University of Split

Faculty of Chemical Technology

PROPOSAL FOR THE ACADEMIC GRADUATE STUDY PROGRAMME

# Chemistry

Split, February 1, 2005

STUDY PROGRAMME / CURRICULUM

# Academic graduate study:

# Chemistry

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# 1. Introduction

## 1.1. General information on the programme

Chemistry and chemical science, permeating the entire modern society, are represented in all developed regions of the EU countries and, therefore, need to take an appropriate position in the Split-Dalmatia County and beyond through the activities of university education institutions.

Chemistry, as a fundamental field of natural sciences and one of the oldest scientific disciplines, has grown up on three mutually related contents: theory, synthesis and analysis. In the global development of contemporary society chemistry was and has remained an unavoidable widely applicable scientific field focusing on industry, environmental protection, pharmacy and nutrition. Fostering, promoting and developing the educational programmes of chemistry, at all levels, is necessary for continual extending of chemistry knowledge as well as for the realization of educational support for the future superstructure of graduate and postgraduate study programmes from other scientific fields like chemical engineering and technology, environmental protection, biology, pharmacy, medicine, agronomy, food technology, etc.

The University of Split, i.e. Dalmatia, have need of a full university study of chemistry, from the undergraduate to postgraduate study programme, to transfer the world knowledge of pure and applied chemistry and to establish basic guidelines for the development of various programmes important for the development of Dalmatia and Croatia.

The graduate study of chemistry is mainly based on the study programmes carried out now at the Faculty of Chemical Technology of Split. The teaching matter of chemistry so far has been insufficient and incomplete for:

a) modern organization of university teaching of chemistry at graduate level,
b) superstructure of postgraduate study from the scientific field of chemistry,
c) completion and/or superstructure of educational studies from the related fields,
d) full mobility of students in Croatia and internationally.

With the establishment of the independence of Croatia the epoch of basic chemical industry was brought to an end in the Split and Dalmatia County. However, today, the need for modern chemistry and its application, especially to food industry and environmental protection, has been actualised. Modern chemistry is mainly orientated toward health, healthy way of life, and, through it, toward environment too. The development of educational programmes of chemistry through the courses like *chemistry of sea, chemistry of atmosphere, chemistry of soil, analytical chemistry of environment*, harmonizes economic aspirations of Dalmatia based on industrial, food and agricultural application of chemistry on the one hand and tourism development on the other.

The proposed study programme of chemistry is compatible and comparable with the programmes of eminent foreign high-education institutions like: Universite de Geneve, Geneve, Switzerland; Unuversite de Provence, Marseille, France; University of Oxford, Oxford, United Kingdom, etc.

## 1.2. Previous experience in the field

The Faculty of Chemical Technology of Split was founded in 1960. During the past period the Faculty has marked the scientific production of Croatia confirming in this way its university and educational maturity and level. By its scientific productivity it has become the third scientific institution of Croatia located outside Zagreb (see Nj. Radić, Kem. Ind. 50,573-576 (2001)). The Faculty lecturers have published a great number of scientific works most of which are included in the scientific base *Current Content*, fully or partly, in the scientific unit of natural sciences under the title *Physical, Chemical and Earth Sciences*.

Since its foundation the Faculty's educational activity is based on two scientific fields: chemistry and chemical engineering, which belong to different scientific areas (natural and technical). The dominant teaching unit (-30%) in the present Faculty's educational programmes has been chemical engineering. Chemistry, along with other natural sciences, has been represented by the same percentage (-30%). Such a limited framework for university educational programmes of chemistry has become a limiting factor for:

a) modern organization of university teaching of chemistry,
b) educational programmes of chemistry important for the superstructure of educational programmes from other related fields,
c) mobility of students in Croatia and abroad.

The proposed undergraduate study of chemistry has grown from the past 45-year teaching and investigation experience of the Faculty. The Faculty teachers have been participating in teaching at other faculties and departments of the University of Split, as well as at other universities abroad.

## 1.3. Student mobility scheme

The study is organized through one-semester courses, which is one of the important conditions for the student mobility. Coordination between the programme of chemistry and similar studies enables the students to complete a part of courses at other faculties (or for the requirements of other faculties) of the University of Split. Thus, the study is open for the student mobility within the framework of the University of Split and within other universities in Croatia that have the same or similar studies. As chemistry, being a fundamental field of natural sciences, has been represented in numerous educational programmes of the universities outside Croatia, the study is open for the student mobility throughout Europe.

The department of chemistry and environmental chemistry of the Faculty of Chemical Technology of Split has already had a multilateral cooperation and student and teacher mobility scheme

through the Central European Exchange Program for University Studies (CEEPUS). Through the mentioned programme cooperation with the following foreign institutions has been realised: 1) Faculty of Material Science and Ceramics, AGH University of Science and Technology, Krakow, Poland, 2) Institute fur Analytische Chemie, Karl-Franzens-Universitat, Graz, Austria, 3) Department of Analytical Chemistry, Slovak, University of Technology, Bratislava, Slovak Republic, 4) Institute of Analytical Chemistry Faculty of Chemical Technology, University of Pardubice, Czech Republic, 5) Faculty of Chemistry and Chemical Engineering, University of Maribor, Slovenia.

## 1.4. Other elements

The possible partners outside the high-school education system interested in cooperation and employment of young people who have completed the undergraduate, graduate and post graduate study programme of chemistry are: Institute for Mediterranean Cultures and Melioration of Karst in Split, Institute for Oceanography and Fishing in Split, County Office for Public Health, Water and Sewage-System Company, Dalmacijavino, Dairy in Split, AD Plastic, Brewery in Split, educational institutions, various inspectorates at state and regional level, etc.

# 2. General description

| | | |
|---|---|---|
| **Type of programme** | Academic Graduate Study | |
| **Programme title** | Academic Graduate Study of Chemistry<br>Study Orientations: Organic Chemistry and Biochemistry, Environmental Chemistry | |
| **Institution** | **Proposed by** | Faculty of Chemical Technology of the University of Split |
| | **Participating institutions** | Faculty of Chemical Technology of the University of Split |
| **Duration** | 2 years | |
| **ECTS** | 120 | |
| **Admission requirements** | Undergraduate study of chemistry completed | |
| **Learning outcomes and competences** | Autonomous work in chemical laboratories for general, special and investigation purposes important for those segments of market and social interest in which the knowledge of chemistry is required, taking part in designing, synthesis, analysis and development of new chemical materials, as well as in the improvement of manufacturing processes and environmental protection. | |
| **Access to further studies** | Postgraduate study of chemistry and other related scientific fields. | |
| **Qualification awarded** | Master of Sciences in Chemistry (Study Orientation - …) | |

# 3. Study/Degree programme

## 3.1. Programme structure with credits

| 1st Semester | | | |
|---|---|---|---|
| **Course code** | **Course title**<br>***Obligatory courses for both orientations*** | **Type of course**<br>**L+S+P*** | **ECTS** |
| | Physical chemistry of electrolyte solutions | 30+15+30 | 7.5 |
| | Physical methods of analysis | 30+15+30 | 7.5 |
| | Quantum chemistry | 30+15+0 | 5.0 |
| | Organic analysis | 30+15+60 | 10.0 |
| **Total:** | | **120+60+120** | **30** |
| * L - lectures; S - seminars; P - laboratory exercises | | | |

## Orientation: Organic chemistry & biochemistry

| 2nd Semester | | | |
|---|---|---|---|
| **Course code** | **Course title**<br>***Obligatory courses*** | **Type of course**<br>**L+S+P *** | **ECTS** |
| | Organic synthesis | 30+15+60 | 10.0 |
| | Chemistry and technology of aromatic plants | 30+15+30 | 6.5 |
| | Introduction to molecular biology | 30+15+15 | 5.0 |
| | General microbiology | 30+0+30 | 5.5 |
| | Laboratory practice | | 3.0 |
| **Total** | | **120+30+150** | **30** |
| * L - lectures; S - seminars; P - laboratory exercises | | | |

| 3rd Semester | | | |
|---|---|---|---|
| **Course code** | **Course title**<br>***Obligatory courses*** | **Type of course**<br>**L+S+P*** | **ECTS** |
| | Flavour chemistry | 30+15+30 | 7.5 |

| | | | |
|---|---|---|---|
| | Modern methods in biochemistry | 30+0+15 | 4.5 |
| | Biochemical engineering | 30+15+30 | 7.5 |
| | Synthesis of biologically active compounds | 30+0+45 | 7.5 |
| | Laboratory practice** | | 3.0 |
| **Total:** | | **120+45+105** | **30** |

* L - lectures; S - seminars; P - laboratory exercises
**Laboratory practice – experimental work on scientific project that will be finalized with presentation (work will be evaluated by principal investigator and head of department)

| **4th Semester** | | | |
|---|---|---|---|
| **Course code** | **Course title**<br>***Optional courses*** | **Type of course**<br>**L+S+P*** | **ECTS** |
| | Optional course | | 18** |
| | Optional course | | |
| | Optional course | | |
| | Graduate thesis | | 12 |
| **Total:** | | | **30** |

* L - lectures; S - seminars; P - laboratory exercises
** Minimum ECTS credits that need to be obtained from optional courses

| **4th semester - optional courses** | | | |
|---|---|---|---|
| **Course code** | **Course title** | **Type of course**<br>**L+S+P*** | **ECTS** |
| | Environmental management system | 30+15+30 | 6.0 |
| | Perfumes and cosmetic preparates | 30+0+30 | 5.0 |
| | Naturally occurring polymeric materials | 30+0+30 | 5.0 |
| | Enzyme kinetics | 30+15+30 | 6.0 |
| | Quality assurance of foods | 30+0+30 | 5.0 |
| | Chemistry of materials | 30+15+30 | 6.0 |
| | Surface chemistry | 30+15+30 | 6.0 |
| | Separation methods and speciation | 30+15+30 | 6.0 |
| | Chemometrics | 30+15+30 | 6.0 |
| | Chemical pharmacology | 30+15+30 | 6.0 |
| | Solid state chemistry | 30+15+30 | 6.0 |
| | Solid state physics | 30+15+30 | 6.0 |
| | Environmental analytical chemistry | 30+15+30 | 6.0 |
| | Energy and development | 30+0+0 | 2.0 |

# Orientation: Environmental chemistry

| 2nd Semester | | | |
|---|---|---|---|
| **Course code** | **Course title** | **Type of course L+S+P *** | **ECTS** |
| | Separation methods and speciation | 30+15+30 | 6.5 |
| | Chemistry of materials | 30+15+30 | 6.5 |
| | Environmental analytical chemistry | 30+15+45 | 7.5 |
| | Surface chemistry | 30+15+30 | 6.5 |
| | Laboratory practice | | 3 |
| **Total** | | **120+60+135** | **30** |
| * L - lectures; S - seminars; P - laboratory exercises | | | |

| 3rd Semester | | | |
|---|---|---|---|
| **Course code** | **Course title** | **Type of course L+S+P*** | **ECTS** |
| | Marine chemistry | 30+15+30 | 6.5 |
| | Atmospheric chemistry | 45+15+15 | 7.5 |
| | Soil chemistry | 30+15+30 | 6.5 |
| | Aquatic chemistry | 30+15+30 | 6.5 |
| | Laboratory practice** | | 3 |
| **Total:** | | **135+60+105** | **30** |
| * L - lectures; S - seminars; P - laboratory exercises<br>** Minimum ECTS credits that need to be obtained from optional courses | | | |

| 4th Semester | | | |
|---|---|---|---|
| **Course code** | **Course title** | **Type of course L+S+P*** | **ECTS** |
| | Optional course | | 18** |
| | Optional course | | |
| | Optional course | | |
| | Graduate thesis | | 12 |
| **Total:** | | | **30** |
| * L+S+P<br>** Minimum ECTS credits that need to be obtained from optional courses | | | |

| 4th Semester - optional courses | | | |
|---|---|---|---|
| **Course** | **Course title** | **Type of** | **ECTS** |

| code | | course L+S+P* | |
|---|---|---|---|
| | Environmental management system | 30+15+30 | 6.0 |
| | Perfumes and cosmetic preparates | 30+0+30 | 5.0 |
| | Chemistry and technology of aromatic plants | 30+15+30 | 6.0 |
| | Enzyme kinetics | 30+15+30 | 6.0 |
| | Quality assurance of foods | 30+0+30 | 5.0 |
| | Chemical ecology | 30+15+30 | 6.0 |
| | Chemometrics | 30+15+30 | 6.0 |
| | Chemical pharmacology | 30+15+30 | 6.0 |
| | Solid state chemistry | 30+15+30 | 6.0 |
| | Solid state physics | 30+15+30 | 6.0 |
| | Energy and development | 30+0+0 | 2.0 |

## 3.2. Course information

# Physical chemistry of electrolyte solutions

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|---|---|---|---|
| **Course title** | Physical chemistry of electrolyte solutions | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30 +15+30) | | |
| **Level of course** | Advanced level | | |
| **Year of study** | 1st year of graduate study | **Semester** | 1st |
| **ECTS (Number of credits allocated)** | 7.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Ivo Tominić, assistant professor | | |
| **Learning outcomes and competences** | The student becomes familiar with basic equations and definitions, as well as with recent significant theoretical progress in comprehension and description of structure and dynamics of electrolyte solutions. | | |
| **Prerequisites** | | | |
| **Course contents** | Ion association and solvation. Transport and relaxation phenomena. Electrolyte solutions at low to moderate concentrations, towards higher concentrations: the description of equilibrium properties. Refined electrolyte theory: models on the Born-Oppenheimer level. Dynamical and transport properties at molar concentrations. | | |
| **Recommended reading** | J. M. G. Barthel, H. Krienke, W. Kunz, Physical Chemistry of Electrolyte Solutions, Modern Aspects, Steinkopfft, Darmstadt, 1998. | | |
| **Supplementary reading** | R. A. Robinson, R. H. Stokes, Electrolyte Solutions, 2nd Revised Edition, Dover Publications, 2002. | | |
| **Teaching methods** | Lectures, seminars, laboratory exercises – work in subgroups of 2 students. | | |
| **Assessment methods** | Written and oral examinations. | | |
| **Language of instruction** | Croatian, English | | |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. | | |

# Physical methods of analysis

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|---|---|---|---|
| **Course title** | Physical methods of analysis | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+30) | | |
| **Level of course** | advanced level course | | |
| **Year of study** | 1st year of graduate study | **Semester** | 1st |
| **ECTS (Number of credits allocated)** | 7.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Josipa Komljenović, assistant professor | | |
| **Learning outcomes and competences** | The course introduces student with basic principles of spectrometry techniques and its applications, automation in analytical laboratory, segmented and flow-injection analysis. | | |
| **Prerequisites** | Finished undergraduate study of chemistry or similarly undergraduate study | | |
| **Course contents** | Basic principle of analytical spectroscopy methods. Instrumentation in optical spectrometry. Elemental analysis. Atomic absorption spectrometry. Flame and electrothermal atomic spectrometry. Atomic emission spectrometry. X-ray fluorescence spectrometry. Analysis of molecules and compound. Ultraviolet and visible spectrometry. Infrared spectroscopy. Raman spectroscopy. Mass spectrometry. Nuclear magnetic resonance. Surface and structural analysis. Auger electron spectroscopy. Analysis of surfaces with electron beams. X-ray diffraction analysis. Automation and miniaturization in analytical laboratory. Continues analysis with air segmentation. Flow-injection analysis. Optimization and control of process | | |
| **Recommended reading** | D. A. Skoog, D. M. West, F. J. Holler, Osnove analitičke kemije, Školska knjiga, Zagreb, 1999. R. Kellner; Douglas A. Skoog, F. James Holler, Timothy A. Nieman, Principles of Instrumental Analysis, Saunders College Publishing, 5th ed. 1998. J. M. Mermet, M. Otto, H. M. Widmer, Analytical Chemistry (The Approved Text to the FECS Curriculum Analytical Chemistry), Wiley-VCH, New York, 1998; Douglas A. Skoog, F. James Holler, Timothy A. Nieman, Principles of Instrumental Analysis, Saunders College Publishing, 5ª ed. 1998. | | |
| **Supplementary reading** | G. D. Christian, Analytical Chemistry, Fifth Edition, John Wiley & Sons, New York, 1994; D. A. Skoog; J. J. Leary, Principles of Instrumental Analysis, fourth edition, Saunders College Publishing, New York, 1992; J. Kenkel, Analytical Chemistry for Technicians, Lewis Publishers, London, 1994. | | |
| **Teaching methods** | Lectures, seminars-problems solving, laboratory exercises-small group | | |
| **Assessment methods** | Write exam. Oral exam or preliminary exam | | |
| **Language of instruction** | Croatian, English | | |

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| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Quantum chemistry

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|---|---|---|---|
| **Course title** | Quantum chemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars (30+15) | | |
| **Level of course** | Basic level course | | |
| **Year of study** | 1st year of graduate study | **Semester** | 1st |
| **ECTS (Number of credits allocated)** | 5.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | | | |
| **Learning outcomes and competences** | To develop an understanding of the fundamental principles of quantum theory and their application to the atomic and molecular systems of interest to chemists. | | |
| **Prerequisites** | | | |
| **Course contents** | Basic postulates, the wave function. The linear harmonic oscillator. The hydrogen atom. Matrix representation of the Schroedinger equation. The Hamiltonian operator of molecules. Huckel orbitals, the EHT (Extended Huckel Theory) method. Ab initio calculations, correlation energy. Quantum mechanics applied to chemical problems: prediction of the molecular properties, optimization of the molecular geometry. | | |
| **Recommended reading** | N. Levine, Quantum Chemistry, 5th Ed., Prentice Hall, 2000. | | |
| **Supplementary reading** | P.W. Atkins, R.S. Friedman, Molecular Quantum Mechanics, 3rd edition, Oxford University Press , 1999.; D.A. McQuarrie, J.D. Simon, Physical Chemistry: A Molecular Approach, University Science Books, Sausalito, 1997. | | |
| **Teaching methods** | Lectures. Seminars using computer and adequate software. | | |
| **Assessment methods** | Written and oral examination. | | |
| **Language of instruction** | Croatian, English. | | |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. | | |

# Organic analysis

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|---|---|---|---|
| **Course title** | Organic analysis | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+60) | | |
| **Level of course** | Advanced level course | | |
| **Year of study** | 1st year of graduate study | **Semester** | 1st |
| **ECTS (Number of credits allocated)** | 10.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Josip Mastelić, assistant professor | | |
| **Learning outcomes and competences** | Student will acquire knowledge about real sample, basic methods of mixtures separation of organic compounds and their concentration, identification by chromatographic and spectroscopic techniques and their quantitative determination. | | |
| **Prerequisites** | | | |
| **Course contents** | Biological samples. Reaction products. Commercial samples. Sample complexity and analysis requirements. Direct sample analysis. Simple analytical gravimetric and volumetric determinations. Complex sample-isolation and concentration. Separation on the basis of solubility, volatility, and acid-basic properties. Chromatographic separations. Compound derivatisations. Analytical chromatography. Thin layer chromatography (TLC). High performance liquid chromatography (HPLC). Gas chromatography (GC). Structure determination of unknown compound. Qualitative and quantitative element analysis. Empiric and molecular formula. Index of hydrogen deficiency. Mass spectrometry (MS). Infrared spectroscopy (IR). Spectroscopy in ultraviolet and visible region (UV/VIS). Nuclear magnetic resonance spectroscopy ($^{1}$H-NMR i $^{13}$C-NMR). Combined techniques. GC/TLC. GC/MS. Identification. Quantisation. Conformation of new structure by synthesis. Enantioselective analysis. Optical purity. Naturalness. Artefacts. | | |
| **Recommended reading** | D. A. Skoog, D. M. West, F. J. Holler, Školska knjiga Zagreb 1999.; E. Pretsch, J. Seibel, J. T. Clerc, Tablice za određivanje struktre organskih spojeva spektroskopskim metodama, SKTH/Kemija u industriji, 1982.; E. Breitmaier, Structure Elucidation by NMR in Organic Chemistry, Practical Guide, John Wiley & Sons, 1993.; E. Pretsch P. Buhlmann, C. Affolter, Structure Determination of Organic Compounds, Springer, 2000. | | |
| **Supplementary reading** | A. Vogel, Vogel's Textbook of Practical Organic Chemistry, fourth edit. Longman, London and New York 1978. | | |
| **Teaching methods** | Lectures, seminars and laboratory exercises | | |
| **Assessment methods** | Oral examination | | |

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| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Organic synthesis

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|---|---|---|---|
| **Course title** | Organic synthesis | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+60) | | |
| **Level of course** | Advanced level course | | |
| **Year of study** | 1st year of graduate study | **Semester** | 2nd |
| **ECTS (Number of credits allocated)** | 10.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Josip Mastelić, assistant professor | | |
| **Learning outcomes and competences** | Student will be able to predict, with high probability, the possibility of simple compounds synthesis. | | |
| **Prerequisites** | | | |
| **Course contents** | Targeted molecule. Carbon skeleton and functional group. Retrosynthetic approach. Synthons and semireactions. Main nucleophilic addition at carbonyl carbon. Review of the main nucleophilic substitution at saturated carbon and carbonyl carbon. Electrophilic reactions at unsaturated carbon-carbon bonds and aromatic compounds. Interconversion of functional groups. Yields. Selectivity. Protecting group. Removing of functional groups. Anelation reactions (Diels-Alder and Robinson anelation). Fragmentation reactions. Stereochemistry and conformation in synthesis. Stereoselective synthesis and preparation of optically pure compounds. Synthesis with isotopes of carbon and hydrogen. Synthesis examples of complex organic compounds. Synthesis of β-vetivon. Synthesis of several steroids. Vitamin A synthesis. | | |
| **Recommended reading** | E. J.Corey, X. M. Cheng, The Logic of Chemical Synthesis, John Wiley & Sons, New York 1989.; Stanley H. Pine, Organska kemija, Školska knjiga, Zagreb, 1994.; J. March Advanced Organic Chemistry 4th ed. J. Wiley & Sons, New York 1992. | | |
| **Supplementary reading** | John McMurry Organic Chemistry 5th ed. Brooks/Cole 2000; T. W. Graham Solomons, Craig B. Fryhle, Organic Chemistry eighth ed. J. Wiley& Sons, 2004; A. Vogel, Vogel's Textbook of Practical Organic Chemistry, 4th edit. Longman, London and New York 1978. | | |
| **Teaching methods** | Lectures, seminars, laboratory exercises | | |

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|---|---|
| **Assessment methods** | Written and oral examination |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Chemistry and technology of aromatic plants

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|---|---|---|---|
| **Course title** | Chemistry and technology of aromatic plants | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+30) | | |
| **Level of course** | advanced level course | | |
| **Year of study** | 1st year of graduate study<br>(2nd year of graduate study) | **Semester** | 2nd<br>(4th) |
| **ECTS (Number of credits allocated)** | 6.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Josip Mastelić, assistant professor | | |
| **Learning outcomes and competences** | Student will be introduced to specific chemical composition of aromatic plants, plant extracts and essential oils as raw materials for perfume, pharmaceutical and food industry. | | |
| **Prerequisites** | | | |
| **Course contents** | Aromatic plants, spices and medicinal herbs. Essential oils. Structures and classification of terpenic compounds. Isoprene rule. Nomenclature. Terpene and related compounds biosynthesis. Essential oil isolations. Distillation methods. Extraction methods: by nonpolar solvents, supercritical $CO_2$ and cold fats. Isolation by pressing. Extraction with polar solvents (alcohol-water). Industrial processing methods (essential oils, spices, teas and herbs extracts). Remaining plant material. Distillation waters. Essential oils processing for isolation of fractions or compounds. Plant quality determination. Basic analysis of essential oils. Oil analysis by chromatographic techniques. Thin layer chromatography. Gas chromatography. Combined technique gas chromatography-mass spectrometry. Enantioselective analysis. Extracts analysis. Croatian aromatic plants. Species and distribution. Plants plantation. Yield and chemism of some essential oils. Usage of aromatic plants, essential oils, some essential oil components and plant extracts in different industries. | | |
| **Recommended** | S. V. Bhat, B. A. Nagasampagi, M Sivakumar, Chemistry of Natural | | |

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| **reading** | Products, Springer-Narosa, 2005.; Tehnička enciklopedija, Vol. 5, str. 360-370, JLZ, Zagreb, 1976.; E. Guenther, The Essential Oils, vol. I-VI, van Nostrand Co, Princeton, 1964.; K. Bauer, D. Garbe, H. Surburg, Common Fragrance and Flavor Materials, VCH, 1990. |
| **Supplementary reading** | J. Petričić, Farmakognozija I, Frmaceutsko-biokemijski fakultet, Sveučilište u Zagrebu, 1983. |
| **Teaching methods** | Lectures, laboratory exercises |
| **Assessment methods** | Oral examination |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Introduction to molecular biology

| | | | |
|---|---|---|---|
| **Course title** | Introduction to molecular biology | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+15) | | |
| **Level of course** | Basic level course | | |
| **Year of study** | 1st year of graduate study | **Semestar** | 2nd |
| **ECTS (Number of credits allocated)** | 5.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Mladen Miloš, associate professor | | |
| **Learning outcomes and competences** | The aim of this series of lectures is to introduce students with structure of biological important macromolecules, particular about nucleic acids (DNA and RNA) and proteins, and review of fundamental biological processes on the level on these molecules. | | |
| **Prerequisites** | | | |
| **Course contents** | Introduction to molecular biology. The prokaryotic cell. The eucariotic cell. Gen is the part of DNA molecule. DNA is the genetic material. Chromatin, chromosomes, histones. DNA structure. DNA replication. DNA polymerases. DNA mutations. DNA repair. Recombination. Restriction endonucleases. Central dogma of molecular biology. RNA structure. Three mayor types of RNA. mRNA. RNA polimerase. Four stages of transcription reaction. Promoters-the start site of transcription. RNA synthesis. Inhibition of the transcription. tRNA. Codon-anticodon interaction. Ribosomes. Aminoacyl-tRNA sintetase. Three stages of protein synthesis. The genetic | | |

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|---|---|
| | code. Protein structure. Posttranslational modification. The operon-the unit for Control of Gene Expression. Mapping of genes. Genome. Sequences of genomes. Cloning. Hybridization of the NK. Electrophoresis of NK. PCR. |
| **Recommended reading** | Alberts et al.: Essential Cell Biology, Second Edition, Garland Science, Taylor & Francis Group, 2004.; J. Darnell, H. Lodish, D. Baltimore: Molecular Cell Biology, Second Edition, W. H. Freeman and Company, New York 1990. |
| **Supplementary reading** | Lubert Stryer: Biokemija, Školska knjiga Zagreb, 1991.; Jeremy M. Berg, John L. Tymoczko, Lubert Stryer: Biochemistry, Fifth Edition, W. H. Freeman and Company New York, 2002.; Voet, Voet, Pratt: Fundamentals of Biochemistry, John Wiley and Sons. Inc., 1999. |
| **Teaching methods** | Lectures. Seminars. Laboratory exercises. |
| **Assessment methods** | Written and oral examination |
| **Language of instruction** | Croatian<br>Possibility of having the lectures in French and English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) Univrsity Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer`s Level. |

# General microbiology

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| **Course title** | General microbiology | | |
| **Course code** | | | |
| **Type of course** | Lectures, laboratory exercises (30+30) | | |
| **Level of course** | Basic level | | |
| **Year of study** | 1st year of graduation study | **Semester** | 2nd |
| **ECTS (Number of credits allocated)** | 5.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Nada Krstulović, full professor | | |
| **Learning outcomes and competences** | A remarkable and fascinating aspect of the microbial world is the staggering diversity of the forms and their importance to humans and biosphere. Microorganisms drive many of the life processes on Earth - macroscopic organisms are utterly and completely dependent on them. For this reason, this is imperative to provide the students general understanding about the basic biochemical and physiological principles underlying microbial life, because these principles direct all life. | | |
| **Prerequisites** | | | |

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| **Course contents** | An Introduction to Microbial Life. The Diversity of Microorganisms. Functional Anatomy of Procaryotic and Eucaryotic Cells. Comparing Procaryotic and Eucaryotic Cells. Structure and Function of Procaryotic Microorganisms (Eubacteria and Archaea). Microbial Physiology: Nutrition and Growth. Control of Microbial Growth, Physical and Chemical Requirements for Growth. Metabolism. Microbial Genetics. Classification of Microorganisms: Bacteria, Fungi, Protozoa, Algae, Slime ,Molds, Lichens and Viruses. Microbial Mechanisms of Pathogenicity. Microbial ecology: Microorganisms and Ecosystems, Metabolic Diversity, Microbial Biodegradation, the Role of Microorganisms in Biogeochemical Cycles. Applications of Microbiology. |
| **Recommended reading** | S. Duraković, Opća mikrobiologija, Prehrambeno-tehnološki inženjering, Udžbenici Sveučilišta u Zagrebu, Zagreb, 1996.; S. Duraković, Primijenjena mikrobiologija, Prehrambeno-tehnološki inženjering, Udžbenici Sveučilišta u Zagrebu, Zagreb, 1996. |
| **Supplementary reading** | R.M. Mayer, I. L. Pepper, C.P. Gerba, Environmental Microbiology, Academic Press, 2000. |
| **Teaching methods** | Combined teaching methods: frontal lectures, work in groups, using modern technologies. |
| **Assessment methods** | Assessments during lectures.<br>Exam: written after main chapter and oral at the end of teaching process. |
| **Language of instruction** | Croatian.<br>English (possibility). |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) Univrsity Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer`s Level. |

# Flavour chemistry

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|---|---|---|---|
| **Course title** | Flavour chemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+30) | | |
| **Level of course** | Advanced level course | | |
| **Year of study** | 2nd year of graduate study of chemistry | **Semester** | 3rd |
| **ECTS (Number of credits allocated)** | 7.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Josip Mastelić, assistant professor | | |
| **Learning outcomes and** | Student will be introduced to the chemistry of the most important flavours, their synthesis pathways, isolation and usage. | | |

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| **competences** | |
| **Prerequisites** | |
| **Course contents** | Flavour and fragrance. Aromatic plants. Fruit and vegetables aromatic compounds. Free, glycosidically and glucosinolated bound aromatic compounds. Aromatic compounds of thermic processing of biological sample. Terpenes. Aliphatic compounds with oxygen, sulfur and nitrogen. Heterocyclic compounds with oxygen, nitrogen and sulfur. Structure and properties. Synthesis of some aromatic compounds. Flavour of tea and tobacco. Flavour of beer, wine and spirit products. Flavour of roasted coffee and roasted hazlenut. Flavour of bread and food articles from crops. Flavour of milk, yoghurt and cheeses. Aromatisation of food, nonalchoholic drinks, ice-creams and sweets. Aromatisation of detergent and hygienic articles. Isolation and concentration of aromatic compounds from samples. Analysis of aromatic compounds. Thin layer chromatography. Gas chromatography. Gas chromatography-mass spectrometry. |
| **Recommended reading** | P. Schreier, *Chromatographic Studies of Biogenesis of Plant Volatiles*, 52, Hüthig, Heidelberg, Basel, New York, 1984; P. Kraft, K.A.D. Swift, Perspectives in Flavour and Fragrance Chemistry, John Wiley & Sons, 2005. |
| **Supplementary reading** | |
| **Teaching methods** | Lectures, seminars, laboratory exercises |
| **Assessment methods** | Oral examination |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Modern methods in biochemistry

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| **Course title** | Modern methods in biochemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, laboratory exercises (30+15) | | |
| **Level of course** | Advanced level course | | |
| **Year of study** | 2rd year of graduate study. | **Semester** | 3rd |
| **ECTS (Number of credits allocated)** | 4.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |

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| **Name of lecturer** | Dr. Mladen Miloš, associate professor |
| **Learning outcomes and competences** | By the end of the course students should be able to understand and show hands-on experience with a range of biochemical techniques which underlie modern biochemistry. |
| **Prerequisites** | |
| **Course contents** | Includes methods for separation and purification, such as centrifugation, column chromatography; methods for detecting and measuring molecules, such as gel electrophoresis and scintillation counting, and methods for studying molecules, such as spectroscopy, redox potential measurement and crystallography. Statistical methods for understanding biochemical data will be introduced. |
| **Recommended reading** | R. Boyer, Modern Experimental Biochemistry, Addison Wesley Longman, 3rd edition, San Francisco, 2000.; S. K. Sawhney, R. Singh, Introductory Practical Biochemistry, Alpha Science International, Ltd, 2001. |
| **Supplementary reading** | L. Stryer, J. M. Berg, J. L. Tymoczko, Biochemistry, 5th edition, 2002. |
| **Teaching methods** | Lectures, seminars and laboratory excercises |
| **Assessment methods** | Written exam, laboratory exercise reports, assessment of research project seminars |
| **Language of instruction** | Croatian<br>Possibility of having the lectures in Italian, French and English |
| **Quality assurance methods** | Quality and efficiency monitoring will be performed on three levels:<br>(1) University level (2) Faculty level, with help of Committee for quality control of teaching (3) Teaching level |

# Biochemical engineering

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|---|---|---|---|
| **Course title** | Biochemical engineering | | |
| **Course code** | | | |
| **Type of course** | Lectures, laboratory exercises (30+15+30) | | |
| **Level of course** | Basic level course | | |
| **Year of study** | 2nd year graduate study | **Semester** | 3rd |
| **ECTS (Number of credits allocated)** | 7.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Davor Rušić, associate professor | | |

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| **Learning outcomes and competences** | Basic knowledge in the field of biotechnological engineering is acquired |
| **Prerequisites** | |
| **Course contents** | Definition of the field of biochemical technology, importance of biochemical engineering, relations with other scientific areas. The notion of biological system. Characteristics of fermentation processes engineering. Characteristics of enzymatic processes engineering. The substrate preparation area. The bioconversion area (bioreactor as the place where biochemical reactions take place, reactor types, reactor design, areation systems, bioreaction kinetics, bioreactors. Bioreactor design. Industrially important biotechnological processes. |
| **Recommended reading** | E. Bailey, D. F. Ollis, Biochemical Engineering Fundamentals, McGraw-Hill, 1986.,N. F. Millis, Biochemical Engineering, Academic Press, N.Y. 1978.,H.V. Blanch, D.S. Clark, Bichemical Engenering, New York, 1966. |
| **Supplementary reading** | K. van't Riet, J. Tramper, Basic Bioreactor Design, M. Dekker, N.Y., 1991. |
| **Teaching methods** | Lectures, laboratory exercises – work in smaller groups, demonstration exercises; seminars using PCs and available software (Mathcad, Matlab, Mathematica). |
| **Assessment methods** | Written and oral examination |
| **Language of instruction** | Croatian and English |
| **Quality assurance methods** | Quality assurance will be performed at three levels: (1) University Level, (2) Faculty Level by Quality Control Committee, (3) Lecturer's Level. |

# Synthesis of biologically active compounds

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| **Course title** | Synthesis of biologically active compounds | | |
| **Course code** | | | |
| **Type of course** | Lectures, laboratory exercises (30+45) | | |
| **Level of course** | Advanced level course | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 3rd |
| **ECTS (Number of credits allocated)** | 7.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Josip Mastelić, assistant professor | | |
| **Learning outcomes and competences** | Student will acquire knowledge about chemical synthesis of biologically active compounds. | | |

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| **Prerequisites** | |
| **Course contents** | Biologically active compounds. Chirality and biological activity. Asymmetric synthesis: aspartame, (S)-naproxen, L-DOPA and L-aminocarboxylic acids. Synthesis and semisynthesis of major steroids. Alcaloid synthesis (morphine, quinine, nicotine, ephedrine, adrenaline and piperine). Sulfonamides and sulfonylureas (bactericides, antidiabetics, antihypertonics). Barbiturates (drugs that effect central nervous system). Cardiovascular drugs. Dofetilide, chemical pacemaker. Anestetics. Pyridine, pyrimidine and imidazole compounds with different therapeutic usage. Semisynthetic antibiotics: tetracyclines, β-lactames and macrolide antibiotics. Taxol synthesis. Vitamin synthesis (vitamin B6, vitamin C). |
| **Recommended reading** | S. V. Bhat, B. A. Nagasampagi, M Sivakumar, Chemistry of Natural Products, Springer-Narosa, 2005.; Graham Solomons, Craig B. Fryhle, Organic Chemistry, 8th ed. J. Wiley& Sons, 2004.; Z. Kniwald, Vitamini i hormoni: proizvodnja i primjena, hrvatska sveučilišna naklada, Zagreb 1993. |
| **Supplementary reading** | Z. Kniewald i dr. Priručnk za pripravu i izolaciju bioloških djelatnih supstancija, Alfej d.o.o., Zagreb, 2000. |
| **Teaching methods** | Lectures, laboratory exercises |
| **Assessment methods** | Written and oral examination |
| **Language of instruction** | Croatian, English. |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Environmental management system

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|---|---|---|---|
| **Course title** | Environmental management system | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+30) | | |
| **Level of course** | Basic level | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4th |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Marija Bralić, assistant professor | | |
| **Learning outcomes and competences** | Introduction with strategy of sustainable development. Study of relationship between environmental and technological development. Definition and review of ISO 14001:1998 and ISO 9001:2002 standards. Knowledge for implementation ISO 14001:1998 environmental | | |

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| | management system. |
| **Prerequisites** | |
| **Course contents** | Technological development and ecosystem. Environmental and sustainable development, visions and future. Additive and integral environmental protection. Control and limitation of technological development. Risk evaluation in environmental, process of evaluation- concept. Definition and history of ISO organization as organization that regulate standards for industrial and other organization. Review of ISO international standards, basic principles of environmental management system, interpretation of ISO 14001:1998 environmental management system and ISO 9001:2002 quality assurance. ISO14001:1998 definition of general and individual purpose, evaluation of aspects and influence, development of environmental management system program, supervision of improvement, skills and expertness. Production and energy saving, principles, metods and eco-efficiency. Control of environmental influence process: waste treatment; dangerous material treatment. Role of eco-engineer in environmental management system. |
| **Recommended reading** | P.O`Neil, Environmental science, London, 1993; I. Cifrić, Održivi razvoj I strategija zaštite okoliša, Zagreb, 2000; McCreary, J.H., ISO 14000: A frame work for Co-ordinating Existing Enviromental Management Responsibilities, UK, 1995; S. Greogori: Introduction to ISO 14001 standard, London, 1995; H.F. Lund, Industrial polltion control handbook, New York, 1997. |
| **Supplementary reading** | I. Cifrić, Socijalna ekologija, Zagreb, 2000; D.W. Moeller, Enviromental Health, London, 1997; C.Sheldon, ISO 14000 and beyond, Environmental mamagement system in the real world, UK, 1997. |
| **Teaching methods** | Lecture, presentation |
| **Assessment methods** | Oral examination |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Perfumes and cosmetic preparates

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|---|---|---|---|
| **Course title** | Perfumes and cosmetic preparates | | |
| **Course code** | | | |
| **Type of course** | Lectures and laboratory exercises (30+30) | | |
| **Level of course** | Basic level course | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4th |
| **ECTS** | 5.0 | | |

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| **(Number of credits allocated)** | Number of allocated credits is based on the lecturer's estimation and inquiry among students. |
| **Name of lecturer** | Dr. Josip Mastelić, assistant professor |
| **Learning outcomes and competences** | Basic knowledge of cosmetology and perfumery. |
| **Prerequisites** | |
| **Course contents** | Chemical composition of fragrance material. Isolation and obtaining of fragrance compounds. Aromatisation of working environment and aromatherapy. The role of aromatic compounds in products for care, clearing and beautifying of human body. Creams and lotions for face clearing. Emolient creams and lotions. Special creams. Cosmetic powders for face. Preparations for care and beautifying eyes and lips. Pastes and powders for teeth. Hair shampoos. Hair preparations for dying, blenching and curling. Lacquers, creams, brilliantines and lotions for hair. Nail-polish. Creams and lotions for hands. Preparations for foaming baths. Salts for bathing. Hair removers. Soaps and creams for shaving. After shaving preparates. Body deodorants. Sunning preparations. Perfumer oils. Preparates for legs care. Cosmetical preparates for children. Plant extracts in cosmetic products. Analysis of fragrance materials. Extracts analysis. Chemical composition of raw materials and functions. Analysis of raw materials and cosmetic products. |
| **Recommended reading** | M. Čajkovac, Kozmetologija, Naklada Slap, Jastrebarsko, 2000.; Tehnička enciklopedija, Vol. 7, str. 311-319, JLZ, Zagreb, 1980.; Tehnička enciklopedija, Vol. 5, str. 360-370, JLZ, Zagreb, 1976.; J. Petričić, Farmakognozija I, Farmaceutsko-biokemijski fakultet, Sveučilište u Zagrebu, 1983. |
| **Supplementary reading** | M. Čajkovac i I. Štivić "Praktikum kozmetologije, Sveučilište u Zagrebu, Farmaceutsko-biokemijski fakultet, Zagreb 1980. |
| **Teaching methods** | Lectures and laboratory exercises |
| **Assessment methods** | Oral examination |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Naturally occurring polymeric materials

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| **Course title** | Naturally occurring polymeric materials |
| **Course code** | |

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|---|---|---|---|
| **Type of course** | Lectures, laboratory exercises (30+30) | | |
| **Level of course** | Basic level course | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4th |
| **ECTS (Number of credits allocated)** | 5.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Branka Andričić, assistant professor | | |
| **Learning outcomes and competences** | Students get acquainted with importance and applications of naturally occurring polymers and polymeric materials. | | |
| **Prerequisites** | | | |
| **Course contents** | Naturally occurring macromolecules. Supermolecular structure of naturally occurring polymers (comparison of natural and synthetic polymers). Biodegradability. Polysaccharides. (starch, cellulose, alginates). Cellulose fibres. Cellulose derivates. Lignin. Proteins. Protein fibres (silk, wool). Properties of natural fibres. Caotchouc. Mastication. Vulcanisation. Processing of caotchouc and manufacture of rubber. Rubber waste: recycling and regeneration of caotchouc. Natural resins. Natural polyesters. Blends of natural and synthetic polymers. | | |
| **Recommended reading** | B. Andričić, Prirodni polimerni materijali, Interna skripta, Kemijsko-tehnološki fakultet, Split, 2003; C. E. Carracher, Seymour/Carraher's Polymer Chemistry, 4th Ed., Marcel Dekker, New York, 1996. | | |
| **Supplementary reading** | R. Čunko, V. Friščić, Tekstilna vlakna, Naklada Modus, Zagreb,2001.<br>M. Šercer, D. Opsenica, G. Barić, Oporaba plastike i gume, MTG-topgraf, Velika Gorica, 2000. | | |
| **Teaching methods** | Lectures. Laboratory exercises. | | |
| **Assessment methods** | Oral examination | | |
| **Language of instruction** | Croatian, English. | | |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. | | |

# Enzyme kinetics

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| **Course title** | Enzyme kinetics |
| **Course code** | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+30) |
| **Level of course** | Advanced level course |

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| **Year of study** | 2rd year of graduate study. | **Semester** | 4rd |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Mladen Miloš, associated professor | | |
| **Learning outcomes and competences** | The aim of this series of lectures is to introduce students to the basic properties of these very important cellular catalysts and to explain how they act to mediate all biochemical reactions. | | |
| **Prerequisites** | | | |
| **Course contents** | Enzymes are biological catalysts. General properties of enzymes. Enzyme nomenclature and enzyme classification. Enzyme specify. The active site. Regulation of enzyme activity. Mechanism of enzyme activity. Cofactors and coenzymes. Vitamins-precursors to coenzyme synthesis. The basic concept of enzyme kinetics. The order of a reaction. The rate constant reaction. The effect of temperature on rate constants. Enzyme kinetics. The activation energy. The Enzyme-substrate reaction. Michaelis – Menten kinetics. Experimental determination of $K_m$ and $v_{max}$. The Lineweaver-Burk "double-reciprocal" plot. The Hanes plot. The Eadie-Hofstee plot. The effect of inhibitors on enzyme kinetics. The competitive reversible inhibition. The uncompetitive reversible inhibition. The mixed (noncompetitive) inhibition. The irreversible inhibition. The feedback inhibition. Effect of pH on the enzyme reaction. Effect of pH on the enzyme stability and structure. Effect temperature on the enzyme stability and structure. Allosteric enzyme kinetics. Allosteric enzymes. The Hill equation. | | |
| **Recommended reading** | Lubert Stryer: Biokemija, Školska knjiga Zagreb, 1991.**;** Jeremy M. Berg, John L. Tymoczko, Lubert Stryer: Biochemistry, Fifth Edition, W. H. Freeman and Company New York, 2002.; Voet, Voet, Pratt: Fundamentals of Biochemistry, John Wiley and Sons. Inc., 1999.**;** Cornish-Bowden: Fundamentals of Enzyme Kinetics, Butterworth, London 1979. | | |
| **Supplementary reading** | Christopher K. Mathews and K. E. Van Holde: Biochemistry, Second edition, ThE Benjamin / Cummings Publishing Company Inc 1996.**;** Thomas M. Devlin: Textbook of Biochemistry, Third Edition, Wiley and Sons Inc., New York, Chichester, Brisbane, Toronto, Singapore, 1992. | | |
| **Teaching methods** | Lectures. Seminars. Laboratory exercises. | | |
| **Assessment methods** | Written and oral examination | | |
| **Language of instruction** | Croatian<br>Possibility of having the lectures in French and English | | |
| **Quality** | Quality and efficiency monitoring will be performed on three levels: | | |

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| **assurance methods** | (1) University level (2) Faculty level, with help of Committee for quality control of teaching (3) Teaching level |

# Quality assurance of foods

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|---|---|---|---|
| **Course title** | Quality assurance of foods | | |
| **Course code** | | | |
| **Type of course** | Lectures, laboratory exercises (30+30) | | |
| **Level of course** | Basic level course | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4rd |
| **ECTS (Number of credits allocated)** | 5.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Josipa Komljenović, assistant professor | | |
| **Learning outcomes and competences** | The course introducing students with legislative bases of control of food safety and quality, statistic and analytical methods used for food analysis. | | |
| **Prerequisites** | | | |
| **Course contents** | Definitions and history of quality. Quality management and quality assurance standards, ISO 9000-scope, requirements. revised series ISO 9000:2000 i ISO 9004:2000. TQM approach. Quality management in testing laboratories, GLP, EN 17025. Food safety and food quality. Food legislation in Croatia. International food standards, Codex Alimentarius. Food legislation in EU. HACCP - principles and implementation. The role of WTO, SPS and TBT agreement Statistical quality control: statistical process control, control charts, process capability, sampling procedures. Methods of analysis. Principles of techniques used in food analysis, instrumental and modern methods. Theoretical bases of analytical methods used for specific food constituents: moisture and water activity, minerals, protein, fats, carbohydrates, vitamins, additives, pesticides and genes modified foods. | | |
| **Recommended reading** | P. A. Luning, W. J. Marcelis, W. M. F. Jongen. Food quality management a techno-managerial approach, Wageningen Pers, Wageningen, Netherlands, 2002.; F. M. Garfield, Quality Assurence for Analytical Laboratories, AOAC International, Gaithersburg, Md., 2000.; V. Turčić, HACCP i higijena namirnica, Zagreb, 2000.; Association of Official Analytical Chemists: Official Methods of Analysis, 17.th. edn. Arlington, Virginia,2000.; H. Charley, Connie Weaver, Foods: a scientific approach, 3rd.edition, Merrill education products, 1997; C. S. James: Analytical chemistry of foods, Aspen Publisher, Inc., Gaithersburg, Maryland, 1999.; Suzanne Niels, Food Analysis, Book News, Inc., Portland, | | |

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| **Supplementary reading** | C.S. James, Analytical Chemistry of Foods, Aspen Publisher, Inc., 1999, I. Bakija, Osiguranje kvalitete: po ISO 9000, Privredni vjesnik; Zagrebačka banka, Zagreb, 1991.; Glasilo Državnog Zavoda za normizaciju i mjeriteljstvo (DZNM), Norme, Pravilnici. |
| **Teaching methods** | Lectures, laboratory exercises-small group, visiting foods industry |
| **Assessment methods** | Oral exam or preliminary exam during semester. |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Chemical ecology

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|---|---|---|---|
| **Course title** | Chemical ecology | | |
| **Course code** | | | |
| **Type of course** | Lecture, presentation (30+15+30) | | |
| **Level of course** | Basic level | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4rd |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Marija Bralić, assistant professor | | |
| **Learning outcomes and competences** | Introduction with ecological systems and lowfulness of ecological systems. Detection and following of pollution origin that cause relation disturbance in ecological system. Protection and determination of risk-ecological aspect. | | |
| **Prerequisites** | | | |
| **Course contents** | Elaboration of basic terms in ecology. The origin of chemical spiecies in eco-system, natural sources. Major sources of disturbance in ecological system under human influeneces. Origin of contamination as result of human activity-review-agriculture, industry, settlements, waste, a special origin of contamination. Sistematization of pollution spieces. Pesticides, metals, artificially fertilizer; mechanisam of toxical activity. Transmission and transmissions mechanisms a pollution spieces in soil, water and air. Detection of pollution spieces in ecological system. Bioacumulation and bioconcentration in organisms and eco-systems. Protection methods, biodegradation. Risk determination-ecology aspect. Strategy and principles of environmental protection. | | |
| **Recommended reading** | S.A. Levin, M.A. Harwell, J.R. Kelly, K.D. Kimball, Ecotoxicology: Problems & Approaches, New York-Berlin, 1989.; C.H.Walker, S.P. | | |

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| | Hopkin, R.M Sibly, D.B. Peakall, Principles of Ecotoxicology, London, 1997.; C. Park, The Enviroment, London, 1997. |
| **Supplementary reading** | S.E. Manahan, Environmental Chemistry, 1994. |
| **Teaching methods** | Lecture, seminar, practice |
| **Assessment methods** | Oral |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Chemistry of materials

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|---|---|---|---|
| **Course title** | Chemistry of materials | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars (30+15+30) | | |
| **Level of course** | basic level course, advanced level course | | |
| **Year of study** | 1st year of graduate study<br>(2nd of graduate study) | **Semester** | 2nd<br>(4rd) |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Marija Bralić, assistant professor; Dr. Slobodan Brinić, assistant professor | | |
| **Learning outcomes and competences** | Introduction with some basic chemical and physical properties of materials. Groups of materials and their use. Sampling and preparation for analysis. | | |
| **Prerequisites** | | | |
| **Course contents** | Introduction. Chemical properties of materials. Chemical bonding, crystal structure. Physical properties of materials: electrical, thermal, optical, magnetic and mechanical. Groups of materials: conductors, semiconductors, metals, ceramics, polymers. Examination and analysis of real samples. Sampling of the gases. Sampling of liquids. Sampling of solids. Preparation of representative samples for analysis. Decomposition of samples. | | |
| **Recommended reading** | J.I. Gersten, F.W. Smith, The Physics and Chemistry of Materials, New York, 2001; B.S. Mitchell, Materials Engineering and Science for Chemical and Materials Engineers, New Jersey, 2004. | | |
| **Supplementary** | C.N.R: Rao, I. Gopalakrishnan, New Directions in Solid State Chemistry, | | |

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| **reading** | Cambridge, 1997; W.D. Callister, Fundamentals of Material Science and Engineering: An Integrated Approach, New York, 2002. |
| **Teaching methods** | Lectures, seminars |
| **Assessment methods** | Oral and written examination |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Surface chemistry

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|---|---|---|---|
| **Course title** | Surface chemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+30) | | |
| **Level of course** | Basic level course | | |
| **Year of study** | 1st year of graduate study | **Semester** | 2nd |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Zoran Grubač, assistant professor | | |
| **Learning outcomes and competences** | Deepen the knowledge of a structure of metallic surfaces, adsorption molecules on surfaces and surface analytical techniques. | | |
| **Prerequisites** | | | |
| **Course contents** | Structure of Metallic Surfaces, Adsorption of Molecules on Surfaces, The Langmuir Isotherm, Surface Analytical Techniques, Overlayer Structures & Surface Diffraction; Surface Imaging & Depth Profiling. | | |
| **Recommended reading** | G.A. Somorjai, Introduction to Surface Chemistry and Catalysis, Wiley-Interscience, New York, 1994.; K. Christmann, Introduction to Surface Physical Chemistry,Springer-Verlag, New York, 1991. | | |
| **Supplementary reading** | P.W. Atkins and J. de Paula, Physical Chemistry, 7th Ed., Freeman, New York, 2002.; A. W. Adamson and A. P. Gast, Physical Chemistry of Surfaces, 6th Ed., Wiley-Interscience, New York, 1997. | | |
| **Teaching methods** | Lectures, seminars, laboratory exercises | | |
| **Assessment methods** | Written and oral examination. | | |
| **Language of instruction** | Croatian, English. | | |

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| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Separation methods and speciation

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|---|---|---|---|
| **Course title** | Separation methods and speciation | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+30) | | |
| **Level of course** | Advanced level | | |
| **Year of study** | 1st year of graduate study | **Semester** | 2nd |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Njegomir Radić, full professor | | |
| **Learning outcomes and competences** | After completion of a process of learning (Course: *Separation Methods and Speciation*) learner is able for independent solving problems in the environmental chemistry area. Also, accepted knowledge and skills in this course provide competence for continuation of education at higher level. | | |
| **Prerequisites** | | | |
| **Course contents** | Sample preparation. Extractin methods. Liquid-liquid extraction. Solid-phase extraction. Head-space technique. Ion exchange. Chromatographic techniques. Gas chromatography (GC). Capillary GC. Liquid chromatography (LC). High performance LC. Ion chromatography. Thin-layer chromatography. Supercritical fluid chromatography. Electrophoresis. The importance and definition of speciation. Computer modelling. Experimental determination of speciation: Anodic stripping voltammetry, Ion exchange, Ultrafiltration, Dialysis, Ion-selective electrodes, ... | | |
| **Recommended reading** | R. Kellner, J. M. Mermet, M. Otto, M. Valcarcel and H. M. Widmer (Urednici), Analytical Chemistry (A Modern Approach to Analytical Science, Second Edition) Wiley-VCHVerlag Gmbh & Co. KGaA, Weinheim, 2004. ; F. W. Fifield and P. J. Haines (Urednici) Environmental Analytical Chemistry, Blackie Academic &Professional, London, 1995. ; . D.C.Harris, Quantitative Chemical Analysis, Fifth Edition, W.H.Freeman and Company, New York, 1999. ;A.M.Ure and C.M.Davidson (Editors), Chemical speciation in the environment, Blackwell Science, Oxford, 2001. | | |
| **Supplementary reading** | J. Wang, Analytical Electrochemistry, VCH, New York, 1994. ; D. Harvey, Modern Analytical Chemistry, McGraw-Hill, Boston, 2000. ; D.A. Skoog, J.J. Leary, Principles of Instrumental Analysis, fourth edition, Saunders College Publishing, New York, 1992. | | |

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| **Teaching methods** | Lectures, problem solving, laboratory experiments |
| **Assessment methods** | Written and oral examination |
| **Language of instruction** | Croatian, English. |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Chemometrics

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|---|---|---|---|
| **Course title** | Chemometrics | | |
| **Course code** | | | |
| **Type of course** | Lectures and seminars (30+15+30) | | |
| **Level of course** | Basic level course. | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4rd |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Josipa Komljenović, assistant professor | | |
| **Learning outcomes and competences** | Course introduces student with basic statistical terms and methods. Familiarizes student with basic statistical programs. | | |
| **Prerequisites** | | | |
| **Course contents** | Introduction - random and systematic error, planning and design of experiments. Statistics of repeated measurements - distribution of results, definition of sample, confidence limits, presentation of results. Significance tests - t-test, F-test, ANOVA, testing normality of distribution. Quality of analytical measurements - estimation of variances, quality control methods, proficiency testings and collabrative trials, uncertainity. Calibration methods in instrumental analyses. Non-parametric methods. Experimental design and optimization. Multivariate analyses. | | |
| **Recommended reading** | J.N. Miller, J.C. Miller, Statistics and Chemometrics for Analytical Chemistry, 4th edition, Pearson Prentice Hall, London, 2000.; B.E. Cooper, Statistics for Experimentalists, Pergamon Press, Oxford, 1969.; H. Lohninger, Teach/Me-Data Analyses, Springer-Verlag, Berlin, 1999. | | |
| **Supplementary reading** | Guide Quantifying uncertainity in analytical measurement, 2nd edition, Eurachem, 2000. | | |
| **Teaching methods** | Lectures and seminars using computers with compatible software. | | |

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| **Assessment methods** | Written and oral examination. |
| **Language of instruction** | Croatian, English. |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Chemical pharmacology

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|---|---|---|---|
| **Course title** | Chemical pharmacology | | |
| **Course code** | | | |
| **Type of course** | Lectures seminars | | |
| **Level of course** | basic level course, advanced level course | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4rd |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Marija Bralić, assistant professor | | |
| **Learning outcomes and competences** | Introduction with some chemical properties of the main drugs. Basic classes of drugs. Chemical stability. | | |
| **Prerequisites** | | | |
| **Course contents** | Introduction: definition and aims. Chemical and stereochemical properties in structure of drugs. Chemical stability and incompatibility of drugs. Activity and mechanism of activity. Pharmacologic classes of drugs. The properties of some drug classes. Evolution and explanation of action of the main drugs. Main phases of drug activity: absorption, distribution, metabolism and elimination. Introduction with some negative effects, resistance and interaction with other drugs. | | |
| **Recommended reading** | J.B. Stenlake, Foundations of Molecular Pharmacology: Chemical Basis of Drug Action, 1979; K.A. Connors, Chemical Stability of Pharmaceuticals: A Handbook for Pharmacists, 1986. | | |
| **Supplementary reading** | T.C. Marrs, R.L. Maynard, F.R. Sidell, Chemical Warfare Agents: Toxicology and Treatment, 1996; L. Poller, Oral Anticoagulants: Chemical and Biological Properties and Clinical Applications, 1996. | | |
| **Form of presentation** | Lecture, presentation | | |
| **Examination** | Oral examination | | |
| **Language of** | Croatian, English | | |

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| **instruction** | |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Solid state chemistry

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|---|---|---|---|
| **Course title** | Solid state chemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+30) | | |
| **Level of course** | Basic level course | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4rd |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. sc. Slobodan Brinić, assistant professor | | |
| **Learning outcomes and competences** | Knowledge of the principles of solid state chemistry that lies at the heart of recent developments in the synthesis, structure determination, property measurements and application of inorganic materials.. | | |
| **Prerequisites** | | | |
| **Course contents** | Introduction to solid state chemistry. Common crystal structures. Principles of solid state synthesis. Experimental methods for characterizing solids. Chemistry of crystals. Crystals defects. Electronic properties. Optical and magnetic properties. | | |
| **Recommended reading** | A.R. West, Basic Solid State Chemistry, 2nd Ed., John Wiley & Sons, New York, 1999.; C.N.R. Rao, J. Gopalakrishnan, New Direction in Solid State Chemistry, 2nd Ed., Cambridge University Press, Cambridge, 1997. | | |
| **Supplementary reading** | A. K. Cheetham, P. Day, Solid State Chemistry: Techniques, Reprint edition, Oxford University Press; 1990. | | |
| **Teaching methods** | Lectures, seminars, laboratory exercises. | | |
| **Assessment methods** | Written and oral examination. | | |
| **Language of instruction** | Croatian, English. | | |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. | | |

# Solid state physics

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|---|---|---|---|
| **Course title** | Solid state physics | | |
| **Course code** | | | |
| **Type of course** | Lecture, seminar, laboratory exercise course (30+15+30) | | |
| **Level of course** | Advanced level course | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4rd |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Magdi Lučić Lavčević, assistant professor | | |
| **Learning outcomes and competences** | On completion of this course, student should be able to:<br>-describe the structures of solid bodies and understand how they are determined experimentally;<br>-explain how diverse properties (mechanical, thermal, electronic, optical and magnetic) are related to atomistic level, using theoretical models. | | |
| **Prerequisites** | | | |
| **Course contents** | Structural properties of solid bodies. Structure of crystals. Diffraction of waves and reciprocal lattice. Experimental diffraction methods. Difusion in solid bodies. Elastic and plastic properties of solid bodies. Fundamentals of quantum mechanics. Energy levels of electrons in solid bodies. Static and transport properties of electrons in metals. Vibrations waves in crystals – phonons. Thermal properties. Semiconductors. Optical properties of dielectrics and semiconductors. Fundamental effects and devices. Microstructures and nanostructures. Magnetism. | | |
| **Recommended reading** | V. Šips: Uvod u fiziku čvrstog stanja, Školska knjiga Zagreb, Zagreb; 1993. V. Knapp, P. Colić: Uvod u električna i magnetska svojstva materije, Školska knjiga Zagreb, Zagreb, 1990; C. Kittel: Introduction to solid state physics, John Wiley&Sons, New York, 2005. | | |
| **Supplementary reading** | R.E. Hummel: Understanding Materials Science, Springer-Verlag, Berlin, 1998. | | |
| **Teaching methods** | Lectures, seminar and laboratory exercise course | | |
| **Assessment methods** | Continuous assessment, written and oral examination. | | |
| **Language of instruction** | Croatian, english | | |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. | | |

# Environmental analytical chemistry

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| **Course title** | Environmental analytical chemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+45) | | |
| **Level of course** | basic level course, advanced level course | | |
| **Year of study** | 1st year of graduate study | **Semester** | 2nd |
| **ECTS (Number of credits allocated)** | 6.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students | | |
| **Name of lecturer** | Dr. Marija Bralić, assistant professor | | |
| **Learning outcomes and competences** | In the course program practice will follow chemical processes in environment. Acquired knowledge will apply in business linked for environment. | | |
| **Prerequisites** | | | |
| **Course contents** | Introduction. Analytical Environmental Data: Assessment and Interpretation. Chemical Principles. Titrimetry and Gravimetry in Environmental Analytical Chemistry. Separation Techniques. Spectrometry and Analytical Environment. Electrochemical Techniques in Analysis of Environmental. Termal Methods of Analysis. Biological Indicators. Specific Applications. The Analysis of Atmospheric Samples. Environmental Radiation and Radiactivity. Contaminated Landisites. The Analysis of Water. Determination of Trace Amounts of Organic Compounds. | | |
| **Recommended reading** | F.W. Fifield, P.J. Haines, Environmental Analytical Chemistry, Blackie academic& professional, London, 1996; | | |
| **Supplementary reading** | C.E. Kupchella, M. C. Hyland, Enviromental science, Massachusetts, 1989. | | |
| **Teaching methods** | Oral examination, laboratory exercises | | |
| **Assessment methods** | Written and oral examination | | |
| **Language of instruction** | Croatian, English | | |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. | | |

# Energy and development

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| **Course title** | Energy and development |
| **Course code** | |

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| **Type of course** | Lectures (30) | | |
| **Level of course** | Basic level course | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 4rd |
| **ECTS (Number of credits allocated)** | 2.0<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students | | |
| **Name of lecturer** | Draga Krpan-Lisica, senior lecturer | | |
| **Learning outcomes and competences** | Student will be acquainted with necessity of energy production for mankind survival, with basic methods of energy production (unrenewable and renewable energy supplys), its influence on inveronmental contamination, and with the most important methods of saving and storage of energy. | | |
| **Prerequisites** | | | |
| **Course contents** | Energy: definition and units, energy inflow the on Earth, Earth's energy balance - energy crises, enegy resources, energy supplays, energy conversion and heat. Consumption of energy; historical development, regional consumption, influence on the life quality, consumption and saving of energy in basic sectors (industry, traffic, households), estimation of global energetics development. Energy of fossil fuels: coal, oil, natural gas, influence on environmente (greenhouse effects, acid rains, particulates, heat contamination), exploitation of waste heat, magnetohydrodynamic generators, gasification and liquefication of coal. Hydroenergy: basic characteristics of water flow, hydro-electric power plants. Nuclear energy: fission, nuclear reactors, nuclear fuels, influence of nuclear energy on mankind and environmente; fusion, projects of fusion devices. Geothermal energy: hydrogeothermal and petrogeothermal energy supplays, influence on environmente. Solar energy: conversion in heat energy (active and passive solar systems, solar furnaces, solar-electric power plants), photovoltaic conversion (photovoltai cells and photovoltaic systems), bioconversion (cultivation and energetical exploitation of biomass). Wind energy: basic characteristics, wind turbines, wind-electric power plants. Energy of oceans and seas: energy of high and low tide, energy of waves, heat energy. Storage of energy. | | |
| **Recommended reading** | D. Krpan-Lisica, Osnove energetike, Hinus, Zagreb, 2001. | | |
| **Supplementary reading** | H. Požar, Osnove energetike 1,2, Školska knjiga, Zagreb, 1992; V. Knapp, Novi izvori energije 1, Školska knjiga, Zagareb, 1993; P. Kulišić, Novi izvori energije 2, Školska knjiga, Zagreb, 1991.; Časopis EGE. | | |
| **Teaching methods** | Lectures, visits to industrial plants | | |
| **Assessment methods** | Oral examination | | |
| **Language of instruction** | Croatian, English | | |
| **Quality assurance** | Quality assurance will be performed at three levels: | | |

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| **methods** | (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Marine chemistry

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|---|---|---|---|
| **Course title** | Marine chemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (30+15+30) | | |
| **Level of course** | basic level course | | |
| **Year of study** | 2th year of graduate study | **Semester** | 3rd |
| **ECTS (Number of credits allocated)** | 6.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students | | |
| **Name of lecturer** | Silvestar Krka, lecturer | | |
| **Learning outcomes and competences** | Emphasis is on basic principles, processes, and properties of Sea. | | |
| **Prerequisites** | | | |
| **Course contents** | Introduction to marine chemistry. The Sea as a source of Raw materials. Characteristics of the Seas. The structure of Water and Sea Water. Physical properties of Sea Water. Water Circulation in the Oceans. Coastal Seas and Estuaries. The chemical Composition of Sea Water. Salinity and Density. Chemical Speciation. Major Elements in Sea Water. Minor Elements. Disolned Gases in Sea Water. The Micronutrient Elements in the Sea. Marine Life. Primary and Secondary Productivsty. Marine Pollution: A Definition. Sources and Types of Marine Pollutants. Domestic Sewage. Petroleum. Thermal Pollution. Radioactive Wastes. Pesticids. Effects of Marine Pollutents. Persistent Organic Compounds. Biodegradable Organics. Patogenes. Nutrients. Heary Metals. The state of some Seas. Legislation. Determination of Salinity and Chlorinity. Determination of pH and alkalinity. Determination of Oxygen. Determination of nutrients. Determination of trace metals. Determination of Organic Components. | | |
| **Recommended reading** | Alison B. Duxbury, Alyn C. Duxbury, Fundamental of oceanography, WCB, Melbourn, Oxford, 1993.; J.P. Rilej, G. Skirrow, Chemical Oceanography, Vol. 1-7, Academic Press, London, 1975.; Ch. E. Kupchella, M. C. Hyland, Environmental Science, Living Within the System of Nature, second edition, Alan and Bacon, Boston, 1989. | | |
| **Supplementary reading** | R.B.Clark, Marine Polution, Clarenddon Press, Oxford, 1986.; W. Stumm, J.J. Morgan, Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters, John Wiley&Sons, New York, 1995. | | |
| **Teaching methods** | Lectures, laboratory exercises, field teaching | | |

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| **Assessment methods** | Oral examination |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Atmospheric chemistry

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|---|---|---|---|
| **Course title** | Atmospheric chemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars, laboratory exercises (45+15+15) | | |
| **Level of course** | Advanced level | | |
| **Year of study** | 2nd year of graduate study | Semester | 3rd |
| **ECTS (Number of credits allocated)** | 7.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Njegomir Radić, full professor | | |
| **Learning outcomes and competences** | After completion of a process of learning (Course: Atmospheric Chemistry) learner is able for independent solving problems in the environmental chemistry area. Also, accepted knowledge and skills in this course provide competence for continuation of education at higher level. | | |
| **Prerequisites** | | | |
| **Course contents** | Environment and technology. General characteristics of the atmosphere. Atmospheric structure and composition. The atmosphere as a photochemical system. The incoming radiation - solar spectrum. Absorption coefficients of atmospheric gases. Energy reradiated to space - cooling of Earth's surface. Environmental chemistry and chemical cycles. Inversions and air pollution. Information system based on inventory of air pollution sources and emission standards. Kinetics of carbon monoxide formation. CO emission control. Thermodynamics and kinetics of sulfur oxide formation. Thermodynamics of NO and $NO_2$ formation. Kinetics of nitric oxide formation in combustion processes. Emission sources of $NO_x$. Chemical and photochemical reactions in the atmosphere. Acid-base reactions in the atmosphere. Reactions of atmospheric oxygen and nitrogen. Atmospheric carbon dioxide and water. Particles in the atmosphere. Processes for particle formation. Gaseous inorganic air pollutants. Sulfur dioxide and nitrogen oxides in the atmosphere. The atmospheric budget and cycles of carbon, sulfur and nitrogen. Lifetime of pollutants in the atmosphere. Organic air pollutants. Hydrocarbons. Aldehydes and ketones. Organohalide, organosulfur and organonitrogen | | |

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| | compounds. Photochemical smog. Automotive emissions. Mechanisms of smog formation. Reactivity of hydrocarbons. Antropogenic change in the atmosphere. Greenhouse gases and global warming. Acid rain. Ozone layer destruction. Photochemical smog. |
| **Recommended reading** | D.J. Jacob, Introduction to Atmospheric Chemistry, Princeton University Press, New Jersey, 1999. ; S. E. Manahan, Environmental Chemistry, Sixth Edition, Lewis Publishers, London, 1994. ; C. Baird, Environmental Chemistry, W. H. Freeman and Company, New York, 1999. ;R.M. Harrison, Understanding Our Environment: An Introduction to Environmental Chemistry and Pollution, Second Edition, The Royal Society of Chemistry, Cambridge, 1992. |
| **Supplementary reading** | P. Brimblecombe, Air Composition and Chemistry, Cambridge University Press, Cambridge, 1986. ; M.J. McEwan and L.F. Phillips, Chemistry of the Atmosphere, Edvard Arnold, London, 1975. ; S.S. Butcher, R.J. Charlson, An Introduction to Air Chemistry, Academic Press, New York, 1972. ; L. Mewman, Measurement Challeges in Atmospheric Chemistry, American Chemical Society, Washington, 1993. |
| **Teaching methods** | Lectures, problem solving, laboratory experiments |
| **Assessment methods** | Written and oral examination |
| **Language of instruction** | Croatian, English. |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Soil chemistry

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|---|---|---|---|
| **Course title** | Soil chemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, seminars and laboratory exercises (30+15+30) | | |
| **Level of course** | Advanced level course | | |
| **Year of study** | 2st year of graduate study | **Semester** | 3rd |
| **ECTS (Number of credits allocated)** | 6.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | | | |
| **Learning outcomes and competences** | Course introduces students with basic understanding of soil chemical reactions and how the soil relates chemically with environment. Provides an appreciation for the role of soil as the medium of plant growth and the role of soil chemistry in land management decisions. Familiarizes the students with literature in the field. Course introduces students with basic | | |

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| | chemical analyses of soil. |
| **Prerequisites** | |
| **Course contents** | D.L. Sparks, Environmental Soil Chemistry, 2nd edition Academic Press, London, 2003.; M. Cresser, K. Killham, T. Edwards, Soil Chemistry and its applications, Cambridge University Press, Cambridge, 1993.; A. Škorić, Postanak, razvoj i sistematika tala, Sveučilište u Zagrebu, 1986; A. Škorić, Sastav i svojstva tla, Fakultet poljoprivrednih znanosti, Zagreb, 1991. |
| **Recommended reading** | T. G. Spiro, W. M. Stigliani, Chemistry of environment, Prentice Hall, New Jersey, 1996; A. Škorić, Priručnik za pedološka istraživanja, Fakultet poljoprivrednih znanosti, Zagreb, 1982.; C.S. Kupchella, M.C. Hyland, Environmental science, 2nd edition, Allyn and Bacon, Massachusetts, 1989. |
| **Supplementary reading** | |
| **Teaching methods** | Lectures, laboratory exercises and preparation of research paper. |
| **Assessment methods** | Written and oral examination. |
| **Language of instruction** | Croatian or English. |
| **Quality assurance methods** | Quality assurance will be performed at three levels:<br>(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |

# Aquatic chemistry

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| **Course title** | Aquatic chemistry | | |
| **Course code** | | | |
| **Type of course** | Lectures, laboratory exercises (30+15+30) | | |
| **Level of course** | basic level course, advanced level course | | |
| **Year of study** | 2nd year of graduate study | **Semester** | 3rd |
| **ECTS (Number of credits allocated)** | 6.5<br>Number of allocated credits is based on the lecturer's estimation and inquiry among students. | | |
| **Name of lecturer** | Dr. Marija Bralić, assistant professor | | |
| **Learning outcomes and competences** | The students will get to know with basic chemical and physical principles that are significance for determination water components in water eco systems. | | |
| **Prerequisites** | | | |
| **Course contents** | Introduction. The Solvent Water. Acids and Bases of Water. Buffer | | |

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| | Intensity and Natural Capacity. Dissolved Carbon Dioxide in Water. Distribution $CO_3^{2-}/HCO_3^-$. River Water Composition and Carbonate Equilibrium. Kinetic of Hydration of $CO_2$. Atmosphere Water Interaction. Acid Rain and Water pH. Metal Ions in Aqueous Solution. Solubility and Hydrolysis. Kinetic of Complex Formation in Water. Composition of Seawater. Percipitation and Solubility. Redox Conditions in Natural Waters. Effect of Complex Formers on the Redox Potential. Kinetics of Redox Processes. Colloids, Coagulation and Filtration. Water and Chemical Characteristics. Water Quality Criterion. Water Pollutants. A System for Accompanying Quality Water. |
| **Recommended reading** | W. Stumm, J.J. Morgam : Aquatic Chemistry, John Wiley & Sons, Inc., New York, 1996., J. Buffle, Complexation Reactions in Aquatic Systems: An Analytical Approach, Ellis Horwood Ltd. Toronto, 1988, P.R. Paquin, Metals in Aquatic Systems: A Review of Exposure, Bioaccumulation, and Toxicity models, Society of Environmental toxicology and Chemistry, London., 2003. |
| **Supplementary reading** | K. Grasshoff, M, Etrhardt, K. Kremling, Methods of Seawater Analysis, Verlag Chemie GmbH, Weinheim, 1983, D. Tuthar, zagađivanje zraka i vode, Sarajevo, 1984 |
| **Teaching methods** | Oral examination, laboratory exercises |
| **Assessment methods** | Written and oral examination |
| **Language of instruction** | Croatian, English |
| **Quality assurance methods** | Quality assurance will be performed at three levels:(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level. |