1. 301101 General Chemistry 1

Prerequisite None (3 credit hours)

**Basic concepts: measurement and units, matter and energy, chemical calculations, the mole and stoichiometry, electronic structure of atoms, periodic table and periodic properties of the elements, chemical bonding and molecular geometry gases, their properties and laws of ideal gases.**

1. 301102 General Chemistry (2)

Prerequisite 301101 (3 credit hours)

**Properties of liquids and solutions, energy relationships in chemical reactions, laws of thermodynamics, chemical equilibrium, chemical kinetics acids and bases and their equilibria, solubility equilibria.**

1. 301103 General Chemistry Practical (1)

(Prerequisite 301101 or Synchronous) (1 credit hours)

**This course includes the following experiments with three practical hours per week: Safety rules, laboratory equipment, and glassware tools, determination of density and determination of the mass of volatile fluid, separation and determination of percentages of mixture components, specific reaction, determination ofthe molecular concentration of sodium hydroxide determination of the percentage of acetic acid in commercial vinegar samples, the chemical formula of hydrate, the empirical formula of magnesium oxide, chemicals in everyday life, properties of inorganic compounds, oxidation and reduction.**

1. 301104 Practical General Chemistry (2)

Prerequisite 301102 or synchronous)(1 credit hours)

**Analysis of bleaching agent, calorimetry, Lechatelier principle, visible spectrophotometric determination of equilibrium constant, determination of the rate law of a chemical reaction, titration of acidic solution, determination of the molecular weight of unknown compound by measurement of freezing point depression of solution.**

1. 301211 Organic Chemistry (1)

(Prerequisite 301102)(3 credit hours)

**Structure and bonding of organic compound, acids and bases in organic compounds, introduction to organic compound and their functional groups: alkanes, alkenes, alkynes, cycloalkanes and alkyl halides, stereochemistry, common organic reaction: substitution, addition and elimination.**

1. 301212 Organic Chemistry (2)

(Prerequisite 301211)(3 credit hours)

**Dienes, aromatic compounds and aromaticity, electrophilic aromatic substitution reactions, physical methods for diagnosing of organic compounds (NMR, UV, IR and mass spectrometry), alcohols, phenols, ethers, aldehydes and ketones.**

1. 301213 Practical Organic Chemistry (1)

(Prerequisite 301211 or synchronous)(2 credit hours)

**This course includes the following experiments with four practical hours per week. This course covers the following two types of experiments**

* **Devices and processes: students learn how to uselaboratory devices, and the basic processes in preparation for chemicalreactions: melting point, simple distillation and fragmentation, steamdistillation, extraction and drying materials, crystallization, adsorptionchromatography**
* **Methods of preparing and studying the propertiesof organic compounds such as: chemistry of alcohol,alginates by displacement or extraction, alkyl halides by substitutionreactions in halogenated organic compounds, separation of products such as Caffeine of tea and coffee, preparation of bromobenzene and nitrophenol, use of molecular models.**

1. 301214 Practical Organic Chemistry (2)

(Prerequisite 301212 or synchronous) (2 credit hours )

**The laboratory material includes the following experiments at a rate of four practical hours per a week : phenol alkylation, preparation of acetophenone by Friedel-Craft’s reaction, preparation of tri-phenyl methanol (carbinol) by grignard reaction also the properties of carbocations, aldehydes and quinones reactions, benzoin preparation, benzyl preparation and benzyl acid, chlorophenzine preparation by Sandmeyer’s, Preparation of aniline by nitrobenzene reduction, benzoic acid preparation of benzoic from nabzobetrol, preparation of azo dyes, 4- bromoacetylidone preparation, 4-bromoellin, preparation of adipic acid, cyclohexanon preparation, preparation of organic acid derivatives such as esters, Diels-alder reaction, many steps preparation.**

1. 301221 Inorganic Chemistry (1)

(Prerequisite 301102)(3 credit hours)

**Inorganic chemistry (1) course giving the students knowledge related to the fundamentals of inorganic chemistry including atomic number, mass number, isotopes, Bohr's theory, an introduction to wave mechanics, wave nature of electrons, uncertainty principle, Schrödinger wave equation, atomic orbitals, quantum numbers, orbital energies in hydrogen-like species, size of orbitals, spin quantum number, magnetic spin quantum number, ground state electronic configurations, penetration and shielding, the periodic table, Aufbau principle, Hund's rule, Ionization energies, electron affinities, bonding models, Lewis structures, homonuclear diatomic molecules, valence bond (VB) theory, molecular orbital (MO) theory, the octet rule, isoelectronic species, electronegativity values, dipole moments, molecular shape, VSEPR model, hybridization of atomic orbitals, multiple bonding in polyatomic molecules, packing of spheres, metallic radii, melting points, band theory of metals and insulators, the Fermi level, sizes of ions, Born-Haber cycle, the solubility of ionic salts, properties of water, Brønsted acids and bases, trends within a series of oxoacids, hard/soft acid/base theory (HSAB), an introduction to coordination complexes, mono- and bi-dentate ligands, ambidentate ligands.**

1. 301231 Analytical Chemistry

(Prerequisite 301102)( 3 credit hours)

**This course covers the analytical measurements, data handling, ways of expressing the concentration of solutions, principles of quantitative analytical chemistry, gravimetric and volumetric methods of analysis, aqueous solution chemistry, general concepts of chemical equilibria, acid-base equilibria, Neutralization Titrations and their applications, precipitation and complexmetric titrations, oxidation-reduction reaction titrations.**

1. 301233 Practical Analytical Chemistry

(Prerequisite 301102)(1 credit hour)

**This lab includes the following experiments for three hours per week:**

**Preparation of analytical reagent, standardization of analyticalreagent, an assay of a strong acid, acidity of the vinegar, alkalinity of water,gravimetric determination of sulfate, determination of ammonia in ammoniumsalts, an assay of sodium carbonate in soda ash, determination of chloride byprecipitation titration, complexation titration with EDTA.**

1. 301311 Organic Chemistry (3)

(Prerequisite 301212)(3 credit hours)

**Carboxylic acids, carboxylic acid derivatives and nucleophilic acyl substitution reactions, carbonyl alpha-substitution reactions, carbonyl condensation reactions, amines, biomolecules: carbohydrates, amino acids, peptides, proteins and lipids.**

1. 301313 Spectrometric Identification of Organic Compounds

(Prerequisite 301311)(3 credit hours)

**Molecular formula and hydrogen deficiency index, Spectra of organic compounds: Infrared spectroscopy, nuclear magnetic resonance spectroscopy for proton, carbon 13 and 2 dimensional NMR, mass spectrometry for organic compounds: fragmentation patterns for organic functional groups, various examples.**

1. 301312 Identification of Organic Compounds

Prerequisite (301214 and 301311)(4 credit hours)

**This course enables the student practically, at a rate of four hours per week, to review his knowledge in organic chemistry and use it in practice to identify unknown organic compounds through systematic laboratory studies of the primary physical, chemical and spectral properties and to define functional groups and then chemical derivatives. The course also examines methods of separation and purification of compounds The course also includes the theoretical study of the aforementioned topics.**

1. 301321Inorganic Chemistry (2) (3 credit hours)

**Inorganic chemistry (2) course giving the students’ knowledge related to the inorganic chemistry including symmetry operations; symmetry elements; point groups; character tables; chiral molecules; Introduction to molecular symmetry; molecular orbital theory; the ligand group orbital approach and application to tri atomic molecules; molecular orbital theory applied to the polyatomic molecules; d-block metal chemistry: ground state electronic configurations; physical properties; the reactivity of the metals; characteristic properties; colour, paramagnetism, complex formation, variable oxidation state; electroneutrality principle; Coordination numbers and geometries; common ligands and nomenclature; Kepert model; coordination numbers in the solid-state; Isomerism in d-block metal complexes; bonding in d-block metal chemistry ( coordination complexes); high-and low-spin state; valence bond theory; crystal field theory; spectrochemical series; crystal field stabilization energy; Jahn-Teller distortions; molecular orbital theory (octahedral complexes); ligand field theory; microstates and term symbols; electronic absorption and emission spectra of octahedral and tetrahedral complexes; Tanabe-Sugano diagrams; evidence for metal-ligand covalent bonding; magnetic properties; thermodynamic aspects; electronic spectra, and magnetic properties.**

1. 301322 Practical Inorganic Chemistry

(Prerequisite 301221 or Synchronous)(2 credit hours)

**This course introduces some practical experiments in inorganic chemistry covering: synthesis and characterization of transition metal complexes; preparation of aluminum and manganese with oxalate or acetylacetonate ligands; preparation of cobalt complexes, nickel complexes; Copper complexes with thiourea. Characterization methods used are Melting point determination, Electrical conductance; IR; UV/VIS; polarmeter and other recent practical methods used to study chemical complexes.**

1. 301323Radiation and Nuclear Chemistry (3 credit hours)

**This course discusses the phenomenon of radioactivity, the properties of radiation, the structure of the atom, isotopes, and nuclei, patterns of nuclear stability, the energy ofnuclear binding, methods of nuclear radioactive decay, alpha, beta, and gamma decomposition, the decomposition of radioactive mixtures, the relationships between energy and range, semiconducting detectors, and radioisotope uses in chemistry. Measurement of radiation and the uses of radioisotopes in industry and nuclear energy**

1. 301331 Introduction to Methods of Instrumental Analysis

(Prerequisite 301231 and 301232)(3 credit hours)

**The students in this course are introduced to the different types of calibration methods and figures of merits for the instruments. Then the properties of electromagnetic radiation will be covered briefly followed by the important components and types of optical instruments, atomic absorption and emission, ultraviolet and visible, IR, and atomic mass Spectroscopy. A quantitative application for each technique will be discussed. Finally, molecular luminescence spectrometry: theory of fluorescence & phosphorescence, instrumentation & applications will be considered.**

1. 301333 Practical Instrumental Analysis Methods

(Prerequisite 303331 or synchronous) (2 credit hours)

**The course will provide students with the knowledge and skills needed to conduct laboratory research, understand instrument design and analyze instrumental results. Over the duration of the course you will be expected to learn the theory behind a range of instrumental techniques, instrumentation hardware and data analysis techniques. Many physically/chemically different analytes are encountered in different sample matrices, such as, solids and liquids. Different sample preparation techniques and analytical instrumentation are needed for analyzing these species. The class will cover the theory of spectroscopic techniques (UV/Vis and IR spectroscopy), potentiometric and conductometric titration, refractive index, high performance liquid chromatography and gas chromatography. Quantitative application will be performed. A quantitative application for atomic absorption Spectroscopy will be discussed. The class will be assessed by the completion of assignments and two exams. The class is 2 semester hours.**

1. 301341 Physical Chemistry (1)

(Prerequisite 301102,303204)(3 credit hours)

**Laws of gases and kinetic theory of gases, concepts based on the first law of thermodynamics: heat and work, concept of enthalpy and its relation with thermochemistry, effect of temperature on enthalpy, concepts based on the second law of thermodynamics: entropy changes, efficiency of thermal processes, Carnot cycle, the third law of thermodynamics, Helmholtz energy, Gibbs energy, properties of total energy and Gibbs energy, chemical potential, standard states, phase changes and diagrams, thermodynamics of liquids and solutions, phase rule, phase diagrams: effect of pressure and temperature on mixtures, phase diagrams for binary and ternary systems.**

1. 301342 Physical Chemistry (2)

(Prerequisite 301341)(3 credit hours)

**Electrochemistry: ionic solutions, theories of electrical conductivity in solutions, mobility of ions in solutions, applications of concepts of thermodynamics on chemical equilibrium: equilibrium in electrochemistry, thermodynamic properties of ions in solutions, electrochemical cells; reactions on electrodes: applications of standard potentials to obtain thermodynamic functions, chemical kinetics: molecular motion in gaseous state, mobility of molecules and ions in solutions, diffusion, reaction rate laws and applications in simple systems, theories of reaction kinetics, kinetics of chain reactions and catalyzed reactions in solutions, catalyzed reactions in solid state and enzymes.**

1. 301344 Practical Physical Chemistry (1)

(Prerequisites: 301341, 301102)(2 credit hours)

**This course includes the following experiments: Adsorption from solution, heat of solution by calorimetric method, effect of solute on boiling point of solvent, effect of pressure on boiling point of a liquid, critical solution temperature for phenol solution in water, partial molal volumes for sodium chloride solution in water, study of phase diagram for two component liquid, study of phase diagram for three component liquid system, equilibrium constant for iodide- iodine reaction in aqueous medium, steam distillation of organic liquid.**

1. 301345 Practical Physical Chemistry (2)

Prerequisites:(301342, 301344) (2 credit hours)

**This course includes the following experiments:**

**Kinetics of catalyzed decomposition of hydrogen peroxide, effect of ionic strength on solubility of benzoic acid, effect of ionic strength on the rate of chemical reaction, kinetics of hydrolysis of ethyl acetate in basic medium followed by electrical conductance, spectrophotometric determination of acid dissociation constant of methyl red, electrical conductance of strong and weak electrolytes,determination of molar conductance at infinite dilution the influence of catalyst (salt effect) on the rate of chemical reaction.**

1. 301343 Physical Chemistry (3)

Physical chemistry (Prerequisite 301342)(3 credit hours)

**Quantum Chemistry, Introduction to Mathematics of Classical Mechanics, The Origin of Quantum Theory, Theoretical Basis, Schrodinger Equation, Applications on Simple Systems, Molecular Energy Levels, Vibrational Molecular Energy Levels, Analysis of vibrational rotational spectrum for diatomic molecules.**

1. 301351 Principles of Industrial Chemistry (3 credit hours)

**Chemical industries and their importance in the economies of countries Study of the economic factor when manufacturing chemicals (prices of total cost and productivity).**

**The main raw materials used in the chemical industry and their natural resourcesintroduction to the manufacture of organic and inorganic compoundspetrochemical industries**

1. 301352 Industrial Organic Chemistry (3 credited hours)

**The course will focus on small-scale organic chemical industry relevant to Jordan and Middle East Market. This course emphasizes the chemical concepts and materials used in the preparation and formulation of soaps, detergents, shampoos, cosmetics, perfumes, dyes/pigments and adhesives.**

1. 301354 Industrial Inorganic Chemistry (3credit hours)

**Industrial Inorganic chemistry course giving the students’ knowledge related to the natural raw materials; sources of inorganic compounds. The history of cement, manufacture of cement; chemical composition of cement; production steps of Portland cement; main constituents of clinker; chemical analysis of cement (the lime saturation factor (LSF), silica ratio (SR), alumina ratio (AR). Purification of water; water treatment; wastewater treatment; chemical analysis of water that includes the test for the determination of total solids, alkalinity, chloride. Ceramics; Processing of ceramic and application; superconducting ceramics. Glass and quartz industry. Extraction of elements for semiconductors, ultrapure silicon. Industries of sulfuric acid and their applications. Industrial of nitric acid and their applications, Industrial of hydrochloric acid and their applications; Industrial of Inorganic fertilizers. Uses of inorganic compounds in detergent, and household cleaning industries.**

1. 301456 Pollution and Industrial Safety (3 credit hours)

**This course studies the fate of chemicals in the air, water, and soil, and their impact on human health and the natural environment. Topics will include water pollution and water treatment, air pollution; greenhouse gases, acid deposition, and ozone layer destruction, sources, and management of hazardous wastes. Moreover, learn basic laboratory rules and basic principles of lab safety, learn to recognize basic laboratory and chemical hazards, and learn certain procedures, practices and tools appropriate to working with hazardous chemicals.**

1. 301361 Environmental Chemistry (3 credit hours)

**This course deals with the application of chemical principles to the study of the environment. Also, studying the distribution and interactions of matter (chemicals) in the environment. It includes natural processes and pollution problems related to air, water, and soil.Moreover, this course emphasizes how the specific discipline of chemistry can help us understand environmental issues, and what it tells us about possible solutions to environmental problems the world is facing. Also, utilize quantitative concepts, such as concentration, exposure levels, and exposure limits, as part of the evaluation of the environmental impact of a substance.**

**Some of the questions we will address in this course are:**

**• How do scientists think about sustainability as it relates to the environment?**

**• How can chemistry help prevent, diagnose, and cure environmental problems?**

**• How do technical, and social issues impact the effectiveness of our environment?**

1. 301392 Field Training (2 credited hours)

**The student spends a training stay for six weeks in average of five hours daily in chemistry or drug factories to acquire practical experience in the field of using analytical chemistry instruments and quality control.**

1. 301411 Heterocyclic Chemistry (3 credit hours)

**Saturated heterocyclic compounds (three to six-membered ring) containing one heteroatom (nitrogen, oxygen or sulfur), aromatic heterocyclic compounds: pyrrole, furan, thiophene, indole, quinoline and isoquinoline, IUPAC and common nomenclature of these compounds, their biological importance, synthesis and chemical reactions of these compounds.**

1. 301421 Main Group Elements (3 credit hours)

**This course aims to provide the student with advanced information in the field of inorganic chemistry. the course topics are:Hydrogen, atomic properties isotopes of hydrogen, hydrogen bonding,dihydride, binaryhydres, preparation and uses, chemical and physical properties of group 1,2, 13, 14, 15, 16,17.**

1. 301422 Organometallic Chemistry (3 credit hours)

**The Organometallics 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; alkali metal organometallics; group 2 organometallics; group 13 organometallics, group 14 organometallics; group 16 organometallics; d and f block organometallic compounds, 18 – electron rule; d block carbonyls; Π acceptor ligands; metal carbonyls: synthesis, structure, properties, and reactions; metal complexes with hydrogen, alkenes, alkilidines; catalysis, homogeneous, heterogeneous and some catalytic industrial processes; hydroformylation; polymerization, Monsanto acetic acid synthesis; hydrogenation of alkenes; ammonia synthesis.**

1. 301425 Inorganic chemistry (3) (2 credited hours)

**Inorganic chemistry (3) course giving the students’ knowledge related to the inorganic chemistry of d-Block metals and f-block metals:**

* **The first row metals: Introduction; Occurrence, extraction, and uses; Physical properties: an overview.**
* **The heavier metals: Introduction: Occurrence, extraction and uses; Physical properties; Effects of the lanthanoid contraction; Coordination numbers; NMR active nuclei.**
* **Reaction mechanisms: Introduction: Ligand substitutions; Types of substitution mechanism; Substitution in square planar complexes; Substitution and racemization in octahedral complexes; Electron-transfer processes; Inner-sphere mechanism; Outer-sphere mechanism.**
* **Introduction: f-Orbitals and oxidation states; Atom and ion sizes; The lanthanoid contraction; Coordination numbers; Spectroscopic and magnetic properties; Electronic spectra and magnetic moments: lanthanoids; Luminescence of lanthanoid complexes; Electronic spectra and magnetic moments: actinoid.**
* **Sources of the lanthanoids and actinoids: Occurrence and separation of the lanthanoids and actinoids.**
* **Inorganic compounds and coordination complexes of the lanthanoids, organometallic complexes of the lanthanoids.**

1. 301431 Separation Techniques of Chemical Compounds

(3 credit hours)

**This course presents the fundamentals of separations starting with physical and chemical separation methods; distillation, recrystallization, and solvent extraction and modes of extraction with emphasis on counter current extraction. Column theory is discussed in detail including efficiency, selectivity, resolution, and band broadening. This course also covers chromatographic separations; liquid chromatography (LC), and Gas chromatography (GC) are covered including principles, instrumentation, and applications. A separate chapter deals with mass spectrometry as a universal detector for GC and LC.**

1. 301451 Introduction to Polymer Chemistry (3 credit hours)

**Introduction to polymerization, types of polymers compared to some types of industrial polymers, (methods of preparing polymers), physical and chemical properties, such as polymers, their relation to synthetic properties and their use in practical life**

1. 301452 Practical Polymer Chemistry (2 credit hours)

**Experiments in the preparation of manufactured plastics, including nylon, rubber and plastics used in the textile industry, and the second part of the experiments study the physical and structural properties of the creditor and methods of finding the partial weight of the creditor**

1. 301453 Petroleum and Hydrocarbons (3 credit hours)

**Introduction to the origin of oil and methods of extraction and its various uses. Also the study of oil components and chemical composition of hydrocarbons and ways of distillation of crude oil and analysis to the components of the original experiments that takes place in the laboratories of refineries.**

1. 301459 Library Search and Seminar (1 credit hour)

**The course aims to introduce the student to the sources of scientific and chemical knowledge with a focus on the use of abstracts, indexes, chemical periodicals, and computer databases. The course also includes writing a paper on a recent topic in chemistry and giving a short lecture about it.**

1. 301492 Special Topics in Chemistry (3credit hours)

**This course is intended to study specific topics of interest in chemistry. Physical Chemistry, organic and inorganic chemistry, analytical chemistry. Subject matter may change from semester to semester based on department and student interest.**