maximum and minimum values of a function, graphs of functions including rational functions (asymptotes) and functions with vertical tangents (cusps), antiderivatives, the indefinite integral, the definite integral, the fundamental theorem of calculus, the area under a curve, the area between two curves, transcendental functions: inverse functions, logarithmic and exponential functions, derivatives and integrals, limits (the indeterminate forms), hyperbolic functions and their inverses, inverse trigonometric functions.

0301102   **Calculus (2)**   **(3 Credit Hours)**
          Prerequisite: 0301101
Techniques of integration: integration by substitution, integration by parts, integrating powers of trigonometric functions, trigonometric substitutions, integrating rational functions, partial fractions, rationalization, miscellaneous substitution, improper integrals, application of definite integral: volumes, length of a plane curve, area of a surface of revolution polar coordinates and parametric equations: polar coordinates, graphs in polar coordinates, area in polar coordinates, infinite series: sequences, infinite series, convergence tests, absolute convergence, conditional convergence, alternating series, power series: Taylor and Maclurine series, differentiation and integration of power series.

0301201   **Calculus (3)**   **(3 Credit Hours)**
          Prerequisite: 0301102
Three dimensional space and vectors rectangular coordinates in 3-space, spheres, cylindrical surfaces, quadric surfaces, vectors: dot product, projections, cross product, parametric equations of lines. Planes in 3-spaces, vector-valued functions: calculus of vector valued functions, change of parameters, arc length, unit tangent and normal vectors, curvature, functions of two or more variable: domain, limits, and continuity, partial derivatives, differentiability, total differentials, the chain rule, the gradient, directional derivatives, tangent planes, normal lines, maxima and minima of functions of two variables, Lagrange multipliers, multiple integrals: double integral, double integrals in polar coordinates, triple integrals, triple integrals in cylindrical and spherical coordinates, change of variables in multiple integrals, Jacobian.

0302101 **General Physics (1)** (3 Credit Hours)
Prerequisite: None
Motion in one dimension, motion in two dimensions, the laws of motion, circular motion, conservation of energy, linear momentum and collisions, rotation of a rigid object about a fixed axis, angular momentum, static equilibrium, universal gravitation, fluid mechanics, oscillatory motion.

0302111 **Practical Physics (1)** (1 Credit Hour)
Prerequisite: 0302101 or Co-requisite
11 experiments each of 3 hrs/week duration: collection and analysis of data, measurements and uncertainties, vectors: force table, kinematics of rectilinear motion, force and motion, collision in two dimensions, rotational motion, simple harmonic motion: simple pendulum, gas's Laws, ballistic pendulum, specific heat capacity of metals.

0302102 **General Physics (2)** (3 Credit Hours)
Prerequisite: 0302101
Electric field, Gauss's law, electric potential, capacitance and dielectrics, current and resistance, direct current circuits, magnetic field, sources of the magnetic field, Faraday's law, inductance, alternating current circuits, the nature of light and the principles of ray optics, image formation.

0302112 **Practical Physics (2)** (1 Credit Hour)
Prerequisite: 0302101 or Co-requisite
12 experiments each of 3 hrs/week duration: electric field mapping, specific charge of copper ions, power transfer, potentiometer, capacitors: RC time constant, Kirchoff's laws, magnetic field of a current, lenses, Young's double slit experiments, electromagnetic induction, Ohm's law, Wheatstone bridge.

0901420 **Engineering Economy** (3 Credit Hours)
Prerequisite: (Passing 90 Cr. Hrs.)
Major elements of feasibility studies. Principles of engineering economy. Equivalence and compound interest formulas. Single payment model. Uniform payment model. Gradient payment model. Exponential payment model. Decision criteria for single and multiple alternatives: present worth, annual worth, future worth, internal rate of return, benefit cost ratio and payback methods. Income-tax effect on decision making.

0904131 **Engineering Graphics and Descriptive Geometry** (3 Credit Hours)
Prerequisite: None
Drawing equipment and use of instruments. Lettering, Geometric construction, Sketching and shape description. Basic descriptive geometry, Developments and intersections. Axonometric, oblique and perspective drawings, Multiview projection, Principal views, Conventional practice, and sectional views. Auxiliary views. Dimensioning techniques. Parallel: Introduction to computer drawing, Drawing aids, Geometrical construction, and the appropriate commands of text, editing, plotting, sections, layers, pictorial views, and dimensioning. Auxiliary views.
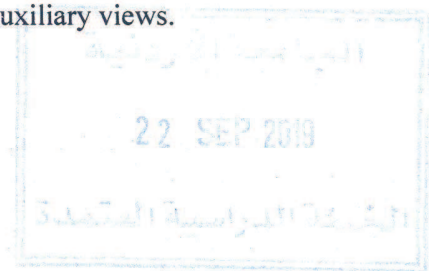
0966111   **Engineering Workshops**   **(1 Credit Hour)**
Prerequisite: None
General safety, materials and their classifications, measuring devices and their accuracy, fits and tolerances, theoretical background for the practical exercises including fitting, forging, carpentry, casting, welding, mechanical saws, shearers, drills, lathes, milling machines, shapers and grinders.

0907101   **Computer Skills for Engineers**   **(3 Credit Hours)**

Prerequisite:1902098, 1932099
This course presents the fundamental concepts of programming using one high level programming language like C++, Java, or Python. It covers the basic structures of the programming language such as variables, data types, control structure, arrays, functions, and introduction to records (struct) and object oriented programming (classes and objects). The course will focus on providing the students with practical programming skills through home works and exams which require writing whole programs.

0303101   **General Chemistry (1)**   **(3 Credit Hours)**
Prerequisite: None
Measurements and significant figures, chemical reactions, stoichiometry, the gaseous state, thermochemistry, electronic structure and periodicity, chemical bonding, molecular shapes, states of matter and intermolecular forces.

0303102   **General Chemistry (2)**   **(3 Credit Hours)**
Prerequisite:0303101
Physical properties of solutions, chemical kinetics, chemical equilibrium, acids and bases, acid-base equilibria in aqueous solutions, solubility and complex ion equilibria, chemical thermodynamics, electrochemistry.

0333109   **Experimental General Chemistry   For Non chemistry**   **(1 Credit Hours)**
Majors
Prerequisite: 0303101 or Co-requisite
The course includes experiments dealing with the following topics:
Safety and laboratory rules, chemical observations, Avogadro's number, stoichiometry, volumetric analysis, oxidation and reduction, colligative properties, thermochemistry and equilibrium.

0333211   **Analytical Chemistry**   **(3 Credit Hour)**
Prerequisite: 0303102
The scope and importance of analytical chemistry, errors and statistical evaluation of data, equilibrium and equilibrium calculations, gravimetric analysis, volumetric analysis: precipitation titrations, complexometric titrations, acid-base titrations.
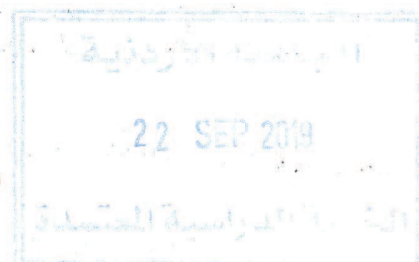
0303216   **Experimental Analytical Chemistry**   **(1 Credit Hours)**
Prerequisite: 0333211 ,0333109
The course includes experiments dealing with the following topics: statistical treatment of data, gravimetric analysis, acid-base titrations, precipitation titrations, complexometric titrations, redox titrations, analysis of real samples.

0333233   **Organic Chemistry For Non Chemistry Majors**   **(3 Credit Hours)**
Prerequisite: 0303101
Hydrocarbons: alkanes, cycloakanes, alkenes, alkynes, aromatic compounds, stereochemistry, halides, alcohols, phenols, ethers, amines, carbonyl compounds and carboxylic acids.

0303239   **Practical Organic Chemistry For Non Chemistry Majors**   **(1 Credit Hours)**
Prerequisite: 0333233 or Co-requisite
The course involves separation, purification of and identification of organic compounds through their physical properties: melting point, distillation, crystallization, extraction, and chromatography, preparation of simple organic compounds, qualitative tests for selected classes of organic compounds.

0303241   **Physical Chemistry (1)**   **(3 Credit Hours)**
Prerequisite: 0303101, 0301102
Gases and kinetic molecular theory, first law of thermodynamics and thermochemistry, the second and third laws of thermodynamics, chemical equilibrium, phases and solutions, phase equilibria and electrolytes.

0903203   **Electrical Engineering**   **(3 Credit Hours)**
Prerequisite: 0302102

Ohm's and Kirchhoff's Laws. Series and parallel connections, Voltage and current division. Nodal and mesh analysis. Superposition. Thevinin's and Norton's theorems. Inductance and capacitance. Source free RL and RC circuits. Response of RL and RC and RLC circuits to unit step function. Characteristics of a sinusoid. The phasor concept. Phasor relationships for R, L, and C elements. Impedance and admittance. Effective values of current and voltage. Instantaneous, average and apparent power and power factor. Three-phase Y- and Delta- connections. Introduction to semiconductors. The PN junction. Applications of PN junctions (rectifiers). Transistors: operation, model, V-I characteristics. Operational amplifiers and gates. Safety considerations. Protective earthing.

0915201   **Mathematical Methods in Chemical Engineering**   **(3 Credit Hours)**
Prerequisite: 0301201
Solution of first, second and higher order ordinary differential equations, system of first order ordinary differential equations. Laplace transforms and Fourier analysis. Solution of partial differential equations types. Solution with application in chemical engineering (mixing, heat and mass transfer, reaction, and fluid flow problems). Using computer applications and focusing on symbolic solutions tools.

0905211   **Chemical Engineering Principles (1)**   **(3 Credit Hours)**
Prerequisite: 0303101
The scope of chemical engineering, The role of the chemical engineer, chemical processes, units and dimensions, conversion of units. Systems of units, dimensional homogeneity, process data representation data analysis, processes and process variables, process representation and flow sheeting, introduction to material balances, degrees of freedom analysis, material balances for single and multiple non-reactive systems, material balance for reactive systems. Ideal Gases, real gases: compressibility and equation of states, single component two-phase systems (vapor pressure). Gas-liquid systems. The phase rule and vapor-liquid equilibria. Liquids and gases in equilibrium with solids. Computer applications using available software.

0905212   **Chemical Engineering Principles (2)**   **(3 Credit Hours)**
Prerequisite: 0905211
Forms of energy, the first law of thermodynamics. Energy balance on a closed system. Steady-state energy balance on open systems and mechanical energy balance. Energy balances on non-reactive and reactive systems. Simultaneous material and energy balances. Balances on transient systems. The course has 2 credit hours in class and 1 credit hour as a laboratory computer work using available software in which they build flow sheets and solve mass/energy balances of various chemical engineering processes, combustion, heat of reactions, solutions.

0905241   **Fluid Mechanics**   **(3 Credit Hour)**
Prerequisite: 0905211
Introduction to fluid mechanics. Fluid properties, Newton's Law of Viscosity, types of fluids. Hydrostatics, the hydrostatic equation for incompressible Fluids, manometers, pressure distribution on submerged surfaces, the center of pressure, buoyancy. Bernoulli's equation. Fluid flow measurements. Laminar and turbulent flows, fluid friction and pressure drop through pipes and fittings. Macroscopic momentum balances. Dimensional analysis, dynamics similitude. Pumps and pumping of liquids, types of pumps and their performance curves.

0935301   **Numerical Methods in Chemical Engineering**   **(3 Credit Hour)**
Prerequisite: 0915201, 0907101
Computers and error analysis, root finding, solution of linear and nonlinear system of equations, interpolation and curve fitting, numerical integration and differentiation and solution of ordinary differential equations. Single and system of ordinary differential equations. Solving initial value problems, introduction to numerical solution of partial differential equations. All methods are emphasized using algorithm development. Programming the main algorithms discussed in the course using available programming language tools.
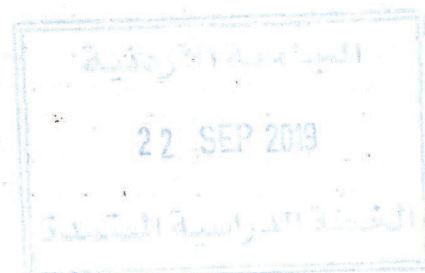
0905302   **Process Analysis by Statistical Methods**   **(3 Credit Hour)**
Prerequisite: 0301102
Introduction to probability and statistics: Fundamentals of statistical of distributions (one and two dimensions), testing hypotheses and confidence intervals, regression analysis, simple comparative experiments, experiments with a single factor, analysis of variance (ANOVA), factorial designs, two-level fraction factorial designs. Applications in chemical engineering and using available software.

0915321   **Chemical Engineering Thermodynamics (1)**   **(3 Credit Hours)**
Prerequisite: 0935212, 0303241
Introduction to engineering thermodynamics. Application of first law of thermodynamics: conservation of energy, control volume analysis (steady and unsteady analysis), flow and work applications. Applications of the second law of thermodynamics: reversible and irreversible processes, entropy relations (control mass & volume analysis), isentropic processes. Component efficiencies: turbines, compressors, pumps, and nozzles efficiency. Thermodynamic cycles and common energy systems: Heat engine cycles, external and internal heat transfer cycles, Rankin cycle, refrigeration, and air conditioning cycles. Thermodynamic Properties of Fluids: Analytical and generalized equations of state. Departure functions based on analytical and generalized relationships. Relationships among thermodynamic properties.

0915322   **Chemical Engineering Thermodynamics (2)**   **(3 Credit Hours)**
Prerequisite: 0915321
Physical equilibria among phases: phase rule, vapor-liquid equilibria for various systems. Equilibrium phase diagrams. Solution thermodynamics: Properties of binary mixtures and solutions: fugacity of gases and liquids, ideal and non-ideal solutions, activity and standard states, Gibbs-Duhem equation, chemical reaction equilibrium. Use of available software.

0915331   **Materials Science and Engineering**   **(3 Credit Hour)**
Prerequisite: 0333233, 0303241
Understanding the structure of materials in term of crystal geometry, structural disorder, and solid solution and phase diagram. Material classification, metals, polymers, ceramics, glass, and composites. Material properties (mechanical, thermal, chemical, optical, and electrical).
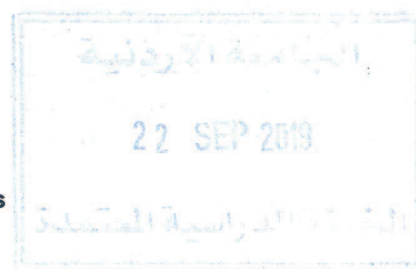
0915341   **Transport Phenomena (1)**   **(3 Credit Hours)**
Prerequisite: 0905241

Momentum transfer: Viscosity and the mechanism of momentum transfer. Shell momentum balance, Application of shell momentum balance. Velocity distribution in laminar flow (steady state), Boundary layer theory. The flow of falling film, flow through circular pipe, Flow through annulus, Flow over moving plate. Introduction to turbulence. Introduction to boundary layer theory. Universal velocity profile in turbulent flow.

Energy transfer:

Basic concept of heat transfer and heat transfer mechanics: (conduction, convection, and radiations). Shell energy balance and its applications: Heat conduction equation, steady-state conduction, the temperature distribution in solids and in laminar flow. Unsteady state heat transfer in solids, Convection heat transfer and the concept of heat transfer coefficient. Introduction to radiation heat transfer.

0915342   **Transport Phenomena (2)**   **(2 Credit Hours)**
Prerequisite: 0915341

Mechanisms of mass transfer. Mass transfer by molecular diffusion: Ficks Law, diffusivity in gas, liquid, and solids, differential equations of mass transfer: steady state and transient analysis. Convective Mass Transfer. The concept of mass transfer coefficient, mass transfer coefficient for different geometries: flat plate, single sphere, cylinder, and flow in pipes. Interphases mass transfer, the two films theory. Momentum, heat and mass transfer analogy.

0905343   **Process Heat Transfer**   **(3 Credit Hours)**
Prerequisite: 0915341

Types of heat exchangers, design of heat exchangers: double-pipe exchanger, shell and tube heat exchanger. Cross flow heat exchangers. Plate heat exchangers, Single, and multicomponent condensation and boiling. Design of condensers and vaporizers. Radiation in heat transfer processes. Design of fired heaters and furnaces. Jacketed vessels and tube coils.

0915351   **Unit Operations of Particulate Solids**   **(3 Credit Hours)**
Prerequisite: 0905241

Characterization of solids: Solid properties, size analysis, solids in bulk, handling and flow of solids, selection and design, solid transfer equipment: Size reduction. Fluid particle systems: packing and packed columns, sedimentation, filtration, solid mixing, flotation and fluidization.

0915361   **Chemical Engineering Lab (1)**   **(1 Credit Hour)**
Prerequisite: 0905241, 0915341

Perform some experiments in fluid mechanics and heat transfer including fluid flow and pressure measurement devices, energy losses and pressure drops in pipes and fittings, heat conduction, heat convection, heat exchangers, pumps, and fans.

0905421 **Chemical Reaction Engineering (1)** **(3 Credit Hour)**
Prerequisite: 0935301, 0915322
Kinetics of homogeneous reactions, rate equations and conservations equation applied to homogeneous reaction, design of isothermal reactors (batch, CSTR, and plug flow), single and multiple ideal reactors, non-catalytic packed bed reactors, choice of reactor for various reactions. Non-elementary homogeneous reactions, yield and selectivity for isothermal reactors with multiple reactions. Collection and analysis of reaction rate data. Reaction mechanisms and enzymatic reactions. Non-isothermal reactions. Stability of CSTR's.

0915422 **Chemical Reaction Engineering (2)** **(3 Credit Hours)**
Prerequisite: 0905421
Design of unsteady-state, isothermal and non-isothermal reactors. Non-elementary reactions including Enzymatic, Polymeric, Photo and electrochemical reactions. Introduction to heterogeneous reactions, introduction to multiphase reaction systems. Non-catalytic fluid-solid reactions and reactors. The concept of rate controlling step. Catalysis and kinetic-catalytic models. Catalytic reaction mechanism, catalytic heterogeneous reactors packed and fluidized bed types. Thermal characteristics, the design of catalytic reactors, deactivation of the catalyst. Introduction to non-ideal reactors and residence time distribution.

0915451 **Separation Processes (1)** **(3 Credit Hours)**
Prerequisite: 0915342
Material balance on steady-state continuous co-current and counter current processes. Distillation: Equilibrium data, batch, flash, continuous binary steady state distillation, multicomponent, steam, Gas absorption: Equilibrium data, multistage continuous contacting, nonisothermal, multi-component, design of trays and packed columns.
Solvent extraction: Phase equilibria, stage-wise calculations, transfer units, tower design, mixer-settler. Design of stirred vessel systems. Leaching: Equilibrium relations, stage-wise calculations.

0915452 **Separation Processes (2)** **(3 Credit Hours)**
Prerequisite: 0915451,0905343
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, the design of driers. Evaporation: Single and multiple effects, and flow arrangements, heat pumps, barometric condensers. Crystallization: Theory, batch and continuous, equilibrium enthalpy balances, the design of different types of crystallizers. Adsorption: Stagewise adsorptions, continuous adsorption, design using LUB concept and regeneration.

0915461   **Chemical Engineering Lab (2)**   **(1 Credit Hours)**
Prerequisite: 0905351,0915322
Perform experiments in solid particulate operations and thermodynamics including size reduction and sieving, fluidization, mixing of solids, vapor-liquid equilibrium, liquid-liquid equilibrium and energy measurements.

0915471   **Environmental Engineering**   **(3 Credit Hours)**
Prerequisite: 0905351
Overview of ecological & environmental systems, environmental ethics, regulations, and standards. Environmental impact assessment and sustainable development. Water pollution and water quality management. Environmental Microbiology. Selection and design of municipal wastewater treatment systems. Air pollution and meteorology. Climate change and global pollution effects. Sources, effects, control of gas and particulate pollutants. Solid waste management and sanitary landfill design.

0915481   **Chemical Process Technology**   **(2 Credit Hours)**
Prerequisite:0915451
Fundamentals of chemical industries. Study of selected industries such as Dead Sea chemical industries (Potash, Bromine, Magnesium, table salt, etc....) oil and gas industries, oil shale technologies, cement, phosphate, pharmaceutical, and food industries. Water desalination.

0905482   **Process Dynamics and Control**   **(3 Credit Hours)**
Prerequisite: 0905421
Introduction to process control and instrumentation, modelling of dynamic behaviour of chemical processes, transfer functions, block diagrams, dynamic behaviour of first- and second-order systems, analysis and design of control systems, types of controllers: feedback, feed-forward, and cascade controllers, design of feedback controllers: P, PI, PD, and PID, closed- and open-loop response, stability analysis, tuning of controllers, state space formulation, introduction to frequency response analysis, Bode stability, computer application using MATLAB.

0915561   **Chemical Engineering Lab (3)**   **(1 Credit Hour)**
Prerequisite: 0915452
Perform experiments in separation processes including diffusion, sorption-desorption, absorption, humidification, distillation, extraction, drying, and evaporation.

0905562   **Chemical Engineering Lab (4)**   **(1 Credit Hours)**
Prerequisite: 0905481, 0905421
Perform experiments in chemical reaction engineering and process control including batch, continuous, and plug flow reactors, measurement of residence time distributions, experimental measurement and control of flow, temperature, pressure, level and pH variables. Dynamic simulation and of open & closed loop processes using software

0915571   **Chemical Process design**   **(3 Credit Hours)**
Prerequisite: 0905482
Evolutionary nature of process design, evolution of conceptual design through process diagrams and flow sheet structure with emphasis on utilities and pipe sizing, synthesis and design of chemical processes by understanding the hierarchy of process design using the onion model, Structure of the chemical process flowsheet, design and optimization of process recycle structure, Sequencing of simple distillation columns, Synthesis and design of heat exchanger networks, Computer applications with emphasis on available flowsheeting packages.

0915581   **Process Safety Engineering**   **(3 Credit Hours)**
Prerequisite: 0915571
Introduction to safety and loss prevention. Hazards of Chemical and toxic materials: indices, grouping, and ratings. Fires and explosions, ignition and ignition sources. Explicability characteristics for gas and dust, explosivity limits, explosion pressures, ignition temperature, and ignition energy. Methods of protection and prevention, such as bursting discs, relief valves, suppression, and inerting. Design of safety valves, HAZOP and risk analyses for process systems. Safety codes and checklist consideration in design and operation. Maintenance and permit to work proforma. Layers of protection analysis and incident investigations. Several case studies.

0935582   **Chemical Plant Design**   **(3 Credit Hour)**
Prerequisite: 0915571
Standards and codes for preparing PFD and P&ID, material and energy balances on the flow sheet level using modern principles of computer-aided flowsheeting, estimation of footprint of major pieces of equipment using shortcut design methods, heuristic tables and process simulators through a case study approach, material of construction, two and three-dimensional plant layout with safety considerations, site location, economic analysis of chemical processes: Methods for estimation of fixed capital cost and cost of manufacturing, profitability analysis, introduction to process optimization, use of computer-aided tools for rapid equipment sizing, cost estimation and economic analysis.

0915591   **Practical Project**   **(1 Credit Hours)**
Prerequisite: 0915452
The course is offered to students in the 5th year. Students will work in groups of 3 to 5 students. Each group will have a supervisor to guide them through the course. Each group must define a problem to work on, identify and specify the requirements in order to execute the project. The project may focus either on experimental work (in the lab) or simulation problem or both. The course will help students to enhance their experimental design and data analysis skills, communications (oral and written) skills, team work and research skills.

0905500 **Practical Training (Student should pass 115 credit hours)** **(3 Credit Hours)**
Students should conduct full time practical training for continuous eight weeks (280 hours) according to the laws of conferring the B.Sc. degree at the school of engineering in local or international chemical companies.

0975598 **Graduation Project (1)** **(1 Credit Hours)**
Prerequisite: 0905500
This course is the first of a two-course sequence in which the students will perform design for a specified process. Students will work in groups, each group will have a supervisor to guide them through the course. The students should select or synthesis a chemical process for which they should provide a flow sheet and all pieces of equipment and perform material and energy balances. The students are expected to submit an interim and/or final report at the end of this course.

**0975599** **Graduation Project (2)** **(2 Credit Hours)**
Prerequisite: 0975598
This course is a continuation of design project (1) which leads students to aquire complete process design experience. A chemical processing process is to be designed including the feasibility study, process and equipment design, and optimization. Emphasis is placed on problem formulation and the analytical aspects of open-ended design situations. Throughout the varied experiences in this course, the common thread will be to develop the students' ability to solve complex, open-ended chemical engineering problems involving technical, environmental, ethical, safety, and economic issues.

0915323 **Fuel and Energy Engineering** **(3 Credit Hours)**
Prerequisite: 0915321
Importance of energy in our life. Energy classification, sources and utilization. Non-renewable energy: Fossil fuels, nuclear energy, hydrogen fuel. Fossil-fuel systems and applications, principles of combustion, gasification, and pyrolysis, waste heat recovery systems. Renewable Energy: solar energy, wind power, tidal power, geothermal energy, and biofuels, environmental impact of energy. Energy storage: Chemical storage, thermal storage and fuel cells. Impact of energy generation and use on the environment.

0915453 **Petroleum Refining Engineering** **(3 Credit Hours)**
Prerequisite: 0915451
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, hydro-treating, catalytic hydrocracking, alkylation. Product blending and production of lubricating oil. Asphalt technology. Supporting processes. Cost estimation and economic evaluation.
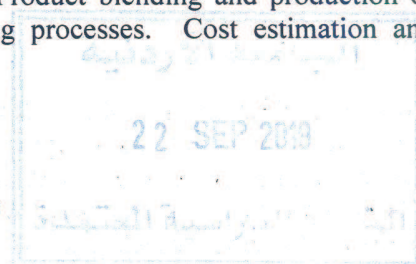
0905483 **Energy Conservation and Management** **(3 Credit Hours)**
Prerequisite: 0905343
Review of energy sources and their applications. Energy auditing. Energy conservation in industrial and commercial sectors. Choice of fuel. Waste heat recovery systems. Energy economics and economic use of electricity. Process integration for efficient use of electricity. Process integration for efficient use of energy including energy cogeneration, selection of heat transfer equipment and enhancement of heat transfer.

0915423 **Biofuel** **(3 Credit Hours)**
Prerequisite: 0915451,0905421
Description of the different "generations" of biofuels: 1.biofuels from sugars, starches, vegetable and animal oils 2. Biofuels from non-food crops like ligno-cellulose 3. Biofuels from algae 4. Biofuels from specially engineered plants. Biomass feedstock's, fuels from cellulose, bioethanol, biobutanol, biodiesel, algae biofuel, biogas, microbial fuel cells. Calculation energy balance of biofuel production. Environmental impacts of biofuel production, economics and life-cycle analysis of biofuel, value-added processing of biofuel residues, thermochemical conversion of biomass to heat, power, and fuel, case studies on biofuel production.

0905424 **Biochemical Engineering** **(3 Credit Hours)**
Prerequisite: 0905422,0915342
Introduction to biotechnology engineering. Elementary biochemistry and microbiology. Microbial metabolisms. Kinetics and mechanisms of enzymatic reactions, enzyme inhabitation, 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.

0915551 **Food Technology** **(3 Credit Hours)**
Prerequisite:0915452,0915351
Fundamental principles of food engineering, food processing in terms of product quality and production system, processing techniques involved in food industry, thermal processing, food preservation, freezing, canning, pickling, dehydration, irradiation, enzyme technology, nutritional practices, separation and concentration, high-pressure and minimal processing methods.

0905454 **Pharmaceutical Technology** **(3 Credit Hours)**
Prerequisite:0915351,0915342
Chemical engineering in the pharmaceutical industry: an introduction. Current challenges and opportunities in the pharmaceutical industry. Dosage forms (liquid dosage forms, semisolid and solid dosage forms). The design and preparation of a successful dosage form with respect to the route of administration and large scale manufacture in a sterile and clean environment. Aspects of chemical kinetics, physical chemistry, physiology, cell biology, mass and heat transfer, and fluid dynamics will be described as they relate to the manufacture of effective dosage forms. Powders in pharmaceutical processes: particles properties and interactions, flow and packing of powders, processes including granulation, fluidization, mixing and blending.

0915572   **Waste Water Treatment**   **(3 Credit Hours)**
Prerequisite :0915471
Overview of water pollutants. Local and international standards for wastewater from industry effluents. Standard methods for wastewater treatment. Primary, secondary and tertiary treatment methods for wastewater such as flocculation, settling, flotation, filtration chemical treatment, biological treatment, sludge treatment and disposal. Membrane separation and adsorption.

0915573   **Air Pollution and Control**   **(3 Credit Hours)**
Prerequisite: 0915471
Air pollutants and sources of air pollution. Ventilation of confined space. Air streams including stack emissions and exhaust fans. Introduction to air dispersion, Gauss model. Local and international standards for air pollutants. Wet and dry air pollution control methods. Air pollution control instruments. Air sampling and measurement of pollutants.

0915552   **Water Desalination**   **(3 Credit Hours)**
Prerequisite :0915452
Need for water desalination: Review of local, regional and worldwide water resources, drinking water standards, types and properties of saline waters. Water desalination technologies and criteria for process selection. Detailed description and design and operational aspects of commercial desalination methods mainly MSF, MEE, VC, and RO including scale formation problems and pretreatment requirements. Post treatment of product water.

0905574   **Hazardous Waste Management**   **(3 Credit Hours)**
Prerequisite: 0915471
Hazardous wastes regulatory framework and international conventions. Hazardous waste sources, properties and classification, storage, transport, fate and transport of contaminants. Hazardous waste minimization and pollution prevention options. Hazardous waste treatment technologies and remediation processes, as well as, safe disposal of hazardous waste. Management of non-conventional hazardous wastes (medical waste, etc).

0905491   **Project Management**   **(3 Credit Hours)**
Prerequisite: 0901420
The course covers key components of project management including project life-cycle and organization, project integration, project scope management, project time and cost management, human resource management, project communications management, decision making and problem solving, project risk management, and project procurement management. Case studies covering a wide variety of project types and industries.
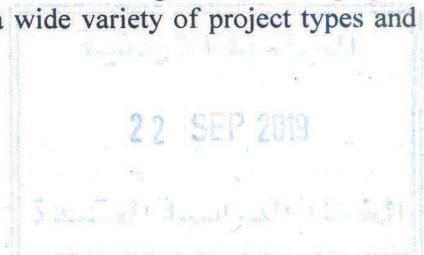
0915381　**Management for Chemical Engineering**　　　**(3 Credit Hours)**
Prerequisite: 3rd year level
Theories of management, Forecasting, Organisation of chemical engineering projects, Breakeven analysis, project evaluation and cashflow diagrams. Critical path method, decision trees and alternatives, inventory control.

0905583　**Quality Control in Engineering**　　　**(3 Credit Hours)**
Prerequisite:0915481, 0905302
Quality improvement, its importance, dimensions and costs. Statistical quality control: basic statistical tools, control charts (x-bar, S, and charts), analysis of charts, process capability. Principles of TQM and trend in quality management. The IOS model and its requirements and specifications, and ISO application.

0905425　**Corrosion Engineering**　　　**(3 Credit Hours)**
Prerequisite:0905421,0915331
Fundamental, principles and laws of electrochemistry. Thermodynamics and kinetics of electrochemical cells. Heat and Mass transfer in electrochemical reactors. Theory of corrosion. Types and mechanisms of corrosion processes. Corrosion control by preventative methods, chemical additives, and electrical techniques.

0905455　**Extractive Metallurgy**　　　**(3 Credit Hours)**
Prerequisite:0905343,0915351
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, aluminium, manganese, magnesium and uranium industries.

0905456　**Fertilizer Technology**　　　**(3 Credit Hours)**
Prerequisite:0915451
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.

0905431　　**Polymers Engineering**　　　　　　　　　**(3 Credit Hours)**
Prerequisite:0905421,0915331
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 melts rheology.　Extrusion. Injection molding.　Blowmolding.　Film blowing. Calendering.

0915531　　**Nanotechnology**　　　　　　　　　　　**(3 Credit Hours)**
Prerequisite:0915452
Introduction to nanotechnology and nanoscale engineering. Synthesis of nanocarobon and nanocomposites, unique chemical and physical properties, materials characterization. Current and potential applications of inorganic, biological, and hybrid materials. Application of nanotechnology for environmental remediation, and water and air treatment. Application of nanotechnology for catalysis and chemical reaction. Nano-sensors design and fabrication, and application for chemical and biological systems. Synthesis and fabrication of nanocomposite materials, bulk metal and ceramic nanocomposite, Polymer-based and polymer-filled nanocomposite, modeling of nanocomposites.

0905584　　**Process Optimization**　　　　　　　　　**(3 Credit Hour)**
Prerequisite:0915571,0905302
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.

0905484　　**Process Modelling and Simulation**　　　　　**(3 Credit Hours)**
Prerequisite: 0905421,0915451
Introduction to modelling and simulation, development, solution and analysis of model equations for batch and continuous systems at steady and unsteady state conditions, analysis of models: Basic concepts of analysis are illustrated through applications to typical chemical engineering problems, which include linear and nonlinear systems, Introduction to simulation methodologies and process flowsheet simulators.

0905586　　**Chemical Product Design**　　　　　　　　**(3 Credit Hours)**
Prerequisite: 0915571
Introduction to chemical product design, process versus product design, strategies for chemical product design: Needs, ideas, selection & manufacture, Product manufacture, Commodity products, Devices, Computer-Aided Methods and Tools for chemical product design: Property prediction, Computer-aided molecular and mixture design, application examples, Case studies.

0915401　　**Selected Topics in Chemical Engineering**　　　**(3 Credit Hour)**
Prerequisite: 4th year level
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.

0915501   **Special Topics in Chemical Engineering**   **(3 Credit Hours)**
                Prerequisite: 5th year level
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.