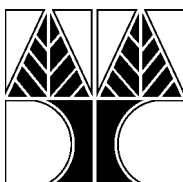


**UNIVERSITY OF CYPRUS**

# **ECTS GUIDE**

**DEPARTMENT OF  
CHEMISTRY**

**2003 - 2004**



**PRODUCTION**  
Publications Team of the  
Service for Research, International and Public Relations  
University of Cyprus

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# SOCRATES PROGRAMME

## MAIN OBJECTIVES

The Republic of Cyprus participates in the SOCRATES Programme through a 1998 bilateral agreement with the European Union. Under the terms of this agreement the Government of Cyprus pays an annual subscription of approximately 500,000 EURO to ensure the right of participation, up to this amount, for all eligible educational institutions of Cyprus.

The University of Cyprus, as one of the eligible institutions nominated by the SOCRATES National Agency which, in the case of Cyprus, is the Ministry of Education and Culture, submitted its first Institutional Contract in November 1997.

The objective of the University is to fully participate in European programmes, with the broad aim of extending its international cooperation, and with specific emphasis on the promotion of European ideals in education. The goals set by SOCRATES - those of promoting a European dimension, transparency, mutual trust and recognition of programmes - are ideals which the University of Cyprus fully supports. Through its existing international contacts, the University has already made a first but significant step in contributing to the realisation of these common goals. SOCRATES provides us with a welcome opportunity to make our contribution towards this pan-european effort, a challenge that we take up with eagerness as well as full awareness of the responsibilities that participation involves.

## ECTS CREDITS

The European Union's goal of promoting the European dimension in education is facilitated to a large extent through the mobility of students. The ERASMUS Action contributes to this effort by enabling students to learn about, and experience European countries other than their own, their languages, ideals and cultures. Moreover, student exchanges are increasingly becoming a major factor in the development of academic and professional careers.

The future aim of the Union is the recognition, on a pan-european level, of study programmes and qualifications, thus making a reality the vision of an open European educational and vocational training area. The European Credit Transfer System (ECTS) was created and is being promoted to contribute to this goal. It is a tool for establishing and securing transparency, as well as a means of building communication and cooperation among institutions, while simultaneously broadening the educational choice of students.

The system is based on three criteria: **Information** (concerning the programme of study and student performance), **Mutual Learning Agreements** (which are signed by the participating institutions and students), and the use of the **ECTS** (which guarantees transparency with respect to student workload, and which is calculated based on lecture hours, laboratories, workshops, assignments and self-study components of the programme). The system is implemented, and its transparency secured, through the following: the information package, the student application/learning agreement and the transcript of records. The use of ECTS is voluntary and is based on mutual trust and recognition of the academic performance of the collaborating institutions.

The main facilitators of ECTS are the students and academic faculty who believe in its goals and who wish to extend student studies abroad. Full academic recognition is a prerequisite for the mobility of students. This means that the study-abroad period (which includes examinations and other forms of assessment) substitutes for an equal period of home study (which also includes examinations and other forms of assessment), irrespective of the fact that the content of study may be different. In other words, ECTS is based on the full-time workload of the students and is not restricted to the hours of attendance in class.

There are 60 credit units in ECTS, which represent the workload for a full academic year; 30 credits for a semester and 20 credits for a trimester/term. At the University of Cyprus, as a rule, the correspondence between home credits and ECTS is exactly 2:1 (2 European credits: 1 University of Cyprus credit).

The University of Cyprus has implemented the credit system in all departments since its inception, and has established this system on criteria almost identical to that of ECTS.

## ELIGIBILITY FOR PARTICIPATION

Students who wish to participate in ECTS must secure in advance the mutual recognition of their credits. Thus, submission of the **Learning Agreement** signed by the host, sending departments and the student is required. Participation in the exchange programme is conditional as follows:

- Students must be citizens of any EU country, the EFTA countries, associated countries in Eastern Europe (Czech Republic, Hungary, Poland, Romania and Slovak Republic), or Cyprus.
- Study at the host University will be free; however, any fees payable to the sending University will still be required.
- Any grant/loan given to students will not be affected by their participation in the ERASMUS exchanges. The period of study abroad should be between 3-12 months.
- First-year students are not entitled to participate in any exchanges.

## DEADLINES

### Fall Semester 2003-2004

Submission of Application: Beginning of July

Arrival of Students/Registration: End of August / Beginning of September

### Spring Semester 2003-2004

Submission of Application: Beginning of November

Arrival of Students/Registration: Third Week of January

## SCHOOL OF GREEK LANGUAGE

SOCRATES/ERASMUS students can attend free of charge the intensive Greek language programme that is offered before the beginning of the Fall Semester (August-September). The intensive programme is of four (4) weeks duration and is intended primarily for exchange students who will be attending courses (of graduate or postgraduate level) at the University of Cyprus.

The intensive programme is offered at both beginner and intermediate levels. Placement of students is based on written examinations.

The courses offered are the following:

- (a) Greek language course, which includes familiarisation with the Cypriot dialect, with which the students will have daily contact.
- (b) Greek civilisation course, which refers to cultural and social issues facing contemporary Greek society.
- (c) Practical exercises in Greek (eg., phonetics and phonology).
- (d) Courses of special interest.

Upon course completion, which is followed by both written and oral examinations, a certificate of the School of Greek Language is issued, recording the programme attended, the level, the duration of attendance, the teaching hours and the distinction achieved.

The School of Greek Language is housed at the renovated Axiothea Street Building situated within the city walls.

## FURTHER INFORMATION

More details concerning the University of Cyprus, Cyprus itself, the administrative services supporting the SOCRATES Programme and other useful information can be found in the *SOCRATES/ERASMUS Information Guide*, which is published separately. The Guide can be obtained from the Service for Research, International and Public Relations of the University of Cyprus (tel.: +357 22 375115, fax: +357 22 375866).

# THE DEPARTMENT OF CHEMISTRY

Chemistry in the University of Cyprus developed until the year 2000 within the Department of Natural Sciences, together with Physics. The Department of Natural Sciences has existed since the establishment of the University of Cyprus. The partitioning of the Department of Natural Sciences into separate Departments of Physics and Chemistry will allow the independent evolution and growth of Chemistry in the University of Cyprus.

The Chemistry Department has at this moment eight (8) members of Faculty members, one visiting scientist and three laboratory technicians. The Department offers a number of courses that lead to an undergraduate Chemistry Degree (BSc), as well as to graduate degrees (MSc and PhD). Teaching is carried out through lectures and laboratory exercises, with additional tutorial sessions in several courses. 25-30 students are accepted in the Undergraduate Chemistry programme every year. The first students were accepted in 1994 and the first BSc degrees were awarded in 1998. The graduate programme in Chemistry started in September 1998.

The principal goal of the Chemistry Department is to advance scientific knowledge and research in Chemistry and to educate highly-qualified graduates, who will work in industry, private enterprises, government, and secondary education, leading to the technological advancement of the country.

## Research in the Department of Chemistry

The Chemistry Department carries out research in all basic areas of Chemistry and in several applied fields as well (Physical Chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, Catalysis, Materials Science). There is a very satisfactory contact with local industry and several government organizations, in spite of the small number of faculty. Chemistry faculty members participate in international research projects and collaborate with many foreign universities and research centers. Members of the Chemistry Department have participated in the past in International and European Research Programmes, while now, with the direct participation of Cyprus in the 5th Framework Programme of the European Union the presence of the Chemistry Department in European projects has increased considerably, while further increase of such participation is anticipated in the future. The following list contains representative research programmes that have been funded in the past or are currently funded, and provides a clearer picture of the breadth of chemical research carried out in the Department:

1. Initiative Avicenne (European Union)
2. Human Capital and Mobility (European Union)
3. Advanced Stimuli Responsive Materials Projects (JHPC/NEDO, Japan)
4. Research Training Networks (5th Framework Programme)
5. Environment and Sustainable Development (5th Framework Programme)
6. Quality of Life (5th Framework Programme)

# UNDERGRADUATE PROGRAMME IN CHEMISTRY

Completion of each course contributes three (3) academic units, with the exception of two Physics courses, two Mathematics courses, and one Computer Science course, which are offered by the Physics Department and by other appropriate Departments of the Faculty of Sciences, and contribute four (4) academic units to the Degree. The courses are subdivided into mandatory courses and electives. Electives are mostly offered in the fourth year of studies. Completion of the degree requires in addition six (6) academic units in a foreign language and twelve (12) academic units in the form of free electives, as is outlined in the general regulations of the University of Cyprus. Free electives are chosen by each student in agreement with his/hers academic advisor.

Lectures are given in the greek language. There are written final exams in each course that the student has to pass. The grade of each course is a combination of the grade of the final exam, with (potentially) grades of mid-term exams, homeworks, literature-based projects or laboratory reports. No courses are considered as formal prerequisites for other courses. However, in a series of related courses (e.g., Inorganic Chemistry I, II, and III), it is clearly not possible to enroll in a course, without first enrolling in the previous course of the series. Courses with code numbers CHE 454, 461, 462 and 463 are chemistry electives, while CHE 451 and 452 constitute the Diploma Thesis, which is mandatory.

## Diploma Thesis

The Diploma Thesis is mandatory for all undergraduate Chemistry students. It is equivalent to two regular semester courses, and is usually undertaken in the fourth year of studies. The subject of the Diploma Thesis is not necessarily original research, although most of the time it is connected to the immediate research interests of the thesis supervisor. Through the Diploma Thesis, the students improve considerably their laboratory chemical skills, come in contact with scientific literature and make a first contact with the complex and difficult problems of everyday chemical practice.

# TABLE OF UNDERGRADUATE COURSES

All courses carry three (3) credit units equivalent to six (6) ECTS credits.

## Fall Semester 2003-2004

<b>Code</b>	<b>Course Title</b>
CHE 151	Inorganic Chemistry I
CHE 161	Physical Chemistry I
CHE 252	Inorganic Chemistry II
CHE 273	Organic Chemistry III
CHE 282	Analytical Chemistry II
CHE 363	Physical Chemistry III
CHE 391	Biochemistry I
CHE 394	Chemical Technology II
CHE 451	Diploma Thesis Work I
CHE 452	Diploma Thesis Work II
CHE 454	Organometallic/Bioinorganic Chemistry
CHE 461	Surface Chemistry
CHE 462	Catalysis
CHE 551	Laboratory of General Chemistry – Qualitative Analysis
CHE 553	Laboratory of Organic Chemistry I
CHE 554	Laboratory of Physical Chemistry I
CHE 557	Laboratory of Physical Chemistry II

## Spring Semester 2003-2004

<b>Code</b>	<b>Course Title</b>
CHE 262	Physical Chemistry II
CHE 271	Organic Chemistry I
CHE 272	Organic Chemistry II
CHE 281	Analytical Chemistry I
CHE 351	Food Chemistry
CHE 353	Inorganic Chemistry III
CHE 392	Biochemistry II
CHE 393	Chemical Technology I
CHE 451	Diploma Thesis Work I
CHE 452	Diploma Thesis Work II
CHE 463	Polymer Chemistry
CHE 552	Laboratory of Analytical Chemistry-Quantitative Analysis
CHE 555	Laboratory of Inorganic Chemistry
CHE 556	Laboratory of Organic Chemistry II

# DESCRIPTION OF UNDERGRADUATE COURSES

All courses are lecture courses. Many courses contain extensive problem-solving sessions. Laboratory courses (Code numbers CHE 551 to 557) are of course an exception, since they are mostly taught through experiments in the chemistry laboratories of the Department.

## FALL SEMESTER 2003-2004

### CHE 151 - Inorganic Chemistry I

**Charis R. Theocharis**

**Course Units: 3 / ECTS Credits: 6**

Introduction: Periodic table of the elements, bonds in inorganic compounds, shapes of inorganic compounds, bond polarity, electrical properties of inorganic solids. Crystal structures of metals and simple ionic compounds (NaCl, CsI, CaF<sub>2</sub>, CdI<sub>2</sub>). Basic concepts in crystallography. Thermodynamic properties of inorganic ionic materials. Systematic chemistry of the elements of groups IA, IIA, IIIB, IVB and VIIB. Transition metal elements. Theory of the structure of complexes.

#### **Bibliography:**

- Μανουσάκη, Γ. *Γενική και Ανόργανη Χημεία*. Εκδόσεις Αδελφών Κυριακίδη.  
Κλούρα, Ν. *Γενική και Ανόργανη Χημεία*.  
Κατάκη, Δ. *Γενική και Ανόργανη Χημεία*.  
Huheey, J.H., E.A. Keiter, R.L. Keiter. *Inorganic Chemistry*. 4th ed. New York: Harper Collins, 1993.

### CHE 161 - Physical Chemistry I

**Epameinondas Leontidis**

**Course Units: 3 / ECTS Credits: 6**

Material Systems and States of Matter: Ideal gases and their laws. Real gases, liquefaction, critical point. Van der Waals gas and its equation of state. Kinetic theory of gases, velocity distribution according to Maxwell and Boltzmann, mean-free-path in a gas, transport phenomena (viscosity, diffusion, thermal conductivity). Heat capacity of gases, equipartition of energy. Intermolecular forces, elementary theory of the liquid state. Radial distribution function. Introduction to the structure of solids.

Introduction to General Thermodynamics: Internal energy, work and heat. First law of thermodynamics. Enthalpy and heat capacities. Thermodynamic processes on the state surface of a single-component system. Joule-Thomson effect. Thermochemistry. Thermodynamic and microscopic definition of entropy. Second law of thermodynamics, spontaneous processes and thermal cycles. Entropic calculations in physical and chemical processes. The path to absolute zero, absolute entropies and the third law of thermodynamics. Gibbs and Helmholtz free energies.

Introduction to Chemical Kinetics: Kinetics and Mechanism. Elementary reactions and their orders. Integrated rate laws. Collision theory for reactions in the gas phase. Dependence of reaction rate on temperature, Arrhenius law, activation energy. Experimental methods for following reaction rates.

#### **Bibliography**

- Κατσάνου, Ν.Α. *Φυσικοχημεία – Βασική Θεώρηση*. Εκδ. 3η Βελτιωμένη. Αθήνα: Παπαζήση, 1992.  
Ρακιντζή, Ν.Θ. *Φυσικοχημεία*. 3η έκδ. Αθήνα: Εκδ. Παπασωτηρίου, 1994.  
Atkins, P.W. *Physical Chemistry*. 6th ed. Oxford: Oxford Univ. Press, 1998.  
Metz, C.R. *Schaum's Solved Problems Series: 2000 Solved Problems in Physical Chemistry*. New York: McGraw-Hill, 1990.

### CHE 252 - Inorganic Chemistry II

**Anastasios Keramidas**

**Course Units: 3 / ECTS Credits: 6**

- Bonding Models in Inorganic Chemistry The Ionic Bond. Lattice Energy. Size Effects. The Predictive Power of Thermochemical Calculations on Ionic Compounds. Covalent character in Predominantly Ionic Bonds. Valence Bond Theory. Molecular Orbital Theory. Electronegativity.

- The Structure and Reactivity of Molecules. The Structure of Molecules. Structure and Hybridization. Bond Lengths. Experimental Determination of Molecular Structure. Some Simple Reactions of Covalently Bonded Molecules.
- The Solid State. The Structures of Complex Solids. Imperfections in Crystals. Conductivity of Ionic Solids. Solids Held Together by Covalent Bonding. Solid-State Materials with Polar Bonds.
- Chemical Forces, Internuclear Distances and Atomic Radii. Types of Chemical Forces. Hydrogen Bonding. Effects of Chemical Forces.
- Acid-Base Chemistry. Acid-Base Concepts. Measures of Acid-Base Strength. Hard and Soft Acids and Bases
- Chemistry in Aqueous and Nonaqueous Solvents Water. Nonaqueous Solvents. Molten Salts. Electrode Potentials and Electromotive Forces.
- Inorganic Chains, Rings, Cages, and Clusters Cages. Boron cage Compounds. Metal Clusters.
- The Chemistry of the Halogens and the Noble Gases Noble Gas Chemistry. Halogen in Positive Oxidation States. Halides. Pseudohalogens. Electrochemistry of the Halogens and Pseudohalogens.

### **Bibliography**

Huheey, J.E. *Inorganic Chemistry. Elements of Structure and Reactivity*. 3d Ed.

Cotton, A., and A. Wilkinson. *Advanced Inorganic Chemistry*. 5th Edition.

## **CHE 273 - Organic Chemistry III**

### **Panayiotis Koutentis**

#### **Course Units: 3 / ECTS Credits: 6**

Electrophilic aromatic substitution. Amines, phenols. Nucleophilic aromatic substitution. Carbohydrates. Pericyclic reactions. Polynuclear aromatic compounds. Heteronuclear compounds.

### **Bibliography**

Morrison and Boyd. *Organic Chemistry*. (Μεταφρασμένο στα Ελληνικά).

Αλεξάνδρου, Ν.Ε. *Γενική Οργανική Χημεία*.

McMurry, J. *Organic Chemistry*.

## **CHE 282 - Analytical Chemistry II**

### **Ioannis Paschalidis**

#### **Course Units: 3 / ECTS Credits: 6**

Analytical Chemistry II is an introductory course to the physical/instrumental methods of chemical analysis and provides basic knowledge of the physical principles, instrumentation and application of instrumental methods used in modern chemical laboratories. The course includes the following chapters:

- Introduction to Chemical Instrumentation: Classification of Analytical Methods, Analytical Instruments, Detectors and Sensors, Signal and Noise, Performance Characteristics of Detectors and Instruments.
- Chromatographic Methods: Definitions, Theory of Chromatography (Plate and Dynamic Theory), Gas Chromatography, Liquid Chromatography / HPLC, Supercritical Fluid Chromatography, Thin Layer Chromatography.
- Methods of Electrophoresis and Field Flow Fractionation: Definitions
- Electrochemical Methods: Introduction, Electrogravimetric and Coulometric Methods, Potentiometric Methods, Voltametric Methods, Conductivity.
- Spectroscopic Methods: Definitions and Theory of Spectroscopy, Absorption Spectroscopy, Fluorescence Spectroscopy, X-ray Spectroscopy, Atomic Absorption Spectroscopy (Flame and Electrothermal), Atomic Emission Spectroscopy (ICP), UV-Vis Spectroscopy, IR/FTIR Spectroscopy, Raman Spectroscopy, NMR Spectroscopy, Mass Spectroscopy
- Additional Methods: Radiometric Methods, Thermal Methods, Methods of Surface Analysis

### **Bibliography**

Pecsok, Shields, Cairns and Mc William. *Σύγχρονες Μέθοδοι στη Χημική Ανάλυση*. Β΄ Έκδοση (μετάφραση). Εκδόσεις Πνευματικός.

Skoog, D.A., and J.J. Leary. *Principles of Instrumental Analysis*. Fourth Edition. Saunders College Publishing.

## CHE 363 - Physical Chemistry III

### Costas Patrickios

#### **Course Units: 3 / ECTS Credits: 6**

Introduction to spectroscopy. Molecular symmetry and point groups. Group theory and character tables. Molecular orbitals and their symmetry. Rotational spectroscopy. Vibrational spectroscopy. Raman spectroscopy. Electronic spectroscopy. Nuclear magnetic resonance spectroscopy. Electron paramagnetic resonance spectroscopy. Scattering techniques.

#### **Bibliography**

- Atkins, P.W. *Physical Chemistry*. 6th Ed. Oxford: Oxford University Press, 1998.  
Cotton, F.A. *Chemical Applications of Group Theory*. 3rd Ed. NY: Wiley, 1991.  
Τσίπη, Κ.Α. *Εισαγωγή στην Κβαντική Χημεία*. Τόμος ΙΙ. *Μοριακή Δομή*. Β΄ Έκδ. Θεσσαλονίκη, 1994.  
Banwell, C.N., E.M. McCash. *Fundamentals of Molecular Spectroscopy*. 4th Ed. London, 1994.  
Carter, R.L. *Molecular Symmetry and Group Theory*. NY: Wiley, 1998.  
Drago, R.S. *Physical Methods for Chemists*. 2nd Ed. Saunders College Publishing. Ft. Worth, 1992.

## CHE 391 - Biochemistry I

### Visiting Professor

#### **Course Units: 3 / ECTS Credits: 6**

- Nucleic Acids structure and biosynthesis: replication, transcription and translation
- Research techniques to study nucleic acid structure
- Amino Acids and Proteins Peptide bond, primary, secondary, tertiary and quaternary structure of proteins
- Techniques for protein purification and characterisation
- Hemoglobin (Structure, function and human genetic disease of hemoglobin chains)
- Molecular diagnostics of human genetic disease
- Enzymes (kinetics of catalysis, regulation, co-enzymes)
- Sugars and polysaccharides
- Lipids and biological membranes
- Metabolism: Overview of thermodynamics, biological order and energy exchange.
- Krebs cycle. Electron transport and oxidative phosphorylation. Glycolysis and gluconeogenesis. Lipid metabolism. Cholesterol metabolism.

#### **Bibliography**

- Stryer, L. *Biochemistry*. W.H. Freeman & Co, 1996.  
Voet & Voet. *Biochemistry*. New York: J. Wiley, 1995.  
Alberts et al. *Molecular Biology of the Cell*. Garland Publ., 1995.

## CHE 394 - Chemical Technology II

### Angelos Efstathiou

#### **Course Units: 3 / ECTS Credits: 6**

This course covers the study of integrated industrial processes for the production of some of the most significant inorganic and organic chemical products. Based on the acquired knowledge during the previous course of Chemical Technology I, an in-depth analysis of all the physical and chemical processes that are used for the production of a given chemical product is attempted. The course covers the following topics:

- Industrial use of water and processes for its purification
- Processes for the production of sulfuric acid (H<sub>2</sub>SO<sub>4</sub>)
- Processes for the production of ammonia (NH<sub>3</sub>) and nitric acid (HNO<sub>3</sub>)
- Processes for the production of cement
- Processes for the production of fertilizers
- Analysis of continuous equilibrium distillation as an important industrial process
- Petroleum – Gasoline and related industry

A deep understanding of the above referenced material is acquired through the solution of about 10-12 problems in a prescheduled series of homework assignments.

## Bibliography

Shreve, G. *Chemical Process Industries*. N.Y.: McGraw-Hill, 1976.

Heaton, C.A. *The Chemical Industry*. Blackie, 1986.

Lebedev, N.N. *Chemistry and Technology of Basic Organic and Petrochemical Synthesis*. Mir Publishers, 1981.

### CHE 451 - Diploma Thesis Work I

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#### **Course Units: 3 / ECTS Credits: 6**

The Diploma Thesis is a mandatory requirement for a Chemistry degree. In the first semester/ first half of a diploma thesis the student is introduced and works on a project under the supervision of a faculty member. In CHE 451 the student does not get an independent grade. At the end of the semester the student performance is graded by the supervision as «Satisfactory» or «Unsatisfactory». In the latter case, the student will have to register for a diploma thesis for two more semesters. The grade for the diploma thesis is given after the completion of CHE 452.

### CHE 452 - Diploma Thesis Work II

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#### **Course Units: 3 / ECTS Credits: 6**

This course is offered in the Winter Semester for students that have started their Diploma Thesis Work in the Spring Semester of the previous academic year. Successful completion of the thesis requires that the student write a thesis, which must be presented in front of a committee during the examination period of the semester. The details of grading a thesis are described in the related internal regulations of the Department. The grade of a Diploma Thesis is identical for CHE 451 and 452. The Diploma Thesis thus becomes equivalent to two regular courses of the undergraduate studies programme in Chemistry.

### CHE 454 - Organometallic and Bioinorganic Chemistry

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#### **Anastasios Keramidis**

#### **Course Units: 3 / ECTS Credits: 6**

This course is offered in the 4th year of the Chemistry Degree as a Departmental Elective.

- Organometallic Chemistry
- The 18-Electron Rule
- Metal Carbonyl Complexes
- Nitrosyl Complexes
- Dinitrogen Complexes
- Metal Alkyls, Carbenes, Carbynes, and Carbides
- Nonaromatic Alkene and Alkyne Complexes
- Metallocenes
- Reactions of Organometallic Complexes
- Catalysis by Organometallic Complexes
- Stereochemically Nonrigid Molecules
- The Inorganic Chemistry of Biological Systems
- Energy Source for Life
- Metalloporphyrins and Respiration
- Dioxygen Binding, Transport, and Utilization
- Electron Transfer, Respiration, and Photosynthesis
- Enzymes
- Nitrogen Fixation
- The Biochemistry of Iron
- Essential and Trace Elements in Biological Systems
- Biochemistry of the Nonmetals
- Medicinal Chemistry

#### **Bibliography**

Huheey, J. E. *Inorganic Chemistry*. (Elements of Structure and Reactivity). 3d Ed.

Cotton, A., and A. Wilkinson. *Advanced Inorganic Chemistry*. 5th Ed.

## CHE 461 - Surface Chemistry

**Charis R. Theocharis**

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### **Course Units: 3 / ECTS Credits: 6**

This course is offered at the 4th year of the Chemistry programme of studies as a Departmental Elective, and contains the following material:

- Introduction: goal, definition of a surface, definition of porosity. Adsorption.
- Solid-liquid and liquid-gas interface. Adsorption isotherms. Sorption.
- Solid-gas interface. BET theory and its extensions.
- Characterization and measurement of porosity.
- Characterization methods for solid surfaces: spectroscopy, photoelectronic spectroscopy, thermogravimetric analysis, adsorption methods, diffraction methods.
- Basic groups of porous materials and their applications.

### **Bibliography**

West, A.R. *Introduction to Solid State Chemistry*. Wiley.

West, A.R. *Basic Solid State Chemistry*. Wiley.

Gregg, S.J. and K.S.W. Sing. *Adsorption. Surface Area and Porosity*. Wiley.

## CHE 462 - Catalysis

**Angelos Efstathiou**

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### **Course Units: 3 / ECTS Credits: 6**

One of the most basic problems of the modern productive chemical industry is the control of the rate and selectivity of the chemical reactions involved in the course of the production of a given valuable chemical compound. The facing of this problem, in most of the industrial chemical units, is done by the use of appropriate solid materials that possess catalytic properties (high activity, selectivity and stability with time on stream). In the last 20 years, the use of catalysts played and will continue to play a significant role for the abatement of very dangerous and toxic gas pollutants (i.e., CO, NO, NO<sub>2</sub>, N<sub>2</sub>O, Chlorinated hydrocarbons) in the environment, as the only viable solution. A characteristic example of the application of catalysis in solving technological environmental problems is the implementation and marketing of the "three-way" catalytic converter in gasoline-driven automobiles.

During this course, basic concepts and principles that govern and explain the catalytic phenomenon are presented. This course is offered as a Chemistry Elective in the last year of studies for the Chemistry Degree.

- Concepts and terms that describe the catalytic phenomenon and the causes of its existence
- Concepts and terms related to the texture and structure of supported metal catalysts
- Basic concepts related to the chemical adsorption and desorption processes associated with a solid surface
- Temperature-programmed desorption techniques
- Preparation and characterization methods of supported catalysts
- Environmental catalysis: Applications to air de-pollution
- The catalytic phenomenon and its relation with the mass and heat transfer processes
- Rates, mechanisms and modeling of heterogeneous catalytic reactions

### **Bibliography**

Bond, G.C. *Heterogeneous Catalysis, Principles and Applications*. 2nd Ed. Oxford Chemistry Series, 1986.

Satterfield, C.N. *Heterogeneous Catalysis in Practice*. Mc-Graw Hill, 1980.

Thomas, J.M., W.J. Thomas. *Principles and Practice of Heterogeneous Catalysis*. Wiley-VCH, 1996.

## CHE 462 - Catalysis

**Angelos Efstathiou**

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### **Course Units: 3 / ECTS Credits: 6**

One of the most basic problems of the modern productive chemical industry is the control of the rate and selectivity of the chemical reactions involved in the course of the production of a given valuable chemical compound. The facing of this problem, in most of the industrial chemical units, is done by the use of appropriate solid materials that possess catalytic properties (high activity, selectivity and stability with time on stream). In the last 20 years, the use of catalysts played and will continue to play a significant role for the abatement of very dangerous and toxic gas pollutants (i.e., CO, NO, NO<sub>2</sub>, N<sub>2</sub>O, Chlorinated hydrocarbons) in the environment, as the only viable solution. A characteristic example of the application of catalysis in solving technological environmental problems is the implementation and marketing of the "three-way" catalytic converter in gasoline-driven automobiles.

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- Basic concepts related to the chemical adsorption and desorption processes associated with a solid surface
- Temperature-programmed desorption techniques
- Preparation and characterization methods of supported catalysts
- Environmental catalysis: Applications to air de-pollution
- The catalytic phenomenon and its relation with the mass and heat transfer processes
- Rates, mechanisms and modeling of heterogeneous catalytic reactions

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Bond, G.C. *Heterogeneous Catalysis, Principles and Applications*. 2nd Ed. Oxford Chemistry Series, 1986.  
Satterfield, C.N. *Heterogeneous Catalysis in Practice*. Mc-Graw Hill, 1980.  
Thomas, J.M., W.J. Thomas. *Principles and Practice of Heterogeneous Catalysis*. Wiley-VCH, 1996.

## **CHE 551 - Laboratory of General Chemistry-Qualitative Analysis**

### **Visiting Professor**

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#### **Course Units: 3 / ECTS Credits: 6**

The students must carry out 10 experiments that cover the following topics:

- Proteolytic titrations
- Preparation and analysis of simple ionic compounds
- Redox reactions and redox titrations
- Preparation and analysis of complexes of V, Cr and Cu
- Ion identification
- Simple spectroscopic methods (UV-visible and IR spectroscopy)

### **Bibliography**

Χατζηγιάννου, Θ.Π. *Ποιοτική Ανάλυση και Χημική Ισορροπία*. Αθήνα: 1992.  
Χατζηγιάννου, Θ.Π. *Εργαστηριακές Ασκήσεις Ποσοτικής Αναλυτικής Χημείας*. Αθήνα: 1992.  
Κλούρα, Ν.Δ. *Τεχνικές και Πειράματα Γενικής και Ανόργανης Χημείας*. Αθήνα: Παπαζήση, 1990.  
Κοτονιάς, Γ.Θ. *Εργαστήριο Ανόργανης Αναλυτικής Χημείας*. Αθήνα: 1989.  
Αναγνωστόπουλου, Α.Κ. *Εργαστηριακές Ασκήσεις Ανόργανης Χημείας*. Θεσσαλονίκη: 1984.  
Μανουσάκης, Γ.Ε. *Ειδικές Εργαστηριακές Ασκήσεις Ανόργανης Χημείας*. Θεσσαλονίκη: 1983.

## **CHE 553 - Laboratory of Organic Chemistry I**

### **Athanassios Nicolaides**

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#### **Course Units: 3 / ECTS Credits: 6**

Introductory laboratory course, which introduces the students to the basic laboratory techniques of organic chemistry, through the following experiments:

- Boiling point. Distillation.
- Recrystallization. Melting point.
- Liquid-liquid extraction.
- Separation of a mixture of organic compounds using extraction.
- Thin-layer chromatography. Analysis of the composition of analgesic drugs.
- Isolation of caffeine from tea-leaves. Preparation of caffeine salicylate.
- Preparation of benzalaniline.

### **Bibliography**

Laboratory notes from previous lecturers (Stella Loukaidou and Manolis Stratakis)

## CHE 554 - Laboratory of Physical Chemistry I

### Visiting Professor

#### Course Units: 3 / ECTS Credits: 6

Statistical analysis in Physical Chemistry experiments. Use of computer to analyze and present experimental data. The experiments are grouped into three groups.

- States of Matter
- Temperature dependence of the viscosity of liquids.
- Phase diagram, liquification and critical point.
- Use of molecular dynamics to study the states of matter.
- Thermodynamics
- Spectrophotometric determination of the equilibrium constant of a complex.
- Spectrophotometric determination of the dissociation constant of an indicator.
- Determination of enthalpies of combustion and hydrogenation using a bomb-calorimeter.
- Determination of enthalpies of dissolution, dilution and neutralization using an open calorimeter.
- Study of Stirling cycle
- Chemical Kinetics
- Study of a chemical reaction using volumetric determination of the product.
- Study of a hydrolysis reaction using spectroscopic determination of the reactant.
- Study of a saponification reaction using conductivity measurements.
- Study of self-catalyzed and oscillating reactions.

#### Bibliography

- Atkins, P.W. *Physical Chemistry*. 6th Ed. Oxford: Oxford University Press, 1998.
- Castellan, G.W. *Physical Chemistry*. 3rd Ed. Menlo Park: Benjamin Cummings, 1983.
- Κατσάνου, Ν.Α. *Φυσικοχημεία: Βασική Θεώρηση*. 3η Έκδ. Αθήνα: Παπαζήση, 1992.
- Μουμτζή, Ι.Α. *Πειραματική Φυσική-Χημεία*. Θεσσαλονίκη: Ζήτη, 1994.
- Milton, J.S., Arnold, J.C. *Probability and Statistics in the Engineering and Computing Sciences*. New York: McGraw-Hill, 1986.
- Λεοντίδη, Ε. *Σημειώσεις Εργαστηριακών Ασκήσεων Φυσικοχημείας Ι*. Λευκωσία: 1999.

## CHE 557 - Laboratory for Physical Chemistry II

### Erpameinondas Leontidis

#### Course Units: 3 / ECTS Credits: 6

Laboratory complement to the courses Physical Chemistry II and III (CHE262 and 364).

**Chemical Equilibrium:** Dissociation constants for weak bases, partitioning equilibria, complex stability constants, vapor-point elevation, freezing-point depression.

**Phase Equilibria:** Vapor-liquid equilibria – study with refractometry. Study of a ternary liquid mixture with turbidity titrations and gas chromatography.

**Surface Phenomena:** Solubilization of pollutants in micelles of surface active substances. Surface tension of solutions and mixtures with the du Nouy ring method and with the maximum bubble pressure method.

**Electrochemistry:** Electrochemical measurements with galvanic cells and their applications. Polarography. Transference numbers and electrolysis.

**Spectroscopy and Quantum Chemistry:** Atomic spectra with a diffraction spectrophotometer. Vibration-rotation spectra using IR-Spectrometry. Quantum calculations on conjugated systems of  $\pi$ -electrons using Hyperchem.

**Chemical Kinetics:** Oxidation mechanism of ascorbic acid. Enzymatic hydrolysis of esters. Study of fast reaction kinetics using the stopped-flow method.

#### Bibliography

- Atkins, P.W. *Physical Chemistry*. 6th Ed. Oxford: Oxford University Press, 1998.
- Castellan, G.W. *Physical Chemistry*. 3rd Ed. Menlo Park: Benjamin Cummings, 1983.
- Λεοντίδη, Ε. *Σημειώσεις Εργαστηριακών Ασκήσεων Φυσικοχημείας ΙΙ*. Λευκωσία: 1999.

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## CHE 262 - Physical Chemistry II

Epameinondas Leontidis

**Course Units: 3 / ECTS Credits: 6**

**Chemical Equilibrium:** Gibbs and Helmholtz free energy. Combination of the first and second law of thermodynamics. Chemical potential, fugacity and activity. Solutions and mixtures, colligative properties. The role of thermodynamics in the study of chemical reaction equilibria. Thermodynamic and practical equilibrium constants. Solubility, acid-base equilibria, complex stability constants, distribution equilibria. Environmental and biological applications of chemical thermodynamics.

**Phase Equilibria:** Phase equilibria of pure substances. Vapor pressure and Clausius-Clapeyron equation. Phase transitions. Mixtures. Raoult's law, Henry's coefficients. Gibbs's phase rule. Vapor-liquid equilibria, distillation, azeotropic mixtures. Partly miscible fluids. Melting and eutectic mixtures. Ternary phase equilibria.

**Electrochemistry:** Electrolyte solutions, ionic strength, Debye-Hückel and Bjerrum theories. Electrical conductance in electrolyte solutions, theories of Arrhenius and Ostwald. Electrical double layer, Poisson-Boltzmann model, zeta potential, biological membranes. Galvanic cells, standard electrode potentials and Nernst equation. Electrolysis and transference numbers.

**Chemical Kinetics:** Unimolecular reactions. Activated complex theory, dynamic potential surfaces and reaction dynamics. Reactions in the liquid phase – encounter theory. Enzymatic and catalytic reactions.

### Bibliography

- Kατσάνου, Ν. *Φυσικοχημεία – Βασική Θεώρηση*. Έκδ. 3η Βελτιωμένη. Αθήνα: Εκδ. Παπαζήση, 1992.  
Ρακιντζή, Ν.Θ. *Φυσικοχημεία*. 3η έκδ. Αθήνα: Εκδ. Παπασωτηρίου, 1994.  
Atkins, P.W. *Physical Chemistry*. 6th ed. Oxford: Oxford Univ. Press, 1998.  
Metz, C.R. *Schaum's Solved Problems Series: 2000 Solved Problems in Physical Chemistry*. New York: McGraw-Hill, 1990.

## CHE 271 - Organic Chemistry I

Athanassios Nicolaidis

**Course Units: 3 / ECTS Credits: 6**

**Introduction:** Nomenclature of organic compounds, purification and analysis of organic compounds.

**Molecular structure and properties:** Atomic and molecular orbitals, chemical bond. Hybridized atomic orbitals (sp<sup>3</sup>, sp<sup>2</sup>, sp). Unconjugated electron pairs. Intramolecular forces, bond-breaking energy, bond polarization, melting point, intermolecular forces, boiling point, solubility, acids and bases.

**Electronic Mechanisms:** Inductive phenomenon, resonance and hyperconjugation. Hammett equation.

**Stereochemistry-Conformation:** Enantiomeric compounds, racemic systems, R-S nomenclature, Diastereomerism, Molecular asymmetry and chiral compounds, Asymmetric syntheses, geometric isomerism. Cis-trans isomerism. Structure and conformation of cyclic compounds. Stereochemistry of N, S and P atoms.

**Classification of reactions and reactants:** Nucleophilic and electrophilic reagents (acids and bases according to Lewis). Classification of reactions. Energy change during a reaction – transition state. Isotopic substitution and labelling.

**Nucleophilic aliphatic substitution reactions:** SN<sub>1</sub> and SN<sub>2</sub> mechanisms. Effect of R, X and N groups on the substitution path. Solvent effects. Substitution reactions: E<sub>2</sub> and E<sub>1</sub> mechanisms.

Spectroscopic Methods: Ultraviolet-visible spectra. Infrared spectra. Nuclear Magnetic resonance spectra.

### Bibliography

- Αλεξάνδρου, Ν.Ε. *Γενική Οργανική Χημεία*. Τεύχος Α'.
- Morrison and Boyd. *Οργανική Χημεία*. 4η Έκδοση. Α' τόμος.
- Sykes, P. *Οδηγός στους Μηχανισμούς της Οργανικής Χημείας*.

## CHE 272 - Organic Chemistry II

Panayiotis Koutentis

**Course Units: 3 / ECTS Credits: 6**

**Alkanes:** Nomenclature. Cyclic alkanes-cyclohexane. Dicyclic-polycyclic alkanes. Synthesis methods. Properties.

**Alkenes:** Structure and synthesis. Electronic properties of double bonds. Hydrogenation. Addition of water, halogens and acids on the double bond, oxidations, other reactions.

**Alkynes:** Electronic structure. Acidity. Synthesis reactions. Free radical reactions. Addition polymers.

**Alkyl-halides and organometallic compounds:** Organo-lithium and organo-magnesium compounds. Grignard reaction. Metallocenes. Organometallic sandwich compounds. Carbenes.

**Alcohols:** Oxidation. Alcohols as acids. C-O bond breaking. Polyols.

**Ethers:** Physical properties. Synthesis. Epoxides, thiols and thioethers.

**Aldehydes and ketones:** Synthesis. Nucleophilic addition to the carbonyl. Addition of alcohols. Acetals, ketals and thio acetals. Addition of ammonia derivatives. Addition of HCN, NaHSO<sub>3</sub>, Wittig reaction. Keto-enol tautomerism. Halogenation of ketones. Aldol additions. Claisen-Schmidt and Cannizzaro reactions. Unsaturated aldehydes and ketones. Iodoformic reduction.

**Carboxylic acids and their products:** Acidity. Synthesis of acids. Nucleophilic substitution at acyl carbon. Anhydrides. Decarboxylation. Acyl chlorides. Esters.

**Amines-Amides:** Synthesis. Hydrolysis and dehydration.  $\alpha$ -halo-acids. Hell-Volhard reaction. Reactions of amines with HONO. Substitution of the N=N bridge in diazonic salts.

## Bibliography

Αλεξάνδρου, Ν.Ε. *Γενική Οργανική Χημεία*. Τεύχος Β'.

Morrison and Boyd. *Οργανική Χημεία*. 4η Έκδοση. Α' τόμος.

Sykes, P. *Οδηγός στους Μηχανισμούς της Οργανικής Χημείας*.

## CHE 281 - Analytical Chemistry I

**Ioannis Paschalidis**

### Course Units: 3 / ECTS Credits: 6

Analytical Chemistry I is a course concerned with the definition of the analytical problem, the reliability and statistical treatment of analytical data, the significance of pre-analytical procedures, the classical methods of chemical analysis and the importance of chemical equilibria calculations in analytical chemistry. CHE 281 covers the following topics:

- Introduction: Definitions, Role of Analytical Chemistry, The Analytical Problem, Classical and Instrumental Methods of Chemical Analysis.
- Errors and Statistical Evaluation of Analytical Data: Errors in Chemical Analysis, Error Propagation, Application of Descriptive and Inductive Methods of Statistics to Analytical Data, (Outliers, Confidence Levels, Comparison of Methods, Detection Limits), Reporting Analytical Data.
- Pre-Analytical Procedures: Classical and Modern Methods of Dissolution and Separation, (mechanical, thermal and chemical methods).
- Classical Methods of Analysis: Gravimetric Methods of Analysis, Methods and Mechanisms of Precipitation, Crystalline and Colloidal Precipitates, Volumetric Titrimetry, Stoichiometric Calculations.
- Chemical Equilibrium and Analytical Chemistry: Definitions (Equilibrium Constants, Activity-Concentration etc.), Equilibria in Aquatic Solutions and pH.
- Acid/Base Titrations: Acid/Base Solutions, Buffer Solution and Acid/Base Indicators, Acid/Base Titration Curves, Species Distribution Diagrammes, Acid/Base Titrations in Nonaqueous Solutions.
- Complex Formation and Complexometric Titrations.
- Solubility Calculations: Solid-Liquid and Solid-Liquid-Gas Phase Equilibria.
- Redox Reactions and Redox Titrations: Redox Reactions, Electrochemical Cells, Electrode and Cell Potential.
- Kinetic Methods of Analysis.

## Bibliography

Χατζηϊωάννου, Θ.Π. *Ποιοτική Ανάλυση και Χημική Ισορροπία*. Αθήνα: 1992.

Pecsok, Shields, Cairns, McWilliam. *Σύγχρονες Μέθοδοι στη Χημική Ανάλυση*. Αθήνα: Πνευματικός, 1980.

Skoog, D.A., D.M. West and F.J. Holler. *Fundamentals of Analytical Chemistry*. New York: Saunders College Publishing, 1996.

## CHE 351 - Food Chemistry

**Stelios Yiannopoulos**

### Course Units: 3 / ECTS Credits: 6

Definition of Food Chemistry. Food and Nutrition - Energy Value. Water: Structure of water and physical properties. Water activity, bound water, water solutions. Moisture determination methods. Lipids: Composition and origin. Chemical and physical properties, physicochemical constants. Oils and Fats technology. Methods of determination and examination of oils and fats. Aminoacids: Classification, methods of separation. Chemical and physical properties. Peptides - Proteins: Structure, classification. Proteins properties. The role of proteins in food

preparation. Novel proteins. Protein determination methods. Carbohydrates: Monosaccharides, oligosaccharides, polysaccharides. Carbohydrates Browning reactions, Dietary Fibers and methods of determination. Inorganic constituents: Metals, trace elements, chlorine, sulphur, iodine, boron. Methods of determination. Vitamins: Fat and water soluble vitamins. Methods of determination. Additives: Colors, preservatives, antioxidants, emulsifiers, stabilisers. Flavor: Basic tastes, artificial flavors. Methods of flavor estimation. Non desirable constituents in foods: Toxic substances derived from vegetable, animal and microbiological sources. Toxic substances derived from environmental pollution or technology treatment. Specific subjects: Meat and meat products. Milk and milk products.

### **Bibliography**

- Μπόσκου, Δ. *Χημεία Τροφίμων*. Δ΄ Έκδοση. Θεσσαλονίκη: Εκδόσεις Γαρταγάνη, 1997.
- Frank, A. Lee. *Basic Food Chemistry*. Second Edition. Westport, Connecticut: The AVI Publishing Company, Inc., 1983.
- Γαλανού, Δ.Σ. *Θέματα Χημείας Τροφίμων*. Γ΄ Έκδοση, Αθήνα: Οργανισμός Εκδόσεων Διδακτικών Βιβλίων, 1984.
- Βουδούρη, Ε.Κ., Μ.Γ. Κοντομηνά. *Ανάλυση Τροφίμων - Θεωρία και Εφαρμογές*. Ιωάννινα: 1987.
- Κιοσέογλου, Β., Γ. Μπλέκας, Δ. Μπόσκου, Μ. Τσιμίδου. *Εισαγωγή στην Ανάλυση Τροφίμων*. Εργαστήριο Χημείας και Τεχνολογίας Τροφίμων. Τμήμα Χημείας Α.Π.Θ., Έκδοση Πανεπιστημιακού Τυπογραφείου Α.Π.Θ., 1995.

## **CHE 353 - Inorganic Chemistry III**

### **Anastasios Keramidas**

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#### **Course Units: 3 / ECTS Credits: 6**

**Coordination Chemistry:** Bonding, Spectra, and Magnetism. Bonding in Coordination Compounds. Valence Bond Theory. Crystal Field Theory. Molecular Orbital Theory. Electronic Spectra of Complexes. Magnetic Properties of Complexes.

**Coordination Chemistry:** Structure. Low Coordination Numbers. Coordination Number 4.

Coordination Number 5. Coordination Number 6. Coordination Number 7. Coordination Number 8. Higher Coordination Numbers. Generalizations about Coordination Numbers. Linkage Isomerism. Other Types of Isomerism. The Chelate Effect.

**Coordination Chemistry:** Reactions, Kinetics, and Mechanisms Substitution Reactions in Square Planar Complexes. Thermodynamic and Kinetic Stability. Kinetics of Octahedral Substitution. Mechanisms of Redox Reactions

**Some Descriptive Chemistry of the Metals.** General Periodic Trends. Chemistry of the Various Oxidation States of Transition Metals. The Chemistry of Elements Potassium-Zinc: Comparison by Electron Configuration. The Chemistry of the Heavier Transition Metals. Oxidation States and EMFs of Groups. The Lanthanide and Actinide Elements. Coordination Chemistry. The Transactinide Elements.

### **Bibliography**

- Huheey, J.E. *Inorganic Chemistry (Elements of Structure and Reactivity)*. 3d Ed.
- Cotton, A., and A. Wilkinson. *Advanced Inorganic Chemistry*. 5th Edition.

## **CHE 392 - Biochemistry II**

### **Visiting Professor**

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#### **Course Units: 3 / ECTS Credits: 6**

The following topics are covered:

- Advanced research and diagnostic techniques of Biochemistry and Clinical Biochemistry
- Cytoskeleton: Structure, function, molecular physiology of muscle contraction and intracellular transport
- Nervous system: generation and propagation of nerve impulse, neuromuscular junction, neurotransmitters
- Signal transduction in intracellular communication, second messenger systems, G protein-coupled receptors
- Hormones: molecular physiology of endocrine system, hormonal control circuitry, metabolic disorders
- Cancer and oncogenes: molecular physiology of carcinogenesis
- Gene therapy: methodology and current applications
- Prions and disease
- Cloning: Plants, animals, humans

### **Bibliography**

- Stryer, L. *Biochemistry*. W. H. Freeman & Co, 1996.
- Voet & Voet. *Biochemistry*. New York: J. Wiley, 1995.
- Alberts et al. *Molecular Biology of the Cell*. Garland Publ., 1995.

## CHE 393 - Chemical Technology I

Angelos Efstathiou

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### **Course Units: 3 / ECTS Credits: 6**

Chemical Technology is the scientific field that is concerned with the knowledge and applications of the most suitable available physical and chemical processes, by which raw materials are converted into useful chemical products with the maximum yield and lowest financial cost. In this course, the basic principles that govern the present modern Chemical Industry are developed. This course covers the following topics:

- Mass balances under steady-state and non steady-state conditions
- Energy balances under steady-state and non steady-state conditions
- Applications of mass and energy balances
- Fluid flow in pipes
- Methods for the measurement of fluid flow
- Pumping of fluids
- Heat transfer under steady-state and non steady-state conditions. Heat Exchangers
- Chemical reactors (plug-flow and CSTR type)
- A deep understanding of the above material is acquired through the solution of about 20-25 problems in a prescheduled series of homework assignments.

### **Bibliography**

Himmelblau, D.M. *Basic Principles and Calculations in Chemical Engineering*. Prentice-Hall Inc., 1982.

Fogler, H.S. *Elements of Chemical Reaction Engineering*. Prentice-Hall Inc., 1986.

Clausen, C.A., G. Mattson. *Principles of Industrial Chemistry*. J. Wiley & Sons, 1978.

Heaton, C.A. *The Chemical Industry*. Blackie, 1986

## CHE 451 - Diploma Thesis Work I

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### **Course Units: 3 / ECTS Credits: 6**

The Diploma Thesis is a mandatory requirement for a Chemistry degree. In the first semester/ first half of a diploma thesis the student is introduced and works on a project under the supervision of a faculty member. In CHE 451 the student does not get an independent grade. At the end of the semester the student performance is graded by the supervision as 'Satisfactory' or 'Unsatisfactory'. In the latter case, the student will have to register for a diploma thesis for two more semesters. The grade for the diploma thesis is given after the completion of CHE 452. CHE 451 is offered in the Spring Semester for students, who wish to start their diploma thesis in the Spring Semester and complete it in the Winter Semester of the following academic year.

## CHE 452 - Diploma Thesis Work II

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### **Course Units: 3 / ECTS Credits: 6**

This course is normally offered in the Spring Semester for students, who have obtained a "Satisfactory" grade in CHE 451 in the previous academic semester. Successful completion of the thesis requires that the student write a thesis, which must be presented in front of a committee during the examination period of the semester. The details of grading a thesis are described in the related internal regulations of the Department. The grade of a Diploma Thesis is identical for CHE 451 and 452. The Diploma Thesis thus becomes equivalent to two regular courses of the undergraduate studies programme in Chemistry.

## CHE 463 - Polymer Chemistry

Costas Patrickios

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### **Course Units: 3 / ECTS Credits: 6**

Introduction, nomenclature and uses. Condensation polymerization. Free-radical polymerization. Ionic polymerization. Photolytic, electrolytic and radiation polymerizations. Polymerization of cyclic organic compounds. Modification reactions of synthetic polymers. Biological polymers and their chemical reactions. Polymers containing inorganic elements. Relationship between macromolecular structure and properties. Electroactive polymers. Biomedical applications of synthetic polymers.

## Bibliography

- Allcock, H.R., F.W. Lampe. *Contemporary Polymer Chemistry*. 2nd Ed. Englewood Cliffs: Prentice Hall, 1990.
- Remp, P., E.W. Merrill. *Polymer Synthesis*. Basel: Hüthig & Wepf, 1986.
- Rosen, S.L. *Fundamental Principles of Polymeric Materials*. 2nd Ed. NY: Wiley, 1993.
- Σμιτζή, Ι.Χ. *Πολυμερή*, Αθήνα: Εθνικό Μετσόβειο Πολυτεχνείο, 1994.
- Cowie, J.M.G. *Polymers: Chemistry & Physics of Modern Materials*. 2nd Ed. Stanley Thornes (Chapman & Hall), Padstow, Cornwall, UK, 1998.
- Odian, G. *Principles of Polymerization*. NY: McGraw-Hill, 1970.
- Stevens, M.P. *Polymer Chemistry: An Introduction*. 2nd Ed. Oxford Univ. Press, 1990.
- Flory, P.J. *Principles of Polymer Chemistry*. Ithaca, NY: Cornell University Press, 1953.
- Hiemenz, P.C. *Polymer Chemistry: The Basic Concepts*. NY: Marcel Dekker, 1984.
- Young, R.J., P.A. Lovell. *Introduction to Polymers*. 2nd Ed. Chapman & Hall, 1996.

## CHE 481 - Fundamentals of Environmental Chemistry

**Ioannis Paschalidis**

### **Course Units: 3 / ECTS Credits: 6**

The elective course "Fundamentals of Environmental Chemistry" is a selection of environmental topics which attempts to provide basic knowledge in order to understand the role of chemical elements (and compounds) in the synthesis and decomposition of inorganic, organic and biological matter in nature, including the effects of human activities.

The following topics are emphasised:

- Geochemical and Elemental Cycles
- Atmospheric Phenomena and Related Chemical Reactions
- Aquatic Systems and Water/Wastewater Management
- Soil Chemistry and Waste Deposition in Geological Formations
- Chemistry and Toxicity of Toxic Metals and Xenobiotica
- Analysis of Environmental Samples

### **Biobibliography**

- O'Neil, P., Chapman and Hall. *Environmental Chemistry*. London: 1993.
- Howard, A.G. *Aquatic Environmental Chemistry*. Oxford: Oxford Science Publishers, 1998.

## CHE 552 - Analytical Chemistry Laboratory-Quantitative Analysis

**Ioannis Paschalidis**

### **Course Units: 3 / ECTS Credits: 6**

This is a course of laboratory experiments concerned with quantitative chemical analysis. The main goal of the experiments is the precise determination of the amount of a species in laboratory or natural samples and the evaluation and statistical treatment of the analytical data. Where possible, both classical and instrumental analytical methods are involved in the analysis, in order to compare and find out their advantages and disadvantages. The experiments cover the following analytical methods:

- Ion-exchange: Determination of Potassium
- Gravimetry: Determination of Calcium, Determination of Nickel.
- Volumetric Titrations: Acid-Base (Preparation of Standard solutions, Evaluation of Titration Curves), - Complexometric Titrations (Hardness of Water), Argentometric Titrations.
- UV-Vis Photometry (vs Volumetry): Statistical Analysis of Experimental Data and Method Comparison
- Potentiometry (vs Volumetry): Experimental Titration Curve determined by Glass-Electrode, Determination of Copper by Ion Selective Electrode.
- Conductivity: Determination of Dissolved Solids (vs Gravimetry), Acid-Base Titration (vs Volumetry).
- Gas Chromatography: Separation of Alkanes
- Determination of Nitrogen by the Kjeldahl method.

### **Bibliography**

- Πασχαλίδης, Ι. *Σημειώσεις Εργαστηρίου Αναλυτικής Χημείας*. Λευκωσία: 1998.
- Χατζηγιάννου, Θ.Π. *Εργαστηριακές Ασκήσεις Ποσοτικής Αναλυτικής Χημείας*. Αθήνα: 1992
- Κοτονιάς, Γ.Θ. *Εργαστήριο Ανόργανης Αναλυτικής Χημείας*. Αθήνα: 1989.
- Fifield, F.W., and D. Kealey. *Principles and Practice of Analytical Chemistry*. Blackie & Son Ltd.

## CHE 555 - Inorganic Chemistry Laboratory I

**Anastasios Keramidas**

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**Course Units: 3 / ECTS Credits: 6**

The course has a lab period of at least 3 hours every week. This is a synthesis laboratory, which is based on 4 large laboratory exercises, each of which consists of 3-4 parts. Goal of the exercises is the synthesis of transition metal complexes, for metals of the first row (V, Cr, Fe, Co), the subsequent chemical analysis of the complexes and their spectroscopic characterization.

### **Bibliography**

Laboratory notes by the lecturer.

## CHE 556 - Organic Chemistry Laboratory II

**Panayiotis Koutentis**

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**Course Units: 3 / ECTS Credits: 6**

This laboratory course strengthens student understanding of the basic techniques of organic synthesis with a series of selected experiments. Experiments currently conducted are:

- Synthesis of benzalaniline
- Synthesis of aspirin
- Thin Layer Chromatography
- Esterification and hydrolysis
- Haloformic reaction
- Isolation of caffeine from tea leaves
- Soaps and detergents
- Synthesis of n-butyl bromide and t-pentyl-chloride.

### **Bibliography**

Laboratory notes by the previous lecturer, M. Stratakis (in Greek).

# POSTGRADUATE PROGRAMME IN CHEMISTRY

The Postgraduate Programme in Chemistry started in the academic year 1998-1999. Upon being accepted in the graduate programme, incoming graduate students select a research advisor, and immediately start to work on a research problem. In addition, they have to complete thirty (30) academic units of graduate courses (seven courses of 4 units each and a graduate seminar of 2 units), following departmental regulations described later in this guide. The courses must be completed within five (5) semesters of study. After completing the courses the graduate students must take a Qualifying Examination on the subject matter of the graduate courses attended. Succeeding in the Qualifying Examination allows a student to continue and obtain a Doctoral Degree in Chemistry. In case of double failure in Qualifying Examinations, the student is not allowed to continue for a Doctoral degree, but can obtain a Master's degree by submitting an appropriate academic thesis.

The Chemistry Department admits each year up to 10 new postgraduate students, the number of which depends on the needs of the section. Applications are submitted to the Department and they are considered for evaluation by a three-member faculty committee. Candidates may be interviewed by the Committee. Upon acceptance to the programme, the students must choose one of the faculty members of the section as his/her research supervisor.

M.Sc. and Ph.D. students after completion of their degree requirements have good opportunities to be employed in the local industry, the public sector, to become Research or University Professors, or to work in the sector of secondary education.

The research in the Chemistry section of the Department is focused on the following topics:

- Chemistry of porous solid materials
- Physical Chemistry of colloids and surfactants
- Computational Chemistry/Molecular Simulation
- Heterogeneous Catalysis/Environmental Catalysis and Technology
- Polymer Synthesis and Characterization
- Synthetic Organic Chemistry
- Synthetic Inorganic Chemistry
- Analytical and Environmental Chemistry

Postgraduate students conduct their research work in laboratories established by the Chemistry faculty members and under the close supervision by them. Financial aid of the order of CYP414.00 (1993-1999) has been granted by the University in order to support the development of research in chemistry.

Postgraduate students can be financially supported by the University through teaching assistantships, or through external research programmes.

The Chemistry postgraduate programme includes both theoretical and experimental-type courses as indicated in the following Tables. A total of 7 courses (4 units) and a seminar (2 units) are required for successful completion of M.Sc. and Ph.D. requirements, in addition to carrying out research. It is possible that for a student holding a M.Sc. degree, part or all of the 30 units can be credited to him/her.

# TABLE OF POSTGRADUATE COURSES

All courses carry four (4) credit units equivalent to seven (7) ECTS credits.

## Theoretical Courses

CHE610	Physical Chemistry of Surfaces
CHE 611	Physicochemical Methods in Inorganic Chemistry
CHE 612	Special Topics in Polymers (Physical Chemistry)
CHE 620	Stereochemistry of Enzyme Reactions
CHE 621	Advanced Organic Synthesis
CHE 622	Chemistry of Molecular Solids
CHE 635	Studies of Dynamic Phenomena in Inorganic Complexes and Metalloenzymes
CHE 636	Group Theory
CHE 637	Zeolite Chemistry
CHE 640	Basic Principles in Colloid Chemistry
CHE 650	Molecular Mechanics and Methods of Molecular Simulations
CHE 652	Thermodynamics and Statistical Mechanics
CHE 670	Heterogeneous Catalysis
CHE 680	Environmental Technology
CHE 681	Biochemical Engineering
CHE 690	Special Topics in Polymers I (Synthesis – Characterization – Technology)

## Experimental Courses

CHE 700	Special Topics/Research Techniques in Colloid Chemistry and Surfactants
CHE 710	Methods of Characterization of Organic Compounds
CHE 720	Synthesis and Characterization Methods of Inorganic Compounds
CHE 740	Special Topics/Research Methods for Characterization of Solid Surfaces
CHE 750	Special Topics/Research Methods for Catalytic Mechanistic Studies
CHE 760	Special Topics/Research Methods for Polymer Synthesis and Characterization
CHE 800	Seminar* (2 credit units)

\* *Note:*

- A written and oral presentation of a subject chosen from the wider spectrum of the research topic of the student.
- The Chemistry section of the Department has already granted one (1) Ph.D. and one (1) M.Sc. diploma. Currently there are 14 postgraduate students in the programme.

# DESCRIPTION OF POSTGRADUATE COURSES

## CHE 611 - Physical Methods of Inorganic Chemistry

Anastasios Keramidas

**Course Units: 4 / ECTS Credits: 7**

Group theory. Introduction to Spectroscopy. Vibrational spectroscopy of Inorganic Molecules. Electronic spectroscopy of transition metals. NMR spectroscopy. FT-NMR, 1-D and 2-D NMR. Electron paramagnetic resonance (EPR) spectroscopy. Magnetism. NMR of paramagnetic compounds. Electrochemical methods. X-Ray crystallography.

### Bibliography

Drago, Russell S. *Physical Methods for Chemists*. Second Edition.

Cotton, Albert F. *Chemical Applications of Group Theory*. Third Edition.

Cotton and Wilkinson. *Advanced Inorganic Chemistry*. Fifth Edition.

Kahn, Olivier. *Molecular Magnetism*.

Weltner, William Jr. *Magnetic Atoms and Molecules*.

Kevin, Larry and Michael K. Bowman. *Modern Pulsed and Continuous-Wave Electron Spin Resonance NMR Spectroscopy Basic Principles, Concepts and Applications in Chemistry*. Second Edition.

Dikanov, A. Sergei, Yuri D. Tsvetkov. *Electron-Spin Echo Envelope Modulation (ESEEM) Spectroscopy*.

Rieger, A. Philip. *Electrochemistry*.

Sobkowiak, Andrzej, Donald T. Sawyer, L. Julian, Roberts, Jr. *Electrochemistry for Chemists*. Second Edition.

Drent, Jan. *Principles of Protein X-Ray Crystallography*.

## CHE 612 - Special Topics in Polymers II. Physical Chemistry.

Epameinondas Leontidis

**Course Units: 4 / ECTS Credits: 7**

- Molecular weights and sizes: Various molecular weights. Characterization of the molecular weight distribution. Techniques for measuring molecular weights and their distribution. Characteristic length scales of polymeric chains. End-to-end distance, radius of gyration, persistence length. Measuring characteristic lengths with scattering methods. The polymeric chain and the gaussian distribution. Freely-jointed and freely-rotating chains. The excluded-volume problem. The Rotational Isomeric State scheme of Flory. Computations of the excluded volume with computer simulation and with renormalization group methods.
- Polymers and solvents. Chemical potential and osmotic pressure. Dilute, semi-dilute and dense polymer solutions. Good and bad solvents. Theta-solvents. Chain conformations in solution. The excluded volume problem. The entanglement length problem. Simple models for dilute polymer solutions. Denser solutions, Flory theory, the chi parameter. Scaling theory of De Gennes. Phase separation in solutions and in polymer blends. Block copolymers and microheterogeneous phases. Polyelectrolytes. Manning's counterion condensation theory. Biological macromolecules in solution.
- Amorphous polymer phases. Melts. Diffusion coefficients, entanglement length, Rouse-Zimm theory of normal modes. The glassy phase and the glass transition temperature. Kinetics and thermodynamics of vitrification – the Kauzmann paradox. The rubber elastic phase. Intermolecular connections and elasticity theory. Viscoelasticity and rheological behavior of melts and solutions. Physical chemistry of gels.
- Crystalline phase. Fusion and crystallization from solutions. Crystal structure from X-Ray Diffraction. Basic models of polymer crystallization. Crystalline lamellae and the reentry problem. Spherulites, dendrites.
- Liquid crystalline phases. Properties, characterization and technological significance.
- Modern applications of polymers. Adsorption of polymers on surfaces. Adhesion of polymers to metals and other materials. Wetting of polymers. Polymers as stabilizers. Polymers as high-tech materials. Dielectric, optical and electronic properties of polymers. Polymers in biomedical applications and in drug delivery. Biodegradable polymers.

### Bibliography

Sperling, L.H. *Introduction to Physical Polymer Science*. 2nd ed. New York: Wiley Interscience, 1992.

Gede, U.W. *Polymer Physics*. London: Chapman and Hall, 1995.

Donth, E.J. *Relaxation and Thermodynamics in Polymers*. Akademie Verlag, 1992.

Strobl, G. *The Physics of Polymers*. Berlin: Springer Verlag, 1996.

## CHE 622 - Chemistry of Molecular Solids

**Charis Theocharis**

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**Course Units: 4 / ECTS Credits: 7**

Topochemical and topotactic reactions. Canellic acid and cyclopentanone-based compounds. Non-classical topochemical reactions. Topochemical reactions on lattice defects. Solid-state polymerization. The diacetylene case. Conductive polymers. Materials with nonlinear optical properties. Liquid crystals.

## CHE 637 - Chemistry of Porous Materials

**Charis Theocharis**

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**Course Units: 4 / ECTS Credits: 7**

Surfaces of solids. Introduction, definitions. Freundlich, BET and BDDT isotherms. Porosity: definition and characterization. Experimental methods. Applications: zeolites, other porous materials.

## CHE 640 - Introduction to Colloid Science

**Epameinondas Leontidis**

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**Course Units: 4 / ECTS Credits: 7**

- Matter in the colloidal state. The main types of colloids. Characteristic phenomena in colloid systems and dispersions. Preparation methods for colloids.
- Optical properties of colloids. Scattering of light, X-rays and neutrons. Optical microscopy. Polarized microscope. Electron microscope. Atomic force microscopy and scanning tunnelling microscope.
- Kinetic properties of colloids. Diffusion. Viscosity. Rheology. Electrophoresis.
- Thermodynamics of interfacial systems. Surface tension. Contact angle. Elementary theory of nucleation, crystal-growth and aggregation.
- Interparticle forces in colloidal systems. Van der Waals forces, modern theory of Lifshitz. Modern double layer theory. Colloid stability, DLVO theory.
- Aggregation colloids. Micelles, liquid-crystalline phases of surfactants. Lamellar phases and vesicles, macro- and microemulsions. Polymers and biological macromolecules as colloids.

### **Bibliography**

Hunter, R.J. *Foundations of Colloid Science*. Vol. I and II. Oxford: Clarendon Press, 1989.

Evans, D. Fennell, and H. Wennerström. *The Colloidal Domain*. NY: VCH Publ., 1999.

Hiemenz, P.C., and R. Rajagopalan. *Principles of Colloid and Surface Chemistry*. 3d ed. NY: Marcel Dekker, 1998.

## CCHE 670 - Heterogeneous Catalysis

**Angelos M. Efstathiou**

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**Course Units: 4 / ECTS Credits: 7**

- Influence of external mass and heat transport processes on the rate and selectivity of a catalytic reaction.
- Influence of internal mass (diffusion) and heat transport processes within porous catalysts on the rate and selectivity of a catalytic reaction. Theory of diffusion within porous materials, experimental methods for the determination of effective diffusivity.
- Analysis of experimental rate data influenced by mass and heat transport phenomena in order to extract intrinsic kinetic parameters.
- Environmental Catalysis: The selective catalytic reduction of NO. From the fundamental research to its applied technology.

### **Bibliography**

Smith, J.M. *Chemical Engineering Kinetics*. McGraw-Hill.

Thomas, J.M., W.J. Thomas. *Principles and Practice of Heterogeneous Catalysis*. Wiley-VCH, 1996.

Research papers.

## CHE 681 - Biomedical Engineering

Costas Patrickios

### Course Units: 4 / ECTS Credits: 7

Introduction: Biochemical Engineering, biotechnology and industry. The chemicals of life: Proteins, nucleic acids, saccharides and lipids. Enzymes and enzyme kinetics. Enzyme applications. Stoichiometry of microbial reactions. Kinetics of substrate consumption, product formation and biomass production in cell cultures. Ideal bioreactors and their modeling.

### Bibliography

Bailey, J.E., D.F. Ollis. *Biochemical Engineering Fundamentals*. 2nd Ed. NY: McGraw Hill, 1986.

Doran, P.M. *Bioprocess Engineering Principles*. London: Academic Press, 1995.

## CHE 695 - Characterisation and Chemical Behaviour of Heavy Metals in the Environment

Ioannis Paschalidis

### Course Units: 4 / ECTS Credits: 7

The postgraduate course "Speciation and Chemical Behaviour of Heavy Metals in the Environment" provides chemical principles that are important to the chemistry of heavy metal ions in natural environment and in particular in natural aquifer systems. The chemical principles that can be applied in order to understand the chemical behaviour and the use of chemical thermodynamics for describing reactions of metal ions under natural conditions and in the presence of naturally occurring ligands are reviewed extensively. Specific topics such as solid phase solubility, hydrolysis, chloride, carbonate and humate complexation, redox reaction, colloid formation and geochemical reaction are discussed in detail and examples of analytical methods/techniques used in the determination and characterisation (speciation) of metal species under environmental condition are given in plenty.

### Bibliography

Merian, E., ed. *Metals and their Compounds in the Environment*. Weinheim: Verlag Chemie, 1991.

Baes, C.F., R.E. Mesmer. *The Hydrolysis of Cations*. Florida: Krieger Publishing, 1986.

Stumm, W., J.J. Morgan. *Aquatic Chemistry*. New York: Wiley Interscience, 1996.

Stumm, W. *Chemistry of the Solid-Water Interface*. New York: J.Wiley and Sons, 1992.

Sposito, G. *Chemical Equilibria and Kinetics in Soils*. Oxford: Oxford University Press, 1994.

*Complexation Reactions in Aquatic System*. New York: J.Wiley and Sons, 1988.

Brookins, D.G. *EH-pH Diagrams for Geochemistry*. Berlin: Springer Verlag, 1988.

*Foundations of Colloid Science*. Oxford: Clarendon Press, 1987.

Selected Papers

## CHE 720 - Methods of Synthesis and Characterization of Inorganic Compounds

Anastasios Keramidas

### Course Units: 4 / ECTS Credits: 7

Synthesis of Inorganic Compounds

- Techniques for synthesizing inorganic compounds in aqueous solutions and in organic solvents.
- Techniques for synthesizing Inorganic Compounds under inert atmosphere (in the absence of water or air or both).

Characterization of Inorganic Compounds.

- Characterization of inorganic compounds in the solid state. X-Ray, IR, UV/Vis, magnetic methods.
- Characterization of inorganic compounds in aqueous solutions and in organic solvents. Potentiometry, UV/Vis, multinuclear NMR, EPR, magnetic methods, Electrochemical methods.

### Bibliography

Drago, S. Russell. *Physical Methods for Chemists*. Second Edition.

Cotton and Wilkinson. *Advanced Inorganic Chemistry*. Fifth Edition.

Gerbelev, N.V., V.B. Arion, and John Burgess. *Template Synthesis of Macrocyclic Compounds*.

Kahn, Olivier. *Molecular Magnetism*.

Weltner, William, Jr. *Magnetic Atoms and Molecules*.

*NMR Spectroscopy Basic Principles, Concepts and Applications in Chemistry*. Second Edition.

Rieger, A. Philip. *Electrochemistry*.

Sawyer, D.T., A. Sobkowiak and Julian L. Roberts, Jr. *Electrochemistry for Chemists*. Second Edition.

## CHE 740 - Methods of Structure Identification

**Charis R. Theocharis**

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**Course Units: 4 / ECTS Credits: 7**

The basics of crystallographic symmetry. Structure-solution methods and the phase problem: Patterson maps, direct methods, methods of structure convergence. Comparison of X-Ray diffraction, neutron and electron diffraction. Spectroscopic methods. EXAFS, XPS, UPS.

## CHE 750 - Special Topics/Research Techniques for Mechanism - Investigations of Catalytic Reactions

**Angelos M. Efstathiou**

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**Course Units: 4 / ECTS Credits: 7**

- Mechanisms of catalytic reactions: elementary step, intrinsic rate, mathematical modeling for the development of a rate expression based on a given mechanistic scheme.
- Research techniques for the study of elementary reaction steps (i.e., adsorption, surface reaction, desorption). Determination of kinetic and thermodynamic parameters.
- Use of stable isotopes for the determination of the mechanism of a heterogeneous catalytic reaction.
- Mass Spectroscopy. Principles, analysis of a vacuum system, quantitative determination of the composition of a gas mixture.
- Practice on the use of a mass spectrometer and some of the research techniques taught.

### **Bibliography**

Research papers.

## CHE 760 - Special Topics/Research Techniques of Polymer Synthesis and Characterization

**Costas Patrickios**

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**Course Units: 4 / ECTS Credits: 7**

Monomer synthesis from an alcohol and methacryloyl chloride. Monomer purification by vacuum distillation. Monomer purification by recrystallization. Determination of monomer purity by gas chromatography. Group transfer polymerization. Free-radical polymerization. Determination of molecular weight by gel permeation chromatography. Determination of impurities in copolymers by reverse-phase chromatography. Monomer and polymer characterization using proton nuclear magnetic resonance spectroscopy. Polymer characterization by viscometry. Polymer characterization by dynamic and static light scattering. Electrochemical polymer characterization. Synthesis of polymer networks. Characterization and applications of polymer networks.

### **Bibliography**

Stevens, M.P. *Polymer Chemistry: An introduction*. 2nd Ed. Oxford Univ. Press, 1990.

Hiemenz, P.C. *Polymer Chemistry: The Basic Concepts*. NY: Marcel Dekker, 1984.

Rempp, P., E.W. Merrill. *Polymer Synthesis*, Basel: Huthig & Wepf, 1986.

Odian, G. *Principles of Polymerization*. NY: McGraw Hill, 1970.

Rosen, S.L. *Fundamental Principles of Polymeric Materials*. 2nd Ed. NY: Wiley, 1993.

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