



University of Split

Faculty of Chemical Technology

PROPOSAL FOR THE ACADEMIC UNDERGRADUATE STUDY PROGRAMME

Chemistry

Split, February 1, 2005

STUDY PROGRAMME / CURRICULUM

Academic undergraduate study: Chemistry

Faculty of Chemical Technology
Teslina 10/V, HR-21000 Split
Phone: + 385 21 385 633
Fax: + 385 21 384 770
dekanat@fff.hr
<http://www.ktf-split.hr>

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. It is necessary to foster, promote and develop the educational programmes of chemistry at all levels for the purposes of continual extending of knowledge of chemistry and 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 undergraduate study of chemistry is mainly based on the study programmes carried out now at the Faculty of Chemical Technology of Split. The duration of present programmes studying has been long with markedly low transfer of students from the first (second) study-year to higher years. The three-year undergraduate study of chemistry enables:

- a) leaving the system of education requiring basic knowledge of chemistry needed for the first professional employment,
- b) reducing the time of studying with the aim of better organization of study and directing the students to dominantly one scientific field (chemistry),
- c) continuation of the study of chemistry at graduate level or continuation of the study of related fields.

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

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 university and 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 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 to student mobility within the framework of the University of Split and other universities in Croatia that have the same or similar studies. Chemistry, being a fundamental field of natural sciences, has been also represented in numerous educational programmes in the universities outside Croatia, so that the study is open to 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 the 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 realized: 1) Faculty of Material Science and Ceramics, AGH University of Science and Technology, Krakow, Poland, 2) Institute für Analytische Chemie, Karl-Franzens-Universität, 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 the young people who have completed the undergraduate, graduate and postgraduate study programme of chemistry are: Institute for Mediterranean Cultures and Melioration of Karts 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 Undergraduate Study	
Programme title	Academic Undergraduate Study of 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	3 years	
ECTS	180	
Admission requirements	Four-year secondary school completed	
Learning outcomes and competences	Autonomous work in chemical laboratories for control of processes and products important for various segments of market and social interest: industry, environment, medicine, pharmacy, nourishment, etc.	
Access to further studies	Graduate study of chemistry and graduate study of chemical technology at the Faculty of Chemical Technology of Split or a graduate study from other related scientific fields.	
Qualification awarded	Baccalaureus/Baccalaurea of Chemistry	

3. Study/Degree programme

3.1. Programme structure with credits

1st Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	Mathematics I	45+45+0	9.0
	Physics I	45+30+30	10.5
	General chemistry	45+30+30	10.5
Total:		135+105+60	30
* L- lectures; S-seminars; P- laboratory exercises			

2nd Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	Mathematics II	30+60+0	7.0
	Physics II	45+15+30	8.5
	Inorganic chemistry I	30+15+30	6.0
	Analytical chemistry I	45+15+30	8.5
Total		150+105+90	30
* L- lectures; S-seminars; E- laboratory exercises			

3rd Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	Inorganic chemistry II	30+30+30	8.0
	Analytical chemistry II	30+15+60	9.0
	Physical chemistry I	60+15+0	6.5
	Organic chemistry I	60+15+0	6.5
		180+75+90	30

* L- lectures; S-seminars; E- laboratory exercises

4th Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	Organic chemistry II	30+15+75	10.0
	Physical chemistry II	30+15+60	8.5
	Natural products	45+0+30	6.0
	Catalysis	30+15+0	3.0
	Practical work in companies, public or private institutions		2.5
Total		135+45+165	30

* L- lectures; S-seminars; E- laboratory exercises

5th Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	General biology	30+0+15	4.0
	Instrumental methods of analysis	30+15+30	6.5
	Biochemistry I	60+15+30	9.0
	The analysis of real substances	30+15+30	5.5
	Material and energy balances	30+30+0	5.0
Total		180+75+105	30

* L- lectures; S-seminars; E-laboratory exercises

6th Semester			
Course code	Course title <i>Obligatory courses</i>	Type of	ECTS

		course L+S+P*	
	Biochemistry II	30+15+30	6.0
	Environmental chemistry	45+15+30	7.5
	Selected processes of chemical industry	45+15+30	7.5
	Final project		9.0
Total			30
* L- lectures; S-seminars; E- laboratory exercises			

3.2. Course information

Mathematics I

Course title	Mathematics I		
Course code			
Type of course	Lectures, seminars (45+45)		
Level of course	Basic level course		
Year of study	1 st year of undergraduate study	Semester	I.
ECTS (Number of credits allocated)	9.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Meri Mirošević Anzulović, senior lecturer		
Learning outcomes and competences	Competent to employ the acquired knowledge of linear algebra, solid analytic geometry and calculus.		
Prerequisites			
Course contents	Set of real numbers. Set of complex numbers. Functions of one real variable. Elementary functions. Sequences. Limit of a sequenc. Limit and continuity of a function. Derivative. The slope of a curve. Instantaneous velocity. Differential .Derivatives and differentials of higher orders. Fundamental theorems of a differential calculus. Indeterminate forms. Curve skeching: local extrema, points of inflection, asymptotes. Matrices and determinants. Systems of linear equation .Vectors. Solid analytic geometry.		
Recommended reading	T. Bradić, R. Roki.,et al, Matematika za tehnološke fakultete, Element, Zagreb, 2003.; Ž. Pauše, Zbirka teorijskih pitanja iz matematike za studente tehnike, Školska knjiga, Zagreb 1995.; B. P. Demidovič, Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb (više izdanja)		
Supplementary reading	S. Kurepa, Matematička analiza I i II dio, Školska knjiga, Zagreb, 1997.; L. Krnić, Z. Šikić, Račun diferencijalni i integralni, I dio, Školska knjiga, Zagreb, 1992.; Hughes-Hallett, Gleason, et al., Calculus, John Wiley and Sons, Inc., New York, 2000.; McCallum, Hughes-Hallett, Gleason et al., Multivariable Calculus, John Wiley and Sons Inc., New York, 2002.		
Teaching methods	Lectures, seminars.		
Assessment methods	Written and oral examination		
Language of	Croatian		

instruction	
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

Physics I

Course title	Physics I		
Course code			
Type of course	Lecture, seminar, laboratory exercise (45+30+30)		
Level of course	Basic level course		
Year of study	1 st year of undergraduate study	Semester	I.
ECTS (Number of credits allocated)	10.5 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 is expected to be able to describe and explain the presented concepts and laws of physics and to demonstrate the use of the theoretical fundamentals on solving practical problems. Furthermore, s/he should know the methods of measurements of selected physical quantities and fundamentals of numerical and graphical presentation of measurement data.		
Prerequisites			
Course contents	Measurement. Motion along a straight line. Motion in two and three dimensions. Force and motion. Work and energy. Conservation of energy. Mass and energy. Systems of particles. Collisions. Rotation. Torque and angular momentum. Oscillations. Mechanical waves. Fluids.		
Recommended reading	N.Cindro, Fizika I, Školska knjiga, Zagreb, 1985; E. Babić, R. Krsnik, M. Očko, Zbirka riješenih zadataka iz fizike, Školska knjiga Zagreb, Zagreb, 1990.		
Supplementary reading	D.Halliday, R.Resnick, J.Walker, Fundamentals of Physics, John Wiley&Sons, New York, 1993; V.Lopac, P.Kulišić, M. Pavičić, Zbirka zadataka iz fizike, FGZ Zagreb, 1983.		
Teaching methods	Lectures, supported by demonstration experiments and/or computer simulations; exercise course designed for developing student's problem-solving skills; exercise course designed for developing student's measuring skills.		
Assessment methods	Continuous assessment, 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		

General chemistry

Course title	General chemistry		
Course code			
Type of course	Lectures, seminars, laboratory exercises (45+30+30)		
Level of course	Basic level course		
Year of study	1 st year of undergraduate study	Semester	I.
ECTS (Number of credits allocated)	10.5 Number of allocated credits is based on the lecturer's estimation and inquiry among students		
Name of lecturer	Dr. Slobodan Brinić, assistant professor; Dr. Zoran Grubač, assistant professor.		
Learning outcomes and competences	The course will provide the knowledge of basic chemical laws and principles. The students will master the nomenclature of chemistry, introduce basic laboratory skills. Involve students in critical thinking about laboratory experiments and involvement chemistry in everyday life. Prepare students for upper level chemistry courses.		
Prerequisites			
Course contents	Introduction to Chemistry. Atoms, Molecules, and Ions. Stoichiometry, Chemical Calculus. The Gas Laws, The Kinetic Molecular Theory of Gas. Thermochemistry. Energy Changes in Chemical Reactions. Quantum Theory and Electronic Structure of Atom. Periodic Relationships among the Elements and Periodic Table Molecular structure of substances. Chemical bond. Intermolecular Forces and Liquids and Solids. Homogenous and Heterogeneous Mixtures, Physical Properties of Solutions. Chemical reactions. Chemical kinetics. Chemical Equilibrium, Heterogeneous and Homogeneous equilibrium. In frame of laboratory exercises student will make experiments from the content of above mentioned topics.		
Recommended reading	I. Filipović, S. Lipanović, 1995. Opća i anorganska kemija I. dio, Školska knjiga, Zagreb.; M. Sikirica, 2001. Stehiometrija, Školska knjiga, Zagreb.		
Supplementary reading	R.Chang, Chemistry, McGraw-Hill, Inc., New York, 1991.; J. W. Hill, R. H. Petrucci, General Chemistry, Prentice-Hall, New Jersey, 2002.; J. C. Kotz, P. Treichel Jr., Chemistry & Chemistry reactivity, Sounders College Publishing, New York, 1999.		
Teaching methods	Lectures, seminar, laboratory exercises.		
Assessment methods	Written and oral exam.		
Language of instruction	Croatian and English		
Quality	Quality assurance will be performed at three levels: (1) University Level, (2) Faculty Level by Quality Control Committee, (3) Lecturer's Level		

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Mathematics II

Course title	Mathematics II		
Course code			
Type of course	Lectures, seminars (30+60)		
Level of course	Basic level course		
Year of study	1 st year of undergraduate study	Semester	II.
ECTS (Number of credits allocated)	7.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Meri Mirošević Anzulović, senior lecturer		
Learning outcomes and competences	Competent to employ the acquired knowledge of calculus and theory of ordinary differential equations.		
Prerequisites			
Course contents	Indefinite integral. Methods of integration. Definite integral. Fundamental theorem of integral calculus. Applications to geometry and physics. Improper integrals. Functions of several variables. Limit and continuity. Partial derivatives of the first order. Directional derivatives. Differentiability. Differential. Tangent plane and normal line. Partial derivatives of higher orders. Maxima and minima. Double integrals. Applications to geometry and physics. Series. Convergence of numeric series. Power series. Taylor series. First order differential equations. Second order differential equations. Applications to physics and chemistry.		
Recommended reading	T. Bradić, R. Roki, et al, Matematika za tehnološke fakultete, Element, Zagreb, 2003.; Ž. Pauše, Zbirka teorijskih pitanja iz matematike za studente tehnike, Školska knjiga, Zagreb 1995.; B. P. Demidovič, Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb (više izdanja)		
Supplementary reading	S. Kurepa Matematička analiza I i II dio, Školska knjiga, Zagreb, 1997.; Hughes-Hallett, Gleason, et al., Calculus, John Wiley and Sons, Inc. New York, 2000.; McCallum, Hughes-Hallett, Gleason et al., Multivariable Calculus, John Wiley and Sons Inc., New York, 2002.		
Teaching methods	Lectures, seminars.		
Assessment methods	Written and oral examination		
Language of	Croatian		

instruction	
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.

Physics II

Course title	Physics II		
Course code			
Type of course	Lecture, seminar, laboratory exercise (45+15+30)		
Level of course	Basic level course		
Year of study	1 st year of undergraduate study	Semester	II.
ECTS (Number of credits allocated)	8.5 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 is expected to be able to describe and explain the presented concepts and laws of fundamental physics and to demonstrate the use of the theoretical fundamentals on solving basic practical problems in topics of chemistry student's interest. S/he should also know the methods of measurements of selected physical quantities.		
Prerequisites			
Course contents	Electric charge. The electric field. Electric potential. Capacitance. Current and resistance. The magnetic field. Ampere's law. Faraday's law. Inductance. Magnetism and matter. Electromagnetic oscillations. Alternating currents. Maxwell's equations. Electromagnetic waves. Geometrical optics. Optical instruments. Interference. Diffraction. Relativity. Ideas of quantum physics. Atoms, lasers and laser light. Atomic nucleus. Radioactivity.		
Recommended reading	N. Cindro, Fizika II, Školska knjiga, Zagreb, 1988; E. Babić, R. Krsnik, M. Očko, Zbirka riješenih zadataka iz fizike, Školska knjiga Zagreb, Zagreb, 1990.		
Supplementary reading	D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, John Wiley & Sons, New York, 1993; V. Henč-Bartolić, P. Kulišić, Valovi i optika, Školska knjiga Zagreb, Zagreb, 1989; V. Lopac, S. Kilić, T. Persi, Fizika II, FGZ Sveučilišta u Splitu, Split, 1988.		
Teaching methods	Lectures, supported by demonstration experiments and/or computer simulations; seminar designed for developing student's problem-solving skills; exercise course designed for developing student's measuring skills.		
Assessment methods	Continuous assessment, written and oral examination		
Language of instruction	Croatian and English		
Quality assurance	Quality assurance will be performed at three levels: (1) University Level, (2) Faculty Level by Quality Control Committee, (3) Lecturer's Level		

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Inorganic chemistry I

Course title	Inorganic chemistry I		
Course code			
Type of course	Lectures, seminar, laboratory exercises (30+15+30)		
Level of course	Basic level course		
Year of study	1 st year of undergraduate study	Semester	II.
ECTS (Number of credits allocated)	6.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Slobodan Brinić, assistant professor.; Dr. Zoran Grubač, assistant professor.		
Learning outcomes and competences	A student will know: the chemical reactivity across the periodic table and properties, compositions of common chemical substances and the roles of inorganic chemistry in industry and in everyday life.		
Prerequisites			
Course contents	Classification of the inorganic substances according to the atomic properties and Periodic Table. Structure and symmetry in solids, bonding theories. General atomic and chemical properties of elements and their compounds, according to oxidation state in the group. In frame of laboratory exercises student will make experiments from the content of above mentioned topics.		
Recommended reading	I. Filipović, S. Lipanović, Opća i anorganska kemija 1. i 2. dio, Školska knjiga, Zagreb, 1995.		
Supplementary reading	F. Albert Cotton et al., Basic Inorganic Chemistry, New York, John Wiley and Sons, 1995.		
Teaching methods	Lectures, seminar, laboratory exercises.		
Assessment methods	Written and oral exam.		
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		

Analytical chemistry I

Course title	Analytical chemistry I		
Course code			
Type of course	Lectures, seminars, laboratory exercises (45+15+30)		
Level of course	Basic level course		
Year of study	1 st year of undergraduate study	Semester	II.
ECTS (Number of credits allocated)	8.5 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 in analytical chemistry (Courses: Analytical Chemistry or Analytical Chemistry I and II) learner is able for independent work in general analytical laboratory. Also, accepted knowledge and skills in fundamentals of analytical chemistry provide competence for continuation of education at higher level. After that higher education process learner is able for independent work in specific analytical laboratory important for natural science and other scientific areas.		
Prerequisites			
Course contents	Introduction. Importance and aims of analytical chemistry (AC). The role of analytical chemist in selection of analytical technique. The analytical chemist as a problem solver. AC in industrial practice and environmental control. The total analytical process, stepwise phases. Errors in AC. Reporting of analytical data. Quality assurance and quality control. Methods based on chemical reactions. Systematic treatment of equilibrium. Equilibrium in homogeneous systems. Acid-base equilibrium, pH, acid-base indicators. Buffers. Complex formation equilibrium. Chelates and polynuclear complexes. Kinetics of complex formation. Fundamentals of electrochemistry. Electrochemical cells. Redox reactions. Electrode potential. Standard and formal potentials. Heterogeneous equilibrium. Gas-liquid systems. Solid-liquid systems. Solubility and solubility product. Effects of secondary reactions in solution: hydrolysis and complexation. Extraction. Fundamentals of chromatographic separations. Gas chromatography. Liquid chromatography		
Recommended reading	D. A. Skoog, D. M. West and F. J. Holler, Fundamentals of Analytical Chemistry, Seventh Edition, Saunders College Publishing, New York, London, 1996. {šesto izdanje (englesko) 1992, prvo izdanje (hrvatsko), Školska knjiga, Zagreb, 1999.}; 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-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004.; T. H. Hadjiioannou, G. D. Christian, C. E. Efstathion and D. P. Nikolelis, Problem Solving in Analytical Chemistry, Pergamon Press, Oxford, New York, 1988.		
Supplementary reading	D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical Chemistry, Eighth Edition, Brooks/Cole, London, 2004.; G. D. Christian, Analytical Chemistry, Sixth Edition, John Wiley & Sons, INC,		

	2004.; D. C. Harris, Quantitative Chemical Analysis, Fifth Edition, W. H. Freeman and Company, New York, 1999.; M. Valcarcel, Principles of Analytical Chemistry, Springer-Verlag, Berlin Heidelberg, 2000.
Teaching methods	Lectures, problem solving, laboratory experiments.
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

Inorganic chemistry II

Course title	Inorganic chemistry II		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+30+30)		
Level of course	Basic level course		
Year of study	2 nd year of undergraduate study	Semester	III.
ECTS (Number of credits allocated)	8.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Slobodan Brinić, assistant professor.; Dr. Zoran Grubač, assistant professor.		
Learning outcomes and competences	Students will be able to apply important theoretical principles of atomic structure and bonding in order to explain and predict chemical properties of inorganic compounds.		
Prerequisites			
Course contents	Chemistry of the transition elements. Coordination compounds, ligand field theory, spectroscopic and magnetic properties. Organometallic compounds. Bioinorganic chemistry. In frame of laboratory exercises student will make experiments from the content of above mentioned topics.		
Recommended reading	F. Albert Cotton et al., Advanced Inorganic Chemistry, New York, John Wiley and Sons, 1999.; W. Kaim, B. Schwederski, Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, J. Wiley & Sons, Chichester, 1994.		
Supplementary reading	I. Filipović, S. Lipanović, Opća i anorganska kemija 1. i 2. dio, Školska knjiga, Zagreb, 1995.		
Teaching methods	Lectures, seminars, laboratory exercises.		
Assessment	Written and oral examination.		

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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

Analytical chemistry II

Course title	Analytical chemistry II		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+60)		
Level of course	Basic level course		
Year of study	2 nd year of undergraduate study	Semester	III.
ECTS (Number of credits allocated)	9.0 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 in analytical chemistry (Courses: Analytical Chemistry or Analytical Chemistry I and II) learner is able for independent work in general analytical laboratory. Also, accepted knowledge and skills in fundamentals of analytical chemistry provide competence for continuation of education at higher level. After that higher education process learner is able for independent work in specific analytical laboratory important for natural science and other scientific areas.		
Prerequisites			
Course contents	Methods of chemical analysis and their application. Gravimetric analysis. Titrimetry (Volumetry). Titration curves. Precipitation titration. Acid-base titration. Acid-base titration in nonaqueous solvents. Complexometric titrations. Redox titration. Electrochemical titrations: potentiometric, amperometric and conductometric titrations. Thermochemical methods. Elemental organic analysis. Kinetic and catalytic methods.		
Recommended reading	D. A. Skoog, D. M. West and F. J. Holler, Fundamentals of Analytical Chemistry, Seventh Edition, Saunders College Publishing, New York, London, 1996. {6 th Ed. (englesko) 1992, 1 st Ed. (hrvatsko), Školska knjiga, Zagreb, 1999.}; 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-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004.; T. H. Hadjiioannou, G. D. Christian, C. E. Efstathion and D. P. Nikolelis, Problem Solving in Analytical Chemistry, Pergamon Press, Oxford, New York, 1988.		
Supplementary	D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of		

reading	Analytical Chemistry, Eighth Edition, Brooks/Cole, London, 2004.; G. D. Christian, Analytical Chemistry, Sixth Edition, John Willey & Sons, INC, 2004.; D. C. Harris, Quantitative Chemical Analysis, Fifth Edition, W. H. Freeman and Company, New York, 1999.; M. Valcarcel, Principles of Analytical Chemistry, Springer-Verlag, Berlin Heidelberg, 2000.
Teaching methods	Lectures, problem solving, laboratory experiments.
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

Physical chemistry I

Course title	Physical chemistry I		
Course code			
Type of course	Lectures, seminars (60+15)		
Level of course	Basic level course		
Year of study	2 nd year of undergraduate study	Semester	III.
ECTS (Number of credits allocated)	6.5 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	Through numerous examples student is learning about basic principles of the thermodynamic and kinetic approach to the physical and chemical changes.		
Prerequisites			
Course contents	The properties of gases, The First Law, The Second Law, Physical transformations of pure substances, Properties of simple mixtures, Phase diagrams, Chemical equilibrium, The electric and magnetic properties of molecules, Molecules and ions in motion, Rates of chemical reactions.		
Recommended reading	P. W. Atkins, Physical Chemistry, Fifth Edition, Oxford University Press, 1994.		
Supplementary reading	S. H. Maron, J. B. Lando, Fundamentals of Physical Chemistry, Macmillan, New York, 1974.; I. Mekjavić, Fizikalna kemija 1, osnovni pojmovi, primjeri i zadaci, Školska knjiga, Zagreb, 1996.; I. Mekjavić, Fizikalna kemija 2, osnovni pojmovi, primjeri i zadaci, Golden marketing, Zagreb, 1999.		
Teaching methods	Lectures, seminars – numerical problems are solved.		

Assessment methods	Written and oral examinations.
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

Organic chemistry I

Course title	Organic chemistry I		
Course code			
Type of course	Lectures, seminars (60+15)		
Level of course	Basic level course		
Year of study	2 nd year of undergraduate study	Semester	III.
ECTS (Number of credits allocated)	6.5 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 about structure-properties relationships of organic compounds, understanding the basic laws of compound transformation. Knowledge about constitutional isomers and stereoisomers, their separation and structure determination by spectroscopy (IR, NMR, UV/VIS, MS). This course is basic for understanding other courses, especially Organic chemistry II, Biochemistry, etc.		
Prerequisites	Competence required by course General chemistry.		
Course contents	Chemical bonding. Intermolecular bonding. Functional groups. Nomenclatures. Molecular formula. Index of hydrogen deficiency. Structure and resonance. Constitutional isomers. Conformation. Three-dimensional molecular shapes. Chirality. Stereoisomers. Optical activity. Enantiomers and diastereomers. R-, S-, E-, Z-isomers. Stereoisomers of allenes, spiranes, biphenyls. Resolving racemic mixtures. Spectroscopy and structure. IR. UV. H ¹ -NMR and C ¹³ -NMR. MS. GC/MS. Bond energy. Reaction enthalpy. Kinetics. Reaction mechanism. Oxidation state and redox reactions. Acid-basic equilibria. Reaction classification. Alkanes. Substitution. Halogenation. Cracking. Cycloalkanes. Conformation. Configuration. Alkenes. Addition. Carbonium ions and free radicals. Polymerization. Alkynes. Alkadienes. Conjugated compounds. 1,2- and 1,4-Additions. Nucleophilic substitution at saturated carbon. Elimination. Organometallic compounds. Electrophilic aromatic substitution.		
Recommended reading	Stanley H. Pine, Organska kemija, Školska knjiga, Zagreb, 1994.; R. T. Morisson, R. N. Boyd, Organska kemija, Liber, Zagreb, 1979.; K. P. C.		

	Vollhardt and N. E. Schore, Organic Chemistry, 3 rd edit., W. H. Freeman and Company, New York, 1999.
Supplementary reading	S. E. Meislich, H. Meislich & J. Scharefkin, 3000 Solved Problems in Organic Chemistry, The McGraw-Hill, 1994; S. Borčić, O. Kronja, Praktikum preparativne organske kemije, Školska knjiga Zagreb, 1991.
Teaching methods	Lectures, seminars.
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

Organic chemistry II

Course title	Organic chemistry II		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+75)		
Level of course	Basic level course		
Year of study	2 nd year of undergraduate study	Semester	IV.
ECTS (Number of credits allocated)	10.0 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 about chemistry of carbonyl group, and chemistry of biomolecules. This course is basic for understanding other courses, especially Biochemistry, Organic synthesis, Organic analysis, Natural organic compounds, Flavour chemistry, etc.		
Prerequisites			
Course contents	Nucleophilic aromatic substitution. Polycyclic aromatic compounds. Carbonyl compounds. Structure and tautomerism. Nucleophilic additions on carbonyl carbon, mechanisms, stereochemistry of aldol condensation. Nucleophilic substitution at acyl carbon. Nucleophilic-electrophilic reactivity of carbonyl compounds. Condensation reactions. α,β -Unsaturated carbonyl compounds. Amines. Azo-compounds. Aminocarboxylic acids. Peptides and proteins. Monosaccharides. Configuration's determination. Disaccharides. Polysaccharides. Heterocyclic compounds. Nucleic acids.		
Recommended reading	Stanley H. Pine, Organska kemija, Školska knjiga, Zagreb, 1994.; R. T. Morisson, R. N. Boyd, Organska kemija, Liber, Zagreb, 1979.; K. P. C. Vollhardt and N. E. Schore, Organic Chemistry, 3 rd edit., W. H. Freeman		

	and Company, New York, 1999.
Supplementary reading	S. E. Meislich, H. Meislich & J. Scharefkin, 3000 Solved Problems in Organic Chemistry, The McGraw-Hill, 1994.; S. Borčić, O. Kronja, Praktikum preparativne organske kemije, Školska knjiga Zagreb, 1991.
Teaching methods	Lectures, seminars, laboratory exercises.
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

Physical chemistry II

Course title	Physical chemistry II		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+60)		
Level of course	Basic level course		
Year of study	2 nd year of undergraduate study	Semester	IV.
ECTS (Number of credits allocated)	8.5 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	Chemical kinetics is raised to a higher level, and both approaches are further elaborated by applying them to processes in electrolyte solutions and on liquid and solid surfaces.		
Prerequisites			
Course contents	Ionic equilibria, Equilibrium electrochemistry, Kinetics of complex reactions, Molecular reaction dynamics, Dynamic electrochemistry, Properties of surfaces, Macromolecules.		
Recommended reading	P. W. Atkins, Physical Chemistry, Fifth Edition, Oxford University Press, 1994.; A. M. Halpern, Experimental Physical Chemistry, A Laboratory Textbook, Second Edition, Prentice Hall, New Jersey, 1997.		
Supplementary reading	S. H. Maron, J. B. Lando, Fundamentals of Physical Chemistry, Macmillan, New York, 1974.; I. Mekjavić, Fizikalna kemija 2, osnovni pojmovi, primjeri i zadaci, Golden marketing, Zagreb, 1999.		
Teaching methods	Lectures, seminars – numerical problems are solved, laboratory exercises – by working out 12 exercises student evidences in practice some of the principles presented through lectures in both semesters.		
Assessment	Written and oral examinations.		

methods	
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

Natural products

Course title	Natural products		
Course code			
Type of course	Lectures, laboratory exercises (45+30)		
Level of course	Basic level course		
Year of study	2 nd year of undergraduate study	Semestar	IV.
ECTS (Number of credits allocated)	6.0 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	Students gain basic knowledge of structural characteristics, properties and biological activity of the main groups of natural products.		
Prerequisites	Competence required by course General chemistry.		
Course contents	Classification of natural compounds. Basic isolation procedures. Chromatographic methods. Carbohydrates: mono- i oligosaccharides, polysaccharides. Lipids. Fats and oils: fatty acids. Waxes. Complex lipids: phospholipids, glycolipids. Terpenoids. Steroids: sterols, bile acids, sex hormones, adrenocortical hormones, cardiac glycosides, saponins. Carotenoids: carotenes, xanthophylls. Vitamins: water-soluble, fat-soluble. Alkaloids. Phenolic compounds: phenolpropanoides, phenolic acids, flavonoids, benzo-, naphtho- and anthraquinones, lignans and lignin. Natural dyes: porphyrins. For each group: definition, basic structural characteristics, natural sources, isolation procedures, physiological functions and properties, structure-activity relationship, applications, processes of production.		
Recommended reading	S.V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural Products, Springer-Narosa, Berlin, 2005.; J. Mann et. al., Natural products: their chemistry and biological significance, Addison Wesley Longman Limited, Harlow, 1994.; P.M. Dewick, Medicinal Natural Products, John Wiley & Sons, Inc., New York, 1997.; R. Ikan, Natural Products – A Laboratory Guide, 2nd ed., Academic Press, San Diego, 1991.		
Supplementary reading	I. Tabaković, Organska kemija prirodnih spojeva, Glas, Banja Luka, 1983.; J. Bruneton, Pharmacognosy, Phytochemistry, Medicinal Plants, Lavoisier publishing Inc., Paris, 1995.; M. M. Bloomfield; L. J. Stephens, Chemistry and the Living Organism, John Wiley & Sons, Inc., New York, 1996.		
Teaching methods	Lectures, laboratory exercises.		

Assessment methods	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.

Catalysis

Course title	Catalysis		
Course code			
Type of course	Lectures, seminars (30+15)		
Level of course	Basic level course		
Year of study	2 nd year of undergraduate study	Semestar	IV.
ECTS (Number of credits allocated)	3.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Tonka Kovačić, full professor		
Learning outcomes and competences	Fundamental knowledge about homogeneous and heterogeneous catalysis, as well as about their industrial applications is obtained. Furthermore, students are acquainted with processes of catalyst research and development.		
Prerequisites	Competence required by courses Physics and General Chemistry		
Course contents	History of catalytic discoveries. General concept of catalysis. Mode of action of catalysts. Fundamentals of homogeneous catalysis. Transition metal analysis. Acid-base reactions. Redox reactions. Kinetics and mechanisms of homogeneously catalysed reactions. Fundamentals of heterogeneous reactions. Physisorption and chemisorption. Kinetics and mechanisms of heterogeneously catalysed reactions. Langmuir-Hinshelwood and Eley-Rideal mechanisms. Energetic aspect of catalytic activity. Steric factors. Electronic factors (metals, semiconductors, isolators). Selectivity. Deactivation (poisoning, deposits on catalyst surface, sintering, evaporation of active component) and regeneration. Components of catalysts: catalytically active materials, supports, promoters. Characterisation of heterogeneous catalysts. Economic importance of catalysts.		
Recommended reading	J. Hagen, Industrial Catalysis: A Practical Approach, Wiley-VCH, Weinheim, 1999.; S. Bhaduri and D. Mukesh, Homogeneous Catalysis: Mechanisms and Industrial Applications, Wiley-Interscience, New York, 2000.		
Supplementary reading	J. M. Thomas, W. J. Thomas, Principles and Practice of Heterogeneous Catalysis, VCH, Weinheim, 1996.		

Teaching methods	Lectures, laboratory exercises.
Assessment methods	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.

General biology

Course title	General biology		
Course code			
Type of course	Lectures, laboratory exercises (30+15)		
Level of course	Basic level course		
Year of study	3 rd year of undergraduate study	Semester	V.
ECTS (Number of credits allocated)	4.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students		
Name of lecturer	Dr. Nada Bezić, assistant professor		
Learning outcomes and competences	The purpose of this course is getting to know the cell organization, the genetic concept, macroscopic structure and relation between living organisms.		
Prerequisites			
Course contents	Cell organelles: nucleus (DNA organization, chromosomes, mitosis, meiosis) plastids, mitochondria, membrane structure, ribosome and other microstructures. Cell organization on molecular level and cell regulation. The follow of genetic information. Plant tissues and organs. Deferent's in anatomy of Monocotyledons, Dicotyledons and Gymnosperm. Morphology of vegetative and reproductive organs, sexual and asexual reproduction. Evolution of A vertebrata and Vertebrata.		
Recommended reading	G. M. Cooper, Stanica: molekularni pristup, Medicinska naklada, Zagreb, 2004.; Denffer, D. i H. Ziegler: Botanika (Morfologija i Fiziologija), Školska knjiga, Zagreb, 1997.		
Supplementary reading	M. W. Berns: Stanica, Školska knjiga, Zagreb, 1997.; Magdenfrau, K. i F. Ehrendorfer: Botanika (Sistematika, evolucija i geobotanika), Školska knjiga, Zagreb, 1997.; Matoničkin I. i R. Erben: Opća zoologija, Školska knjiga, Zagreb, 1994.		
Teaching methods	Lectures, laboratory exercises.		
Assessment methods	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.

Instrumental methods of analysis

Course title	Instrumental methods of analysis		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+30)		
Level of course	Basic level course		
Year of study	3 rd year of undergraduate study	Semester	V.
ECTS (Number of credits allocated)	6.5 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: Instrumental methods of Analysis) learner is able for independent work in instrumental analytical laboratory which is important for natural science and other scientific areas. Also, accepted knowledge and skills in this course provide competence for continuation of education at higher level.		
Prerequisites	Competence required by courses Analytical Chemistry (I, II).		
Course contents	Instrumental techniques and their application for continuous and process analysis. Optimization and experimental design. Optimization of analytical control of technological process. Electroanalysis. Potentiometry. Electrogravimetry and coulometry. Voltammetry (Polarography). Amperometry. Elemental analysis. Atomic absorption spectrometry. Flame emission spectrometry. X-ray fluorescence spectrometry. Analysis of molecules and compounds. Ultraviolet and visible spectrometry. Infrared spectroscopy. Raman spectroscopy. Mass spectrometry. Nuclear magnetic resonance (NMR) spectroscopy. Surface and structural analysis. Photoelectron spectroscopy. Auger electron spectroscopy. Analysis of surface with electron beams. X-ray diffraction analysis. The separation in analytical chemistry. Ion exchange and extraction. Gas chromatography. High-performance liquid chromatography. Chromatographic methods for process control. Electrophoresis. Automation, miniaturization and simplification of analytical processes. Continuous analysis with air segmentation. Flow injection analysis. Chemical sensors. Biosensors. Process analytical chemistry.		
Recommended reading	D. A. Skoog, D. M. West and F. J. Holler, Fundamentals of Analytical Chemistry, Seventh Edition, Saunders College Publishing, New York, London, 1996. {šesto izdanje (englesko) 1992, prvo izdanje (hrvatsko),		

	Školska knjiga, Zagreb, 1999.}); 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-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004. ; T. H. Hadjiioannou, G. D. Christian, C. E. Efstathion and D. P. Nikolelis, Problem Solving in Analytical Chemistry, Pergamon Press, Oxford, New York, 1988. ; D.T. Sawyer, W.R. Heineman, J.M. Beebe, Chemistry Experiment for Instrumental Methods, John Wiley & Sons, New York, 1984. ; F. McLennan and B. Kowalski (Editors), Process Analytical Chemistry, Blackie Academic & Professional, London, 1995. ; I. Piljac, Elektroanalitičke metode, RMC, 1995.
Supplementary reading	D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical Chemistry, Eighth Edition, Brooks/Cole, London, 2004.; G. D. Christian, Analytical Chemistry, Sixth Edition, John Willey & Sons, INC, 2004.; D. C. Harris, Quantitative Chemical Analysis, Fifth Edition, W. H. Freeman and Company, New York, 1999.; H. H. Willard, L. L. Merritt, Jr., J. A. Dean, Instrumental Methods of Analysis, seventh edition, Wadsworth Publishing Company, Belmont, California, 1988.; D. A. Skoog, J. J. Leary, Principles of Instrumental Analysis, fourth edition, Saunders College Publishing, New York, 1992.
Teaching methods	Lectures, problem solving, laboratory experiments
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.

Biochemistry I

Course title	Biochemistry I		
Course code			
Type of course	Lectures, seminars, laboratory exercises (60+15+30)		
Level of course	Basic level course		
Year of study	3 rd year of undergraduate study.	Semester	V.
ECTS (Number of credits allocated)	9.0 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	During this course the students learn the basis of biochemistry, the relationship between the three-dimensional structure of proteins and their biological activity, main components of biologic systems and the		

	generation and storage of metabolic energy.
Prerequisites	Competence required by courses General chemistry and Organic chemistry.
Course contents	History of biochemistry. Elementary constitution of living organisms. Water, bioelements, biomolecules and kinds of chemical bonds in living organisms. Exchanges of energy between cell and environment. Proteins. Amino acid, peptides and proteins. Ionization properties of amino acids. Structure and biologic function of proteins. Enzymes. Enzyme catalysis and regulation of biochemical processes. Non protein catalysts: ribosimes, coenzymes and vitamins. Carbohydrates. Glycoconjugates and their role. Lipids: fats, phospholipids, glycolipids and sphingolipids. Common features of biological membranes. Membrane proteins and membrane transport. Energy in biologic systems. ATP as the universal currency of free energy in biologic systems. Electrochemical and concentration gradients. Irreversible and reversible processes. A thermodynamically unfavorable reaction can be driven by a favorable one. Metabolism: basic concepts and design. Degradation of carbohydrates (glycolysis). Fatty acid metabolism (β -oxidation). Amino acid degradation and the urea cycle. Metabolic energy. Citric acid cycle. Oxidative phosphorylation. Basic principles of metabolism regulation.
Recommended reading	L. Stryer, Biokemija, Školska knjiga, Zagreb, 1991.; J. M. Berg, J.L. Tymoczko and L. Stryer, Biochemistry V edition W. H. Freeman and Comp., New York, 2002.
Supplementary reading	P. Karlson, Biokemija, Školska knjiga, Zagreb, 1993.; L. Stryer, Biochemistry, IV edition, W. H. Freeman and Comp., San Francisko, 1995.
Teaching methods	Lectures, seminars, laboratory exercises.
Assessment methods	Oral examination, written examination, written and oral examination
Language of instruction	Croatian and French
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.

Aalysis of real substances

Course title	Aalysis of real substances		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+30)		
Level of course	Basic level course		
Year of study	3 th year of undergraduate study	Semester	V.
ECTS (Number of	5.5 Number of allocated credits is based on the lecturer's estimation and		

credits allocated)	inquiry among students		
Name of lecturer	Silvestar Krka, lecturer		
Learning outcomes and competences	Collecting, determining and interpretation of information about the analysis of real substances		
Prerequisites	Competence required by courses Analytical chemistry I and Analytical chemistry II.		
Course contents	Importance of the analysis of real substances: Raw materials, Industry products. Evolution and Process Control. Sampling of gases, liquids and solids. Analytical Separations. The Preparation of the Sample for the Analysis. Decomposition and disolutions of Samples. Evolution of Selected Methods. The choice of the Method of analysis. Techniques of Separation Reporting and interpretation of analytical date. Moisture in solids and gases. Determination of Water. Methods for the analysis of Materials: Cement, Minerals, Alloys and Metals, Petroleum, Water... Quality control. Tolerance. Referent Materials. Sampling. Preparation of the Samples for the Analysis: Gypsum, Cement... Separations and Analysis: Minerals, Alloys.		
Recommended reading	F. M. Garfield, Quality Assurance Principles, AOAC, New York, 1995; R. Kellner, J. M. Mermet, M. Otto, M. Walcavcel and H. M. Widmer, Analytical Chemistry (A Modern Approach to Analytical Science, Second Edition) Wiley-VCHVerlag, Gmbh&Co. KGaA, Weinheim, 2004.		
Supplementary reading	A.I. Vogel, A. Tekst-book quantitative inorganic analysis, Third Edition Longman, London, 1975.; W.D. Callister, Jr., Materials Science and Engineering, John Wiley & Sons, inc., New York, 1994.		
Teaching methods	Lectures, laboratory exercises, presentation exercises		
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.		

Material and energy balances

Course title	Material and energy balances		
Course code			
Type of course	Lectures, seminars (30+30)		
Level of course	Basic level course		
Year of study	3 rd year of undergraduate study	Semester	V.
ECTS	5.0 Number of allocated credits is based on the lecturer's estimation and		

(Number of credits allocated)	inquiry among students.
Name of lecturer	Dr. Nenad Kuzmanić, associate professor
Learning outcomes and competences	The purpose of this course is to acquaint the student with the manner in which the laws of conservation of mass and energy can be applied to industrial chemical processes, and to give a systematic approach to the solution of problems relate the inputs and outputs of manufacturing systems.
Prerequisites	Competence required by courses Mathematics I and General Chemistry.
Course contents	Introduction to engineering calculations. Process classification and process variables. General balance equation. Differential and integral types of material balances. Material balances in non-reactive systems. Material balances on continuous, semibatch and batch processes. Balances on multiple-unit processes. Recycle and bypass calculations. Material balances in reactive systems. Combustion reactions. Material balances in multiphase systems. Energy and energy balances. Energy balances on open and closed systems. Energy balances on nonreactive and reactive processes. Simultaneous material and energy balances.
Recommended reading	R. M. Felder, R. W. Rousseau, Elementary Principles of Chemical Processes, 3 rd edition, John Wiley & Sons, Inc., New York, 2000.; D. M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, 6 th edition, Prentice-Hall Inc., New Jersey, 1996.; R. H. Perry, D. W. Green, J. O. Maloney, Perry's Chemical Engineer's Handbook, 7 th edition, McGraw-Hill, New York, 1999.
Supplementary reading	W. L. Luyben, L. A. Wenzel, Chemical Process Analysis: Mass and Energy Balances, Prentice Hall, Englewood Cliffs, New Jersey, 1988.; T. Bradić et al., Matematika za tehnološke fakultete, Sveučilište u Zagrebu, Multigraf - Zagreb, Zagreb, 1994.
Teaching methods	Seminars thematically follow the lectures. They include methods for organizing known information about process variables, setting up material and energy equations, and solving these equations for unknown variables applying mathematical methods.
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.

Biochemistry II

Course title	Biochemistry II
Course code	
Type of course	Lectures, seminars, laboratory exercises (30+15+30)

Level of course	Basic level course		
Year of study	3 rd year of undergraduate study.	Semester	VI.
ECTS (Number of credits allocated)	6.0 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	Biochemistry II offer to students the knowledge about the storage, transmission and expression of genetic information, biosynthesis of macromolecular precursors, the principles of molecular physiology.		
Prerequisites	Competence required by courses General chemistry, Organic chemistry and Biochemistry I.		
Course contents	Biosynthesis of macromolecular precursors. Biosynthesis of amino acids, carbohydrates, lipids and nucleotides. The storage, transmission and expression of genetic information. Genetic role, structure of DNA molecule. Organization of DNA in genome. Genes, histones, nucleosomes and chromosomes. Process of DNA replication. Initiation and replication forks. DNA replication and test of the correctness of base pairing. Errors and their corrections at stage of replication. RNA in generation and in translation of genetic information. Synthesis and modifications of RNA molecules. Ribosomes and ribosomal RNA. Transfer RNA and their role in biosynthesis of proteins. Messenger RNA and process of transcription. Genetic code and protein synthesis. Control of genetic information expression in procaryotes and eucaryotes. The principles of molecular physiology. Communication among the living cells. Sensory systems and hormone action. Muscle contraction and cell motility.		
Recommended reading	L. Stryer, Biokemija, Školska knjiga, Zagreb, 1991; J.M. Berg, J.L. Tymoczko and L. Stryer, Biochemistry V edition W. H. Freeman and Comp., New York,		
Supplementary reading	P. Karlson, Biokemija, Školska knjiga, Zagreb, 1993; L. Stryer, Biochemistry, IV edition, W. H. Freeman and Comp., San Francisco, 1995		
Teaching methods	Lectures, seminars, laboratory exercises		
Assessment methods	Oral examination, written examination, written and oral examination		
Language of instruction	Croatian and French		
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.		

Environmental chemistry

Course title	Environmental chemistry
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Course code			
Type of course	Lectures, seminars, laboratory exercises (45+15+30)		
Level of course	Basic level course		
Year of study	3 rd year of undergraduate study	Semester	VI.
ECTS (Number of credits allocated)	7.5 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	Learn base chemical lawfulness which are happening in environment. In the course program practice will follow chemical processes in environment. Acquire knowledge will apply in business linked for environment.		
Prerequisites			
Course contents	Introduction. Environment components. Water and gas in water and ecosystem. Hydrogen and ecosystem. Carbonate. Carbonate and Water Ecosystem. Photosynthesis and Carbon Compound. Nitrogen. Natural Transformation Processes in the Nitrogen Cycle. Nitrate ions in Water and Food. Sulphur. Micro-organisms and Sulphur Function. Sulphur Dioxide and Environment. Phosphorus and Phosphate. Iron. Iron in natural systems. Iron in Industrial system. Aluminium. Aluminium in Industrial system. Aluminium in Water. Potassium. Radioactive Potassium. Element Environmentally Problem. Essential and Toxic Element. Organic Compounds in Environmental. Hazardous Organic Compounds. Synthetic Organic Compounds. Dioxins. Polychlorinated biphenyls (PCBs). Polynuclear aromatic hydrocarbons (PAHs). Ion in Solution. Solubility, Acid-Base Reaction. Complex Reaction. Gravimetry and Volumetry. Sampling. Statistically treatment of Results.		
Recommended reading	P. O'Neil, Environmental Science, London, 1993; W. Stumm, J. J. Morgan, Aquatic Chemistry, New York, 1996; B. J. Alloway, Heavy Metals in Soils, London, 1995; D. Tuhtar, Zagađivanje zraka i vode, Sarajevo, 1984,		
Supplementary reading	V. Glavač, Uvod u globalnu ekologiju, Zagreb, 1999; M. Črnjar, Ekonomija i zaštita okoliša, Rijeka, 1997., C. Baird, Environmental chemistry, New York, 1998., C. E. Kupchella, M. C. Hyland, Environmental science, Massachusetts, 1989		
Teaching methods	Oral examination, laboratory exercises		
Assessment methods	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.		

Selected processes of chemical industry

Course title	Selected processes of chemical industry		
Course code			
Type of course	Lectures, seminars, laboratory exercises (45+15+30)		
Level of course	Basic level course		
Year of study	3 rd year of undergraduate study	Semester	VI.
ECTS (Number of credits allocated)	7.5 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Jelica Zelić, associate professor / Dr. Ivka Klarić, full professor		
Learning outcomes and competences	Familiarizing with characteristics of the basic processes in the inorganic and organic industry and their importance for the economy development, with special reference to the technological, economical and environmental aspects.		
Prerequisites	Competence required by courses Inorganic chemistry and Organic chemistry.		
Course contents	Water in the technological processes. Waters-treatment processes (basic processes and reactions, equipment and process control). The chemical processing of solid fuels. The most important examples of basic inorganic chemical industry processes (synthesis of ammonia, processes of nitric and sulphuric acids production). The high-temperatures reaction in the solid state and sintering processes in the production of ceramic materials. Forming processes of dispersion systems with water, hydration processes. Electrochemical industrial processes, electrolyses of aqueous solutions and melting salts. Primary and secondary processes of the processing of petroleum. Processes for production of components for organic synthesis (alkanes, alkenes, acetylene, aromatic hydrocarbons, synthesis gas) from the petrochemical sources (natural gas, petroleum). Alternative (nonconventional) methods for raw materials production for organic synthesis. Technological processes in organic synthesis according the criteria of similar chemical reactions (thermodynamics and kinetics, catalysts), specially the production of fine chemicals: hydrogenation and dehydrogenation, hydroformilation, oxidation reactions, alkylation, esterification, nitration, sulfonation and sulphating, hydrolysis, polymerisation.		
Recommended reading	R. Krstulović, Tehnološki procesi anorganske industrije, Sveučilište u Splitu, Tehnološki fakultet u Splitu, Split, 1986.; W. D. Callister, Jr., Materials science and engineering, 5 th ed., J. Wiley and Sons, Inc. New York, 2000.; G. D. Hobson, Modern Petroleum Technology, 5 th ed., J. Wiley, New York, 1984.; G. M. Wells, Handbook of Petrochemicals and Processes, Ashgate Publ., Ltd., Aldershot, 1999.		
Supplementary			

reading	
Teaching methods	Lectures, seminars, laboratory exercises, field teaching.
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.