

## Description of Courses

### CH211 Physical Chemistry I

This course is fundamental concepts of quantum mechanics will be covered especially for the description of chemistry at the molecular level. The energetic structures associated with electronic and nuclear motions in atoms and molecules will be lectured for the understanding of molecular structures and chemical reactions.

### CH213 Physical Chemistry II

This course presents thermodynamic principles and their chemical applications to gases, liquids, and solids with an emphasis on equilibrium properties of chemical reactions, phase, and solution.

### CH221 Organic Chemistry I

This course is aimed at sophomores in chemistry-related fields and covers the basic concepts and general principles of organic chemistry to give students an ability to explore structure analysis, organic reactions, and applications for their own advanced study.

### CH223 Organic Chemistry II

This course presents sophomores in chemistry-related field the basic concepts and the general principles of organic chemistry and gives them the ability to explore structural analysis, organic reactions, and applications useful for advanced study. Topics covered include: alicyclic hydrocarbons, aromaticity and electrophilic aromatic substitution, arenes and their derivatives, spectroscopy and structure, alcohols, ethers and epoxides, neighboring group effects and catalysis by transition metal complexes, aldehydes and ketones, enantiotopic and diastereotopic ligands and faces, carboxylic acids, carboxylic acid derivatives, aldol and Claisen condensations, tests.

Prerequisite Course : CH221

### CH241 Inorganic Chemistry I

This course is designed to equip undergraduates in chemistry at KAIST with a modern insight of inorganic chemistry with a good balance among theoretical development, descriptive chemistry, and applications. The principal purpose is to develop the fundamental concepts of transition metal coordination compounds such as the molecular symmetry, group theory, structures, bonding, electronic spectra, acid-base chemistry and reaction mechanisms.

### CH242 Inorganic Chemistry II

This course is designed to provide juniors in chemistry with an understanding of periodic trends for the elements, simple compounds and more complex compounds. Course topics include : periodic trends for the elements, complex compounds, solid-state chemistry, solution chemistry.

Prerequisite by topics : Review of atomic theory, theories of chemical bonds, molecular symmetry in inorganic chemistry, theories of coordination chemistry.

Prerequisite course : CH241

### CH252 Chemistry Lab I

This is designed for students majoring in Chemistry to practice the basic techniques of chemical

experiments mainly in physical and analytical chemistry fields.

### **CH263 Introduction to Analytical Chemistry**

This course is designed to give sophomore chemistry majors a broad scope of analytical chemistry from simple chemical methods to instrumental methods. It includes data analysis, systematic treatment of chemical equilibria, acid-base titrations, electroanalytical methods, spectroscopic techniques, mass spectrometry, and chromatography.

### **CH315 Physical Chemistry III**

This course gives junior chemistry majors a broad scope of physical chemistry covering fundamental concepts of transport, spectroscopy, kinetics, statistical thermodynamics, and solid state materials. Emphasis is on properties of ideal and non-ideal solutions, surface phenomena, structure of matter, transport properties, chemical kinetics, and electrochemistry. Prerequisite Course : General Chemistry, Calculus, Analytical Chemistry, Physical Chemistry I

### **CH325 Bioorganic Chemistry**

The purpose of this course is for students to learn the fundamental chemistry of the molecules of life in one semester. After completion of this course, students ought to understand the molecular structure and the reactivity of organic molecules.

### **CH336 Physical Organic Chemistry**

This course is designed to give juniors in chemistry an insight of bonding and conformational analysis, nucleophilic substitution at carbon, elimination and addition reactions, carbene chemistry and cycloaddition reaction.

Topics include : Structure and mechanism, aliphatic nucleophilic substitution, elimination reactions, addition reactions, aromatic electrophilic substitution, molecular rearrangement, aliphatic radical substitution, pericyclic reaction, kinetic studies, linear Gibbs energy relations, acid & bases, and reaction medium.

### **CH352 Chemistry Lab. II**

This is designed for students majoring in Chemistry to practice the basic techniques of chemical experiments especially in the organic field. The class is consisted of organic reactions such as oxidation and C-C bond-forming reactions, which are essential parts of organic transformations.

### **CH353 Chemistry Lab. III**

This is designed for students majoring in Chemistry to practice the basic techniques of chemical experiments mainly in inorganic chemistry and biochemistry fields.

### **CH381 Biochemistry I**

This course is designed to teach structure and function of protein, storage of metabolic energy, and introduce recombinant DNA technology for various biochemical studies. Topics discussed include : amino acids and proteins, molecules of heredity, protein conformation, enzymes, introduction to biological membranes, bioenergetics, carbohydrates, glycolysis, the citric acid cycle, oxidative phosphorylation, pentose phosphate pathway, gluconeogenesis, glycogen metabolism.

### **CH382 Biochemistry II**

This course is designed to teach metabolic reactions of biomolecules and their regulation in chemical, physiological, and genetical aspects.

### **CH416 Introduction to molecular spectroscopy**

This course is using the light-matter interaction, molecular structures can be experimentally determined. Theoretical background for the interpretation of the experiment will be lectured with some practical examples. Basic concepts and application of molecular spectroscopy will be given.

### **CH417 Chemical Reaction Dynamics**

This course is covers chemical kinetics with a discussion of various theories. Theories of rate constants and chemical dynamics are treated with special emphasis on applications to other fields, including industry.

### **CH418 Computation Chemistry**

This course covers numerical methods for molecular mechanics, the principle of molecular dynamics and the Monte Carlo method.

### **CH419 Introduction to Solid-State Chemistry**

This course will introduce physical chemical properties of solids and nanostructured materials including crystal structure, lattice vibration, electronic band structure, electrical conductivity, optical properties and magnetism.

### **CH437 Organic Spectroscopy**

This course is designed to give students in chemical science an understanding of spectroscopic methods of structure determination and qualitative analysis in organic chemistry.

### **CH438 Organic Spectroscopy**

The purpose of this course is for students to understand the mechanism and the reactivity of various organic reactions in detail and to apply the basic knowledge to design synthetic strategies for the total synthesis of natural product, new drug candidates and new electronic materials.

### **CH439 Introduction to Organometallic Chemistry**

Organometallics using either transition metals or main group metal species have been explosively expanded as demonstrated in the recent Nobel prize in chemistry for those chemistry (2001, 2005, and 2010). In this class, a range of aspects of the organometallics chemistry including theoretical background, basic concept, important organometallic reactions, and synthetic applications will be delivered to senior undergraduates and graduate students.

### **CH444 Inorganic Materials Chemistry**

This calss will describe the structures and related physical and chemical properties of inorganic compounds. The main themes are chemical applications of group theory, defect structures and properties of solid materials, and current trends in inorganic chemistry.

#### **CH450 Chemical Writing and Presentation**

Anyone making a career in chemistry must be able to write acceptable scientific papers and presentations in English. This course aims to guide chemistry graduates and senior undergraduates with English as a second language to organize and write effective manuscripts and to deliver better presentations in English. The course is fully interactive and is based on abundant practice.

#### **CH451 Advanced Chemistry Lab.**

This is designed for students majoring in Chemistry with the basic techniques of chemical experiments. This course provides advanced techniques in chemical experiments and research methods and offers students opportunities to identify one's favorite research field in chemical science.

#### **CH452 Introduction to Nanochemistry**

Nanoscience and nanotechnology are utilizing new physicochemical properties that appear when the size of material is reduced to nanometer. Students will learn the fundamental basics of nanoscience and its application as a chemist. They will study how to synthesize nanoparticle, nanowire, thin film and combined structures of such nanomaterials as well as their unique properties. Furthermore, diverse applications including plasmonics, nanosensor, catalysis, biomaterial, mechanics, material science will be introduced.

#### **CH471 Introduction to Polymer Chemistry**

This course is designed to introduce polymer chemistry at the advanced undergraduate level for students with a background in organic chemistry. Topics include : concepts of polymerization reaction mechanisms, kinetics and stereochemistry. Prerequisites by topic : Organic Chemistry I

#### **CH484 Introduction to Chemical Biology**

This class focuses on understanding basic scientific principles underlying chemical biology that is an emerging interdisciplinary research field. Students will learn a variety of aspects of chemical biology ranging from fundamentals to applications. Main textbook would be "Chemical Biology" edited by Stuart L. Schreiber (Wiley-VCH).

#### **CH491 LRP(Laboratory Rotation Program)**

The newly enrolled chemistry major, complete 4 one-week laboratory rotations in a semester. The course makes the students acquire the basic understanding of sub-fields in chemistry as well as feeling a sense of belonging.

#### **CH492 Undergraduate Colloquium**

The current status of ever diversifying subjects in chemistry and future perspectives will be introduced and discussed for chemistry majors. The course is intended to guide chemistry majors in deciding their sub-fields and their career path.

#### **CH502 Quantum Chemistry I**

The purpose of this course is to give graduate students in Chemistry the ability to understand electronic structure and spectroscopic properties of atoms and molecules by means of theoretical techniques, such as ab initio and semiempirical methods. Topics include : Hartree-Fock Approximation, configuration interaction, ab initio and semiempirical methods.

Prerequisite Course : CH315

Prerequisites by topic : Matrix algebra, Hypergeometric functions, Fundamentals of classical mechanics, and Group theory.

### **CH503 Statistical Thermodynamics I**

This course covers the principles of statistical mechanics and many practical applications involving gas, solid, liquid, surface and dielectric properties. Also, emphasis is made on the dynamical aspects of topics such as transport phenomena and chemical reactions. Statistical mechanics of gas, solid, liquid, surface, dielectric properties, transport, phenomena is also covered.

### **CH504 Advanced Physical Chemistry**

This course, diverse fields of physical chemistry, such as quantum chemistry, computational chemistry, spectroscopy, chemical kinetics, and surface & solid state chemistry, will be discussed to help graduate students whose research field is non-physical chemistry to grasp the core concepts of physical chemistry.

### **CH521 Advanced Organic Chemistry I**

This course surveys both classical and modern concepts using electronic interpretation of organic reactions. Topics include electrophilic reactions of Aromatic compounds, Nucleophilic reactions, Stereochemistry, Hammett linear free-energy relationships, Addition-elimination molecular rearrangements and Woodward-Hoffmann-type relationships.

### **CH522 Organic Synthesis**

The lecture covers carbon-carbon bond formation of organic syntheses including alkylation, aldol condensation, free radical reaction rearrangement and cycloaddition reaction.

### **CH523 Organic Synthesis II**

This course allows graduate students in Chemistry to survey new widely applied synthetic methods in organic synthesis and to understand the basic ideas and advances in the field.

Topic include : Formation of carbon-carbon single bonds, formation of carbon-carbon double bonds, the Diels-Alder and related reactions, Reactions at unactivated C-H bonds, Synthetic applications of organoboranes and organosilanes, Oxidation reactions, and Reduction reactions.

### **CH541 Advanced Inorganic Chemistry**

This course is intended for first-year graduate students. The principal purpose is to introduce the fundamental theoretical concepts of geometrical and electronic structures of transition element compounds.

Descriptive Chemistry will not be developed to any great extent in this lecture. Prerequisite by topic: Inorganic Chemistry, Physical Chemistry, Analytical Chemistry

### **CH542 Organometallic Chemistry**

This course is designed for senior undergraduate and graduate students in teaching reaction mechanisms, and synthetic and catalytic aspects of transition metal organometallic compounds.

Prerequisite Courses : CH341 and CH342

Prerequisite by Topics: General properties of organometallic complexes, survey of organometallic

complexes and their reactions categorized by ligands, reaction mechanisms, characterization of organometallic complexes, catalytic processes, applications to organic synthesis, and bioorganometallic Chemistry.

#### **CH581 Advanced Biochemistry**

This course covers advanced description of biosynthesis of macromolecules including such topics as replication gene expression, protein synthesis as well as a discussion of nature and functional aspects of protein and nucleic acid structures.

#### **CH582 Protein Chemistry**

This class aims to understand proteins and their actions by studying basic chemistry, kinetics, and thermodynamics, and structure. Students will gain an understanding of protein structure and activity relationship and principle mechanisms governing protein stability and folding. Lastly, the course will focus on recent advances in protein engineering.

#### **CH604 Quantum Chemistry II**

This course presents molecular spectroscopy and modern quantum chemistry with main emphases on the understanding of modern electronic structure calculations.

Topics include : Brief review of rudimentary Quantum Mechanics, Atomic spectra, Rovibronic spectra of diatomic molecules, Rovibronic spectra of polyatomic molecules, Magnetic resonance spectroscopy, Modern spectroscopy, Ab initio MO calculations and Semi-empirical MO calculations.

#### **CH605 Statistical Thermodynamics II**

This course presents a rigorous treatment of classical statistical mechanics with the application to real systems followed by the recent theory of critical phenomena.

#### **CH606 Molecular Reaction Dynamics**

This course is designed to give graduate students in Physical Chemistry major an ability to interpret chemical and physical observations of reaction chemical species and to predict their behavior in different environments. Topics include : Basic concepts of elementary reactions, Molecular collisions, Reaction scattering, and Molecular energy transfer.

Prerequisites by Topic : Chemical Kinetics, CH417 and Calculus and differential equations, operational mathematics, and matrix algebra.

#### **CH607 Surface Chemistry**

This course is designed to give high-level understanding to the Chemistry of solids, mainly metal and gas-solid interface structures. Thermodynamics and dynamics of the solid surface are discussed with a brief introduction to solid state dynamics. The main area of study is the absorption and desorption of gas molecules on metal surfaces and implications of these phenomena to the theory of catalytic behavior.

Topics include : Principle of the surface analysis methods such as Auger, XPS, LEED, SEXAFS, Chemisorption on surfaces, and Catalytic reactions on surfaces.

#### **CH609 Electrochemistry**

This course is designed to provide graduate students in Chemistry with insight into electrode processes in various electrochemical excitation situations. The principal purpose is to apply this knowledge to the study of various electrochemical properties and analysis of compounds. Topics covered are : basic principles and applications for the study of electrochemical properties and analysis of compounds.

#### **CH610 Structural Biochemistry**

In this class we will discuss theoretical background and practical application of NMR and x-ray crystallographic techniques used for structural studies of biological macromolecules.

#### **CH626 Natural Product Chemistry**

This course is designed to acquaint the graduate student with isolations, purifications and structural elucidations, and total syntheses of various interesting biologically active natural products. Isolation and structural determination of natural products are introduced. Organic synthesis of natural products in selected topics such as antibiotics, toxins, proteins, steroids, and various alkaloids is introduced.

#### **CH627 Heterocyclic Chemistry**

This course is designed to give graduate students a grasp of topics surrounding the synthesis and characterization of heterocycles and utilization of heterocycles for general organic syntheses. The effects of hetero-atoms on reactivity will be discussed. The course also deals with some topics such as the synthesis and characterization of heterocyclic compounds, and how to use these compounds for organic synthesis.

#### **CH628 Organometallic Chemistry**

This course involves a systematic survey of organic reactions regarding organometallics particularly organotransition metal complexes including addition, elimination, insertion, and oxidation / reduction reactions.

#### **CH632 Stereochemistry**

This course is designed to introduce graduate students to the study of reaction mechanisms, the determination of relative configurations and the synthesis of optically active compounds. Topics include : Fundamental comprehension of stereochemistry in organic chemistry, resolution, asymmetric synthesis, stereocontrolled organic reactions and new chiral auxiliaries.

#### **CH644 Bio-Inorganic Chemistry**

This course is designed to discuss the role of metal ions in biological processes observed in biological systems. Metallobiomolecules which will be discussed in detail include metalloproteins for electron transport, oxygen binding, and metal transport and storage, metalloenzymes for various functions of hydrolysis, redox-reaction, and isomerization, and non-proteins for photo-redox and metal-ion transport and storage. The role of metal in medicine and environment as well as synthetic model approach to metallobiomolecules will be also emphasized.

#### **CH645 Catalysis Chemistry**

This course is designed to introduce graduate students in Chemistry and Chemical Engineering to fundamental concepts of heterogeneous catalysts and to illustrate various aspects of homogeneous and

heterogeneous catalysis research.

Topic include: Catalytic activities of transition metal systems, Heterogeneous Catalysis, Catalytic cycles, Ligand systems.

#### **CH646 Materials Chemistry**

This class will introduce the current trends in materials researches including organometallic catalysts, molecular materials, and nanostructured and hybrid materials on the basis of basic concepts in inorganic chemistry. I will also deal with synthesis, analysis, and application methods for materials systematically.

#### **CH671 Organic Chemistry of High Polymers**

This course is designed to give graduate students in Chemistry a survey of the synthesis and reactions of organic polymers and their physical characterization including kinetics of radical species and condensation polymerization, stereochemistry of polymers, ionic polymerizations and other organic chemistry of polymers.

#### **CH672 Specialty Polymer Chemistry**

This course involves synthesis and properties of photonically and electronically functional polymers. Focus is on conducting polymers, photoconducting polymers, photoresponsive polymers, nonlinear optical polymer, electroluminescent polymers, polymer batteries, and photoresists.

#### **CH673 Polymer Physical Chemistry**

This course involves thermodynamic analysis of structure and properties of polymer systems. The focus here is on polymer structure, thermodynamics of polymer solutions, elasticity of rubber, phase equilibrium, friction, and transport processes.

#### **CH674 Organic Electronic Materials**

The course provides the basic principles, various organic and polymeric materials as well as their syntheses and the device fabrications of organic thin-film transistor, organic light-emitting diode and organic photovoltaic cell which are strongly connected with industrial fields.

#### **CH675 Introduction to Lithography**

Lithography is applied widely to manufacturing of semiconductor microchips, displays, and MEMS devices. This course discusses the physics of lithographic process, resist processing, and emerging lithographic technologies such as nanoimprint lithography, interference lithography, immersion lithography, and scanning probe lithography.

#### **CH711 Special Topics in Physical Chemistry I**

This course is designed to give students exposure to "hot topics" and recent advancements in the field of gas and liquid phase studies through lectures and seminars. The formal structure of this course combines lectures by the instructor as well as seminars contributed by students.

#### **CH712 Special Topics in Physical Chemistry II**

This course is designed to give students exposure to "hot topics" and recent advancements in the field



of solid phase and surface studies through lectures and seminars. The formal structure of this course combines lectures by the instructor as well as seminars contributed by students.

#### **CH713 Special Topics in Physical Chemistry III**

This course is designed to give students exposure to “hot topics” and recent advancements in the field of theoretical and computational studies through lectures and seminars. The formal structure of this course combines lectures by the instructor as well as seminars contributed by students.

#### **CH733 Special Topics in Organic Chemistry I**

This course covers special topics in physical organic chemistry such as mechanisms of new organic reactions, molecular dynamics, chemical structures and reactivity, and new molecular orbital calculations.

#### **CH734 Special Topics in Organic Chemistry II**

This course involves the study of recent research papers in the aim to acquire various synthetic strategies applicable in synthesizing organic compounds such as terpenoid, macrolide, alkaloid, carbohydrate, and heterocyclic compounds. Based on this new knowledge, students are expected to apply new tools in their own studies and to develop their creativity in their research. The formal structure of this course involves lectures by the instructor as well as seminars contributed by students.

#### **CH735 Special Topics in Organic Chemistry III**

This course involves the study of electron rearrangements in various chemical functional groups and the progression of chemical properties due to structural changes. Mechanisms of many biologically active compounds are considered in great depth and the synthesis of new compounds and their synthetic strategies are studied.

#### **CH746 Special Topics in Inorganic Chemistry I**

This course is designed to expand on recent “hot topics” in inorganic chemistry through lectures and seminars in the aim to increase students’ exposure to broader fields other than their immediate research interests.

#### **CH747 Special Topics in Inorganic Chemistry II**

This course is designed to involve in-depth study of a special topic, such as crystallography and inorganic structure. The formal structure of this course may involve seminars contributed by students and case studies in addition to the normal lectures.

#### **CH773 Special Topics in Polymer Chemistry I**

This course is composed of lectures on special topics selected from recent “hot topics” in polymer chemistry. The topics include synthetic metals, liquid crystals, photonic polymers, degradable polymers, thermoresistant polymers and new materials.

#### **CH774 Special Topics in Polymer Chemistry II**

This course involves an in-depth study of molecular weight distribution, degrees of freedom, structural regularity, determination of micro-structures, and the relationship between chemical structure and

polymer properties.

#### **CH782 Special Topics in Biochemistry I**

This course involves lectures on special topics selected from recent hot topics in nucleic acid biochemistry and discussions through seminars. Topics including the properties and structures of nucleic acids, gene structure and function, gene expression, gene recombination, and their applications will be covered.

#### **CH783 Special Topics in Biochemistry II**

This course develops selected recent “hot topics” in protein biochemistry and discussions through seminars. Topics include the physical and chemical properties of proteins, protein structure, protein purification, the formation of the protein-ligand complexes, enzyme reaction theory and enzyme reaction mechanisms.