



University of Split

Faculty of Chemical Technology

PROPOSAL FOR THE ACADEMIC GRADUATE STUDY PROGRAMME

Chemical Technology

Split, February 1, 2005

STUDY PROGRAMME / CURRICULUM

Academic graduate study: Chemical Technology

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1. Introduction

1.1. General information on the programme

By the graduate study of chemical technology, the Faculty of Chemical Technology of Split, as a high-education and scientific institution, is trying to offer a new impetus for economic development and rational economizing on natural resources. This study provides knowledge required for designing, leading and developing of sustainable chemical processes, as well as the knowledge on the methods of quality investigations and their development at the process of analysis.

The graduate study is organized through three study orientations: Materials, Environmental Protection and Chemistry and Technology of Mediterranean Cultures.

The basic knowledge from the field of chemical engineering is applied in the manufacture and analysis of materials, in the investigations of various degradation processes and in the protection of construction materials in different surroundings.

Sustainable development is closely connected with industry and environment. When they finish this study, the students can be quickly involved in work to solve many problems and promote the interrelation between technological development and environment, with an emphasis on water resources and coastal sea, and on soil and atmosphere protection.

An increasing need for healthy food and development of tourism stimulate the exploitation of Mediterranean resources. The obtained knowledge of chemical engineering will be applied in the development of sustainable technological manufacturing processes of Mediterranean cultures and food production in accordance with Codex Alimentarius references and the requirements of modern sciences on food and nutrition.

The aim of the study is to reinforce individual abilities of students so that they can competently respond to the challenges of new technologies development. The study is applicable to all branches of economy and various scientific fields and, also, it is fundamental for successful entrepreneurship. After they finish the study, students can be employed with the acquired knowledge in chemical, food, pharmaceutical, cosmetic, metal, construction, shipbuilding and other industries, on the jobs of quality protection, marketing, management, recycling and disposal of waste, and other jobs requiring qualification and knowledge obtained at the study. After they finish the study, students can continue their education at the postgraduate study of the Faculty of Chemical Technology or at some other postgraduate studies of related faculties.

The proposed study programmes are based on the scientific knowledge of chemistry, chemical engineering and food technology, which significantly contributes to modern education of new experts.

When elaborating the programmes, special care was taken to harmonize the subjects and their teaching programmes with related studies at other high-school institutions. In that way the programmes are mutually comparable and, also, they stimulate the student and teacher mobility. The proposed programme can be compared with the programmes of the following high-school institutions: Università degli Studi di Roma “La Sapienza”, Rome, Italy; Universidad Rey Juan Carlos, Madrid, Spain; Delf University of Technology, Delf, Holland; Università degli Studi di Padova, Padua, Italy, etc.

What the programmes of the above mentioned institutions and our proposed programme have in common is that, during the first year of the graduate study, the focus is on acquiring such basic knowledge of the scientific fields represented in this study that is not mastered at undergraduate study. In the third semester, students are offered to choose numerous optional subjects of their profession and beyond, while the last semester is for the work on graduate thesis.

1.2. Previous experience in the field

The Faculty of Chemical Technology of Split was founded in 1960, responding the economic demands of the region and aiming at fulfilling its personnel and professional needs. On the grounds of the acquired scientific knowledge and economic demands, the teaching programmes have been continually improved and up-dated. Close cooperation between this region economy and the Faculty has resulted in great number of projects, expertise, elaborates and, in particular, in opening new study orientations and post graduate studies, the content of which is just the result of this region needs. The proposed graduate study represents the existing study of chemical technology with the study orientations: Chemical-Technological Processes (classes: Polymer Materials, Inorganic Materials, Corrosion and Protection of Materials), Environmental Protection, and Chemistry and Technology of Mediterranean Cultures.

1.3. Student mobility scheme

The proposed programme of graduate study of chemical technology and its comparability with the related studies in the Republic of Croatia and the EU countries enables the student and teacher mobility. It can be realized through the enrolment of particular subjects in other university studies, as well as of the whole semesters in the related studies, or through the work on the final project. The students will be also given an opportunity to enrol in a certain number of courses out of their profession. The studies suitable for the realization of that mobility are the components of the University of Split, but also of other Croatian universities and high-school institutions of the EU countries.

1.4. Other elements

The possible partners outside high-school education system interested in continuation of the study of chemical technology are the economy and public services of the Split-Dalmatia County, as well as: cement industry, shipbuilding industry, processing of polymer materials, Institute for Oceanography and Fishing, Croatian Hydrographical Institute, Institute for Adriatic Cultures and Melioration of Karsts, Institute for Civil Engineering, Public Health Institute and other County and City public services. It is important to point out that due to the geographic position of Split there is a growing presence of students not only from Dalmatia but also from Bosnia and Herzegovina, so that such a trend is expected to continue in the future.

2. General description

Type of programme	Academic Graduate Study	
Programme title	Academic Graduate Study of Chemical Technology Study Orientations: Materials, Environmental Protection, Mediterranean Cultures	
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 chemical technology or an undergraduate study of related faculties completed.	
Learning outcomes and competences	Designing, leading and developing of the processes of chemical, food and related industries; method development and quality investigation; participating in designing, synthesis and analysis as well as in the development of new chemical materials and improvement of manufacturing processes and environmental protection; work in manufacturing plants of chemical and other related industries; work in the controlling, scientific and investigation laboratories, institutes and other public institutions.	
Access to further studies	Postgraduate study from the scientific field of chemical engineering.	
Qualification awarded	Master of Science of Chemical Technology (Study Orientation - ...)	

3. Study/Degree programme

3.1. Programme structure with credits

Orientation: Materials

1st Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	Applied mathematics	30+15+0	4.0
	Thermodynamics of real processes	30+15+30	6.5
	Instrumental methods of analysis	30+15+30	6.5
	Automatic control process	30+15+30	6.5
	Mechanical and heating operations	30+15+30	6.5
TOTAL:		150+75+120	30
* L- lectures; S – seminars; P – laboratory excercises			

2nd Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	Chemical reactors	30+15+15	5.0
	Electrochemical engineering	30+30+30	6.5
	Inorganic processes in heterogeneous systems	45+15+45	8.0
	Polymerization processes	45+15+45	8.0
	Practical work in companies, public or private institutiones		2.5
TOTAL:		150+75+135	30
* L- lectures; S – seminars; P – laboratory excercises			

3rd Semester			
Course code	Course title <i>Optional courses</i>	Type of course L+S+P*	ECTS
	Optional course		30**
	Optional course		
	Optional course		

	Optional course		
	Optional course		
	Optional course		
TOTAL:			30
*L- lectures; S – seminars; P – laboratory exercises			
** Minimum ECTS credits that need to be obtained from optional courses. Minimum of two courses from each group of optional courses has to be chosen.			

3rd Semester – Optional courses			
Course code	Optional courses of group - Organic materials	Type of course L+S+P*	ECTS
	Structure and properties of polymers	30+0+30	5.0
	Polymer characterization	30+0+30	5.0
	Combinated polymeric materials	30+0+30	5.0
	Production of plastics	30+0+30	5.0
	Naturally occurring polymeric materials	30+0+30	5.0
	Coatings	30+0+30	5.0
*L- lectures; S – seminars; P – laboratory exercises			

3rd Semester – Optional courses			
Course code	Optional courses of group - Anorganic materials	Type of course L+S+P*	ECTS
	Glass and ceramics	30+0+30	5.0
	New inorganic materials	30+0+30	5.0
	Technology of building materials	30+0+30	5.0
	Non-metallic composites	30+0+30	5.0
	Structure and properties of inorganic non-metallic materials	30+0+30	5.0
	Corrosion and degradation of building materials	30+0+30	5.0
*L- lectures; S – seminars; P – laboratory exercises			

3rd Semester – Optional courses			
Course code	Optional courses of group Material protection	Type of course L+S+P*	ECTS
	Corrosion and material protection	30+0+30	5.0
	Electrodeposition processes	30+0+30	5.0
	Surface protection technology	30+0+30	5.0
	Electrochemical methods and theirs application	30+0+30	5.0
	Corrosion inhibitors	30+0+30	5.0
	Direct energy conversion	30+0+30	5.0
*L- lectures; S – seminars; P – laboratory exercises			

4th Semester			
Course code	Course title <i>Obligatory and optional courses</i>	Type of course L+S+P*	ECTS
	Optional course		5.0**
	Process design	30+30+0	5.0
	Graduate thesis		20.0
TOTAL:			30
*L- lectures; S – seminars; P – laboratory excercises			
** Optional course has to be chosen in accordance with mentor of graduate thesis. Minimum ECTS credits that need to be obtained from optional courses is indicated.			

4th Semester - Optional courses			
Course code	Course title	Type of course L+S+P*	ECTS
	All optional courses from the groups Organic materials, Anorganic materials and Material protection		
	Marine and submarine mineral raw materials	30+0+30	5.0
	Solid waste and recycling	30+0+30	5.0
	Wastewater engineering	30+15+30	6.5
*L- lectures; S – seminars; P – laboratory excercises			

Orientation: Environmental protection

1st Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	Applied mathematics	30+15+0	4.0
	Thermodynamics of real processes	30+15+30	6.5
	General biology	30+0+15	4.0
	Biochemistry	60+15+30	9.0
	Instrumental methods of analysis	30+15+30	6.5
TOTAL:		180+60+105	30

*L- lectures; S – seminars; P – laboratory excercises

2nd Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	General microbiology	30+0+30	5.5
	Essentials of ecology	45+15+0	6.5
	Environmental chemistry	45+15+30	7.5
	Environmental engineering	45+15+30	8.0
	Practical work in companies, public or private institutiones		2.5
TOTAL:		165+45+90	30

*L- lectures; S – seminars; P – laboratory excercises

3rd Semester			
Course code	Course title <i>Obligatory and optional courses</i>	Type of course L+S+P*	ECTS
	Wastewater engineering	30+15+30	6.5
	Solid waste and recycling	30+0+30	5.0
	Optional course		18.5**
	Optional course		
	Optional course		
	Optional course		
TOTAL:			30

*L- lectures; S – seminars; P – laboratory excercises

** Minimum ECTS credits that need to be obtained from optional courses. Minimum of one course from each group of optional courses has to be chosen.

3rd Semester - Optional courses

Course code	Optional courses of group - Waters and sea	Type of course L+S+P*	ECTS
	Marine chemistry	30+15+15	5.0
	Marine pollution	30+15+0	4.0
	Acquatic chemistry	30+15+15	5.0
	Microbiology of polluted waters	30+15+15	5.0
	Environmental management system	30+15+15	5.0

*L- lectures; S – seminars; P – laboratory excercises

3rd Semester - Optional courses			
Course code	Optional courses of group - Air	Type of course L+S+P*	ECTS
	Atmospheric chemistry	30+15+15	5.0
	Plastics and the environment	30+15+15	5.0
	Ionised radiation in the biosphere	30+15+0	4.0
	Ecotoxicology	30+0+30	5.0

*L- lectures; S – seminars; P – laboratory excercises

3rd Semester - Optional courses			
Course code	Optional courses of group - Soil	Type of course L+S+P*	ECTS
	Soil chemistry	30+15+15	5.0
	Processes of solidification and stabilization	30+0+30	5.0
	Corosion and environment	30+0+30	5.0
	Recycling of plastics	30+0+30	5.0
	Nanotecnology and environment	30+15+0	4.0

*L- lectures; S – seminars; P – laboratory excercises

4th Semester			
Course code	Course title <i>Obligatory and optional courses</i>	Type of course L+S+P*	ECTS
	Optional course		3.0**
	Energy and development	30+0+0	2.0
	Process design	30+30+0	5.0
	Diplomski rad		20.0
TOTAL			30

* L- lectures; S – seminars; P – laboratory excercises

** Optional course has to be chosen in accordance with mentor of graduate thesis. Minimum ECTS credits that need to be obtained from optional courses is indicated.

Orientation: Mediterranean cultures

1st Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	General biology	30+0+15	4.0
	Biochemistry	60+15+30	9.0
	Water technology	30+15+30	5.5
	Biotechnological processes	30+15+30	5.5
	Unit processes in food industry	30+15+30	6.0
TOTAL:		180+60+135	30
*L- lectures; S – seminars; P – laboratory excercises			

2nd Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	General microbiology	30+0+30	5.5
	Hygiene and sanitation	30+15+30	6.0
	Mediterranean fruits and vegetables technology	45+15+30	8.0
	Technology of aquaculture	45+15+30	8.0
	Practical work in companies, public or private institutiones		2.5
TOTAL:		150+45+120	30
*L- lectures; S – seminars; P – laboratory excercises			

3rd Semester			
Course code	Course title <i>Obligatory and optional courses</i>	Type of course L+S+P*	ECTS
	Grape processing	45+15+30	8.0
	Olive processing	45+15+30	8.0
	Quality assurance of foods	30+0+30	5.0
	Optional course		9.0**
	Optional course		
	Optional course		
TOTAL:			30
* L- lectures; S – seminars; P – laboratory excercises			
** Minimum ECTS credits that need to be obtained from optional courses.			

3rd Semester			
Course	Optional courses	Type of	ECTS

code		course L+S+P*	
	Technology of citrus products	30+0+15	4.0
	Mediterranean nutrition	30+0+15	4.0
	Biochemical engineering	30+0+15	4.0
	Chemistry and technology of aromatic plants	30+0+15	4.0
	Methods of analysis	30+0+15	4.0
	Corrosion and material protection	30+0+15	4.0
	Separation processes	30+0+15	4.0
	Perfumes and cosmetic preparates	30+0+15	4.0
	Modern methods in biochemistry	30+0+15	4.0
	Applied mathematics	30+15+0	4.0
*L- lectures; S – seminars; P – laboratory excercises			

4th Semester			
Course code	Course title <i>Obligatory courses</i>	Type of course L+S+P*	ECTS
	Packing	30+0+30	
	Process design	30+30+0	
	Graduate thesis		
TOTAL:			30
*L- lectures; S – seminars; P – laboratory excercises			

Applied mathematics

Course title	Applied mathematics		
Course code			
Type of course	Lectures, seminars (30+15)		
Level of course	Advanced level		
Year of study	1 st year of graduate study	Semester	I.
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. Tanja Vučićić, assistant professor		
Learning outcomes and competences	The course provides an understanding of and competence in basic topics of mathematics and statistics that are relevant for implementation in chemistry. A computer package Mathematica 5, Wolfram Research is introduced.		
Prerequisites			
Course contents	Numerical methods for solving equations. Differential equations and their application in chemistry. Empirical equations deriving. The least square method. Algebraic interpolation. Numerical integration. Elements of the probability theory. Elementary mathematical statistics. Some applications of the graph theory in chemistry.		
Recommended reading	N. Bogdanić, Primijenjena matematika, textbook, University of Split, 1980.; (New edition co-authored by Tanja Vučićić in preparation); D. Vukičević, Uvod u statistiku, textbook, University of Split, to appear.		
Supplementary reading	E. Kreyszig, Advanced Engineering Mathematics, J. Wiley & Sons, Inc., New York, 1999.; R.J. Harshbarger and J.J. Reynolds, Calculus with Applications, D. C. Heath and Company, Lexington, Massachusetts – Toronto, 1990.		
Teaching methods	Frontal presentation of brief theoretical introductions to selected topics (Course contents) followed by numerical solving of problems illustrating the theory. Student groups are appointed a seminar paper topic each. 6 hours are spent on teaching students how to use Wolfram Research software Mathematica 5 in solving the problems.		
Assessment methods	Written and oral examination		
Language of instruction	Croatian		
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.		

Thermodynamics of real processes

Course title	Thermodynamics of Real Processes		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+30)		
Level of course	Advanced level course		
Year of study	1 st year of graduate study	Semester	I.
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. Vanja Martinac, associate professor		
Learning outcomes and competences	Students acquire knowledge in applying the basic laws of thermodynamics and advanced mathematical methods to solutions of chemical engineering problems.		
Prerequisites			
Course contents	<p>General consideration. Thermodynamic probability and Boltzmann equation. Equations of state of a real gas and mixture. Fugacity. Method of calculating fugacity. The principle of corresponding states. Application to gases and liquids. Improved principle of corresponding states. Pitzer correlation - acentric factor. Partial molal quantities. Methods of calculation of partial molal quantities in binary mixtures. Excess functions. The third law of thermodynamics and calculation of equilibrium transformation. Heterogeneous reactions-changes in reagents' surface area. Introduction to thermodynamics of open systems - work, energy and heat, enthalpy, partial molal quantities, heat in open system, relation between entropy and heat, affinity, thermodynamic functions of non-equilibrium states, entropy balance - entropy production and entropy flow in open system, dissipation function, relation between reaction rates and the affinities. Thermodynamic analysis of elastic deformation of a solid. Equation of state for elastic deforming axis. Caloric properties. Thermodynamic deformation processes. Application of thermodynamic theory to man and society.</p>		
Recommended reading	<p>N. Petric, V. Martinac, Kemijsko-inženjerska termodinamika, Termodinamika realnih procesa, Kemijsko-tehnološki fakultet, Split, 1998.; J. M. Smith, H. C. Van Ness, M. M. Abbott, Introduction to Chemical Engineering Thermodynamics, 6th Ed., McGraw-Hill, New York, 2000.; B. E. Poling, J. M. Prausnitz, J. P. O'Connell, The Properties of Gases and Liquids, 5th Ed., McGraw-Hill, New York, 2000.; S. I. Sandler, Chemical and Engineering Thermodynamics, 3rd Ed., Wiley, New York, 1999.</p>		
Supplementary reading	<p>M. Graetzl, P. Infelta, The bases of Chemical Thermodynamics, Vol. 1. & Vol. 2., Universal Publishers, Florida, 2000.; S. M. Walas, Phase Equilibria in Chemical Engineering, Butter. Publ., Boston, 1985.; T. E. Daubert, Chemical Engineering Thermodynamics, McGraw-Hill, New</p>		

	York, 1985.
Teaching methods	Lectures. Seminars – solving problems in accordance with the lecture program using a PC and available software. 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.

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	Advanced level		
Year of study	1 st year of graduate study	Semester	I.
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			
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 et al. (Editors), Analytical Chemistry (A Modern Approach to Analytical Science, Second Edition) Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004.; T.H. Hadjiioannou, et al., Problem Solving in Analytical Chemistry, Pergamon Press, Oxford, New York, 1988.; D.T. Sawyer et al., Chemistry Experiment for Instrumental Methods, John Wiley & Sons, New York, 1984.
Supplementary reading	D.A. Skoog et al., 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 et al. Instrumental Methods of Analysis, seventh edition, Wadsworth Publishing Company, Belmont, California, 1988.;
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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Automatic control process

Course title	Automatic control process		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+30)		
Level of course	Advanced level course		
Year of study	1 st year of graduate study	Semester	I.
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. Ratimir Žanetić, full professor		
Learning	Student acquires the knowledges and qualifies for analysis and synthesis		

outcomes and competences	of closed - loop control systems which will use for introduction elements automatic control and for following qualification in this area.
Prerequisites	
Course contents	Behavior control process. Models and modeling. Examples of mathematics models. Laplace transforms. Transfer function. Transients conversions. Frequency response. Analysis of first - order and second - order process. Behavior of closed control loop. First - order and second - order process in closed - loop control systems. Characteristics of closed - loop control system. Analysis of stability. Routh criterion. Nyquist criterion. Synthesis of closed loop control system. Behavior of controller and modes of performance. Controls of valves. Adjustment of closed control loop.
Recommended reading	J. Božičević, Temelji automatike I, Školska knjiga, Zagreb, 1992; J. Božičević, Automatsko vođenje procesa, Tehnička knjiga, Zagreb, 1971.
Supplementary reading	D.E Seborg, T.F. Edgar, D.A. Mellichamp, Process Dynamics and Control, J. Wiley, New York, 1989.; W. J. Palm, Control Systems Engineering, J. Wiley, New York, 1994.
Teaching methods	Lectures, laboratory exercises, presentation exercises, seminars by use personal computer and program support
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.

Mechanical and heating operations

Course title	Mechanical and heating operations		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+30)		
Level of course	Advanced level course		
Year of study	1 st year of graduate study	Semester	I.
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. Edita Mitrović – Kessler, full professor		
Learning outcomes and competences	Outcomes and competences necessary for work in manufacturing facilities in chemical industry and congenial industries, as well as for work in various institutes, universities and other public service laboratories.		
Prerequisites			

Course contents	Fluid statics and its application. Rheological properties of fluids. Differential momentum balance. Macroscopic momentum balance. Incompressible flow in pipes and channels. Flow of compressible fluids. Flow past immersed bodies. Transportation of fluids. Pumps, fans, blowers and compressors. Agitation and mixing of liquids. Blending and mixing. Liquid – liquid dispersion. Gas – liquid dispersion. Agitator selection and scale up. Suspension of solid particles. Heat transfer and its application. Heat transfer by steady - state and unsteady –state conduction. Principles of heat flow in fluids. Heat transfer to fluids without phase change. Heat transfer by forced convection in laminar and turbulent flow. Heat transfer to liquid metals. Heat transfer to fluids with phase change. Radiation to semitransparent materials. Combined heat transfer by conduction, convection and radiation. Extended surface and scraped - surface heat exchangers. Evaporation. Absorption with chemical reaction. Operations involving particulate solids. Mixing and size reduction of solids. Ultrafine grinders.
Recommended reading	E. Mitrović – Kessler: Tehnološke operacije, Tehnološki fakultet Split, Split, 1986.; W.L. McCabe: Unit Operations of Chemical Engineering, McGraw Hill, New York, 2001.; J.H. Lien: Heat Transfer Textbook, 3 rd edition, Phlogiston Press, Cambridge, 2003.
Supplementary reading	Chosen articles from journals and reviews recommended by course lecturer.
Teaching methods	Every theoretical chapter is followed by exercises, which will be held in a half - industrial laboratory. Also visits to existing industry facilities in the neighbouring area are foreseen.
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.

Chemical reactors

Course title	Chemical reactors		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+15)		
Level of course	Advanced level course		
Year of study	1 st year graduate study	Semester	II.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		

Name of lecturer	Dr. Davor Rušić, associate professor	
Learning outcomes and competences	Knowledge in the field of analysis and design of chemical reactions is acquired.	
Prerequisites		
Course contents	Reactor as a processing unit in a technological process. Selection of reactor. Reactor design and size determination. Batch reactors (reactor models, optimization of the reactor). Continuous tank reactors (reactor models, unsteady state, heat transfer, mixing). Plug flow tube reactors (reactor models). Multi-phase reactors (for gas-liquid reactions, three-phase reactors with solid phase as catalyst).	
Recommended reading	Z. Gomzi, Kemijski reaktori, HINUS, Zagreb, 1998.; C.G. Hill, Chemical Engineering and Reactor Design, J. Wiley, N.Y. 1977.; G.F. Froment and K. B. Bischoff, Chemical Reactor Analysis and Design, J. Wiley, N.Y., 1977.; D.D. Perlmutter, Stability of Chemical Reactors, Prentice-Hall, Englewood, N.J., 1972.; J. Villadsen, M.L. Michelsen, Solution of Differential Equation Models by Polynomial Approximation, Prentice – Hall, Inc. Englewood Cliffs, New Jersey, 1978.	
Supplementary reading	J.M. Coulson and J.F. Richardson, Chemical Engineering, Volume Three, Pergamon Press, 1979.	
Teaching methods	Lectures, seminars using PCs and available software (Mathcad, Matlab, Mathematica).	
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.	

Electrochemical engineering

Course title	Electrochemical engineering	
Course code		
Type of course	Lectures, seminars, laboratory exercises (30+30+30)	
Level of course	Advanced level course	
Year of study	1 st year of graduate study	Semester II.
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. Maja Kliškić, associate professor	

Learning outcomes and competences	Student will be able to use the aspects of electrochemical engineering on electrochemical processes. Also, he will be introduced to fundamental principles for optimisation electrochemical processes.
Prerequisites	
Course contents	Introduction. Technology of electrochemical processes. Constituent parts and operation in Electrochemical reactor. Velocity of electrochemical reactions and material balance. Minimum voltage for electrolysis. Balance on electrode. Individual reactions in electrochemical reactors. Required working potential. Efficiency and energy balance. Transport phenomena in electrochemical systems – complex systems. Current and potential distributions on working electrode. Electrochemical reactor with parallel plane electrodes. Annular geometry electrochemical reactor. Electrochemical reactor with vibrating and rotating electrode. Electrochemical reactor with free convection. Electrochemical reactor with bubbling gas mixture. Electrochemical reactor with porous electrode. Electrochemical reactor with movement particles electrode. Description and qualification of electrochemical reactor. Demand in construction of electrochemical reactor. Type of materials for construction of electrochemical reactor. Corrosion systems.
Recommended reading	Đ. Matic, Elektrokemijsko inženjerstvo, Kemija u industriji, Zagreb, 1988.; K. Scott, Electrochemical Reaction Engineering, Academic Press, London, 1991.; D. Pletcher, F.C. Walch, Industrial Electrochemistry, Charman and Hall, New York, 1990.
Supplementary reading	F. Lapicque, A. Strock, A.A. Wragg, Electrochemical Engineering and Energy, Plenum Publishing Corporation, New York, 1990.; F. Goodridge, K. Scott, Electrochemical Process Engineering, Plenum Publishing Corporation, New York, 1995.
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: (1) University Level, (2) Faculty Level by Quality Control Committee, (3) Lecturer's Level.

Inorganic processes in heterogeneous systems

Course title	Inorganic processes in heterogeneous systems
Course code	
Type of course	Lectures, seminars, laboratory exercises (45+45+45)
Level of course	Advanced level course

Year of study	1 st year of graduate study	Semester	II.
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. Petar Krolo, full professor		
Learning outcomes and competences	Knowledge of processes of formation and obtaining of technologically important materials formed at higher and high temperatures, and of processes providing for application of such or similar materials in practice.		
Prerequisites			
Course contents	Thermal decomposition processes. Industrial examples. Sintering processes and solid-state reactions. Technical silicates and similar materials. Processes of formation of silicates and aluminates in melts. Obtaining carbon materials: graphite, carbides etc. Reduction of MeO and obtaining metals. Purification of metal melts. Steel. Electrolysis in melted salts. Reactions with water in heterogeneous systems at lower temperatures. Hydration of partially or fully dehydrated mineral compounds of CaSO ₄ and lime. Reaction of anhydrous silicates, aluminates and similar substances with water and additions. Hydration and environmental protection.		
Recommended reading	R. Krstulović, Tehnološki procesi anorganske industrije, Sveučilište Split, Tehnološki fakultet u Splitu, Split, 1986.; W. E. Brown, D. Dollimore, A. K. Galwey, Reactions in the Solid State, Elsevier, Amsterdam, 1980.; H. Schmalzried, Chemical Kinetics of Solids, VCH, Weinheim, 1995.; W. F. Smith, Principles of Materials Science and Engineering, McGraw-Hill, New York, 1990.		
Supplementary reading	L.L. Lench, J.K. West, Chemical Processing of Advanced Materials, J Wiley, New York, 1992.; Y-M. Chiang, D.P. Birnie, W.D. Kingery, Physical ceramics, Principles for Ceramic Science and Engineering, John Wiley & Sons, Inc., New York, 1997.; S.N. Ghosh, Cement and Concrete Science Technology, Vol.1., Part I, ABI Books Private Limited, New Delhi, 1991.; W. Vogel, Kemija stakla, SKTH/ Kemija u industriji, Zagreb, 1985.		
Teaching methods	Lectures. Seminars. Laboratory exercises. Field teaching		
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.		

Polymerization processes

Course title	Polymerization processes		
Course code			
Type of course	Lectures, seminars, laboratory exercises (45+15+45)		
Level of course	Advanced level course		
Year of study	1 st year of graduate study	Semester	II.
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. Ivka Klarić, full professor		
Learning outcomes and competences	Getting to know mechanism of polymerization reactions (step-growth and chain growth ones) and their technological processing as the important entry in the world of polymer chemistry and polymeric materials. Work in the appropriate units and/or laboratories.		
Prerequisites			
Course contents	Classification of polyreactions. Step-growth polymerizations (kinetics on the example of polyesterification reaction without and with acid catalysts, distribution of molecular masses in linear step-growth polymers, effect of nonstoichiometric reactant ratios, theory of gel formation). Chain growth polymerization: Free radical polymerizations (initiators; kinetics of basic reactions -chain initiation, chain propagation, chain termination and chain transfer; rate of polymerization, average kinetic chain length, average degree of polymerization and molecular mass, molecular mass distribution). Ionic polymerization: Anionic and cationic polymerizations (catalysts, kinetics, kinetic chain length, average degree of polymerizations and molecular mass, distribution of molecular masses). Copolymerization (reactivity ratios, copolymer composition equation), experimental determination of reactivity ratios, Alfrey-Price Q-e scheme, distribution of monomers in a copolymer. The examples of step-growth and chain growth polymers. Coordination polymerizations (mechanism - monometallic and bimetallic) and stereoregular polymers. Metallocens catalysts. Polymerization procedures (homogeneous and heterogeneous). Industrial production of the most famous synthetic polymers (polyethylene, poly(vinylchloride), polystyrene, polypropylene).		
Recommended reading	H. Ulrich, Introduction to Industrial Polymers, Hanser, Munich, 1992; F. Rodrigez, Polymer Science and Technology, Taylor and Francis 1996; Z. Janović, Polimerizacije i polimeri, Kemija u industriji, Zagreb, 1997; A.G. Odian, Principles of Polymerization, 4 th edition, Wiley, New York, 2004;		
Supplementary reading	H. Ulrich, Row Materials for Industrial Polymers, Hanser Publishers, Vienna 1988; A. Ravve, Principles of Polymer Chemistry, Plenum Press, London, 1995; G.M. Wells, Handbook of Petrochemicals and Processes, Ashgate Publishing Ltd, Aldershot, 1999;		
Teaching methods			
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.

Structure and properties of polymers

Course title	Structure and properties of polymers		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 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	Knowledge of static and dynamic aspects of macromolecular structure and polymeric system; relationship between polymer properties and macromolecular structure.		
Prerequisites			
Course contents	Polymeric molecules, polymeric materials: basic definitions and terminology. Molecular structures of polymers: size of macromolecules, number of repeating units, shape of macromolecule, configuration, conformation. Supermolecular structure, amorphous state, crystalline structures. Dynamics of polymer structures. Physical state, phase state and deformation states of polymers. Transition temperatures. Thermomechanical curve. Chemical reactions of polymers: modification, degradation. Mechanical properties: deformations, relaxation phenomena, ultimate mechanical properties, mechanical properties of polymer products. Thermal properties, flammability of polymers. Electrical properties. Optical properties. Solubility of polymers. Diffusion and permeation of gasses and vapours in polymers. Ecological problems concerning polymeric materials. Methods for determination of structure and properties of polymers: spectroscopic methods, thermoanalytic methods.		
Recommended reading	C.E. Carraher, Jr., Seymour/Carracher's Polymer Chemistry, 4 th Edition, Marcel Dekker, Inc., New York, 1996.; I. M. Campbell, Introduction to Synthetic polymers, Oxford University Press, Oxford, 2000.; D. J. David, A. Misra, Relating Materials Properties to Structure, Technomic Publishing Co., Inc., Lancaster, 1999; P. J. Haines, Thermal Methods of Analysis, Principles, Application and Problems, Blackie Academic & Professional, Glasgow, 1995.		

Supplementary reading	Z. Janović, Polimerizacije i polimera, Hrvatsko društvo kemijskih inženjera i tehnologa, Zagreb, 1997.; D. W. van Krevelen, Properties of Polymers, Elsevier Science B. V., Amsterdam, 1997.
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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Polymer characterization

Course title	Polymer characterization		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Nataša Stipanelov Vrandečić, assistant professor		
Learning outcomes and competences	Student gets acquainted with thermodynamic and kinetic behavior of polymers as a base for their characterization and creation of new materials.		
Prerequisites			
Course contents	Statistics of polymer chain. Conformation of polymer molecules in dilute solution, distribution function. Polymer solutions: swelling and solution of polymers, solubility parameters. Statistical thermodynamics of polymer solutions. Theory of dilute polymer solutions. Statistical theory of crosslinked polymers swelling. Phase equilibrium in polymer systems: binary systems, ternary systems, theory of fractionation. Polydispersity of polymers and its determination. Methods of determination of the average molecular masses and average dimensions of polymeric coils: osmometry, light-scattering, diffusion and ultracentrifugation, viscometry. Flow of concentrated polymer solutions and polymer melts: rheological methods, flow curves. The relation between flow and molecular parameters, relation between flow and polymeric melts temperature. Viscosity of concentrated polymeric solutions.		
Recommended	I. Klarić: Karakterizacija polimera, Interna skripta, Tehnološki fakultet,		

reading	Split, 1983.; L.H. Sperling, Introduction to Physical Polymer Science, 2 nd Edition, John Wiley & Sons, Inc., 1992.;
Supplementary reading	G. Kämpf, Characterization of Plastics by Physical Methods: Experimental Techniques and Practical Application, Hanser Publishers, München, 1986.; E. Schröder and G. Müller, Polymer Characterization, Hanser Publishers, München, 1989
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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Combinated polymeric materials

Course title	Combinated polymeric materials		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 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	Student is acquainted with multicomponent polymeric systems: blends and composites as well as with dependence of materials properties on composition and structure.		
Prerequisites			
Course contents	Polymer blends. Basic principles and reasons of industrial development of polymer blends. The methods of blending. Thermodynamics of blending. Theoretical estimation of polymer miscibility. Determination of polymer/polymer miscibility. Properties of miscible polymer blends. Properties of immiscible polymer blends. Compatibilization methods. Commercial blends and alloys. Blends with liquid crystalline polymers. Polymer matrix composites. Fillers and reinforcements. Interface modification. Properties of fibre reinforced polymer composites. Mechanism of reinforcement and mechanical properties. Particle reinforced composites. Composites with polymeric fillers. Nanocomposites. Composite preparation methods.		

Recommended reading	L.A. Utracki, Polymer Alloys and Blends, Hanser Publ., Munich, 1989; D.J. David, A. Misra, Relating Materials Properties and Structure, Technomic Publ. Co. Basel, 1999.
Supplementary reading	M.J. Folkes, P.S. Hope, Polymer Blends and Alloys, Blackie Academic & Professional, London, 1995; S. Datta, D.J. Lohse, Polymeric Compatibilizers, Hanser Publ., Munich, 1996.
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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Production of plastics

Course title	Production of plastics		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 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	Students will get acquainted with modern trends in production of plastics, theoretical background and basic processes. They will be able to understand and apply engineering approach of plastic design according to the market's needs.		
Prerequisites			
Course contents	Historical background of plastics production procedures. Types of polymers. Mechanical, thermal and rheological properties of polymers (processing properties). Energy and heat balance of plastic production processes. Modern trends in plastic production. Additives to polymers. Improvement of polymers. Primary shaping procedures: continued (extrusion, calendaring, coating) and discontinued (compression moulding, transfer moulding and injection moulding, casting, sintering). Secondary shaping procedures: warm and cold secondary shaping, blowing, drawing, shrinkage. Bonding, welding. Surface improvement of plastics. Production of foamy and reinforced plastics. Recycling and recovery processes of plastic waste. Waste disposal and management.		

Recommended reading	T.A. Oswald, G. Menges, Materials Science of Polymers for Engineers, Carl Hanser Verlag, Munich, 1996.; I. Čatić, Uvod u proizvodnju polimernih tvorevina, Društvo plastičara i gumaraca, Zagreb, 1990.; M. Šercer D. Opsenica, G. Barić, Oporaba plastike i gume, mtg-topograf d.o.o., Velika Gorica, 2000.
Supplementary reading	I. Čatić, F. Johannaber, Injekcijsko prešanje polimera i ostalih materijala, Društvo za plastiku i gumu i Katedra za preradu polimera Fakulteta strojarstva i brodogradnje Sveučilišta u Zagrebu, Zagreb, 2004.; I. Čatić, Toplo i hladno oblikovanje polimera, Društvo plastičara i gumaraca, Zagreb, 1985.; M. Ravlić, Reologija PVC talina i otopina, Društvo plastičara i gumaraca, Zagreb, 1986.
Teaching methods	Lectures. Exercises in industrial plants and laboratories. Field school lectures.
Assessment methods	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.

Naturally occurring polymeric materials

Course title	Naturally occurring polymeric materials		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Basic level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 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, 4 th Ed., Marcel Dekker, New York, 1996.
Supplementary reading	R. Čunko, V. Friščić, Tekstilna vlakna, Naklada Modus, Zagreb, 2001.; 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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Coatings

Course title	Coatings		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Nataša Stipanelov Vrandečić, assistant professor		
Learning outcomes and competences	Student gets acquainted with theory of paint and surface coatings, as well as with production, application and quality control.		
Prerequisites			
Course contents	Basic characteristics, definitions, systematization and application of coatings. Application of polymeric materials in surface coatings. Pigments. Solvents and diluents. Additives. Types of surface coatings. The physical chemistry of dispersion. Particle size and particle size measurement. An introduction to rheology. The rheology of coatings. Mechanical properties of coatings. Specification and control of appearance. Durability testing. Computers and modelling in paint and coating formulation.		
Recommended reading	R. Lambourne and T.A. Strivens (Edit.), Paint and Surface Coatings, Woodhead publishing Ltd., Cambridge, 1999. D, Stoye and W. Freitag,		

	Resins for Coatings, Hanser Publisher, Cincinnati, 1996.
Supplementary reading	P. Swaray, Surface Coatings, Science and Technology, Wiley Inc., New York, 1986.
Teaching methods	Lectures. Laboratory exercises. Visits to the industrial plants.
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.

Glass and ceramics

Course title	Glass and ceramics		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Jelica Zelić, associate professor		
Learning outcomes and competences	Familiarizing with raw materials and basic processes of glass and ceramics production. Understanding glass and ceramics structures connected with their properties.		
Prerequisites			
Course contents	Vitreous state. Thermodynamic and kinetic aspects, structure models. Definition, constitution, properties and structure of commercial glasses. Classification of glasses. Basic production processes and glass processing. Raw materials and demands for their quality. Preparation of glass mixtures. Glass melting processes. Glass forming operations (pressing, drawing, blowing, sagging). Glass dyeing. Defect in glass. Glass-ceramics materials. Historical overview and meaning of ceramic industry. Classification of ceramics. Natural raw materials. Synthesis of ceramic powders. Phase diagrams of the systems important in ceramics. The clay-water systems. Characterization of ceramic slurries (rheological properties, plasticity, etc.). Forming processes of ceramic products (pressing, slip casting, jiggering, extrusion, etc.). Drying and firing processes. Sintering processes. Overview of traditional and advanced ceramic materials, their properties and applications.		

Recommended reading	W. Vogel, Kemija stakla, SKTH, Zagreb, 1985.; M. Tecilazić-Stevanović, Osnove tehnologije keramike, Tehnološko-metalurški fakultet, Beograd, 1990.; Y-M. Chiang, D. P. Birnie, W.D. Kingery, physical Ceramics, Principles for Ceramic Science and Engineering, J. Wiley & Sons, Inc., New York [<i>etc.</i>], 1997.
Supplementary reading	
Teaching methods	Lectures, 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.

New inorganic materials

Course title	New inorganic materials		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Petar Krolo, full professor		
Learning outcomes and competences	Acquisition of knowledge of development and properties and application of new inorganic materials.		
Prerequisites			
Course contents	Development of new inorganic materials. Special properties of new materials. New inorganic materials for information technology industry, transportation, process technology, modern medicine, satellite technology and space exploration. Inorganic materials based on sol-gel technology and chemical vacuum deposition (CVD). Type I and Type II superconductors. New bio-ceramic materials. Low-temperature ceramics. Glass-ceramics and glass-metals. Materials based on carbon fibres. New optical and opto-electronic materials. Liquid crystals. Special alloys and composite materials.		
Recommended	W.A. Goddard, D.W. Brenner, S.E. Lyshevski, G.J. Iafrate, Nanoscience,		

reading	Engineering and Technology, CRC Press, New York, 2003.; S.K. Mazumdar, Composites Manufacturing, Materials Product and Process Engineering, CRC Press, New York, 2002.; W.D. Callister, Materials Science and Engineering, John Wiley & Sons, Inc., New York, 1994.; L.L. Hench, J.K. West, Chemical Processing of Advanced Materials, John Wiley & Sons, Inc., New York, 1992.
Supplementary reading	R.W. Dull et al., A Teacher`s Guide to Superconductivity for High School Studets, Oak Ridge National Laboratory, WWW-Book, 2001.; L. Cot et al., Inorganic membranes and solid state sciences, Solid State Sciences, 2 (2000) 313-334.; M. Long, H.J. Rack, Titanium alloys in total joint replacement – a materials science perspective, Biomaterials, 19 (1998) 1621-1639.; C. Piconi, G. Maccauro, Zirconia as a ceramic, Biomaterials, 20 (1999) 1-25.
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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer`s Level.

Technology of building materials

Course title	Technology of building materials		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer`s estimation and inquiry among students.		
Name of lecturer	Dr. Petar Krolo, full professor		
Learning outcomes and competences	Acquisition of knowledge on obtaining and properties of specific non-metallic construction materials.		
Prerequisites			
Course contents	Significance and role of construction materials in modern civil engineering. Inorganic non-metallic construction materials Inorganic mineral binders. Gypsum and concrete pre-fabricates. Technological process of obtaining construction bricks and tiles. Expanded clay products.		

	Construction ceramics. Insulating inorganic materials. Aggregates, fillers and inorganic pigments for mortars and wall coats. Technical and decorative stone. Stone properties and exploiting.
Recommended reading	J.M. Illston, Construction Materials, E.& PN Spon, London, 1994; A.M. Brandt, Cement-Based Composites, Materials, Mechanical Properties and Performance, E & FN SPOON, London, 1994.; Advances in composite materials, Ed. By G. Piatti, Applied Science Publishers LTD, 1978.; S.N. Ghosh, Cement and Concrete Science Technology, Vol.1., Part I, ABI Books Private Limited, New Delhi, 1991.
Supplementary reading	R.S. Boynton, Chemistry and Technology of Lime and Limestone, John Wiley & Sons, Inc., New York, 1980.; Z. Supek, Tehnologija s poznavanjem robe, Školska Knjiga, Zagreb, 1982; Tehnička enciklopedija JLZ "Miroslav Krleža", Zagreb.
Teaching methods	Lectures. Laboratory exercises. Field teaching
Assessment methods	Oral examination
Language of instruction	Croatian, English, German
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.

Non-metallic composites

Course title	Non-metallic composites		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Petar Krolo, full professor		
Learning outcomes and competences	Basic knowledge of production, properties and application of some types of non-metallic composite materials.		
Prerequisites			
Course contents	Composite non-metallic materials. Types and properties. Hydraulic mineral binders and composites. Mineral and substitution additives in production of cement composites. Additions for cement composites of programmed properties. Concretes. Concrete based on cement binder. Fresh and hardened concrete. Light concretes. Ceramic and bio-ceramic		

	composites and materials. Selective inorganic membranes. Complex non-metallic catalysts. Carbon composite materials. Other non-metallic composite materials.
Recommended reading	S.K. Mazumdar, Composites Manufacturing, Material Product, and Process Engineering, CRC Press, New York, 2002.; L.W.D. Callister, Materials Science and Engineering. John Wiley & Sons, Inc., New York, 1994.; L. Hench. J.K. West, Chemical Processing of Advanced Materials, John Wiley & Sons, Inc., New York, 1992.
Supplementary reading	S.N. Ghosh, Cement and Concrete Science Technology, Vol.1., Part I, ABI Books Private Limited, New Delhi, 1991.; Application of Admixtures in Concrete, Ed. A.M. Paillere, E&FN SPON, London, RILEM, 1995.; P. Bartos, Fresh Concrete, Properties and test, Elsevier, Amsterdam, 1992.; A. Đureković, Cement, cementni kompozit i dodaci za beton, IGH i Školska knjiga, Zagreb, 1996.
Teaching methods	Lectures. Laboratory exercises. Field teaching
Assessment methods	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.

Structure and properties of inorganic non-metallic materials

Course title	Structure and properties of inorganic non-metallic materials		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Jelica Zelić, associate professor		
Learning outcomes and competences	Basic knowledge about structure and properties of inorganic non-metallic materials and methods of investigation, as important preconditions to control quality of materials of predetermined properties.		
Prerequisites			
Course contents	Crystalline and amorphous state. Basic crystallographic principles. Crystal structure. Symmetry elements. Crystal systems and symmetry. Unit cell parameters. Bases of crystal chemistry. Coordination number, Pauling's rules for ionic crystal. Theory of close packed structure. Main types of		

	crystal structure. Silicate structures. Crystal lattice defects, isomorphism, solid solutions, polymorphism. Physical, electronic, thermal and optical properties of crystal materials. The significance of the structural phases analyses in control and managing of manufacturing processes and in holding out qualities of final industrial products. Methods of structural characterization of silicates, oxides and other inorganic engineering materials. X-ray diffraction (XRD), qualitative and quantitative analyses. X-ray fluorescence spectroscopy. Infrared spectroscopy. Methods of identification of microstructure, electron microscopy and microanalysis. Methods of thermal analysis, differential thermal analysis (DTA), thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC).
Recommended reading	A.R. West, Solid State Chemistry and its Applications, John Wiley & Sons, New York, 1992.; W. Borchardt-Ott, Crystallography, 2 nd ed., Springer-Verlag, Berlin Heidelberg New York, 1995.; B. E. Warren, X-Ray Diffraction, Dover Publ., New York, 1990.
Supplementary reading	
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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Corrosion and degradation of building materials

Course title	Corrosion and degradation of building materials		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Jelica Zelić, associate professor		
Learning outcomes and competences	Familiarizing with processes of deterioration and degradation of commercial inorganic non-metallic materials, with experimental methods, and with materials protection at conditions of their exploitation in a particular environmental.		

Prerequisites	
Course contents	Structure, physical and chemical properties of building materials (concrete, reinforced concrete, natural stone, technical glasses, refractories, etc.). Factor influencing corrosion and degradation processes of compacted materials. Types of environmental aggressiveness. Classification of corrosion processes and their mechanisms in dependence of aggressive environmentals. Corrosive effect of seawater. Microbiological corrosion. Corrosion control methods. Selected examples and experimental methods in corrosion studies. Silicate glasses corrosion in water, bases and acids solutions. Corrosion of natural stone, ceramics, concrete and reinforcement at conditions of their exploitation in a particular environmental. Influence of corrosion products on structure durability of materials. Overview of the protective measures in practice. Additions for prevent the alkali-silicate reaction. Pozzolana, silica fume, fly ashes. New composite materials with improved resistance and structure durability.
Recommended reading	W.D. Callister Jr., Materials Science and Engineering: an introduction, 5 th ed. J. Wiley&Sons, Inc., New York, 1999.; P. Marcus, J. Oudar, Corrosion Mechanisms in Theory and Practice, M. Dekker, New York, 1995.; I. Biczok, Concrete corrosion, concrete protection, Akademiai Kiado, Budapest, 1972.
Supplementary reading	
Teaching methods	Lectures, laboratory exercises, field teaching.
Assessment methods	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.

Corrosion and material protection

Course title	Corrosion and material protection		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		

Name of lecturer	Dr. Maja Kliškić, associate professor
Learning outcomes and competences	This course will enable student to acquire creative approach in solving corrosion problems to which he will certainly meet in his work. Students will be introduced to fundamental principles of corrosion and corrosion protection and with basic guidelines for selection of the system for corrosion protection and evaluation of its durability.
Prerequisites	
Course contents	The definition and economic impact of corrosion. Classification of corrosion phenomenon. Chemical corrosion, thermodynamic conditions. The mechanisms and kinetics of corrosion processes. Chemical corrosion resistance. Occurrence of electrochemical corrosion. Thermodynamic conditions. The mechanism and kinetic of electrochemical corrosion process. Types of electrochemical corrosion of metals. Corrosion of inorganic materials (corrosion of concrete, concrete reinforcement, Corrosion of ceramic materials and glass in aggressive mediums). Corrosion of organic materials. Corrosion in special conditions: in atmosphere, water, seawater, soil, melt (smelt). Biocorrosion. Stray current corrosion. Corrosion investigations and standardisation of methods. Corrosion protection. Materials selection, constructional and technological measures. Intervention in corrosion medium. Electrochemical protection methods. Coatings and Linings. Protection from biocorrosion. Importance of corrosion inspection and servicing.
Recommended reading	I. Esih, Z. Dugi, Tehnologija zaštite od korozije, Školska knjiga, Zagreb 1990.; I. Esih, Osnove površinske zaštite, Fakultet strojarstva i brodogradnje Sveučilišta u Zagrebu, Zagreb, 2003.; J.R. Davis, Corrosion – understanding the basic, ASM International, 2000.
Supplementary reading	M.G. Fontana, Corrosion Engineering, McGraw Hill, New York, 1986.; W.D. Callister, Jr., Materials Science and Engineering 3 rd ed., J. Willey & Sonss, New York 1994.; R. Babolan, Corrosion Tests and Standards, Amer. Tech. Publ. Ltd. New York, 1995.; P. Marcus, J. Oudar (Eds.), Corrosion Mechanisms in Theory and Practice, M. Dekker, New York, 1995.
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: (1) University Level, (2) Faculty Level by Quality Control Committee, (3) Lecturer's Level.

Electrodeposition proceses

Course title	Electrodeposition processes
Course code	

Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Jagoda Radošević, full professor		
Learning outcomes and competences	Student will get knowledge that allowed him independently realisation and monitoring of electroplating process. With acquired knowledge he may also investigate and improve electrodeposition processes.		
Prerequisites			
Course contents	Introduction. Technological processes of production galvanic and chemical coating. Metal deposition on cathode. Electrocrystallization. Distribution of current and metal sediment on cathode. Sedimentary power of electrolyte. Preparation of specimen for metallic coatings deposition. Galvanization. Composition of bath. Material and shape of anodes for electroplating. Temperature, bath convection and current density. Current sources and facilities for electroplating. The most important processes of metal electroplating. Tin-plating in different electrolytes. Zinc-plating. Nickel-plating. Cathodic and anodic processes in deposition of nickel. Basic electrolyte components. Influence of additives on plating shining nickel. Nickel anodes. Copper plating. Chromium plating. Deposition of metallic chromium on cathode. Basic electrolyte components for chromium plating. Anodes and anode processes. Coating errors. Plating with noble metals. Manufacturing of metallic coatings by spraying with melting metal. Coatings which was produced by diffusion processes. Electroplating of non-metal substrates. Electroplating of product of porous materials. Electroforming. Mechanical preparation of model for galvanization. Galvanization in electroforming. Reinforcing of galvanic layers. Separation of galvano from model. Final treatment of galvano. Production of foils, sheets and pipes by electroforming.		
Recommended reading	W.J. Lorenz, E.B. Budevski, G.T. Staikov, Electrochemical Phase Formation and Growth: An Introduction to The Initial Stages of Metal Deposition, Germani, 1996.; O.P. Solonenko, M.F. Zhukov, Advanced Surface Coating and Hardening Technologies, Cambridge International Science Publishing, UK, 1996.		
Supplementary reading	S.F. Kistler, P.M. Schweizer, Liquid Films Coating: Scientific Principles and Their Technological Implications, Chapman and Hall, UK, 1996.; M.M. Maksimović, Galvanotehnika, Tehnološko-metalurški fakultet, Beograd, Beograd, 1995.		
Teaching methods	Lectures, laboratory exercises, field lecturing		
Assessment methods	Written and oral examination		
Language of	Croatian, English		

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.

Surface protection technology

Course title	Surface protection technology		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Maja Kliškić, associate professor		
Learning outcomes and competences	After passing the exam, student will be able to choose efficient corrosion protection system and pursue its maintenance. He will be informed in application of norms that are concern in materials surface protection.		
Prerequisites			
Course contents	Economical aspects of surface protection. Selection of protection system. Temporary and permanent protection. Surface preparation and standards. Criteria for metal coatings. Criteria for conversion coatings and enamel. Efficiency in exploitation of organic coatings and linings. Classification of coatings and linings according to type, composition and purpose. Coatings systems. Designing and performing corrosion protection system with coatings. Coatings for temporary protection. Methods for application of coatings and linings. Coating inhibitors. Inhibitor mixtures. Application of inhibitors in marine transport. Protection isolation and elimination of problems which are connected with corrosion. Servicing of corrosion protection systems. Methods for examination of quality of protection coatings and linings.		
Recommended reading	I. Esih, Z. Dugi, Tehnologija zaštite od korozije, Školska knjiga, Zagreb, 1990.; I. Esih, Osnove površinske zaštite, Sveučilište u Zagrebu, Zagreb 2003.; D.A. Jones, Principles and Prevention of Corrosion, 2 nd Ed. Prentice Hall, Upper Sadle River, 1996.		
Supplementary reading	P.S. Litzinger, Protective Coatings, in Process Industries Corrosion 1986.		
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: (1) University Level, (2) Faculty Level by Quality Control Committee, (3) Lecturer's Level.

Electrochemical methods and theirs application

Course title	Electrochemical methods and theirs application		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Senka Gudić, assistant professor		
Learning outcomes and competences	Student will acquire proficiency in knowledge that allowed him to perform electrochemistry experiment and complete the research of mechanism and kinetics of electrode processes.		
Prerequisites			
Course contents	Introduction. Electrochemical system. Electrodes and electrode materials. Electrodes and cell calibration. Instruments. Potentiostat. Galvanostat. Hydrodynamic electrodes. Limiting current at hydrodynamic electrodes. Hydrodynamic electrodes in the study of electrode processes. Rotating disc electrode and rotating ring-disc electrode. Linear potential sweep methods. Method of polarization resistance measurement. Tafel method. Cyclic voltammetry. Cyclic voltammetry on planar and spherical electrode. Cyclic voltammetry of coupled component system. Application of cyclic voltammetry. Pulse methods. Chronoamperometry. Chronocoulometry. Chronopotentiometry. Pulse voltammetry. Polarography. Other pulse methods. Application of pulse methods. Impedance methods. Detection and measuring of impedance. Faradaic impedance of simple electrode processes. Presentation of results in complex impedance plane. Complexes systems and constant phase element. Admittance. A.c. voltammetry. A.c. polarography. Application.		
Recommended reading	C.M.A. Brett and A.M. Oliveira-Brett, <i>Electrochemistry: Principles, Methods and Applications</i> , Oxford University Press, Inc., New York, 1993.; A.J. Bard and L.R. Faulkner, <i>Electrochemical Methods: Fundamentals and Applications</i> , 2nd Edition, J. Wiley & Sons, Inc., New York, 2001.		
Supplementary	H.D. Abruna (Ed.), <i>Electrochemical Interfaces: Modern Techniques for in-</i>		

reading	situ Interface Characterization, VCH Publishers, Inc., Cambridge, 1991.
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: (1) University Level, (2) Faculty Level by Quality Control Committee, (3) Lecturer's Level.

Corrosion inhibitors

Course title	Corrosion inhibitors		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Senka Gudić, assistant professor		
Learning outcomes and competences	After passing this exam, student will be able to correctly select corrosion inhibitor, which depends of material, environment, and other conditions of use and estimate its efficiency.		
Prerequisites			
Course contents	Introduction. The inhibition of corrosion of materials – electrochemical aspects. The effect of inhibitors on the electrochemical reaction kinetics. Activity mechanism of corrosion inhibitors. Adsorption processes. The effect of composition and chemical structure of organic compound on their protective properties. The role of the chemical composition of the medium in the protection of materials from corrosion. The effect of pH. Inhibitor selection for acid, neutral and alkaline solutions. Inhibition of localised corrosion. Inhibitors for atmospheric corrosion. Inhibitors for temporary protection. Use of inhibitors on steam phase. Determination of inhibitor efficiency using electrochemical and non-electrochemical techniques. Real problems of inhibition of materials corrosion. Possibilities for improving the effectiveness of inhibitors. Ecological acceptability of corrosion inhibitors of materials. Inhibitors toxicity. Possibility of replacement toxic inhibitors with new environmental friendly corrosion inhibitors.		
Recommended	Y.I. Kuznetsov, Organic Inhibitors of Corrosion of Metals, Plenum Press, New York, 1996.; E. Kalman, Routes to the Developmens of Low Toxicity		

reading	Corrosion Inhibitors in Corrosion Inhibitors, The Institute of Materials, London, 1994.; V.S. Sastri, Corrosion Inhibitors, J. Wiley & Sons, Inc., New York, 1998.
Supplementary reading	R.W. Revie (Ed.), Uhlig's Corrosion Handbook, J. Wiley & Sons, Inc., New York, 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: (1) University Level, (2) Faculty Level by Quality Control Committee, (3) Lecturer's Level.

Direct energy conversion

Course title	Direct energy conversion		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Jagoda Radošević, full professor		
Learning outcomes and competences	Students will acquire knowledge about possibilities and methods of direct energy conversion. After passing this exam they will be able to select the most useful and suitable energy converter, considering their usage. Also, obtain knowledge afford students to participate in development and researches in this science field.		
Prerequisites			
Course contents	Introduction in problem of direct energy conversion. Historical review. Primary energy sources. Limitations in exploitation of energy. State of energy conversion (review). Reasons for direct energy conversion. Principles of energy conversion. Basic definitions and units. Irreversible thermodynamics. Unique theory for energy converter. Device's classification. Equation for efficiency of conversion. Photoelectric converters. Review principles of radiation. Optical effects at semiconductors and p-n junctions. Application photoelectric effect on p-n junction in solar batteries. Construction and manufacture of converters and batteries. Thermoelectric converters. The thermoelectric effects. As solid state description of the thermoelectric effects. Energy relations in		

	thermoelectric converter. Thermionic converters. Electron work function and surface phenomena. Role of cesium in thermoionic converter. Thermodynamic analysis of a thermoionic converter. Essence of electrochemical energy conversion. Description (specification) of electrochemical systems. Thermodynamic aspects of electrochemical energy conversion. Factor of efficiency. Fuel cell. Classification of fuel cell. Fuel cell as energy converter. Review of realised systems and systems in development. Hydrogen – oxygen (air) fuel cell. Fuel cell with ion-exchangeable membrane.
Recommended reading	R. Decher, Direct Energy Conversion, Oxford University Press, New York, 1997.
Supplementary reading	A.J. Appleby, Fuel Cells: Trends in Research and Applications, Hemisphere Publishing Corporation, New York, 1987.
Teaching methods	Lectures, laboratory exercises, field lecturing
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.

Process design

Course title	Process design		
Course code			
Type of course	Lectures, seminars (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Jelena Perić, Full Professor		
Learning outcomes and competences	Students will know the basic principles and the methodology of process and process equipment design. They will also acquire knowledge of the methodology used in chemical process industry to evaluate the ultimate commercial feasibility.		
Prerequisites			
Course contents	Steps in the designing and retrofitting chemical processes. Investment decision. Cooperation designer and investor. Plant location. Methods of evaluation of optimum plant location. Chemical process research and development. Selection of process. Laboratory and pilot plant research.		

	Pilot plant and scaling studies. Process and equipment scale up. Similarity laws. Models and scale up methods in chemical engineering. Process creation. Flowsheets. Synthesis and optimum process structure. Principles of flowsheet simulation. Industrial chemical engineering equipments. Equipment sizing. Optimum size capacity. Preliminary process appraisal costs. Investment cost. Production and maintenance costs. Profitability analysis. Selection of equipment for unit operations and processes. Selection of construction material. Detailed design. Plant layout. Ancillary materials and equipments. Power supply. Water supply. Environmental protection. Engineering ethics.
Recommended reading	Waren D. Seider et al., Process Design Principles, John Wiley & Sons Inc., New York, 2004; R. Smith, Chemical Process Design, McGraw-Hill, New-York, 1995; F. Šef and Ž. Olujić, Projektiranje procesnih postrojenja, SKTH/Kemija u industriji, Zageb, 1988.; E. Beer, Priručnik za dimenzioniranje uređaja kemijske procesne industrije, HDKI/Kemija u industriji, Zagreb, 1994.; M. S. Peters and K. D. Timmerhaus, Plant Design and Economics for Chemical Engineers, McGraw-Hill, New York, 2003.
Supplementary reading	R.H. Perry et al., Perry's Chemical Engineer's Handbook, 7 th edition, McGraw-Hill, New York, 1997; James M. Douglas, Conceptual Design of Chemical Processes, McGraw-Hill, New York, 1988.
Teaching methods	Lectures; seminar tasks (synthesis and simulation of selected processes, equipment sizing, economic evaluation....). The seminars are arranged in groups or individually, with the use of computers.
Assessment methods	Oral examination, seminar presentations
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.

Marine and submarine mineral raw materials

Course title	Marine and submarine mineral raw materials		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	basic level course		
Year of study	2 nd year of graduate study	Semester	IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Vanja Martinac, associate professor		

Learning outcomes and competences	Students acquire knowledge of marine and submarine mineral resources and their exploitation.
Prerequisites	
Course contents	Minerals expected in beach deposits. Submerged beaches. Beaches being exploited now and exploration methods. Mineral raw materials from sea water. Extraction of minerals from seawater: NaCl, magnesium compounds, bromine, gold etc. Production of minerals in conjunction with the desalination of sea water. New technologies for mineral extraction from the sea. The concentration of elements by marine organisms. Superficial deposits of the continental shelf. Phosphate deposits-distribution and exploration. Other minerals on the continental shelves - glauconite, barium sulphate, organic sediments, etc. Sediments of the ocean floor. Pelagic sediments. Calcareous and siliceous oozes, red clay and other minerals. Manganese nodules. Physical characteristic of the nodules, methods of exploration, concentration of Mn, Co, Ni, Cu, etc. Associated sediments. Effect of ocean-floor currents and animals. Mining of superficial sediments from the ocean floor. Economic aspects of ocean mining. The manganese nodules as a mineral resource. Legal problems involved in ocean mining – law of the sea.
Recommended reading	Handbook of Marine Mineral Deposits by D.S. Cronan (Editor), CRC Press, Boca Raton, 2000.; F.J. Millero, Chemical Oceanography, 2 nd Ed., CRC Press, Boca Raton, 1996.; E. Brown et al., Seawater: Its compositions, properties and behaviour, Butterworth Heinemann in association with The Open University, 2 nd Ed., Walton Hall, Milton Keynes, 1997.; H. Rabia, J.P. Levy, Delineation of Mine-sites and Potential in different Sea areas, In Seabed Minerals Series, Vol. 4., Kluwer Academic Publishers, Netherlands, 1987.
Supplementary reading	E.D. Brown, Seabed Energy and Mineral Resources and the Law of the Sea, Crane Russak & Co, 1985.
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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Solid waste and recycling

Course title	Solid waste and recycling
Course code	

Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Maja Kliškić, associate professor		
Learning outcomes and competences	After passing this exam students are competent to do planning, researching or be technical chairman in industry and national institutions with knowledge of ecologic and recycling possibilities of material.		
Prerequisites			
Course contents	Introduction. Energy, economics, ecology. Solid waste definition and relationship to other harmful substances. Structure and physical-chemistries characteristic of land. Transmission of harmful substances through land. Types and diffusion of solid waste: urban, industrial, agriculture waste, mining waste. General, physical and chemical parameters of solid waste. Handling with solid waste, sanitary and safety measures. Collecting, transport and mechanical treatment of solid waste: sanitary disposal, composting, heat treatment. Devices. Materials supply from solid waste: direct recycling, recycling systems. Energy supply from solid waste: solid waste as second fuel, heat and electric energy supply. Biogas. Using and processing of some components of solid waste: iron and steel, aluminium and alloys, cuprum, zinc, nickel and alloys, plumbum. Processing and stabilization of waste from mining. Using the refuse paper and textile industry waste. Processing and using the refuse rubber. Processing of agroindustry and agriculture waste. Neutralization of wrapping of pesticides.		
Recommended reading	H.D. Sharma, S.P. Lewis, Waste Containment Systems, Waste Stabilization and Landfills, J. Wiley & Sons, New York, 1994.; B.J. Alloway, D.C. Ayres, Chemical Principles of Environmental Pollutions, Blackie Academic & Profesional, Glasgow, 1994.		
Supplementary reading	W. Petruk, Waste Characterization and Treatment, Society for Mining Metallurgy and Exploration, Montreal, 1998.; D.G. Wilson, Handbook of Solid Waste Management, Van Nostrad Reinhold Comp. New York, 1977.; Stručni i znanstveni časopisi (Industry and Environment- UNEP).		
Teaching methods	Lectures, laboratory exercises, field lecturing		
Assessment methods	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.		

Wastewater engineering

Course title	Wastewater engineering		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	IV.
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. Jelena Perić, full professor		
Learning outcomes and competences	Students will acquire knowledge in the field of wastewater engineering. They will know the sampling techniques and the techniques of valuation of wastewater quality parameters required for the selection of appropriate treatment procedure and appropriate calculation procedure for process equipment capacity.		
Prerequisites			
Course contents	Water in the biosphere. Hydrologic cycle. Natural water quality. Water quality management. Water and sustainable. Definition of water pollution and contamination. Source and classification of pollutants. Source of wastewaters. Municipal and industrial wastewater characteristics. Sampling methodology. Methodology of research and control of industrial wastewaters. Specific and nonspecific parameters. Wastewater treatment systems. Pretreatment, primary treatment, secondary treatment, tertiary treatment. Coarse solids removal. Separation of grease and oil. Separation of settleable suspended matter. Colloidal systems. Stability and destabilization of colloids. Coagulation and flocculation in wastewater treatment. Biological wastewater treatment. Microbial metabolism parameters. Microorganism types. Aerobic and anaerobic processes. Biological nitrogen and phosphorus removal processes. Biological reactors. Biological sludge. Sludge treatment and disposal. Physicochemical unit processes: adsorption, ion exchange, aeration, neutralization, chemical precipitation, chemical oxidation and reduction, membrane processes. Wastewater treatment procedures and equipment. Design of facilities for physical and chemical treatment of wastewater.		
Recommended reading	Metcalf & Eddy Inc., Wastewater Engineering: Treatment, Disposal and Reuse, McGraw-Hill Inc., Boston, 1991; S. Tedeschi, Zaštita voda, HDGI, Zagreb, 1997.; A. P. Sincero and G. A. Sincero, Physical-Chemical Treatment of Water and Wastewater, CRC Press, New York 2002.		
Supplementary reading	L. D. Benefield, J.F. Judkins, B. L. Weand, Process Chemistry for Water and Wastewater Treatment, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1982.		
Teaching methods	A lecture, seminar tasks, laboratory exercises, visits to facilities for wastewater treatment.		

Assessment methods	Oral examination, seminar presentations
Language of 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.

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	1 st year of graduate study	Semester	I.
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 organisation, 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 <i>Monocotyledons</i> , <i>Dicotyledons</i> and <i>Gymnosperm</i> . Morphology of vegetative and reproductive organs, sexual and asexual reproduction. Evolution of <i>A vertebrata</i> and <i>Vertebrata</i> .		
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.; K. Magdenfrau, i F. Ehrendorfer: Botanika (Sistematika, evolucija i geobotanika), Školska knjiga, Zagreb, 1997.; I. Matoničkin i R. Erben: Opća zoologija, Školska knjiga, Zagreb, 1994.		
Teaching methods			
Assessment methods	Written and oral examination		
Language of			

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.

Biochemistry

Course title	Biochemistry		
Course code			
Type of course	Lectures, seminars, laboratory exercises (60+15+30)		
Level of course	basic level course		
Year of study	1 st year of graduate 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	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			
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, 5 th 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 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.

General microbiology

Course title	General microbiology		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Basic level		
Year of study	1 st year of graduate study	Semester	II.
ECTS (Number of credits allocated)	5.5 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			
Course contents	An Introduction to Microbial Life. The Diversity of Microorganisms. Functional Anatomy of Prokaryotic and Eucaryotic Cells. Comparing Prokaryotic and Eucaryotic Cells. Structure and Function of Prokaryotic 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, Zagreb (Udžbenici Sveučilišta u Zagrebu), 1996.; S. Duraković, Primijenjena mikrobiologija, Prehrambeno-tehnološki inženjering, Zagreb (Udžbenici Sveučilišta u Zagrebu), 1996.		

Supplementary reading	R.M. Mayer, I.L. Pepper and 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. Exam: written after main chapter and oral at the end of teaching process.
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.

Essentials of ecology

Course title	Essentials of ecology	
Course code		
Type of course	Lectures, seminars (45+15)	
Level of course	Basic level	
Year of study	1 st year of graduate study	Semester II.
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. Mladen Šolić, associate professor	
Learning outcomes and competences	Understanding the relationship between organisms and their environment is essential for understanding all the life processes on the Earth, evolution of life and changes in its diversity on spatial and temporal scale. Students will gain theoretical background in fundamental ecological principles as well as knowledge necessary for sustainable exploitation of the living resources on the Earth.	
Prerequisites		
Course contents	Introduction: Definition of ecology, Life and physical environment. Physiological ecology: Adaptations to physical environment, Response to variation in the environment, Biological factors in environment. Ecosystem ecology: The ecosystem concept, Trophic levels in ecosystem, Production and energy flow in ecosystems, Pathways of elements in the ecosystems, Nutrient regeneration in ecosystems. Population ecology: Population structure (spatial and age structure), Population dynamic (population growth, population regulation, population fluctuation and cycles), Life history. Population interactions: Competition, Resources and consumers, Predation, herbivory and parasitism. Mutualism. Coevolution. Community ecology: The concept of the community, Structure of the community,	

	Community development. Biodiversity.
Recommended reading	M.Šolić, Osnove ekologije, http://www.izor.hr/hr/nastava/osnove_ekologije/OE_prez.html ; M. Begon, J.L. Harper and C.R. Townsend: Ecology: Individuals, Populations and Communities, 3 rd edn. Blackwell, London, 1996.; Ricklefs, R.E. Ecology. W.H. Freeman and Company, New York, 1990.
Supplementary reading	S.I. Dodson et al., Ecology. Oxford University Press, 1998.; J.R. Krebs and N.B. Davies: 3An Introduction to Behavioural Ecology, 3 rd edn. Blackwell Scientific Publication, Oxford, 1993.
Teaching methods	Regular weekly classes or block classes. Lectures, power-point presentations, video presentations, class discussions, group projects and demonstration methods
Assessment methods	Class participation, homework assignments, papers, written quizzes, and final exam
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.

Environmental chemistry

Course title	Environmental chemistry		
Course code			
Type of course	Lectures, seminars, laboratory exercises (45+15+30)		
Level of course	basic level course, advanced level course		
Year of study	1 st year of graduate study	Semester	II.
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. Sulfur. 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 sa 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, 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.

Environmental engineering

Course title	Environmental engineering		
Course code			
Type of course	Lectures, seminars, laboratory exercises (45+15+30)		
Level of course	Advanced level course		
Year of study	1 st year of graduate study	Semester	II.
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. Nenad Kuzmanić, associate professor		
Learning outcomes and competences	Students will be acquainted with the basic principles and application of unit operations of chemical engineering in environmental protection. This knowledge is indispensable for systematic approaches to the solution of problems relate the waste substances treatments.		
Prerequisites			
Course contents	Chemical engineering role in environmental protection. Unit operations in		

	environmental engineering. Mechanical separation. Effectiveness of separation. Product purity and yield. Separation based on the motion of particles through fluids. Gravity settling processes. Equipments for sedimentation. Centrifugal settling processes. Principles of centrifugal sedimentation. Sedimenting centrifuges. Hydrocyclones. Flotation. Plants for natural and generated flotation. Gas-solids separations. Dry collectors: filters for gas cleaning, cyclones, electrofilters. Wet collectors - scrubbers. Adsorption – principles and equipments. Membrane processes for separation of gaseous and liquid mixtures. Membrane structure. Flow patterns in membrane separators. Ultrafiltration. Electrodialysis. Reverse osmosis.
Recommended reading	W.L. McCabe, J.C. Smith, P. Harriott, Unit Operations of Chemical Engineering, McGraw-Hill, 6 th edition, New York, 2000.; T.D. Reynolds, P. Richards, R. Reynolds, Unit Operations and Processes in Environmental Engineering, Brooks Cole, New York, 1995.; M. Hraste, Mehaničko procesno inženjerstvo, HINUS, Zagreb, 2003.; R.H. Perry, D.W. Green, J.O. Maloney, Perry's Chemical Engineer's Handbook, 7 th edition, Mc Graw-Hill, New York, 1999.
Supplementary reading	S. Tedeschi, Zaštita voda, Sveučilište u Zagrebu, Zagreb, 1997.; V. Koharić, Mehaničke operacije, Sveučilište u Zagrebu, Zagreb, 1996.; H.S. Peavy, D.R. Rowe, G. Tchobanoglous, Environmental Engineering, McGraw-Hill Book Co., New York, 1985.; E. Beer, Priručnik za dimenzioniranje uređaja kemijske procesne industrije, HDKI/Kemija u industriji, Zagreb, 1994.
Teaching methods	Seminars and laboratory exercises thematically follow the lectures. Seminars include methods for organizing known information about process variables, setting up material and energy equations relate to unit operations in environmental engineering. The exercises involve the practical work in semi industrial-scale laboratory. The visits to industrial plants, which apply waste substances treatments, are planed as well.
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.

Marine chemistry

Course title	Marine chemistry
Course code	
Type of course	Lectures, seminars, laboratory exercises (30+15+15)
Level of course	Basic level course

Year of study	2 th year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 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. Dissolved Gases in Sea Water. The Micronutrient Elements in the Sea. Marine Life. Primary and Secondary Productivity. Marine Pollution: A Definition. Sources and Types of Marine Pollutants. Domestic Sewage. Petroleum. Thermal Pollution. Radioactive Wastes. Pesticides. Effects of Marine Pollutants. Persistent Organic Compounds. Biodegradable Organics. Pathogens. Nutrients. Heavy 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. Riley, 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 Pollution, 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		
Assessment methods	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.		

Marine pollution

Course title	Marine pollution	
Course code		
Type of course	Lectures, seminars (30+15)	
Level of course	Advanced level course	
Year of study	2 nd year of graduate study	Semester III. or Iv.
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. Ante Barić, full professor	
Learning outcomes and competences		
Prerequisites		
Course contents	The following issues are included within the course: What is pollution? Sources of marine pollution (urban wastewater, industrial wastewater, run-off from agricultural and public surfaces, river inputs, radioactive waste, atmospheric fallout, waste from ships). Impacts of pollutants on the marine ecosystem (persistence in the marine environment, toxicity and other harmful effects, accumulation in organisms and sediments, biological transformations which create harmful substances, impacts on dissolved oxygen). Biomonitoring, bioindicators and biomarkers. Characteristics of specific pollutants (organic matter, metals, crude oil and oil products, persistent organic pollutants (POPs) biologically non-degradable detergents and other surface active substances, radioisotopes, solid waste, plastics, heat). Impacts of mariculture on marine environment.	
Recommended reading	R.B. Clark, Marine Pollution, (Fifth Edition), Clarendon Press, Oxford, 2001.; E.A. Laws, Aquatic Pollution, An Introductory Text (Third Edition). Willey Intersci. Publ., New York, 2000.	
Supplementary reading	Selected articles from Scientific journals	
Teaching methods	Lecturing and home works	
Assessment methods	Tests during the course and a oral exam at the end of the course	
Language of instruction	Croatian, possibility of English in a part of lectures and at the exam	
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.	

Aquatic chemistry

Course title	Aquatic chemistry		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+15)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 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	Competition acquired by courses Analytical chemistry, Physical chemistry		
Course contents	Introduction. The Solvent Water. Acids and Bases of Water. Buffer Intensity and Natural Capacity. Dissolved Carbon Dioxide in Water. Distribution $\text{CO}_3^{2-}/\text{HCO}_3^-$. 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.		

Microbiology of polluted waters

Course title	Microbiology of polluted waters	
Course code		
Type of course	Lectures, seminars, laboratory exercises (30+15+15)	
Level of course	Advanced level course	
Year of study	2 nd year of graduate study	Semester III. or IV.
ECTS (Number of credits allocated)	5.0 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	Students will have competences in microbiological pollution sources in the water environments and how microbiological pollution, as an ecological factor, influences the environmental changes.	
Prerequisites	Competence acquired by courses: General Microbiology	
Course contents	Introduction to microbiological pollution of water environments. A pollution Sources. Microorganisms which are actual or potential pathogens: Pathogenic bacteria, Viruses, Pathogenic Fungi, Algal Biotoxins. Monitoring of the sanitary quality of water. Faecal pollution indicators. Quality Criteria and Standards. Survival of alohtonic microorganisms in water environments. Accumulation of alohtonic microorganisms in organisms. Determination of faecal pollution indicators in the waters and organisms (shellfish). Microbiological pollution as an ecological factor influencing the environmental changes.	
Recommended reading	N. Krstulović, I M. Šolić, Alohtoni mikroorganizmi u moru, Skripta, 2004.; S. Duraković, Primijenjena mikrobiologija, Prehrambeno-tehnološki inženjering, Zagreb (Udžbenici Sveučilišta u Zagrebu), 1996.; Pike E.B., Gale, P. & Bryan J.J. Health risks of freshwater and the development of microbial standards. Water research Centre Report, London, 1989.	
Supplementary reading	UNEP/WHO: Assessment of the state of pollution of the Mediterranean sea by pathogenic microorganisms, Coordinating Unit for Mediterranean Action Plan, Athens 1991.	
Teaching methods	Combined teaching methods: frontal lectures, using modern technologies.	
Assessment methods	Written and oral examination	
Language of instruction	Croatian, 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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Environmental management system

Course title	Environmental management system		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+15)		
Level of course	Basic level		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Student will be introduced to the chemistry of the most important flavours, their synthesis pathways, isolation and usage.		
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 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, methods 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 management 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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Atmospheric chemistry

Course title	Atmospheric chemistry		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+15)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 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 (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 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, Edward Arnold, London, 1975.; S.S. Butcher, R.J. Charlson, An Introduction to Air Chemistry, Academic Press, New York, 1972.; L. Mewman, Measurement Challenges 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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Plastics and the environment

Course title	Plastics and the environment		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+15)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 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	Students are qualified for development of the environmentally optimal polymerisation processes, as well as for the total evaluation of polymers sustainability in the environment.		

Prerequisites	
Course contents	Basic principles of polymer chemistry. Plastics and the environment, global and local concerns. Common polymers (polyethylenes, polypropylene, poly(vinyl chloride), polystyrene, poly(ethylene terephthalate)). Control and suppressions of emissions in polymerization processes. Improvement of polymerization process on a "green" chemistry basis. Polymers and energy. Environmental effects on polymers (solar radiation, temperature, moisture, oxygen, atmospheric pollutants). Degradation mechanisms of polymers. Stabilization of polymers against environmental effects. Environmental weathering tests. Laboratory-accelerated weathering tests. Biodegradable polymers from renewable resources and petroleum-derived products. Biodegradable water-soluble polymers. Plastics in the marine environment. Test methods for biodegradable polymers. Flammability and combustion of polymers. Combustion mechanisms. Hazardous emissions from thermal destruction of plastics. Combustion testing methods.
Recommended reading	A.L. Andrady, Plastics and the Environment, John Wiley and Sons, Inc., New Jersey, 2003.; J.D. Hamilton and R. Sutcliffe, Ecological Assessment of Polymers, Van Nostrand Reinhold, New York, 1997.; Articles from scientific and professional journals.
Supplementary reading	A. Azapagic, A. Emsley, I. Hamerton, Polymers, the Environment and Sustainable Development, John Wiley & Sons Ltd, Chichester, 2003.; W. Tötsch and H. Gaensslen, Polyvinylchloride Environmental Aspects of a Common Plastics, Elsevier Science Publishers Ltd, Barking, 1992.
Teaching methods	Lectures, problem solving, laboratory and field exercises.
Assessment methods	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.

Ionised radiation in the biosphere

Course title	Ionised radiation in the biosphere		
Course code			
Type of course	Lectures, seminars (30+15)		
Level of course	Advanced level course		
Year of study	1 st year of graduate study	Semester	III. or IV.
ECTS (Number of	4.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		

credits allocated)	
Name of lecturer	Dr. Mile Dželalija, associate professor
Learning outcomes and competences	Competences in understanding of the basic properties of nuclei, and radioactivity. Understanding of nuclear fission and its application in nuclear power reactors. Understanding the role of nuclear physics in environmental radiation protection, especially in the biosphere.
Prerequisites	
Course contents	Introduction. Structure of nuclei. Radioactivity. Accelerators. Nuclear energy. Power from nuclear fission. Nuclear fusion. The passage of energetic particles through matter. Radiation in the environment. Radiation damage. Radioactivity in the natural environment. Radiation doses. Effects of low and large doses. Nuclear reactor accidents. Radiation protection. Radiation risks. Selected measurements.
Recommended reading	M. Dželalija, Ionizirajuće zračenje u biosferi (in preparation), University of Split, 2005.
Supplementary reading	M. Eisenbud, Th. Gesell, Environmental Radioactivity: From Natural, Industrial and Military Sources, 4 th edition, Academic Press, San Diego, 1997
Teaching methods	Combined teaching methods: frontal lectures, work in groups, using modern technologies.
Assessment methods	Assessments during lectures. Exam: written (analytical problems) and oral (understanding the role of nuclear physics in environmental radiation protection, especially in the biosphere).
Language of instruction	Croatian, English
Quality assurance methods	At the beginning and at the end of the teaching process: questionnaires about learning outcomes and competences, and about the course.

Ecotoxicology

Course title	Ecotoxicology		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Basic level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of	Dr. Jasna Maršić Lučić, assistant professor		

lecturer	
Learning outcomes and competences	Gaining theoretical and practical knowledge on directly and indirectly effect of toxic substances on nature and their interactions.
Prerequisites	
Course contents	History of ecotoxicology. Xenobiotics, poissone and poisonousness. Detoxycations. Physiological classification of the toxicants. Pathophysiological effects of poisoning. Absorbtion and distribution of toxicant in human body. Bioaccumulation, bioconcentration and biodegradation. Biodinamics. Biochemical mechanisms of toxicity. Bioaccumulation and bioconcentration in marine organisms. Transport mechanisms in the environment.
Recommended reading	V. Srebočan, Veterinarska toksikologija, Medicinska naklada, 1993.; M.A. Kamrin, Toxicology : a primer on toxicology principles and applications, Lewis publishers, 1988.
Supplementary reading	C.H. Walker, S.P. Hopkin, R.M. Sibly and D.B. Peakall, Principles of ecotoxicology, Taylor & Francis publ. 1997.
Teaching methods	Lecture. 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.

Soil chemistry

Course title	Soil chemistry		
Course code			
Type of course	Lectures, seminars and laboratory exercises (30+15+15)		
Level of course	Advanced level course		
Year of study	2 st year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer			
Learning	Course introduces students with basic understanding of soil chemical		

outcomes and competences	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 chemical analyses of soil.
Prerequisites	
Course contents	Introduction to soil science. Soil solid phase - mineral and organic components. Soil solution phase - chemical principals, soil solution characteristics, precipitation and dissolution processes. Soil/Solution interface. Surface exchange reactions. Soil acidity. Electrochemistry and the soil - soil redox potential and some practical implementations. Colloidal properties. Soil fertility. Pollution problems.
Recommended reading	D.L. Sparks, Environmental Soil Chemistry, 2 nd 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.
Supplementary 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, 2 nd edition, Allyn and Bacon, Massachusetts, 1989.
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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Processes of solidification and stabilization

Course title	Processes of solidification and stabilization		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		

Name of lecturer	Dr. Petar Krolo, full professor
Learning outcomes and competences	Basic knowledge of processes of solidification and stabilisation, as well as practical basics for disposal of most frequent harmful substances by appropriate binding materials. Knowledge is acquired for application of methods of examination of successfulness of stabilisation processes.
Prerequisites	
Course contents	Basics of the solidification and stabilisation processes for permanent disposal of specific hazardous substances in an ecologically acceptable manner. Processes of solidification, physical and chemical processes, Processes of stabilisation. Types of hazardous substances and selection of appropriate matrices according to the type of impurity. Solidification and stabilisation of soil with impurities. Disposal of industrial hazardous substances; slurry and salts, organic harmful substances, powdery harmful substances, hospital waste, slag and ashes, etc. Possibilities of development of composite materials based on solidified hazardous additions and application in civil engineering. Methods of examination of successfulness of solidification and stabilisation. Static and dynamic examinations of rinsing of solidified materials and analysis of elutes.
Recommended reading	S.S. Suthersan, Remediation Engineering Design Concepts, CRC Press, New York, 1999.; F.H. Chen, Soil Engineering: Testing, Design, and Remediation, CRC Press, London, 2000.; H.O. Chang (ed.), Hazardous and Radioactive Waste Treatment Technologies, CRC Press, New York, 2001.; M.J. Culliane, L.W. Jones, Ph.G. Malone, Handbook of stabilization and solidification of hazardous wastes, U.S. Environmental Protection Agency, Cincinnati, 1986.; I. Liu, Environmental Engineers' Handbook, CRC Press, New Jersey, 1999.
Supplementary reading	TCLP – Test metode 1311, U.S. Environmental Protection Agency, Cincinnati, 1992.; B.J. Alloway, Heavy Metals in Soils, Blackie Academic & Professional, London, 1995.
Teaching methods	Lectures. Laboratory exercises. Field teaching.
Assessment methods	Oral examination
Language of instruction	Croatian, English, German
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.

Corrosion and environment

Course title	Corossion and environment
Course code	
Type of course	Lectures, laboratory exercises (30+30)

Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Maja Kliškić, associate professor		
Learning outcomes and competences	After passing this exam students will acquire knowledge about corrosion processes and their impact on environment. Also, they will be able to examine possibilities in application of less damaging methods and corrosion protective agents.		
Prerequisites			
Course contents	Ecological and economical importance of material's protection from corrosion. Causes and types of corrosion processes and their impact on environment. Corrosion caused damages. Evaluation of impact of corrosion processes on environment and state of environment before establishing system of protection. Methods of corrosion protection which effect negatively on ecological system. Environmental friendly corrosion inhibitors (problems of toxic inhibitors). Application and examination of non-toxic corrosion inhibitors. Problem of sacrificial anodes in cathodic protection. Toxic additives in protective organic coatings. Corrosion caused ecological problems in a different branches of the industry. Evaluation of a possibilities in application of less damaging methods and corrosion protective agents.		
Recommended reading	H.H. Uhling, R.W. Revie, Corrosion and Corrosion Control. John Wiley and Sons, Inc., New York, 1985.; R.P. Roberge, Handbook of Corrosion Engineering, McGraw-Hill, New York, 2000.; Y.I. Kuznetsov, Organic Inhibitors of Corrosion of Metals, Plenum Press, New York, 1996.		
Supplementary reading	K. J. Naughton, Controlling Corrosion in Process Equipment, McBroaw Hill book Comp., New York, 1980.		
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: (1) University Level, (2) Faculty Level by Quality Control Committee, (3) Lecturer's Level.		

Recycling of plastics

Course title	Recycling of plastics
Course code	

Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
ECTS (Number of credits allocated)	5.0 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	Knowledge about economic stewardship with plastic waste at the environmentally optimal level.		
Prerequisites			
Course contents	Basic principles of polymer molecules, polymers and polymeric materials. Mechanisms of degradation/depolymerization. Polymers and sustainable development. Life cycle stages of plastics. Environmental impacts by plastic production stage. Environmental aspects of polymer additives. Global consumption of polymers and environmental impacts by using stage of plastic products. Plastic waste categories, marking of plastic products. Plastic waste recycling and sustainable development. Mechanical recycling. Primary and secondary recycling. Homogeneous and heterogeneous (mixed) plastic waste. Compatibility of polymers. Overview of plastic recycling technology. Sorting, size reduction, removal of non-plastic materials. Plastic-plastic separation. Physical separation, dry methods, wet methods, surface-property based separation methods. Chemical separation. Plants for homogeneous and heterogeneous plastic waste mechanical recycling. Recycling of thermosets and elastomers. Energy recovery. Chemical recycling. Solvent-based recovery. Biodegradation. Performance of plastic waste in land and in compost. Life cycle assessment (LCA). Life cycle analysis of recycled plastic waste.		
Recommended reading	M. Šercer, D. Opsenica, G Barić, Oporaba plastike i gume, mtg topograf d.o.o., Velika Gorica, 2000.; A. Azapagić, A. Emsley; I. Hamerton, Polymers, the Environment and Sustainable Development, John Wiley & Sons Ltd, Chichester, 2003.		
Supplementary reading	L. Lundquist, Y. Leterrier, P. Sunderland, J.E. Manson, Life Cycle Engineering of Plastics, Elsevier Science Ltd, Oxford, 2000.; A.L. Andrady, Plastics and the Environment, Wiley-Interscience, New Jersey, 2003.; A.L. Bisio, M. Xantos, How to Manage Plastics Waste, Carl Hanser Verlag, New York, 1995.; Articles from scientific and professional journals.		
Teaching methods	Lectures. Laboratory exercises.		
Assessment methods	Oral examination.		
Language of instruction	Croatian, English.		
Quality assurance	Quality assurance will be performed at three levels:		

methods	(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.
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Nanotechnology and environment

Course title	Nanotechnology and environment		
Course code			
Type of course	Lecture, seminars (30+15)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III. or IV.
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. Magdi Lučić Lavčević, assistant professor		
Learning outcomes and competences	The knowledge of fundamentals of nanotechnology and its applications related to environment; the knowledge of nanotechnology-based methods used in monitoring, protecting and remediation of environment.		
Prerequisites			
Course contents	Nanoparticles, nanomaterials and nanotechnology. The use of nanotechnology in environment. The possible influence of nanotechnology on the environment. Toxicology and biological interactions of nanomaterials. Geochemistry of nanoparticles in air and water. Metrology for nanomaterials. Sensors for biological and chemical parameters of environment, based on nanotechnology. Production of «green energy» based on nanotechnology. Nanocatalysts. Treatment of pollution in water and gases.		
Recommended reading	Introduction to nanoscale science and technology, M. Di Ventra et al. (Eds.), Springer-Verlag, 2004; Chemical and biological sensors, A. Mulchandani (Ed.), Oxford University Press, 2000.		
Supplementary reading	Nanostructured catalysts, S.L. Scott (Ed.), Springer-Verlag, 2003.		
Teaching methods	Lectures, seminar designed for individual student projects on selected topics.		
Assessment methods	Oral presentation, 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.		

Energy and development

Course title	Energy and development		
Course code			
Type of course	Lectures (30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	IV.
ECTS (Number of credits allocated)	2.0 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 supplies), its influence on environmental 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, energy resources, energy supplies, 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 liquefaction 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 supplies, influence on environmente. Solar energy: conversion in heat energy (active and passive solar systems, solar furnaces, solar-electric power plants), photovoltaic conversion (photovoltaic 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 methods	Quality assurance will be performed at three levels: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Water technology

Course title	Water technology		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+30)		
Level of course	Advanced level course		
Year of study	1 st year of graduate study	Semester	I.
ECTS (Number of credits allocated)	5.5 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Jelena Perić, full professor		
Learning outcomes and competences	Students get to know the water conditioning in food processing and chemical industry, as well as methods of technological wastewater treatments.		
Prerequisites			
Course contents	Water in nature. Physicochemical water properties. Water quality. Using water for specific purposes. Water in industry. Water as raw material, boiler feed water, cooling water, washing water and wastewater. Water in the food industry. Quality requests. Water conditioning. Sedimentation, chemical clarification, filtration and degasification. Removal of iron and manganese. Disinfection of water. Removal of hardness by chemical precipitation processes. Water softening and deionisation by ion exchange processes. Ion exchangers. Mechanism and kinetics of ion exchange. The advanced methods of water conditioning: electrodialysis, ultrafiltration, reverse osmosis, membrane techniques. Mechanical, physicochemical and biological wastewater treatment methods. Pollution and contamination of natural waters. Classification of natural waters and coastal seas. The legislation for wastewater disposal into natural recipients.		
Recommended reading	A.P. Sincero and G.A. Sincero, Physical-Chemical Treatment of Water and Wastewater, CRC Press, New York, 2002; S. Tedeschi, Zaštita voda, HDGI, Zagreb, 1997.; A.M. Wachinski and J.E. Etzel, Environmental Ion Exchange, Lewis Publishers, New York, 1997.		

Supplementary reading	L.D. Benefield, et al., Process Chemistry for Water and Wastewater Treatment, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1982; W. Stum and J.J. Morgan, Aquatic Chemistry, John Wiley & Sons Inc., New York, 1996.
Teaching methods	Lectures, seminar tasks, laboratory exercises, visits to facilities for conditioning of water and wastewater treatment.
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.

Biotechnological processes

Course title	Biotechnological processes		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+30)		
Level of course	Basic level course		
Year of study	1 st year of graduate study	Semester	I.
ECTS (Number of credits allocated)	5.5 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 basic biotechnological processes and application possibilities of biological materials in industrial processes.		
Prerequisites			
Course contents	Definition, scope and importance of biotechnology. Scheme of the biotechnological process. Bioreactor. Biocatalysts (application of enzyme catalysis, immobilized enzymes). Biosensors. Fermentation. Kinetics of fermentation processes: enzyme catalysed reactions, microbial reactions. Yeasts, alcoholic fermentation (beer, wine, bread). Fermentation by lactic acid bacteria. Anaerobic biomass fermentation. Bio-preservation of food. Miscellaneous microbial derived products that improve nutrition values of food: vitamins, antibiotics, amino acids and sweeteners. Microorganisms as food. Biological fuel generation. Biotechnological perspectives in polymer industry, mining industry, environmental protection.		
Recommended reading	S. Prentis, Biotehnologija, Školska Knjiga, Zagreb, 1991; J. E. Smith, Biotechnology, Cambridge University Press, Cambridge, 2000, A. Scragg, ed. Biotechnology for Engineers-Biological Systems in Technological		

	Processes, Ellis Horwood LTD, Chichester, 1988.
Supplementary reading	Lj. Tratnik, Mlijeko - tehnologija, biokemija i mikrobiologija, Hrvatska mljekarska udruga, Zagreb, 1998; T. Lovrić, Procesi u prehrambenoj industriji s osnovama prehrambenog inženjerstva, Hinus, Zagreb, 2003.
Teaching methods	Lectures. Seminars. Laboratory exercises. Visits to industrial plants.
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.

Unit processes in food industry

Course title	Unit processes in food industry		
Course code			
Type of course	Lectures, seminars, exercises (30+15+30)		
Level of course	Advanced level course		
Year of study	1 st year of graduate study	Semester	I.
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. Višnja Katalinić, assistant professor		
Learning outcomes and competences	Being familiar with and able to conduct processes in food industry as well as understanding processes and product development; acquiring basic knowledge necessary to perform experimental scientific work in the field of food technology and engineering.		
Prerequisites			
Course contents	History of Food industry; Unit processes in Food industry; Food classification and characterization; Major physical and thermophysical properties; Food spoilage; Kinetics of degradation changes; Principles of food stability, preservation and safety; Food preservation by application of heat (Blanching; Pasteurisation; Heat sterilization); Food preservation through temperature reduction (Chilling; Freezing); Food packing and preservation in controlled atmosphere; Food preservation through water removal (Evaporation; Drying); Concentration processes (Membrane processes; Freezing concentration); Biological processes; Preserving by chemical additives; Chemical processes in food technology; "Minimal processing" principles and novel food processing; Mechanical and physical processes; Extrusion-cooking; Extraction processes in Food industry; Food emulsions; Complete process lines; Current issues and		

	trends in Food industry. Laws and regulations that govern the Food industry.
Recommended reading	T. Lovrić, Procesi u prehrambenoj industriji s osnovama prehrambenog inženjerstva, Hinus, Zagreb, 2003.; P. Fellows, Food Processing Technology, 2 nd edition, CRC Press, Boca Raton, 2000.; M.S. Lewis, Physical properties of Foods and Food Processing Systems, VCH Publishers, 1987.; K. J. Valentas, E. Rotstein and R.P. Singh, Handbook of food engineering practice, CRC press, 1997.
Supplementary reading	D.R. Heldman and R.W. Hartel, Principles of food processing, Chapman and Hall, 1997; J. Larousse and B. Brown, Food canning technology, Wiley-VCH Inc., 1997.; M. Cheryan, Ultrafiltration and Microfiltration Handbook, Technomic Publishing Inc; Lancaster, 1998.; N.N. Potter, Food science, 5 th edition, Chapman&Hall, 1995.
Teaching methods	Lectures. Seminars. Plant tours/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.

Hygiene and sanitation

Course title	Hygiene and sanitation		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15+30)		
Level of course	Advanced		
Year of study	1 st year of graduate 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. Siniša Pavić, senior lecturer		
Learning outcomes and competences	After having passed this exam, student will be competent in determining health propriety of foodstuffs in the Mediterranean setting according to their sensory, microbiological and chemical-toxicological properties as well as implementing sanitation, i.e., disinfection, disinsection and deratization measures.		
Prerequisites			
Course contents	Getting acquainted with sensory, microbiological and chemical-toxicological characteristics in foodstuffs of the Mediterranean setting; perishing and decomposing processes in specific foodstuffs as well as		

	laboratory monitoring procedures in quality and health propriety of the abovementioned. Training techniques in implementation of disinfection, disinsection and deratization regarding foodstuff production and storage as well as HACCP programmes in health food production.
Recommended reading	A. Asaj: "Dezinfekcija", Medicinska naklada, Zagreb 2000.; A. Asaj: "Zdravstvena dezinfekcija u nastambama i okolišu", Medicinska naklada, Zagreb 1999.; A. Asaj: "Deratizacija u praksi", Medicinska naklada, Zagreb 1999.; A. Asaj: "Higijena na farmi i u okolišu", Medicinska naklada, Zagreb 2003.
Supplementary reading	A. Asaj: "Zoo higijena" (Veterinarski priručnik), Medicinska naklada, Zagreb 1996.
Teaching methods	Lectures, laboratory exercises and field exercises
Assessment methods	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.

Mediterranean fruits and vegetables technology

Course title	Mediterranean fruits and vegetables technology		
Course code			
Type of course	Lectures, seminars, exercises (45+15+30)		
Level of course	Advanced level course		
Year of study	1 st year of graduate study	Semester	II.
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. Višnja Katalinić, assistant professor		
Learning outcomes and competences	Subject should make student familiar with scientific basis and technological background that enables successful postharvest handling and management, preservation and processing of fresh fruits and vegetables. Emphasis is placed upon Mediterranean fruits and vegetables.		
Prerequisites			
Course contents	History of fruit and vegetable processing; Trends in processing and production; Mediterranean fruits and vegetables; Neglected Mediterranean fruits and vegetables; Classification and quality attributes of fresh fruits and vegetables (appearance, texture, flavor and nutritive value); Maturity at harvest, harvesting methods and postharvest maintenance of quality;		

	Postharvest physiology of fruit and controlled maturation; Preservation of fresh and minimally processed fruits and vegetables; Intermediate goods of fruits and vegetables; Fruit and vegetable processing (Technology of fruit and vegetable juices and concentrates; Technology of frozen, sterilized and dried products; Technology of fermented products; Technology of pectin and products based on pectin gel; Technology of candied fruits and other fruit products); Direct food additives in fruit processing; Packaging of fruit and vegetables products; Quality parameters; Waste management; Technologies of major Mediterranean fruit and vegetable products: Production of citrus juice, pectin, aroma, essential oil; Grape, olive, carob, fig, sour cherry "Maraska" and pomegranate products; Mediterranean vegetable products (artichokes, broad beans, eggapple); The potentials of neglected Mediterranean fruits and vegetables.
Recommended reading	D.M. Barrett, L.P. Somogyi, H.S. Ramaswamy, Processing Fruits: Science and Technology, 2 nd edition, CRC Press, Basel, 2004.; T. Lovrić, V. Piližota, Konzerviranje voća i povrća, Globus, Zagreb, 1994.; W. Jongeng, Fruit and vegetable processing: Improving quality, CRC, 2002.; D.K. Salunke, Handbook of vegetable science and technology, Marcel Dekker, New York, 1998.
Supplementary reading	P.R. Ashort, Chemistry and technology of soft drinks and fruit juices, Chipsbooks, 1998.; G.A. Tucker, L.F.J. Woods, Enzymes in food processing, AVI Publishing Company, New York, 1991.; T. W. Goodwin, Plant pigments, Academic Press Limited, London, 1998.; R.W. Watson, Vegetables, fruits and herbs in health promotion, Chapman&Hall, 2000.
Teaching methods	Lectures. Seminars. Plant tours/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.

Technology of aquaculture

Course title	Technology of aquaculture	
Course code		
Type of course	Lecture, seminars, laboratory exercises (45+15+30)	
Level of course	Specialised	
Year of study	1 st year of graduate study	Semester II.
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. Leon Grubišić, assistant professor	
Learning outcomes and competences	Objective of this course is introduction of students to technologies processes of aquaculture and bio-ecological conditions necessary for rearing. Students will get theoretical and practical knowledge necessary for working in hatchery, farms and laboratories.	
Prerequisites		
Course contents	Introduction. Background, status and production trends in world aquaculture. Classification of rearing: extensive - intensive, mono-piculture. Description rearing systems. Landbased and marine farming. Water as rearing environment. Collecting and broodstock management. Biology and methods culture of plankton. Artificial reproduction and rearing of stock. Bio-ecological necessary conditions and farming technology of marine species. Cage rearing. Farming technology of shellfish. Artificial spawning and culture of crustaceans. Aquaculture and environment.	
Recommended reading	M.C.M. Beveridge, Cage aquaculture. Fishing News Books, Blackwell, Oxford, 1996.; I. Katavić, Marikultura. Manuskript 2005. ; A. Moretti, et al. Manual on hatchery Production of seabass and gilthead seabream. Volume1. FAO 1999.; M. Landau, M. Introduction to aquaculture. John Wiley and Sons.Inc 1991.; B.F. Phillips & J. Kittaka Spiny lobsters fisheries and culture., Fishing News Books. Second edition. 1987.	
Supplementary reading		
Teaching methods	Lectures. Seminars. Laboratory exercises.	
Assessment methods	Oral examination	
Language of instruction	Croatian, Polish, 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.	

Grape processing

Course title	Grape processing	
Course code		
Type of course	Lectures, seminars, laboratory exercises (45+15+30)	
Level of course	Advanced level course	
Year of study	2 nd year of graduate 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. Višnja Katalinić, assistant professor
Learning outcomes and competences	Being familiar and able to control winemaking technology and technology of wine products, as well as understanding process and product development; Quality control of all production steps up to the final product; Utilization of winemaking by-products and ecological treatment of waste; Identifying and solving problems in winemaking; Acquiring basing knowledge for scientific research activities.
Prerequisites	
Course contents	Introduction; Grape like a row material for wine production; Mechanical and chemical composition of grape; Grape cultivars; Influence of some parameters on quality attributes of grape; Ripening and harvest; Winery, equipment, operation, sanitation; Processing grape to must; Prefermentation practices; Yeasts; Biochemistry and kinetics of alcoholic fermentation; Malolactic fermentation; Acetic acid bacteria; Technology of white, red and rose wine production; Chemical composition of wines; Postfermentation treatments; Physical and chemical stability of wines (tartarate, protein and colloidal stability); The role of sulphur dioxide; Utilization of enzyme in juice and wine production; Stabilization, clarification, filtration, centrifugation, aging; Microoxygenation process; Bottling; Spoilage and defects of wine; Sparkling, botrytized and special wines; Quality control and sensory evaluation of wines; Legal restrictions in wine making; Technology of wine distillates production; Grape seed oil; Grape pigments; Grape antioxidants; Winery by-products from the economic and ecological viewpoint.
Recommended reading	R.B. Boulton et al., Principles and practices of winemaking, New York, Chapman/Hall, 1996; P. Ribereau-Gayon et al., Handbook of enology, Vol 1. The microbiology of Wine and Vinification, Chapman&Hall, 2000; P. Ribereau-Gayon et al., Handbook of enology, Vol 2. The Chemistry and wine stabilization and treatments, Chapman&Hall, 2000; R.J. Clarke and J. Baker, Wine flavour chemistry, ChapmanHall, 2004;
Supplementary reading	K.C. Fugelsang, Wine microbiology, New York, ChapmanHall, 1997; R.P. Vine et al., Winemaking, From grape growing to market place, New York, Chapman& Hall, 1997, C.S. Ough and M.A. Amerine, Methods for analysis of musts and wines, Second edition, New York, John Wiley&Sons, 1988.
Teaching methods	Lectures. Seminars. Plant tours/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.

Olive processing

Course title	Olive processing		
Course code			
Type of course	Lectures, seminars, laboratory exercises (45+15+30)		
Level of course	Advanced level course		
Year of study	2 nd year of professional 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	Mirko Gugić, senior lecturer		
Learning outcomes and competences	Comprehensive understanding and management of the virgin olive oil and table olive production; quality control of all production steps up to the final product; Acquiring basic knowledge for scientific research activities within this field of interest		
Prerequisites			
Course contents	Introduction to the olive culture; Chemical, physical and morphometrical characteristics of main olive sorts in RH; Quality factors of virgin olive oil and table olives; Quality of virgin olive oil and table olives; Regulation on virgin olive oil and table olives; Optimal technological ripeness of olive fruits for the production of virgin olive oil and table olives; Olive fruit harvest; Fruit storage up to the processing into oil or table olives; Fruit processing methods into oil; Fruit processing methods into table olives; Storage of oil and semi-finished products – table olives; Final processing and packaging for the market; By-products of the olive fruit processing from the economic and ecological viewpoint.		
Recommended reading	B. Škarica et al., Maslina i malinovo ulje visoke kakvoće u Hrvatskoj, Mario Bonifačić, Punat, 1996; V. Curci, L' Olio d'oliva di qualita, Edagricole Edizioni Agricola della Calderini, Bologna, 1999; V. Curci, Manuale dell 'olio d'oliva; Edagricole Edizioni Agricola della Calderini, Bologna, 2001.		
Supplementary reading	S. Perica i I. Kovačević, Suvremeno maslinarstvo, Avium, Split, 1994.; P. Bakarić, Maslina od berbe do prerade, Dubrovnik, 2003; P. Bakarić, Kada brati masline, Dubrovnik, 2000; Word catalogue of olive varieties, IOOC, Madrid, 2000		
Teaching methods	Lectures. Seminars. Plant tours/Laboratory exercises.		
Assessment methods	Oral examination		
Language of instruction	Croatian.		
Quality assurance	Quality assurance will be performed at three levels:		

methods	(1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.
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Quality assurance of foods

Course title	Quality assurance of foods		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+0+30)		
Level of course	Basic level course,		
Year of study	2 nd year of graduate study	Semester	III.
ECTS (Number of credits allocated)	5.0 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	Competences acquired by course: Unit processes in food industry.		
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 Assurance for Analytical Laboratories, AOAC International, Gaithersburg, Md., 2000.; V. Turčić, HACCP i higijena namirnica, Zagreb, 2000.; J.M. Kelly Upravljanje ukupnom kvalitetom (total Quality Management) Potecon, Zagreb, 1997. 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, D. Skoog, D.M. West and F.J.Holler, Osnove analitičke kemije,		

	Školska knjiga Zagreb, 1999.
Supplementary reading	C.S. James, Analytical Chemistry of Foods, Aspen Publisher, Inc., 1999H. Skoko, Upravljanje kvalitetom, Sinergija, Zagreb, 2000.; M.J. Juran, Planiranje i analiza kvalitete: od razvoja proizvoda do upotrebe 3. izd., Mate, Zagreb, 1999.; I. Bakija, Osiguranje kvalitete: po ISO 9000, Privredni vjesnik; Zagrebačka banka, Zagreb, 1991.; B. Petz, Osnove statističke metode za nematematičare, 3. izd., Naklada Slap, Jastrebarsko, 1997.; 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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Technology of citrus products

Course title	Technology of citrus products		
Course code			
Type of course	Lectures, laboratory exercises (30+15)		
Level of course	Advanced level course		
Year of study	2 nd year of professional study	Semester	III.
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	Mirko Gugić, senior lecturer		
Learning outcomes and competences	Students will be completely acquainted with the chemical constitution and technological characteristics of citrus, which are important for the product quality. They will learn processing techniques, chemical reactions and quality control of citrus products. The acquired knowledge will be implemented in the citrus processing management and development processes.		
Prerequisites			
Course contents	History and significance of citrus. Technological development of citrus industry. Description of citrus fruit. Chemical constitution and characteristics of citrus. Citrus processing. Sap production technology. Standards (Codex). Processing techniques and methods in the sap production. Chemical reactions in the sap production process. Other citrus products. Citrus nutrition value. Production of citrus essential oils.		

	Production by-products. Quality control. Legal regulations. HPLC-MS characterisation of citrus essential oils. Present and future application of citrus essential oils. Therapeutic characteristics of essential oils.
Recommended reading	G. Dugo and A. Di Giacomo, Citrus The genus citrus, Taylor&Francis, London, 2002; D.A. Kimball, Citrus processing. A complete guide, Sec. ed. C.H.I.P.S., 1999; A. Di Giacomo, and B. Mincione, Gli olii essenziali agrumari in Italia, baruffa editore (Reggio Calabria), 1994. D. M. Barrett, L.P. Somogyi, H. S. Ramaswamy, Processing Fruits: Science and Technology, Sec. Ed. , CRC Press, Basel, 2004;; W. Jongeng, Processing fruits: Science and technology, Vol. 1. and Vol. 2., Technomic, Basel, 1996;
Supplementary reading	P. R. Ashort, Chemistry and technology of soft drinks and fruit juices, Chipsbooks, 1998; G. A. Tucker, L. F. J. Woods, Enzymes in food processing, AVI Publishing Company, New York, 1991; T. W. Goodwin, Plant pigments, Academic Press Limited, London, 1998; S. Nagy, C. S. Chen, P. E. Shaw, Fruit juice processing and technology, AGSCIENCE Inc. Auburndale, Florida, 1993.
Teaching methods	Lectures, plant tours/laboratory exercises.
Assessment methods	Oral examination
Language of instruction	Croatian language.
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.

Mediterranean nutrition

Course title	Mediterranean nutrition		
Course code			
Type of course	Lectures, laboratory exercises (30+15)		
Level of course	Advanced level course		
Year of study	2 nd year of professional study	Semester	III.
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	Mirko Gugić, senior lecturer		
Learning outcomes and competences	Getting acquainted with the specific qualities of Mediterranean nutrition; Correct interpretation of biological-nutritive effects of Mediterranean nutrition on man's health; Competent valuation of the respective nutrition as the basis for the scientific research.		
Prerequisites			

Course contents	Introduction to Food science; Mediterranean food and nutrition; Mediterranean food and health; Advantages of Mediterranean food and nutrition in comparison to other familiar types of nutrition in the world.
Recommended reading	R. Živković, Dijetetika, Medicinska naklada,. Zagreb, 2002; G. Mazza, Functional foods: Biochemical and processing aspects, Technomic Pub. Co., Lancaster, Pennsylvania, 1998; P. Viola, Le huile d'olive et la sante, COI, 1997; Olive Oil Quality of life, Ed. IOOC, 2002.
Supplementary reading	M. E. Sjills, J. A. Olson, M. Shike, Modern nutrition in health and disease, Vol 1. i Vol. 2., Williams&Wilkins, Baltimore, 1994.
Teaching methods	Lectures, plant tours/laboratory exercises.
Assessment methods	Oral examination
Language of instruction	Croatian language.
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.

Biochemical engineering

Course title	Biochemical engineering		
Course code			
Type of course	Lectures, laboratory exercises (30+15)		
Level of course	Basic level course		
Year of study	2 nd year of graduate study	Semester	III.
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. Davor Rušić, associate professor.		
Learning outcomes and competences	Basic knowledge in the field of biotechnological engineering is acquired.		
Prerequisites	Competences acquired by courses: Biochemistry		
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, aeration systems, bioreaction kinetics (the notion of reaction rate, effect of product and substrate, reaction thermodynamics, biocatalysis)), bioreactors		

	(sterility in the reactor system, method of reaction execution, keeping biomass in the reactor, mass transfer, heat transfer, rheology and mechanical strength and mechanical strength of biological material). Bioreactor design and analysis. 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, Biochemical Engineering, 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.

Chemistry and technology of aromatic plants

Course title	Chemistry and technology of aromatic plants		
Course code			
Type of course	Lectures, laboratory exercises (30+15)		
Level of course	Advanced level course		
Year of study	2 nd year graduate study of chemistry	Semester	III.
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. 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 reading	S.V. Bhat, B.A. Nagasampagi, M. Sivakumar, Chemistry of Natural 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, Farmaceutsko-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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.

Separation processes

Course title	Separation processes		
Course code			
Type of course	Lectures, laboratory exercises (30+15)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	III.
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. Edita Mitrović – Kessler, full professor		
Learning outcomes and competences	Outcomes and competences necessary for work in manufacturing facilities in chemical industry and congenial industries, as well as for work in various institutes, universities and other public service laboratories.		
Prerequisites			
Course contents	Liquid – liquid mixtures. Distillation. Continuous distillation. Separation		

	of binary mixtures. Separation of multicomponent mixtures. Distillation equipment. Extraction. Liquid – liquid extraction. Commercial liquid – liquid extraction equipment. Decantation. Ion – exchange separations. Liquid with dissolved solids. Membrane filtration. Evaporation. Crystallization from solutions. Foam separation processes. Solid – liquid mixtures. Filtration theory. Batch filtration. Continuous filtration. Centrifugation. Sedimentation. Drying of wet solids. Solid mixtures. Flotation. Leaching.
Recommended reading	E. Mitrović – Kessler: Tehnološke operacije, Tehnološki fakultet Split, Split, 1985.; Phillip A. Schweitzer: Handbook of Separation Techniques for Chemical Engineers, 2 nd edition, McGraw Hill, New York 1988.
Supplementary reading	Chosen articles from journals and reviews recommended by course lecturer.
Teaching methods	Every theoretical chapter is followed by exercises, which will be held in faculty of Chemical technology laboratories, as well as in laboratories of appropriate institutes like "Institutes of Adriatic Cultures and Karst Melioration". Also, visits to existing industry facilities in the neighbouring area are foreseen.
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.

Perfumes and cosmetic preparates

Course title	Perfumes and cosmetic preparates		
Course code			
Type of course	Lectures and laboratory exercises (30+15)		
Level of course	Basic level course		
Year of study	2 nd year of graduate study of chemistry	Semester	III.
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. 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, bleaching 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, plant tours/laboratory exercises.
Assessment methods	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.

Modern methods in biochemistry

Course title	Modern methods in biochemistry		
Course code			
Type of course	Lectures, seminars, laboratory exercises (30+15)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study.	Semester	III.
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. Mladen Miloš, associated professor (with assistants).		

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	Competences acquired by courses: General chemistry and Biochemistry
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, 3 rd 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, 5 th edition, 2002.
Teaching methods	Lectures, seminars and laboratory exercises
Assessment methods	Written exam, laboratory exercise reports, assessment of research project seminars.
Language of instruction	Croatian, Italian, French and English.
Quality assurance methods	Quality and efficiency monitoring will be performed on three levels: (1) University level (2) Faculty level, with help of Committee for quality control of teaching (3) Teaching level

Packaging

Course title	Packaging		
Course code			
Type of course	Lectures, laboratory exercises (30+30)		
Level of course	Advanced level course		
Year of study	2 nd year of graduate study	Semester	IV.
ECTS (Number of credits allocated)	5.0 Number of allocated credits is based on the lecturer's estimation and inquiry among students.		
Name of lecturer	Dr. Nataša Stipanelov Vrandečić, assistant professor		
Learning outcomes and competences	Student gets acquainted with the role and functions of packaging and packaging materials, and with the selection of packaging materials regarding to interactions in food-packaging systems.		

Prerequisites	
Course contents	Role and systematisation of packaging according to function, packaging material and durability. Packaging functions: protective, storage, transport, marketing, usage. Packaging materials: types (wood, paper, textile, glass, metal, polymeric materials) and properties (physical, chemical, mechanical, technological and physiological). Production and processing of packaging materials. Packaging forms. Packaging of foodstuffs. Food and packaging material – chemical interactions. Contemporary methods of product and packaging marking. Packaging waste management. Biodegradable packaging.
Recommended reading	N. Stričević, Suvremena ambalaža I, Školska knjiga, Zagreb, 1982.; N. Stričević, Suvremena ambalaža II, Školska knjiga, Zagreb, 1983.; P. Ackermann, M.J. Gerstad and T. Ohlson (eds.), Food and Packaging Materials - Chemical Interactions, The Royal Society of Chemistry, Cambridge, 1995.; K. Galić, N. Ciković, K. Berković, Analiza ambalažnog materijala, Hinus, Udžbenici Sveučilišta u Zagrebu, Zagreb, 2000.
Supplementary reading	Journal Ambalaža, Tectus d.o.o., Zagreb; Zbornik radova II. stručno- - znanstvenog skupa Ekološka ambalaža-plastična ambalaža, Zagreb, 1995.
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: (1) University Level; (2) Faculty Level by Quality Control Committee; (3) Lecturer's Level.