Study Plan for the Bachelor's *Degree in Chemistry*

The Department of Chemistry offers a Bachelor's Degree of science upon completion of the following requirements:

1. The fulfillment of the conditions stated in the regulations of awarding the Bachelor's degree at Yarmouk University No. (2) for the year 1991 and its amendments issued in accordance with the bylaws of awarding academic degrees and diplomas at Yarmouk University No. 76 for the year 1976.
2. University course requirements stated under the above regulations.
3. Faculty of Science course requirements stated earlier.
4. Chemistry Department course requirements according to the following :

I. Single Major (86 Credit hrs.) :

1. Obligatory courses (63 Credit hrs.) :

Chem. 102, Chem. 105, Chem. 106, Math. 102, Phys. 102, Phys. 105, Phys. 106, Math. 206, Chem. 211, Chem. 212, Chem. 213, Chem. 214, Chem. 221, Chem. 231, Chem. 232, Chem. 311, Chem. 321, Chem. 323, Chem. 331, Chem. 334, Chem. 341, Chem. 342, Chem. 345, Chem. 346, Chem. 417 (equivalent to Chem. 312), Chem. 442 (equivalent to Chem. 343)

2. Elective courses (23 Credit hrs.) :

a. **(15 Credit hrs.)** : chosen from the following courses offered by the Department :

Chem. 351, Chem. 411, Chem. 412, Chem. 413, Chem. 414, Chem. 415, Chem. 416 (equivalent to Chem. 313), Chem. 421, Chem. 422, Chem. 423, Chem. 431, Chem. 443, Chem. 451, Chem. 452, Chem. 453, Chem. 454, Chem. 461, Chem. 491, Chem. 492, Chem. 493, Chem. 494, Chem. 495, Chem. 496, Chem. 499.

b. **(8 Credit hrs.)** : chosen from the following courses :

Phys. 103, Phys. 201, Phys. 202, Stat. 105, Stat. 111, Math. 203, Math. 241, Bio. 102, Bio. 105, Bio. 106, Bio. 214, Geo. 102, Geo. 105, Geo. 106, Geo. 215, Env. 101B, Env. 252, CIS 103, MIS 120.

Table (1)
Single Major Credit Hours

Requirements	Obligatory	Elective	Total
University requirements	21	6	27
Faculty requirements	21	-	21
Department requirements	63	23	86
Total	105	29	134

II. Major / Minor (86 Credit hrs.) :

1. Major in chemistry (65 Credit hrs.) :

a. Obligatory courses (60 Credit hrs.) :

Chem. 102, Chem. 105, Chem. 106, Math. 102, Phys. 102, Phys. 105, Phys. 106, Math. 206, Chem. 211, Chem. 212, Chem. 213, Chem. 214, Chem. 221, Chem. 231, Chem. 232, Chem. 311, Chem. 321, Chem. 323, Chem. 331, Chem. 334, Chem. 341, Chem. 342, Chem. 345, Chem. 346, Chem. 417 (equivalent to Chem. 312)

b. Elective courses (5 Credit hrs.) :

Chosen from the following courses :
Phys. 103, Phys. 201, Phys. 202, Stat 105, Stat. 111, Stat. 201, Math 203, Math 241, Bio. 102 , Bio. 105, Bio. 106, Geo. 102, Geo. 105, Geo. 106, Env. 101B, Env. 252, CIS 103, MIS 120.

2. Minor (21 Credit hrs.) :

In any of the Departments of the Faculty of Sciences or the Departments of the Faculty of Information Technology and Computer Science.

Table (2)
Major / Minor Credit Hours

Requirements	Obligatory	Elective	Total
University	21	6	27
Faculty	21	-	21
Department	60	5	65
Minor			21
Total			134

III. Minor in chemistry (21 Credit hrs.) :

1. Obligatory courses (15 Credit hrs.) :

Chem. 102, Chem. 105 , Chem. 106, Chem. 215, Chem. 221, Chem. 231, Chem. 232

2. Elective courses (6 Credit hrs.) :

Chosen from the following courses :

Chem. 216, Chem. 321, Chem. 331, Chem. 334, Chem. 341, Chem. 342,
Chem. 351, Chem. 453

Table (3)
The Significance of the Second Digit in Course Numbers

Digit	Title	Digit	Title
0	General Chemistry	5	Industrial, Applied and Theoretical Chemistry
1	Organic Chemistry	6	Biochemistry
2	Inorganic Chemistry	7	-
3	Analytical Chemistry	8	-
4	Physical Chemistry	9	Research, Seminar, Special Topics

Table (4)
Courses Offered by the Department of Chemistry for the Bachelor's Degree in Chemistry

Course No.	Course Name	Weekly Hours		Credit Hrs.	Prerequisites
		Theory	Lab.		
Chem. 099	General Chemistry	3	-	3	-
Chem. 101	General Chemistry (1)	3	-	3	-
Chem. 102	General Chemistry (2)	3	-	3	Chem. 101, Chem. 105
Chem. 103	Introductory Chemistry (For Archeology and Anthropology Students)	3	-	3	-
Chem. 105	General Chemistry Lab. (1)	-	3	1	Chem. 101 or concurrently
Chem. 106	General Chemistry Lab. (2)	-	3	1	Chem. 102 or concurrently
Chem. 211	Organic Chemistry (1)	3	-	3	Chem. 102
Chem. 212	Organic Chemistry (2)	3	-	3	Chem. 106, Chem. 211
Chem. 213	Organic Chemistry Lab. (1)	1	4	2	Chem. 212 or concurrently
Chem. 214	Organic Chemistry Lab. (2)	1	4	2	Chem. 212, Chem. 213
Chem. 215	Organic Chemistry (For Biology , medical physics and Chem. Minors Students)	3	-	3	Chem. 102, Chem. 106
Chem. 216	Organic Chemistry Lab (For Biology Students and Chem. Minors)	1	4	2	Chem. 215 or concurrently

Table (4) (Continued)

Chem. 221	Basic Inorganic Chemistry	3	-	3	Chem. 211
Chem. 231	Analytical Chemistry	3	-	3	Chem. 102, Chem. 106
Chem. 232	Analytical Chemistry Lab.	-	3	1	Chem. 231 or concurrently
Chem. 311	Organic Chemistry (3)	3	-	3	Chem. 212
Chem. 321	Chemistry of Transition Metals	3	-	3	Chem. 212, Chem. 221
Chem. 323	Inorganic Chemistry Lab.	1	4	2	Chem. 321 or concurrently
Chem. 331	Instrumental Analysis	3	-	3	Chem. 212, Chem. 232
Chem. 334	Instrumental Analysis Lab.	1	4	2	Chem. 331 or concurrently
Chem. 341	Physical Chemistry (1)	3	-	3	Chem. 102, Chem. 106, Math. 206
Chem. 342	Physical Chemistry (2)	3	-	3	Chem. 341
Chem. 345	Physical Chemistry Lab (1)	1	3	2	Chem. 342 or concurrently
Chem. 346	Physical Chemistry Lab (2)	1	3	2	Chem. 342, Chem. 345
Chem. 351	Chemistry and Life	3	-	3	Chem. 212, Chem. 221
Chem. 411	Chemistry of Carbanions and Carbenes	3	-	3	Chem. 311
Chem. 412	Free Radicals in Organic Synthesis	3	-	3	Chem. 311
Chem. 413	Heterocyclic Chemistry	3	-	3	Chem. 311
Chem. 414	Polymers Chemistry	3	-	3	Chem. 311
Chem. 415	Named Organic Reactions	3	-	3	Chem. 311
Chem. 416	Organic Spectroscopy	3	-	3	Chem. 212
Chem. 417	Identification of Organic Compounds	2	5	4	Chem. 214, Chem. 311

Table (4) (Continued)

Chem. 421	Organometallic Chemistry	3	-	3	Chem. 321
Chem. 422	Descriptive Inorganic Chemistry of the Elements	3	-	3	Chem. 321
Chem. 423	Heterogeneous Catalysis	3	-	3	Chem. 321
Chem. 431	Chromatography and Mass Spectrometry	3	-	3	Chem. 331, Chem. 334
Chem. 442	Physical Chemistry (3)	3	-	3	Chem. 342, Chem. 345
Chem. 443	Physical Chemistry (4)	3	-	3	Chem. 442
Chem. 451	Industrial Chemistry	2	3	3	Chem. 214, Chem. 341
Chem. 452	Computer Applications in Chemistry	2	3	3	Math. 206, Chem. 342
Chem. 453	Environmental Chemistry	3	-	3	Chem. 221, Chem. 231
Chem. 454	Computational Chemistry	3	3	3	Chem. 211, Chem. 442
Chem. 461	Biochemistry	3	-	3	Chem. 311, Chem. 321
Chem. 491	Seminar	1	-	1	Department approval
Chem. 492	Special Topics in Inorganic Chemistry	3	-	3	Department approval
Chem. 493	Special Topics in Analytical Chemistry	3	-	3	Department approval
Chem. 494	Special Topics in Physical Chemistry	3	-	3	Department approval
Chem. 495	Special Topics in Organic Chemistry	3	-	3	Department approval
Chem. 496	Special Topics in Chemistry	3	-	3	Department approval
Chem. 499	Research	-		3	Department approval

Suggested Registration
Time Table

First Year

First Semester		Second Semester	
Course No.	**Credit Hours**	**Course No.**	**Credit Hours**
Math. 101	3	Math. 102	3
Phys. 101	3	Phys. 102	3
Phys. 105	1	Phys. 106	1
Chem. 101	3	Chem. 102	3
Chem. 105	1	Chem. 106	1
Univ. Obligatory	3	Univ. Obligatory	3
Univ. Obligatory	3	Univ. Obligatory	3
Total	**17**	**Total**	**17**

Second Year

First Semester		Second Semester	
Course No.	**Credit Hours**	**Course No.**	**Credit Hours**
Math. 206	3	Chem. 212	3
Chem. 211	3	Chem. 213	2
Chem. 231	3	Chem. 221	3
Chem. 232	1	Geo. 101	3
Univ. Obligatory	3	Univ. Obligatory	3
Univ. Obligatory	3	Univ. Obligatory	3
Total	**16**	**Total**	**17**

Third Year

First Semester		Second Semester	
Course No.	**Credit Hours**	**Course No.**	**Credit Hours**
Chem. 311	3	Cs. 101	3
Chem. 321	3	Chem. 323	2
Chem. 214	2	Chem. 331	3
Chem. 341	3	Chem. 334	2
Bio. 101	3	Chem. 342	3
Univ. Obligatory	3	Chem. 417	4
Total	**17**	**Total**	**17**

Fourth Year

First Semester		Second Semester	
Course No.	**Credit Hours**	**Course No.**	**Credit Hours**
Chem. 442	3	Chem. 346	2
Chem. 345	2	Dept. Elective	3
Stat. 101	3	Dept. Elective	3
Dept. Elective	3	Dept. Elective	3
Dept. Elective	3	Dept. Elective	3
Dept. Elective	3	Dept. Elective	3
Total	**17**	**Total**	**16**

Course Description of the Department of Chemistry Courses for the Bachelor's Degree

Chem. 099 – General Chemistry (3 credit hrs.)
Periodic table and electronic configuration , Matter, properties of matter, states of matter , Chemical reactions in aqueous solutions , Properties of solution; colligative properties , Chemical equations, blancing chemical equations, calculations based on chemical equations , Chemical equilibrium , Oxidation and reduction , Acids and bases and equilibrium in aqueous solutions , Organic chemistry : (Hydrocarbons, isomerism and nomenclature , Aromatic hydrocarbons , Functional groups in organic chemistry , Basic reactions in organic chemistry).

Chem. 101 - General Chemistry (1) (3 credit hrs.)
Chemistry and measurement, stoichiometry of atoms and molecules, stoichiometry of chemical reactions, properties of solutions, atomic structure, periodic table and electronic configurations of atoms and ions, molecular structure, chemical bonding, molecular shapes, gases, thermochemistry.

Chem. 102 - General Chemistry (2) (3 credit hrs.)
Chemical kinetics, thermochemistry and thermodynamics, electrochemistry, acids and bases, chemical equilibrium, precipitation reactions, introduction to organic chemistry.

Chem. 103 - Introductory Chemistry (For Archaeology Students) (3 credit hrs.)
Periodic table of the elements, stoichiometry, reactions in aqueous solutions, atomic structure, chemical bonding, inter-molecular attractive forces.

Chem. 105 - General Chemistry Lab (1) (1 credit hr.)
Lab. safety and basic Lab. techniques, formula of hydrate, empirical formula of a compound, limiting reactant, periodic chart and periodic law, spectroscopy and molecular geometry, properties of inorganic compounds and metathesis reactions, molecular weight of a volatile liquid, preparation of an alum, aspirin synthesis, standardization of NaOH solution and equivalent weight of an acid, bleach analysis.

Chem. 106 - General Chemistry Lab (2) (1 credit hr.)
Colligative properties (FW Determination), calorimetry, determination of a rate law, spectrophotometric determination of an equilibrium constant, equilibrium constant for a slightly soluble salt, solubility product constant and common-ion effect, qualitative analysis: common anions, group I cations, group II cations, group III cations and general unkonwn.

Chem. 211 - Organic Chemistry (1) (3 credit hrs.)
Bonding, molecular properties and structure of organic compounds, nomenclature, preparations, physical properties, stereochemistry, reactions and reaction mechanisms of alkanes, alkenes, alkynes and aromatic compounds.

Chem. 212 - Organic Chemistry (2) (3 credit hrs.)
Introduction to Spectroscopy including MS, IR, NMR techniques used for identification of organic compounds, structures, nomenclature, preparations, physical properties, reactions and reaction mechanisms of alkyl halides, alcohols, phenols, ethers, sulfur compounds, aldehydes, ketones, carboxylic acids and their derivatives, amines and aryl amines.

Chem. 213 - Organic Chemistry Lab (1) (2 credit hrs.)
Basic techniques which are used for separations and purifications of organic compounds, identifications of some functional groups and preparation of some organic compounds.

Chem. 214 - Organic Chemistry Lab (2) (3 credit hrs.)
Experiments cover basic reactions for the preparations of various organic compounds including multistep synthesis experiments and identifications of some functional groups.

Chem. 215 - Organic Chemistry (For nonmajor chemistry students) (3 credit hrs.)
Bonding, molecular properties and structure of organic compounds, nomenclature, preparations, physical properties, stereochemistry, reactions and reaction mechanisms of alkanes, alkenes, alkynes and aromatic compounds, alkyl halides, alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids and their derivatives, amines, aryl amines, and introduction to carbohydrates, proteins and lipids.

Chem. 216 - Organic Chemistry Lab (For nonmajor chemistry students) (2 credit hrs.)
Techniques used for separations and purifications of organic compounds, identifications of some functional groups and preparation of some organic compounds.

Chem. 221 – Basic Inorganic Chemistry (3 credit hrs.)
Atomic structure, periodic table, valence bond theory, the use of hybridization concept to explain molecular properties, symmetry, molecular orbital theory for simple compounds, donor- acceptor concept, crystal structure of some compounds, descriptive chemistry of main- group elements.

Chem. 231 - Analytical Chemistry (3 credit hrs.)
Statistical treatment of analytical data, gravimetric analysis, acid-base equilibria, acid-base titrations, complex formation titrations, precipitation reactions and titrations, introduction to electrochemistry, qualitative analysis by atomic spectroscopic methods.

Chem. 232 - Analytical Chemistry Lab (1 credit hr.)
Gravimetric analysis, acid-base reactions, precipitation reactions, complex formation reactions, oxidation-reduction reactions.

Chem. 311 - Organic Chemistry (3) (3 credit hrs.)
Carbonyl alpha-substitution and condensation reactions, pericyclic reactions, rearrangements, polynuclear aromatic compounds, heterocyclic compounds, carbohydrates, fats and proteins.

Chem. 321 – Chemistry of Transition Metals (3 credit hrs.)
Electronic structure and general properties of transition elements. Transition metal complexes: definition, types of ligands , coordinate bond, coordination number and nomenclature, magnetic properties and electronic structure using theories of bonding, structural aspects of coordination compounds: geometries and isomerism, substitution reactions, organometallic compounds : the 16-and 18-electron rules, synthesis, structure and bonding of organometallic compounds.

Chem. 323 - Inorganic Chemistry Lab (2 credit hrs.)
Preparation of typical inorganic complexes of some non-transition and transition elements. Characterization of these complexes using physical techniques.

Chem. 331 – Instrumental Analysis (3 credit hrs.)
Electromagnatic radiation and its interactions with matter, components of instruments for optical spectroscopy, molecular fluorescence spectroscopy, atomic spectroscopy, emission spectroscopy, potentiometric methods, voltametry and polarography, an introduction to chromatography, an introduction to mass spectrometry.

Chem. 334 – Instruemntal Analysis Lab. (2 credit hrs.)
Various experiments covering spectroscopic methods which includes application of atomic absorption spectroscopy, atomic emission spectroscopy, molecular ultraviolet/visible spectroscopy, separation methods which include ion–exchange chromatography, gas chromatography (GC) and high performance liquid chromatography (HPLC); electro analytical methods which include direct potentiometric measurements and potentiometric titrations.

Chem. 341 - Physical Chemistry (1) (3 credit hrs.)
Empirical properties of gases and the ideal gas law, real gases, the structure of gases (kinetic theory of gases), properties of liquids and solids, the law of thermodynamic (Zeroth law), energy and the first law of thermodynamics; thermochemistry, the second law of thermodynamics, entropy and the third law of thermodynamics, spontaneity and equilibrium, chemical equilibrium, phase equilibrium in simple systems and the phase rule.

Chem. 342 - Physical Chemistry (2) (3 credit hrs.)
The ideal solution and colligative properties, the ideal dilute solution, equilibrium between condensed phases, equilibrium in non ideal systems, equilibrium in electrochemical cells, chemical kinetics : empirical laws and mechanism, activation energy, collision theory, the transition state theory, Gibbs energy and entropy of activation, heterogeneous reactions.

Chem. 345 - Physical Chemistry Lab (1) **(2 credit hrs.)**

Heat of combustion, heat of solution of an inorganic compound, boiling point elevation, vapor-pressure of pure liquid, equilibrium dissociation constant of methyl red, the EMF of Zn/Cu galvanic cell and the determination of the equilibrium constant and the thermodynamic properties of this cell, binary solid-liquid phase diagram, effect of ionic strength on solubility, chemical equilibrium in solution for the reaction $I_{2aq} + I^-_{aq} = I^-_{3aq}$, the phase diagram of two component system, "binary liquid - vapor phase diagram", the distillation of an organic compound by using the water vapor, determination of the partial molar volumes of NaCl and H_2O solution.

Chem. 346 - Physical Chemistry Lab (2) **(2 credit hrs.)**

Conductance of solution, chemical kinetics, iodine clock, kinetics of the decomposition of benzene diazonium ion, Infra-red study of HCl, atomic spectra of hydrogen, molecular fluorescence of iodine, the equivalent-conductance at dilution of the solutions of KCl, CH_3COOK (potassium acetate) and HCl, the dissociation equilibrium constant determination of acetic acid solution by conductometric method, absorption spectrum of a conjugated dye, adsorption from solution, surface tension of solution, conductometric study of an electrolytic colloid and three component system.

Chem. 351 - Chemistry and Life **(3 credit hrs.)**

Chemistry and its importance for technology of industry, importance of metals in human life, industrial extraction of metals, alloys : properties and uses, preparation of important inorganic compounds (sodium hydroxide, chlorine, hydrogen, acids, glass, cement), chemical fertilizers : nitrogen and phosphate, preparation and uses, herbicides : types, advantages and limitations, petroleum as important energy source : its derivatives and refinery, polymers and plastics, paints, dyes and detergents, chemistry and human health : drugs and medicines, anti-acids, antibiotics, heart-diseases drugs and anti cancer drugs.

Chem. 411 - Chemistry of Carbanions and Carbenes **(3 credit hrs.)**

Definition, structure and stability of carbanions, general methods for preparation of carbanions, general reaction types of carbanions, preparation and reactions of alkyl carbanions, preparation and reactions of carbanions stabilized by α-heteroatom, preparation and reaction of carbanions stabilized by Π conjugation with one heteroatom, preparation and reactions of carbanions stabilized by Π conjugation with two heteroatoms, Molecular rearrangements, introduction to the synthon approach.

Chem. 412 - Free Radicals in Organic Synthesis **(3 credit hrs.)**

General introduction, definition, stability of radicals and radical reactions, methods of radical formation, intermolecular formation of aliphatic carbon-carbon bonds, carbon-carbon bond formation of aromatic systems, free radical reactions of organomercury and alkyl chromium complexes.

Chem. 413 - Heterocyclic Chemistry **(3 credit hrs.)**

Introduction, nomenclature, synthesis, reactions, and reaction mechanisms of three-, four-, five- and six- membered rings with one and more heteroatom and polynuclear heterocyclic compounds.

Chem. 414 – Polymers Chemistry (3 credit hrs.)

Classification of polymerization reactions, structure-property relations in high polymers. step-growth polymerization, homogeneous chain-growth polymerization, heterogeneous chain-growth polymerization, synthesis of polymers and degradation reactions of polymers.

Chem. 415 – Named Organic Reactions (3 credit hrs.)

This course will cover the most important named organic reactions used in the synthesis of organic compounds and in molecular rearrangement.

Chem. 416 - Organic Spectroscopy (equivalent to Chem. 313) (3 credit hrs.)

Study and use of spectroscopic techniques in the identification of organic compounds including MS, IR, NMR, UV-Visible spectroscopy.

Chem. 417 - Identification of Organic Compounds (4 credit hrs.)
(equivalent to Chem. 312)

This course enables the student to identify unknown organic compounds. It includes separation and identification of mixtures of organic compounds by wet chemistry. It covers also the preliminary examinations, physical properties, spectroscopic and derivatization studies.

Chem. 421 – Organometallic Chemistry (3 credit hrs.)

Properties, nomenclature, classification and stability of organometallic compounds, organometallic compounds of selected elements of the first three periods, organometallic compounds of the transition elements : classification of ligands and theories of bonding. (ligands discussed include alkyl, alkyldienes, allyls, dienes, five and six-electron donors).

Chem. 422 – Descriptive Inorganic Chemistry of the Elements (4 credit hrs.)

Introduction, hydrogen, alkali metals, alkaline earth metals, representative elements (IIIA-VIIIA), transition metals : physical and chemical properties, preparation methods, uses, structural aspects.

Chem. 423 - Heterogeneous Catalysis (3 credit hrs.)

Basic concepts of catalysis, activity and selectivity of catalysts, supported metal catalysts. metallic clusters, amorphous and crystalline alloy catalysts, catalyzed reactions and mechanisms, catalysts preparation, surface characterization, reactors.

Chem. 431 - Chromatography and Mass Spectrometry (3 credit hrs.)

Theory of chromatography, gas chromatography, high performance liquid chromatography, supercritical fluid chromatography, principle of mass spectrometry, ionization methods in mass spectrometry, types of analyzers in mass spectrometry, atomic mass spectrometry, molecular mass spectrometry, some of applications mass spectrometry in different branches of chemistry organic, inorganic, biological and analytical.

Chem. 442 - Physical Chemistry (3) (equivalent to Chem. 343) (3 credit hrs.)
Surface chemistry, structure of matter and quantum chemistry (an introduction), hydrogen atom, molecular spectroscopy, transport properties, conductivity.

Chem. 443 - Physical Chemistry (4) (3 credit hrs.)
Introduction of quantum chemistry, postulates in quantum, some simple systems, molecular spectroscopy, electronic spectroscopy.

Chem. 451 - Industrial Chemistry (3 credit hrs.)
Theoretical part : Energy resources, mass and energy balance, heat transfer, unit operations, distillation, extraction, types of reactors, macrokinetics, recovery and refining of petroleum chemical conversion processes in petroleum industries, aromatics, alkanes and alkenes in chemical industries, surfactants and detergents, paints, cement, fertilizers, plasticizers, plastics, natural polymers (cellulose and rubber), synthetic fibers, environmental issues in chemical industries.
Experimental part : Experiments to various topics from the descriptive part plus Tours to a variety of industrial plants in Jordan.

Chem. 452 - Computer Applications in Chemistry (3 credit hrs.)
Performing mathematical operations using electronic components (Operational Amplifiers), instruments interfacing with computer using operational amplifiers, data acquisition and storage, data manipulation, graphing, equations and curve fitting using graphic software, building and solving equations using math cad software, molecular structure drawing in two and three dimensions, estimation of ^{1}H and ^{13}C NMR spectra using ISIS and Chem. office software, using NIST data bases for mass spectral analysis, locating chemistry related sites on the internet and literature search on the web.

Chem. 453 - Environmental Chemistry (3 credit hrs.)
Sources of pollutants, sinks and transport of chemical species and quantitation of chemical species. Applying the principles of chemistry to such topics as atmospheric chemistry, air pollution, water pollution and solid waste management, study of common environmental problems, such as : ozone depletion, particles in the atmosphere, photochemical smog, greenhouse effect and global warming and acid rain.

Chem. 454 – Computational Chemistry (3 credit hrs.)
Introduction to computational chemistry, molecular mechanics, introduction to quantum chemistry and Huckel theory, intoruction to Hartree Fock equation 1, comparison between semiempirical methods, introduction to Gauss View, introduction to Gaussian, basis set, frequency calculation, vibrational analysis in Gaussian, correlated ab initio methods, modeling transition state in Gaussian, thermochemistry, thermochemistry in Gaussian, electronic transitions and NMR predictions, solvation models, introduction to DFT (The course includes a three hours lab).

Chem. 461 - Biochemistry **(3 credit hrs.)**

The course includes two major parts :

Bioorganic chemistry: Structure, reactivity, and synthesis of compounds occurring in nature, chemistry of biomolecules (carbohydrates, lipids, amino acids, and nucleotides, steroids, terpenes, and alkaloids). Energetic and metabolic control, enzymes, mechanisms and kinetics, biosynthesis and functions of macromolecules such as DNA, RNA, and proteins, introduction to biotechnology and introduction to biological membranes.

Bioinorganic chemistry : How cells control of the choice and uptake of metal ions, regulate gene expression and insert the right metals into proteins, electron transfer proteins and multicomponent systems. Attention will also be given to the emerging areas in bioinorganic chemistry, for instance, platinum anticancer compounds and metalloneurochemistry.

Chem. 491 – Seminar **(1 credit hrs.)**

***Chem. 492 - Special Topics in Inorganic Chemistry** **(3 credit hrs.)**

***Chem. 493 - Special Topics in Analytical Chemistry** **(3 credit hrs.)**

***Chem. 494 - Special Topics in Physical Chemistry** **(3 credit hrs.)**

***Chem. 495 - Special Topics in Organic Chemistry** **(3 credit hrs.)**

***Chem. 496 - Special Topics in Chemistry** **(3 credit hrs.)**

Chem. 499 – Research **(3 credit hrs.)**

* The contents of these courses are assigned by the instructor.