

## Department of Chemistry

### Bachelor Degree in Chemistry



#### **OVERVIEW**

The Department of Chemistry was established in September **1991**; the same year the University of Petra (UOP) was established. The Department offers a program leading to a Bachelor Degree in Chemistry. It also offers general courses to serve university students and special courses to serve students of the Faculty of Pharmacy, Engineering, Information Technology and Medical Sciences.

#### **VISION**

Department of Chemistry at University of Petra is an incubator of excellence in Jordan and the region, for students and scholars.

#### **MISSION**

Department of Chemistry prepares knowledgeable and competent chemists and other chemistry - related professionals who are committed to excellence in their professional pursuits, with a sound background in both experimental and theoretical aspects of chemistry.

## **OBJECTIVES**

Department of Chemistry promotes the aims and objectives of UOP by providing high quality program to our students, and by conducting related scholarly and service activities. Our aims and objectives are:

- Assisting our students in acquiring and applying chemical knowledge.
- Training them to understand the discipline and the process of learning.
- Providing them with an acute awareness of the responsibility of a professional.
- Expanding the frontiers of chemistry by maintaining an active research program in the major fields of chemistry.
- Supporting our professional and geographical communities on chemistry related activities with a commitment to active and ethical involvement.

### **Intended Learning Outcomes (ILOs) of the Program**

The chemistry program educational Objectives are carefully designed to satisfy the department mission. These objectives are designed to be specific, measurable, achievable, realistic, and time-bound. The Intended Learning Outcomes of the Department of Chemistry cover four skills. They are listed below:

#### **Knowledge Skills:**

- K1. Demonstrate knowledge and understanding of essential facts, concepts, principles and theories, perform experiments and find suitable industrial applications related to organic, inorganic, analytical and physical chemistry.
- K2. Nomenclature and use of the suitable terminology of chemical compounds, either by common names or systematic (IUPAC) names.
- K3. Describe the principles of quantitative and qualitative chemical analysis, using conventional methods and instrumental techniques.

**Intellectual Skills:**

- I1. Explain the nature and behavior of chemical compounds, their classification, chemical structure, reactivity, mechanisms, physical properties, and characterizations using different techniques.
- I2. Estimate chemical data by performing calculations and derivation related to general, analytical, physical, organic and inorganic chemistry.

**Practical Skills:**

- P1. Use of laboratory equipment and standard procedures safely.
- P2. Appreciate the importance of carrying out careful and precise measurements to generate reliable data.
- P3. Prepare and separate compounds, and analyze substances.
- P4. Prepare scientific reports, and make oral presentations.
- P5. Use of the scientific literature effectively, demonstrating scholarship in the research.

**Transferable Skills:**

- T1. Communication skills, covering both written and oral communications.
- T2. Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made based on limited information.

Our learning outcomes are assisted on a regular basis as you will find in our course files and our program effectiveness. The learning outcomes of the program are put into practice within the individual courses of the program. The instructors of courses write the descriptions of learning outcomes of the courses, where the contribution of the individual course in learning outcomes of the program is calculated at the end of each study year.

<b>Requirements for a Bachelor Degree in Chemistry</b>	<b>(2018/2019)</b>
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Course No.	Course Title	Credit Hours	Prerequisite	Total
<b>University Requirements (24 Hours)</b>				
<b>University Compulsory Requirements (12 Hours)</b>				
9400100	National Education	3		12
9400109	Military Sciences	3		
9400111	Arabic Language (1)	3	9401099/P.T	
9400121	English Language (1)	3	9402099/P.T	
<b>University Elective Requirements (12 Hours)</b>				
<b>University Elective Requirements (Humanities) (3 Hours)</b>				
9400103	Human Civilization	3		3
9400112	Arabic Language(2)	3	9400111	
9400122	English Language(2)	3	9400121	
9400191	Principles of Communication	3		
9700102	Human Rights	3		
<b>University Elective Requirements (Social &amp; Economic Sciences) (3 Hours)</b>				
9300104	Entrepreneurship and Innovation	3		3
9400104	Political Science	3		
9400105	Contemporary Issues	3		
9400133	Jerusalem and Palestinian Cause	3		
9400171	Introduction to Sociology	3		
<b>University Elective Requirements (Science, Technology, Agriculture &amp; Health) (6 Hours)</b>				
9100101	Science & Life	3		6
9200101	Sports & Health	3		
9500101	First Aid	3		
9500111	Food and Nutrition in Our Life	3		
9600101	Computer Skills	3	9601099/P.T	
<b>Faculty Compulsory Requirements (21 Hours)</b>				
101101	General Chemistry (1)	3		21

101102	General Chemistry (2)	3	101101	
101106	General Chemistry Lab. (1)	1	101101/ Concurrent	
101107	General Chemistry Lab. (2)	1	101102/ Concurrent	
103101	Calculus (1)	3		
103102	Calculus (2)	3	103101	
104101	General Physics (1)	3		
104102	General Physics (2)	3	104101	
104106	General Physics Lab.	1	104102/ Concurrent	
<b>Department Compulsory Requirements (54 Hours)</b>				
101211	Organic Chemistry (1)	3	101102	57
101212	Organic Chemistry (2)	3	101211	
101213	Organic Chemistry Lab. (1)	2	101211	
101231	Inorganic Chemistry (1)	3	101102	
101232	Inorganic Chemistry (2)	3	101231	
101241	Analytical Chemistry	3	101102	
101243	Analytical Chemistry Lab.	1	101241/ Concurrent	
101311	Organic Chemistry (3)	3	101212	
101312	Organic Chemistry Lab. (2)	2	101213	
101321	Physical Chemistry (1)	3	103102, 101102	
101322	Physical Chemistry (2)	3	101321	
101323	Physical Chemistry Lab. (1)	2	101321	
101331	Inorganic Chemistry (3)	3	101232	
101343	Instrumental Methods of Analysis	3	101243	
101344	Instrumental Methods of Analysis Lab.	1	101343/ Concurrent	
101345	Electroanalytical Chemistry	3	101241	
101346	Synthesis & Analysis of Chemical Products	2	101212	
101347	Synthesis & Analysis of Chemical Products Lab.	1	101346/ Concurrent	

101421	Physical Chemistry (3)	3	101322, 103222	
101422	Physical Chemistry Lab. (2)	2	101323	
101431	Inorganic Chemistry Lab.	2	101232	
101445	Seminar	1	Dept. Approval	
101448	Research Project	2	Dept. Approval	
<b>Department Elective Requirements (18 Hours)</b>				
101313	Biochemistry	3	101212	18
101413	Heterocyclic Chemistry	3	101212	
101425	Surface Chemistry & Colloids	3	101322	
101435	Special Topics in Chemistry	3	101232	
101441	Environmental Chemistry	3	101102	
101442	Chemical Physics	3	101421	
101443	Physical Organic Chemistry	3	101311	
101447	Quality Control	3	101241	
101451	Nuclear Chemistry	3	101241	
101452	Environmental Pollution	3	101102	
101453	Petroleum Chemistry	3	101212	
101454	Organic Industries (1)	3	101212	
101455	Inorganic Industries	3	101232	
101456	Computer Applications in Chemistry (1)	3	101321	
101457	Computer Applications in Chemistry (2)	3	101321	
101458	Organic Industries (2)	3	101212	
<b>Department Supportive Compulsory Requirements (6 Hours)</b>				
103222	Differential Equations	3	103102	9
103231	Principles of Statistics	3	103201	
503101	Biology (1)	3		
<b>Free Requirements (6 Hours)</b>				
				6
<b>Total Hours</b>				<b>132</b>

**Suggested study plan for a bachelor degree in Chemistry 2018/2019**

First Year (33 Cr. Hrs.)					
First Semester			Second Semester		
Course No.	Course Title	Cr. Hrs.	Course No.	Course Title	Cr. Hrs.
101101	General Chemistry (1)	3	101102	General Chemistry (2)	3
101106	General Chemistry Lab. (1)	1	101107	General Chemistry Lab. (2)	1
103101	Calculus (1)	3	103102	Calculus (2)	3
104101	General Physics (1)	3	104102	General Physics (2)	3
9400111	Arabic Language(1)	3	104106	General Physics Lab.	1
9400121	English Language(1)	3	9400100	National Education	3
			9400109	Military Sciences	3
		16			17
Second Year (33 Cr. Hrs.)					
First Semester			Second Semester		
Course No.	Course Title	Cr. Hrs.	Course No.	Course Title	Cr. Hrs.
101211	Organic Chemistry (1)	3	101212	Organic Chemistry (2)	3
101231	Inorganic Chemistry (1)	3	101213	Organic Chemistry Lab. (1)	2
101241	Analytical Chemistry	3	101232	Inorganic Chemistry (2)	3
101243	Analytical Chemistry Lab	1	101321	Physical Chemistry (1)	3
103231	Principles of Statistics	3	103222	Differential Equations	3
xxxxxx	Univ. Elective Req. ( 1 )	3	xxxxxx	Univ. Elective Req. ( 2 )	3
		16			17
Third Year (33 Cr. Hrs.)					
First Semester			Second Semester		
Course No.	Course Title	Cr. Hrs.	Course No.	Course Title	Cr. Hrs.
101311	Organic Chemistry (3)	3	101345	Electroanalytical Chemistry	3
101312	Organic Chemistry Lab. (2)	2	101421	Physical Chemistry (3)	3
101322	Physical Chemistry (2)	3	101422	Physical Chemistry Lab. (2)	2

101323	Physical Chemistry Lab. (1)	2	xxxxxx	Dept. Elective Req. ( 1 )	3
101331	Inorganic Chemistry (3)	3	503101	Biology (1)	3
xxxxxx	Univ. Elective Req. ( 3 )	3	xxxxxx	Univ. Elective Req. ( 4 )	3
		16			17
<b>Fourth Year (33 Cr. Hrs.)</b>					
<b>First Semester</b>			<b>Second Semester</b>		
Course No.	Course Title	Cr. Hrs.	Course No.	Course Title	Cr. Hrs.
101343	Instrumental Methods of Analysis	3	101346	Synthesis & Analysis of Chemical Products	2
101344	Instrumental Methods of Analysis Lab.	1	101347	Synthesis & Analysis of Chemical Products Lab (1)	1
101445	Seminar	1	101431	Inorganic Chemistry Lab.	2
xxxxxx	Dept. Elective Req. ( 2 )	3	101448	Research Project	2
xxxxxx	Dept. Elective Req. ( 3 )	3	xxxxxx	Dept. Elective Req. ( 4 )	3
xxxxxx	Univ. Elective Req. ( 5 )	3	xxxxxx	Dept. Elective Req. ( 5 )	3
xxxxxx	Free Req. (1)	3	xxxxxx	Free Req. (2)	3
		17			16
<b>Total (132 Credit Hours)</b>					



**Following is the course description of all chemistry courses, indicating the total credit hours, theory credit hours and practical credit hours for each course:**

<b>101101</b>	<b>General Chemistry (1)</b>	<b>(3-3-0)*</b>
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**Prerequisites: None**

This course introduces basic ideas of general chemistry covering: the atomic/molecular view of matter, scientific measurements, elements - compounds and the periodic table, the mole and stoichiometry, reactions in aqueous solutions, redox reactions, the quantum mechanical atom, chemical bonding, theories of bonding and structure.

\*(3-3-0): total credit hour - theory credit hour - practical credit hour

<b>101102</b>	<b>General Chemistry (2)</b>	<b>(3-3-0)</b>
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**Prerequisites: 101101**

This course introduces basic ideas of general chemistry covering: properties of gases; intermolecular attractions and the properties of liquids and solids; properties of solutions; chemical kinetics; chemical equilibrium, acids and bases; thermodynamics, energy and chemical change.

<b>101103</b>	<b>General Chemistry</b>	<b>(3-3-0)</b>
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**Prerequisites: None**

This course introduces basic ideas of general chemistry covering: chemistry and the atomic/molecular view of matter, scientific measurements, the periodic table, the mole and stoichiometry, redox reactions, the quantum mechanical atom, the basics of chemical bonding, theories of bonding and structure.

<b>101106</b>	<b>General Chemistry (1) Laboratory</b>	<b>(1-0-1)</b>
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**Prerequisites: 101101 or concurrently**

This course introduces basic ideas of practical general chemistry covering: safety laboratory instructions, introduction to laboratory equipment, qualitative analysis (chemical tests for some anions and cations), quantitative analysis (experiments for determination of: density of solids and liquids, empirical formula of a compound, limiting reactant, formula of hydrated copper(II) sulfate, volumetric analysis, vinegar analysis, chemicals in everyday life).

<b>101107</b>	<b>General Chemistry (2) Laboratory</b>	<b>(1-0-1)</b>
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**Prerequisites: 101102 or concurrently**

This course introduces basic ideas of practical general chemistry covering: experiments for determination of: molecular weight of a volatile liquid, pH, Equilibrium constant (by spectrophotometry), molar solubility and  $K_{sp}$ , Farady's constant, Rate law. Experiments involving: analysis of hydrogen peroxide, colligative properties, potentiometric titration, electrolytic cell, hydrolysis and buffers.

**101108      General Chemistry Laboratory      (1-0-1)****Prerequisites: 101103 or concurrently**

This course introduces basic ideas of practical general chemistry covering: safety laboratory instructions, introduction to laboratory equipment, qualitative analysis (chemical tests for some anions and cations), quantitative analysis (experiments for determination of: empirical formula of a compound, limiting reactant, molecular weight of a volatile liquid, Faraday's constant, molar solubility and  $K_{sp}$ , volumetric analysis, vinegar analysis).

**101115      Organic Chemistry for Medical Sciences      (3-3-0)****Prerequisites: 101103**

This course introduces basic ideas of organic chemistry covering: classification of organic compounds, chemical bonding, hydrocarbons; Alkanes, alkenes, alkynes, cycloalkanes and aromatics; stereochemistry, alkyl halides, alcohols, phenols, ethers, epoxides, aldehydes, ketones, amines, carboxylic acids and derivatives.

**101117      Organic Chemistry Laboratory      (1-0-1)****Prerequisites: 101115 (or Concurrently)**

This course introduces basic ideas of practical organic chemistry covering: separation and purification of organic compounds; synthesis using various techniques; identification of functional groups by different organic methods.

**101211      Organic Chemistry (1)      (3-3-0)****Prerequisites: 101102**

This course introduces basic ideas of organic chemistry covering: atomic structure and bonding in organic compounds, constitution and properties of the different classes of organic compounds (alkanes, cycloalkanes, alkenes, alkynes and alkyl halides) with considerable attention to nomenclature, stereochemistry, reaction mechanisms, and synthetic organic chemistry.

**101212      Organic Chemistry (2)      (3-3-0)****Prerequisites: 101211**

This course introduces further topics of organic chemistry covering: spectroscopic techniques in organic chemistry (Mass spectrometry, UV-Visible, IR, and NMR), Basic chemistry of aromatic compounds and organic compounds of different functional groups (alcohols and phenols, ethers and epoxides, aldehydes and ketones and carboxylic acids), with considerable attention to nomenclature, stereochemistry, reaction mechanisms, and synthetic organic chemistry.

**101213      Organic Chemistry Laboratory (1)      (2-0-2)****Prerequisites: 101211**

This course introduces further topics of practical organic chemistry covering: separation and purification of organic compounds; synthesis using various techniques; identification of functional groups by different organic methods.

**101231 Inorganic Chemistry (1) (3-3-0)****Prerequisites: 101102**

This course introduces basic ideas of inorganic chemistry covering: Atomic structure, electromagnetic radiation, atomic spectra and the Bohr model of the hydrogen atom, wave properties of matter, some principles of quantum mechanics, atomic orbitals, the building-up principle, atomic parameters, bonding theories, the octet rule, structure and bond properties, the VSEPR theory, VBT, the H<sub>2</sub> molecule, polyatomic molecules, MOT, homonuclear and heteronuclear diatomic molecules, structures of solids, unit cells, crystal structure, close packing, alloys, energies of ionic bonding, molecular symmetry, symmetry elements and symmetrical operations, point groups, polar and chiral molecules.

**101232 Inorganic Chemistry (2) (3-3-0)****Prerequisites: 101231**

This course introduces further topics of inorganic chemistry covering: Lewis acids and bases; transition metals and coordination chem., bonding ; electronic structure and isomerism in complex ions, crystal field theory, ligand - field theory, transition metal complexes and color, electronic spectra of atoms, reaction mechanisms of d-metal complexes.

**101241 Analytical Chemistry (3-3-0)****Prerequisites: 101102**

This course introduces basic ideas of analytical chemistry covering: introduction to analytical chemistry, quantitative analysis including errors and the treatment of analytical data; titrimetric and gravimetric methods of analysis; review of chemical equilibrium; acid-base titrations; acid-base equilibria in complex systems; complex formation titrations.

**101243 Analytical Chemistry Laboratory (1-0-1)****Prerequisites: 101241 (or Concurrently)**

This course introduces basic ideas of practical analytical chemistry covering: gravimetric and volumetric analysis, acid-base reactions, and oxidation-reduction reactions.

**101311 Organic Chemistry (3) (3-3-0)****Prerequisites: 101212**

This course introduces further selected topics in organic chemistry (carbanions and enolates, amines and heterocycles, polynuclear aromatic hydrocarbons, pericyclic reactions) with considerable attention to nomenclature, stereochemistry, reaction mechanisms, and synthetic organic chemistry.

**101312 Organic Chemistry Laboratory (2) (2-0-2)****Prerequisites: 101213**

This course introduces additional techniques of separating organic mixtures, as well as, systematic identification of organic compounds based on their: physical, chemical and spectral properties. This course is designed to augment organic chemistry 101213.

**101313 Biochemistry (3-3-0)****Prerequisites: 101212**

This course introduces basic ideas of biochemistry covering: chemistry of biologically important chemicals such as: carbohydrates; amino acids and proteins; lipids; nucleic acids; metabolic pathways; vitamins, with considerable attention to nomenclature in biological systems, and importance of stereochemistry.

**101321 Physical Chemistry (1) (3-3-0)****Prerequisites: 101102 and 103102**

This course introduces basic ideas of physical chemistry covering: kinetic-molecular theory of ideal gases; molecular collisions. equilibrium states and reversibility, first, second and third laws of thermodynamic, chemical equilibrium in solution, temperature and pressure dependence of equilibrium constants, phase recognition, vapor pressure relations, the Clausius - Clapeyron equation, classification of phase transitions, the chemical potential, equilibrium between Phases, phase rule and phase diagram.

**101322 Physical Chemistry (2) (3-3-0)****Prerequisites: 101321**

This course introduces further topics of physical chemistry covering: chemical kinetics and Pre exponential factor theories, Reactions in solution, influence of ionic strength, influence of hydrostatic pressure, reaction dynamics, types of composite reactions, steady state treatment, catalysis, solutions of electrolytes, Faraday's law of electrolysis, molar conductivity, Arrhenius theory, Ostwald's dilution law, Debye - Huckel theory, thermodynamics of electrochemical cells, applications of emf measurements, surface chemistry, the Langmuir isotherm, chemical reactions on surfaces.

**101323 Physical Chemistry Laboratory (1) (2-0-2)****Prerequisites: 101321**

This course introduces basic ideas of practical physical chemistry covering experiments in the main field of: thermodynamics, thermo-chemistry, spectrophotometry, solutions and phase equilibria.

**101331 Inorganic Chemistry (3) (3-3-0)****Prerequisites: 101232**

This course introduces some important topics of inorganic chemistry covering: s and p block organometallic compounds; Classification; nomenclature; structure and bonding; stability; electron deficient; electron-rich and electron-precise organometallic compounds, d and f block organometallic compounds, 18 – electron rule ; 16 – electron rule; d block carbonyls;  $\Pi$  acceptor ligands; metal carbonyls: synthesis, structure, properties and reactions; metal complexes with hydrogen, alkenes, alkylidines, alkylidynes, dienes, allyls and polyenes; catalysis, homogeneous,

heterogeneous and some catalytic industrial processes e.g. hydroformylation; polymerization, Monsanto acetic acid synthesis; hydrogenation of alkenes; SO<sub>2</sub> – oxidation; ammonia synthesis.

**101343 Instrumental Methods of Analysis (3-3-0)**

**Prerequisites: 101243**

This course introduces further topics of inorganic chemistry covering an introduction to theoretical and practical aspects of instrumental analysis. This includes: ultraviolet/visible spectroscopy, flame photometry, atomic absorption spectroscopy, x-ray fluorescence, infrared absorption spectroscopy, electro analytical methods, high performance liquid chromatography and gas chromatography.

**101344 Instrumental Methods of Analysis Laboratory (1-0-1)**

**Prerequisites: 101343 (or Concurrently)**

This course introduces some important contents related to analytical methods covering: qualitative and quantitative chemical analysis using different instrumental methods, such as: ultraviolet/visible spectroscopy, flame photometry, infrared absorption spectroscopy, electro analytical methods, high performance liquid chromatography and gas chromatography.

**101345 Electro-analytical Chemistry (3-3-0)**

**Prerequisites: 101241**

This course introduces some important contents related to electrochemical methods used in analysis covering theory and instrumental techniques that encompass static and dynamic electro-analytical measurements, such as: potentiometry, voltammetry, polarography, coulometry, gas sensing probes and electrogravimetry. Focus will be on analytical applications, utilizing correct techniques for solving specific analytical problems.

**101348 Analysis and Synthesis of Chemical Products (1-1-0)**

**Prerequisites: 101241**

This course introduces some important contents covering: preparation, analysis and applications of some industrial products, such as: detergents, dyes, soaps and some natural products.

**101349 Analysis and Synthesis of Chemical Products Lab.(1-0-1)**

**Prerequisites: 101348 or concurrently**

This course introduces some important practical contents covering: manufacture, analysis and applications of some industrial products, such as: polymers, detergents, cosmetics, dyes, insecticides, oils, fats and natural products.

**101413 Heterocyclic Chemistry (3-3-0)****Prerequisites: 101212**

This course introduces some important contents related to heterocyclic chemistry covering: synthesis and reactions of the following classes of heterocycles: saturated heterocycles containing one heteroatom (N, O or S); heteroaromatics: Furan, thiophene, pyrrole, pyridine, quinoline and isoquinoline; indole; nomenclature of condensed heteroaromatics; natural occurrence and biological activity of heterocyclic compounds.

**101421 Physical Chemistry (3) (3-3-0)****Prerequisites: 101322 and 103222**

This course introduces the idea of quantum chemistry covering: electromagnetic radiation and the old quantum theory, quantum mechanics of some simple systems, quantum mechanics of hydrogen-like atoms, many-electron atoms, approximation methods in quantum mechanics, molecular orbital theory, Hückel theory for more complex molecules, emission and absorption spectra, Beer - Lambert law, Zeeman effect and an introduction to NMR.

**101422 Physical Chemistry Laboratory (2) (2-0-2)****Prerequisites: 101323**

This course introduces further experiments in physical chemistry covering chemical kinetics; electrochemistry; transfer process and spectroscopy.

**101425 Colloids and Surface Chemistry (3-3-0)****Prerequisites: 101322**

This course introduces basic ideas of colloidal chemistry covering: an introduction to chemistry of surfaces and colloids, the structure of surface and adsorbed layers, liquid films on surface, solid-liquid interface, instruments used in chemistry of surfaces and colloids, physical properties of colloidal particles, types, preparation and application of colloidal solutions, stability of colloidal systems, characterization of colloidal systems (Microscopy, FF-TEM, Cryo-TEM, SANS, AFM), rheology of colloids, coagulation phenomenon, critical micelle concentration, emulsion and its application.

**101431 Inorganic Chemistry Laboratory (2-0-2)****Prerequisites: 101232**

This course introduces some practical experiments in inorganic chemistry covering: synthesis and characterization of transition – metal complexes. Characterization methods used are: melting point determination, Electrical conductance; IR; UV/VIS.; and other recent practical methods used to study chemical complexes when available.

**101435 Special Topics in Chemistry (3-3-0)****Prerequisites: 101232**

This course is taught by staff members from different fields of chemistry, under different topics according to each staff member's specialization.

**101441 Environmental Chemistry (3-3-0)**

**Prerequisites: 101102**

This course introduces some topics related to environmental chemistry covering: environmental chemical concepts, the earth atmosphere, stratospheric chemistry, tropospheric chemical smog, tropospheric chemical precipitation, atmospheric aerosols, chemistry of urban and indoor atmosphere, the chemistry of global climate.

**101442 Chemical Physics (3-3-0)**

**Prerequisites: 101421**

This course introduces some topics related to chemical physics covering: importance of angular momentum in chemical physics (especially in atomic structure); electron spin and algebraic matrices representing electronic structure.

**101443 Physical Organic Chemistry (3-3-0)**

**Prerequisites: 101311**

This course introduces some topics related to physical organic chemistry covering: the relation between chemical structure and reactivity, investigation of the mechanism by different approaches including: chemical kinetics, stereochemistry and spectroscopy, detailed mechanisms of selected organic reactions.

**101445 Seminar (1-1-0)**

**Prerequisites: Department Approval**

The student gets acquainted with the different literature sources, undertakes a literature search in a topic in chemistry, and submits a specialized chemical term paper.

**101447 Quality Control (3-3-0)**

**Prerequisites: 101241**

This course introduces some important topics related to quality control covering: basic principles of quality; good manufacturing procedures; statistical tables; laboratory accreditation; quality related costs; inspection and testing methods.

**101448 Research Project (2-0-2)**

**Prerequisites: Department Approval**

Research project, including literature survey under the supervision of departmental staff members. A joint research project with local industries may be arranged.

**101451 Nuclear Chemistry (3-3-0)****Prerequisites: 101241**

This course introduces some important topics related to nuclear chemistry covering: Introduction, early history of radioactivity, atomic nuclei, atomic structure, nuclear particles, nuclear properties, binding energy, nuclear shell structure, radioactive decay processes, nuclear stability, alpha, beta and gamma decay, equations of radioactive decay and growth, exponential decay, interaction of radiation with matter, radioactive applications, tracers in chemical applications, analytical applications, radiochemistry applied to medicine.

**101452 Environmental Pollution (3-3-0)****Prerequisites: 101102**

This course introduces some important topics related to environmental pollution covering fundamental concepts of the different types of environmental pollution and problems. The causes and results of: water, air, nutrients, radial, thermal, noise and land pollution. Special focus will be on: ecology, greenhouse effect, global warming, acid rain, ozone depletion, environmental regulations and pollution control methods.

**101453 Petroleum Chemistry (3-3-0)****Prerequisites: 101212**

This course introduces some important topics related to petroleum chemistry covering: composition of natural gas; coal and petroleum (crude oil), petroleum refinery (unit operations for isolation of different cuts, treating, and unit processes, for manufacture of other chemicals not found in petroleum), natural gas as a source for syngas for production of methanol and other petrochemicals, gasoline and octane number.

**101454 Organic Industries (1) (3-3-0)****Prerequisites: 101212**

This course introduces some important topics related to industrial organic chemistry covering: basic organic industrial chemistry, industrial catalysis, and selected organic industries as decided by the instructor.

**101455 Inorganic Industries (3-3-0)****Prerequisites: 101232**

This course introduces some important topics related to industrial inorganic chemistry covering preparation of some industrial inorganic products and the challenges involved, such as: sulfur industry, nitrogen based industrial products, mineral extraction, mineral fertilizers, industrial and domestic water production, industrial gas productions, inorganic solids, cement, glasses, and pigments. Emphasis is on learning the importance of inorganic chemical industry, its economic impact, individual chemical processes and production challenges.



**101456      Computer Applications in Chemistry (1)      (3-0-3)**

**Prerequisites: 101321**

Applications of computers in advanced topics in chemistry and graphing applications.

**101457      Computer Applications in Chemistry (2)      (3-0-3)**

**Prerequisites: 101321**

Computer programming and its applications in chemistry; Basic and Fortran languages and their applications in solving problems.

**101458      Organic Industries (2)      (3-3-0)**

**Prerequisites: 101212**

This course introduces some additional important topics related to industrial organic chemistry covering selected organic industries, including: polymers, rubber, plastics, resins, synthetic fibers, sponge and adhesives.

**9100101      Science and Life      (3-3-0)**

**Prerequisites: None**

Science in the Arab and Islamic world in the middle ages (history of science; scientific communication between Arabs and Europeans; translation; the scientific renaissance of the Arabs in the middle ages); science, technology and society (the nature of science and technology and their mutual relations; characteristics of contemporary science and technology; the impact of science and technology on modern society; science and technology in developing countries).