UNDERGRADUATE UNIVERSITY STUDY PROGRAMME CHEMISTRY

Undergraduate University Study
Programme Chemistry, 180 ECTS, 3 years

I. Year

I. Winter semester

General Chemistry 1 (ECTS 6)

General Chemistry, Laboratory 1 (ECTS 4)

History of Chemistry (ECTS 3)

Mathematics 1 (ECTS 6)

Computer Laboratory (ECTS 3)

Introduction to Scientific Work: Informatology and Documentation in Chemistry (ECTS 4)

Physical Education 1 (ECTS 1)

Foreign language 1 (English) (ECTS 2)

Course name	General Chemistry 1		
Code	K1125		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	I.	**Semester**	Winter
ECTS	6		
Lecturer	Anamarija Stanković, PhD, assistant prof.		
The aim or purpose of the course	Understand the basic concepts in chemistry, make the matter comprehensible, acquire basic knowledge for understanding and performing laboratory exercises, and apply chemical calculus in solving problems.		
Prerequisites for enrollment	there are no prerequisites		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Valorise basic chemical terms 2. Analyse basic terms about the structure of atoms and PSE 3. Critically evaluate the type of molecules/formula units and their potential reactions 4. Determine basic terms and principles that encompass the field of thermochemistry, energy and gases 5. Evaluate chemical bonding and accuracy of the structure of the chemical compound. 6. Apply theoretical knowledge in solving stoichiometric problems and performing laboratory exercises		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="6"><table>
<tr><th>Teaching activity</th><th>ECTS</th><th>Learning outcome</th><th>Student activity</th><th>Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th></th><th></th><th></th><th></th><th></th><th>min</th><th>max</th></tr>
<tr><td>Knowledge test (written colloquia)</td><td>3,6</td><td>1-6</td><td>Preparation for the written exam</td><td>Three written colloquia</td><td>40</td><td>60</td></tr>
<tr><td>Final exam</td><td>2,4</td><td>1-6</td><td>Revision of the course content</td><td>Written exam
Oral exam</td><td>30</td><td>40</td></tr>
<tr><td>Total</td><td>6</td><td></td><td></td><td></td><td>70</td><td>100</td></tr>
</table></td></tr>
<tr><td>Consultations</td><td colspan="6">In agreement with the students</td></tr>
<tr><td>Acquired competencies</td><td colspan="6">Acquiring basic knowledge in chemistry, and being able to apply the acquired knowledge in all other chemistry courses</td></tr>
<tr><td>Content</td><td colspan="6">1. Chemistry – scientific discipline; fundamental definitions, basic concepts, measurement units. Classification and properties of substances (physical and chemical); Physical and chemical changes of substances, aggregation states.
2. Elements, compounds and mixtures atomic approach, Atom - through history; today. Atomic number, mass number and atomic symbol. PSE – throughout history; today.
3. Stoichiometry of chemical formulas, equations of chemical reactions. Number and plurality of substances, corresponding legalities; Determination of formulas of unknown compounds (empirical and molecular formula).
4. Compounds - introduction to chemical bonds. Electronegativity and bond polarity. Introduction to metal bonding. Lewis symbols and the octet rule. Ionic and covalent bond.
5. Classes of chemical reactions, solution concentration and the role of water as a solvent, precipitation reactions, acid-base reactions, redox reactions
6. Gas laws and their experimental foundations
7. Forms of energy and their conversion; Thermochemistry: energy flow and chemical change
8. Quantum theory and atomic structure. Atomic emission spectra. Bohr's model of the atom. Fundamentals of quantum mechanics, wave function.
9. Electronic configuration and chemical periodicity
10. Forms of molecules, Introduction to the theory of repulsion of valence shell electron pairs
11. Theories of covalent bonding. Valence Bond Theory (VB) and Orbital Hybridization. Theory of molecular orbits (MO) and electronic delocalization.</td></tr>
<tr><td>Recommended literature</td><td colspan="6">1. M. S. Silberberg, Chemistry: The Molecular Nature of Matter and Change 9th, McGrawHill Education, New York, 2021
2. R. Chang, J. Overby, General Chemistry: the Essential Concepts, 6. izd., McGraw-Hill, Inc., New York, 2011.
3. Filipović, S. Lipanović, Opća i anorganska kemija, Školska knjiga, Zagreb, 1997.
4. M. Sikirica, Stehiometrija, Šk. Knjiga, Zagreb, 2008.</td></tr>
<tr><td>Additional literature</td><td colspan="6">1. M. S. Silberberg, Chemistry: The Molecular Nature of Matter and Change – previous editions
2. R. Chang, J. Overby, General Chemistry: the Essential Concepts – previous editions</td></tr>
<tr><td>Forms of teaching</td><td colspan="6">Lectures, Seminars</td></tr>
<tr><td>Teaching type</td><td colspan="2">Lectures</td><td colspan="2">Seminars</td><td colspan="2">Exercises</td></tr>
<tr><td>(hours per week)</td><td colspan="2">3</td><td colspan="2">2</td><td colspan="2">0</td></tr>
<tr><td>total</td><td colspan="2">45</td><td colspan="2">30</td><td colspan="2">0</td></tr>
</table>

Methods of testing knowledge and taking exams	Students' knowledge is checked during the semester by means of three written partial colloquia. If the student does not pass one of the three colloquia or is not satisfied with the grades achieved on the colloquia, he must take the final exam (written) and oral exam. The total grade consists of: partial colloquia - 60% (20% + 20% + 20%), and an oral exam (40%). If the student did not pass the partial colloquium, he must take a final exam (written)(60%) and an oral exam (40%)
Language of teaching and possibilities of following in other languages	Croatian (language of teaching). English (possibility of following).
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	General chemistry practicum 1		
Code	K1102		
Type	Mandatory		
Level	Undergraduate study		
Year	1st	**Semester**	Winter
ECTS	4		
Lecturer	Anamarija Stanković, PhD, assistant prof.		
Goal or purpose of the course	Objective: to acquaint students with the basic principles of work in the laboratory, basic chemical utensils and fundamental chemical experiments.		
Prerequisites for enrollment	there are no prerequisites		
Learning outcome	**After successfully completing the course, the student will be able to:** 1. Organize work in the chemical laboratory. 2. Determine basic chemical concepts and methods. 3. Integrate adopted methods in all areas of chemistry. 4. Judge the determination of the basic physical and chemical characteristics of substances. 5. Provide the necessary equipment for the proper performance of experiments and accurate reading of the results. 6. Apply the basic rules for safe work in the laboratory.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0,3	1-6	**Class attendance**	**Attendance records**	9	10
Knowledge test (written colloquia)	2,7	1-6	**Preparation for the written exam**	**Written colloquium**	10	20
Final exam	1	1-6	**Repetition of study matter**	**Oral exam**	44	70

	Total	4	1-6			63	100
Consultations	An hour after each exercise or an appointment after agreement with the students.						
Acquired competencies	Acquiring practical and theoretical knowledge in chemistry that enables successful follow-up of classes and acquisition of knowledge in higher years of study.						
Content	Introduction: Introductory lecture: safety measures at work and providing first aid. Laboratory equipment and dishes. Gas burner flame properties and glass processing. Measurement of mass and density of samples. Preparation of solutions. Decanting and filtering. Recrystallization. Fractional crystallization. Sublimation. Distillation. Distillation of water at reduced pressure. Ion exchangers and water deionization. Determination of boiling point. Determination of melting temperature. Volumetric analysis. Determination of equivalent unit of metal. Determining the molar mass of a volatile substance using the Dumas method. Determination of the molar mass of CO_2.						
Recommended literature	1. M. Sikirica, B. Korpar-Čolig, Praktikum iz opće kemije, Školska knjiga Zagreb, 2001. 2. I. Filipović i S. Lipanović, Opća i anorganska kemija, I i II. Dio, Školska knjiga, Zagreb, 1995. 3. M. Sikirica, Stehiometrija, Šk. Knjiga, Zagreb, 2008. 4. M. Silberberg, Chemistry, 3. izd., McGraw-Hill, Inc., New York, 2003.						
Additional literature	1. F. Plavšić, A. Wolf-Čoporda, Z. Lovrić, D. Čepelak, Siguran rad s kemikalijama, O-tisak Zagreb, 2006.						
Forms of teaching	Introductory lecture. Independent and demonstration laboratory exercises. Mandatory entrance exams, keeping a laboratory diary and writing reports.						
Teaching	Lectures			Seminars		Exercises	
(Hours per week)	-			-		4	
(Total)	-			-		60	
Method of testing knowledge and taking exams	Oral entrance exam, written final exam. The final grade is made up of the average of the grades of individual exercises (colloquiums, results and performance of exercises - 75%) and the success of the final exam (25%).						
Language of teaching and possibilities of following in other languages	Croatian (language of teaching). English (possibility of following).						
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys						

Course name	History of Chemistry		
Code	K1124		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	I.	**Semester**	Winter
ECTS	3		
Lecturer	Anamarija Stanković, PhD, assistant prof.		

The aim or purpose of the course	Knowledge of the development of ideas, theories and experimental methods throughout the history of chemistry. Based on historical examples, develop knowledge and sensitivity to connect modern ideas, theories and methods in chemistry.
Prerequisites for enrollment	there are no prerequisites
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. To establish the most important approaches in the development of chemistry (epistemological, epistemological and sociological) in a certain civilization environment. 2. Comment on the contributions of chemistry in the development of European civilization. 3. Assess a certain paradigm in the scientific community, recognize the reasons for abandoning that paradigm and the features of scientific revolutions. 4. Distinguish the creative connection of experimental results up to a specific discovery using examples from the history of chemistry. 5. To review the importance of the genesis of research in achieving a certain result in chemistry. 6. Compare the level of a certain scientific environment with the scientific contribution in that environment (Croatian chemists and Nobel laureates).
Relationship between learning outcomes, teaching methods and grading	
Consultations	In agreement with the students
Acquired competencies	After knowing the ideas, theories and experimental methods through the history of chemistry and the genesis of the work and activities of famous chemists, the student acquires the ability to connect experimental results within the official theory, but also the possibility of upgrading or growing the same theory based on new experiments. It develops its creative potential. They also learn why "old" claims and problems began to be re-investigated only after many decades had passed and why the role of experiments in chemistry is important.
Content	Chemistry in the age of Egyptian and Greek civilization. The combination of Egyptian technology and Greek philosophy in the Hellenistic era in the Alexandrian scientific circle. The development of protochemistry until the Arab conquests. Chinese, Indian and Arabic alchemy. European alchemy. Iatrochemistry and mineralogical chemistry (practical alchemy). Chemistry at the dawn of the modern age. Phlogiston theory and revolution in chemistry. Atoms, molecules, symbols, masses and chemical laws. Periodic table of elements. Beginnings and development of organic and physical chemistry. Brief development of Croatian chemistry: alchemists, phlogistonists, founding of the University and Croatian Nobel laureates.

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	0,5	1-6	**Class attendance**	**Evidence list**	10	20
Knowledge test (written colloquia)	1,5	1-6	**Preparation for the written exam**	**Written colloquium**	15	30
Final exam	1	1-6	**Repetition of study matter**	**Oral exam**	40	50
Total	3	1-6			65	100

Recommended literature	S. PAUŠEK-BAŽDAR, Povijest kemije (skripta), Zagreb, 2002. S. PAUŠEK-BAŽDAR, Flogistonska teorija u Hrvata, HAZU, Zagreb, 1994. S. PAUŠEK-BAŽDAR, Paracelsus, Filozofija renesanse, sv. 3, ŠK, Zagreb, 1996 T. BURCKHARDT, Alkemija (prijevod E. Kukavica), Lingua Patria, Sarajevo, 2005. J. BRONOWSKI, Porijeklo znanja i imaginacije (prijevod), Stvarnost, Zagreb, 1978 D. GRDENIĆ, Povijest kemije, ŠK i Novi Liber, Zagreb, 2001.		
Additional literature	M. BAIGENT, R. LEIGH, Eliksir i kamen Kovači i alkemičari (prijevod), Stari grad, Zagreb, 2000. M. ELIADE, Kovači i alkemičari (prijevod), Zora, Zagreb, 1983. J. EVOLA, Hermetička tradicija i Kraljevsko umijeće (prijevod), Fabula nova, Zagreb, 2008. J. R. PARTINGTON, A History of Chemistry, 4. vol., II. izdanje New York, 1996. V. RABINOVIč, Alkemija kao fenomen srednjovjekovne kulture (prijevod), Beograd, 1989. R. TATON (ed.), Histoire Généra le des Sciences, II. izdanje, Pariz, 1998.		
Forms of teaching	**Lectures, Seminars**		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week) total	2	-	-
	30	-	-
Methods of testing knowledge and taking exams	Oral exams		
Language of teaching and possibilities of following in other languages	Croatian (language of teaching). English (possibility of following).		
The method of monitoring the quality and performance of each course and/or module	Survey, oral reviews and questions during lectures, motivation for choosing a final paper from the history of chemistry in general and from the history of Croatian chemistry.		

Course name	Mathematics 1		
Code	K1201		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	1.	**Semester**	Winter
ECTS	6		
Lecturer	Prof.dr.sc. Dragan Jukić		
The aim or purpose of the course	To acquaint students with the basic ideas and methods of mathematics, with special emphasis on differential calculus. Through the lectures, basic concepts will be treated in an informal way, illustrating their usefulness and application.		
Prerequisites for enrollment	No prerequisites.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Integrate knowledge about sets of numbers. 2. Verify statements related to the set of natural numbers. 3. Identify the elementary functions in the problem and apply their properties. 4. Conclude in which applications sequences occur and apply knowledge about their convergence.		

	5. Choose a suitable mathematical method for solving problems in which the differential calculus is applied. 6. Establish and solve problems in which extremes of functions of several variables occur.
Relationship between learning outcomes, teaching methods and grading	

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-6	**Class attendance**	**Attendance records**	9	10
Knowledge test (written colloquia)	3	1-6	**Preparation for the written exam**	**Written colloquium**	25	50
Final exam	2	1-6	**Repetition of study matter**	**Oral exam**	20	40
Total	6	1-6			54	100

Consultations	Fridays at 12pm
Acquired competencies	Students will get to know the basic ideas and methods of mathematical analysis, especially the differential calculus. Through the lectures, basic concepts will be treated in an informal way, illustrating their usefulness and application. During the exercises, students should master the appropriate technique and train themselves to solve specific problems.
Content	Introduction: Sets. Natural and integers numbers. The principle of mathematical induction. Rational and real numbers. Supremum and infimum of a set. Absolute value function. Complex numbers. Functions: Definition of function, representation and basic properties of function. Composition of functions and inverse function. Elementary functions. Definition of sequence and concept of limit of sequence. Some special sequences. Limit of function. Continuous functions. Differential calculus: Derivative of function. Differentiation rules and derivatives of elementary functions. Differentiation of an implicit function. Higher derivatives. Differentials. Theorems on derivative. L'Hospital's rule. Applications of the derivatives (tangent and normal, increase and decrease of a function, local extrema, convexity and concavity of a graph, points of inflection, sketching the graph of a function, curvature of a curve). Partial derivatives. Local extrema of function of several variables.
Recommended literature	1. D. Jukić, R. Scitovski, Matematika I, Prehrambeno tehnološki fakultet, Odjel za matematiku, Osijek 2000. 2. B. P. Demidović, Zadaci i riješeni primjeri iz više matematike s primjenom na tehničke nauke, Tehnička knjiga, Zagreb, 1986.
Additional literature	1. M. Crnjac, D. Jukić, R. Scitovski, Matematika, Osijek, 1994. 2. J. Pečarić i dr., Matematika za tehnološke fakultete, Zagreb, 1994. 3. S. Kurepa, Matematička analiza 1 i 2, Tehnička knjiga, Zagreb, 1972. 4. V. Devide i dr., Riješeni zadaci iz više matematike, Školska knjiga, Zagreb, 1979.

Forms of teaching	Lectures with the use of technical aids.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	2	-
total	45	30	-
Methods of testing knowledge and taking exams	Lectures and exercises are mandatory. The exam consists of a written and an oral part, and is taken after listening to lectures and completing exercises. During the semester, written assignments will be organized that can replace the written and oral part of the exam.		
Language of teaching and possibilities of following in other languages	Lectures are in Croatian. There is a possibility of lectures in English.		
The method of monitoring the quality and performance of each course and/or module	Anonymous survey.		

Course name	**Computer practicum**		
Code	K1207		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	1.	**Semester**	Winter
ECTS	3		
Lecturer	MSc Marija Bubalo, lecturer		
The aim or purpose of the course	Train students for: - working with basic MS Office applications: Word, Excel, PowerPoint - working with basic programs for working in a network environment (e-mail, Web browsers)		
Prerequisites for enrollment	there are no prerequisites		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine the basic concepts of information technology. 2. Create files. 3. Differentiate between types of computer networks. 4. Design and create text materials using a text editor. 5. Design tabular calculations. 6. Determine the presentation technique.		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th>Teaching activity</th><th>ECTS</th><th>Learning outcome</th><th>Student activity</th><th>Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th></th><th></th><th></th><th></th><th></th><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1</td><td>1-6</td><td>Class attendance</td><td>Attendance records</td><td>20</td><td>30</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1,60</td><td>1-6</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>12</td><td>20</td></tr>
<tr><td>Final exam</td><td>0,40</td><td>1-6</td><td>Repetition of study matter</td><td>Oral exam</td><td>30</td><td>50</td></tr>
<tr><td>Total</td><td>3</td><td></td><td></td><td></td><td>62</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students</td></tr>
<tr><td>Acquired competencies</td><td>Train students for working with basic:
- MS Office applications: Word, Excel, PowerPoint
- programs that will be used in office, library, archive, documentation, museum, etc. operations
- programs for working in a network environment (e-mail, Web browsers, WebCT)</td></tr>
<tr><td>Content</td><td>During the exercises, students' knowledge and skills are first checked in order to adapt the training to their needs and skills. In particular, the level of skills for working with basic MS Office applications is checked: Word, Excel, PowerPoint, groups are determined and students are further prepared to work in a network environment.
Special emphasis is placed on creating tables for research related to the profession. Students practice using network services, get to know the logic of search engines. As part of this course, new content is necessarily introduced as available tools and applications are changed/improved.</td></tr>
<tr><td>Recommended literature</td><td>Grupa autora: ECDL, osnovni program, Pro-mil, Varaždin, 2005.</td></tr>
<tr><td>Additional literature</td><td>1. Ljiljana Milijaš: PC- škola 2000, Promil, Varaždin 2000.
2. D. Grundler, D. Franulović-Šarić, T. Rolich: Primijenjeno Računarstvo, Graphis, Zagreb 2000.</td></tr>
<tr><td>Forms of teaching</td><td>Exercises - mandatory. During the exercises in the multimedia-equipped classroom, various tasks are done. During the semester, students' knowledge is regularly checked through colloquiums and independent practical works.</td></tr>
<tr><td>Teaching type</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td>-</td><td>-</td><td>3</td></tr>
<tr><td>-</td><td>-</td><td>45</td></tr>
</table>
</td></tr>
<tr><td>(hours per week) total</td><td></td></tr>
<tr><td>Methods of testing knowledge and taking exams</td><td>colloquia, practical work</td></tr>
<tr><td>Language of teaching and possibilities of following in other languages</td><td>Croatian language (basic)</td></tr>
</table>

The method of monitoring the quality and performance of each course and/or module	Anonymous survey, written or oral reviews during lectures and at the end of the exam.

Course name	Physical and health culture 1, 2, 3 and 4		
Code	K1210, K1211, K1212, K1213		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	1. and 2.	**Semester**	Winter and Summer
ECTS	1 ECTS point per semester		
Lecturer	Josip Cvenić, senior lecturer		
The aim or purpose of the course	Maintaining motor and functional abilities, and acquiring new motor and theoretical information in the field of physical and health culture		
Prerequisites for enrollment	There are no prerequisites		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare aerobic and anaerobic training. 2. Argument the influence of a particular exercise on a muscle group. 3. Choose the training option and load according to their own capabilities. 4. Measure their results and compare them with norms and other students. 5. Choose their own exercise program.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-5	**Class attendance**	**Attendance records**	15	30
Knowledge test (written colloquia)			**Preparation for the written exam**	**Written colloquium**		
Final exam			**Repetition of study matter**	**Oral exam**		
Total	1				15	30

Consultations	Thursdays 12.00 - 13.00 in cabinet no. 27 in the Department of Mathematics
Acquired competencies	Knowledge of basic forms of physical exercise and application in everyday life. Based on the initial condition, create a program with adapted kinesiology content. Adopt theoretical information about a healthy lifestyle, proper nutrition and the bad influence of a sedentary lifestyle. Acquire habits for daily and regular physical exercise.
Content	The core of the program consists of sets of various kinesiology activities that can be divided into basic and special curriculum. Students choose them based on their interest, level of acquisition of motor skills, level of ability, health status and conditions available at the university or department. The basic program contains the following kinesiology activities (athletics, basketball, football, volleyball, dance structures, swimming, handball, table tennis...) while special programs consist of activities that were less represented in the

	primary and secondary school curricula (ice skating, fitness, aerobics, beach volleyball, hiking tours, tennis, karate, teakwando, squash, bowling...).
Recommended literature	1. Pearl, B., Moran G. T. (2009). Trening s utezima, Gopal d.o.o, Zagreb
Additional literature	1. Caput – Jogunica, R., Bagarić I., Babić D., Ćurković S., Špehar N., Alikalfić V. Nastavni plan i program tjelesne i zdravstvene kulture u visokom obrazovanju (skripta). Zagreb, 2007. 2. Delija K., K. Pleša (2004). Vrednovanje u području edukacije. U V. Findak (ur.), 13. ljetna škola kineziologa Republike Hrvatske, Rovinj, 2004. (str. 22-28). Hrvatski kineziološki savez 3. Findak, V. (1999). Metodika tjelesne i zdravstvene kulture. Zagreb: Školska knjiga 4. Findak, V. (2004). Vrednovanje u području edukacije, sporta i sportske rekreacije. U V. Findak (ur.), 13. ljetna škola kineziologa Republike Hrvatske, Rovinj, 2004. (str. 12-20). Hrvatski kineziološki savez 5. Janković, V., N. Marelić (1995). Odbojka. Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu. Milanović, D. (ur.) (1996). Fitnes. Zbornik radova međunarodnog znanstveno-stručnog savjetovanja of fitnesu, 5. zagrebački sajam sporta, Fakultet za fizičku kulturu, Zagreb 6. Jukić I., G. Marković (2005). Kondicijske vježbe s utezima. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu. 7. Mišigoj-Duraković, M. (2008). Kinantropologija. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu. 8. Volčanšek, B. (1996). Sportsko plivanje. (Udžbenik)Fakultet za fizičku kulturu, Zagreb. 9. Vukić, Ž., Jančić S., Vukić Ž. (1997). Model ustroja nastave tjelesne i zdravstvene kulture i športa na visokim učilištima (skripta). Osijek, Ekonomski fakultet Osijek.
Forms of teaching	Practical training at different sports locations

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	2
total	-	-	30

Methods of testing knowledge and taking exams	Regular attendance at practical training (80% attendance)
Language of teaching and possibilities of following in other languages	Croatian language (language of learning and teaching). English and German language (possible for actively monitoring class)
The method of monitoring the quality and performance of each course and/or module	Anonymous survey

Course name	English Language 1
Code	K1208
Type	Mandatory

<table>
<tr><td>Level</td><td colspan="3">Undergraduate University Study of Chemistry</td></tr>
<tr><td>Year</td><td>1.</td><td>Semester</td><td>Winter</td></tr>
<tr><td>ECTS</td><td colspan="3">2</td></tr>
<tr><td>Lecturer</td><td colspan="3">Mr.sc. Lidija obad</td></tr>
<tr><td>The aim or purpose of the course</td><td colspan="3">The improvement of four language skills with the special focus on reading.
Foreign language teaching for special purposes introduces chemistry- related vocabulary and enables students to understand scientific texts and to be able to summerize them.</td></tr>
<tr><td>Prerequisites for enrollment</td><td colspan="3">Learning English as a foreign language in primary and secondary school.</td></tr>
<tr><td>Learning outcomes</td><td colspan="3">After successfully completing the course, the student will be able to:
1. To interpret simple scientific texts and their key words
2. To apply different reading techiques
3. To integrate and to apply both language and chemistry knowledge in the understanding of different texts
4. To evaluate the relevant scientific literature
5. To apply the gained knowledge when writing a scientific paper</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="3">
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>0.20</td><td></td><td>Class attendance</td><td>Attendance records</td><td>10</td><td>20</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>0.30</td><td></td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>35</td></tr>
<tr><td>Final exam</td><td>1.50</td><td></td><td>Repetition of study matter</td><td>Oral exam</td><td>30</td><td>45</td></tr>
<tr><td>Total</td><td>2.00</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td colspan="3">In agreement with students</td></tr>
<tr><td>Acquired competencies</td><td colspan="3">Insight into specialized professional texts; the understanding of the structure and organization of specialized professional texts; the interpretation and the summary of key information</td></tr>
<tr><td>Content</td><td colspan="3">Introduction to Chemistry, Chemical Changes, Acids and bases, The Chemical Laboratory Equipment, The Burner</td></tr>
<tr><td>Recommended literature</td><td colspan="3">Lidija Obad, English for Students of Food Technology I; PTF Osijek, 2012.</td></tr>
<tr><td>Additional literature</td><td colspan="3">Bujas, Englesko-hrvatski rječnik, Globus, 1999.</td></tr>
<tr><td>Forms of teaching</td><td colspan="3">lectures</td></tr>
<tr><td>Teaching type</td><td>Lectures</td><td>Seminars</td><td>Exercises</td></tr>
<tr><td>(hours per week)</td><td>2</td><td></td><td></td></tr>
<tr><td>total</td><td>30</td><td></td><td></td></tr>
</table>

Methods of testing knowledge and taking exams	Midterm exams; Written and oral examination
Language of teaching and possibilities of following in other languages	English
The method of monitoring the quality and performance of each course and/or module	Student Evaluation Questionnaire

I. Year

II. Summer semester

General Chemistry 2 (ECTS 6)

General Chemistry, Laboratory 2 (ECTS 4)

Analytical Chemistry 1 (ECTS 6)

Mathematics 2 (ECTS 6)

General Physics 1 (ECTS 6)

Physical Education 1 (ECTS 1)

Foreign language 2 (English) (ECTS 2)

Course name	General Chemistry 2		
Code	K1126		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	I.	**Semester**	Summer
ECTS	6		
Lecturer	Vlatka Gvozdić, PhD, associate professor		
The aim or purpose of the course	Make the course content understandable, confirm connection of principles and concepts in chemistry, and apply chemical calculation in problem solving tasks.		
Prerequisites for enrollment	Finished course in General chemistry 1		
Learning outcomes	7. Apply stoichiometry and chemical calculation in solving tasks 2. Explain intermolecular interactions 3. Determine basic kinetics, electrochemistry and thermodynamics terms 4. Determine basic theories and concepts of acids and bases in reaction systems such as buffer solutions and neutralization reactions 5. Comment on structure of complex compounds 6. Determine basic concepts in radio and nuclear chemistry		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	0,6	1-4	**Class attendance**	**Attendance records**	5	10
Knowledge test (written colloquia)	3	1-4	**Preparation for the written exam**	**Written colloquium** 1 **Written colloquium** 2	15 15	25 25
Final exam	2,4	1-4	**Revision of the course content**	**Oral exam**	25	40

	Total	6				60	100

Consultations	In agreement with the students		
Acquired competencies	Acquiring and understanding basic knowledge in chemistry, necessary for following other chemistry courses.		
Content	1. Intermolecular forces. Properties of liquid state. Properties of the solid state. The equilibrium nature of phase changes. Phase diagrams. 2.Types of solutions. Energy changes in the solution process. Colligative properties of solutions. 3. Kinetics. Rates and Mechanisms of chemical reactions. The effect of concentration and temperature on the rate constant. Catalysis (homogenous and heterogenous. 4. Equilibrium . The mass action expression and the equilibrium constant. Le Châtelier's principle. 5. Equilibrium in electrolyte solutions. Acid -base equilibria. Buffer solutions. Acid-base titration curves. 6.Thermodynamics. Hess's law.The second law of thermodynamics. Entropy, free energy and work. The entropy change and the equilibrium state. Chemistry in biological energetics. 7. Electro- chemistry .Half reactions and electrochemical cells. An overview of electrochemical cells. The relation between amounts of charge and product. The effect of concentration on cell potential. Electrolytic cells. 8. Introduction to transition metal complexes . 9. Nuclear reactions.		
Recommended literature	1. M.Silberberg, Chemistry, 3nd ed., McGraw-Hill, New York, 6.izd. , McGraw-Hill, Inc., New York, 2011. 2. R.Chang, J.Overby, General Chemistry:the Essential Concepts, 6 izd., McGraw-Hill, inc., , New York, 2011. 3.P.W.Atkins, M.J.Clugston. Načela fizikalne kemije.Zagreb, Školska knjiga 1996. 4. M.Sikirica: Stehiometrija, Školska knjiga , Zagreb, 1987.		
Additional literature	1. I.Filipović, S Lipanović, Opća i anorganska kemija, Školska knjiga, Zagreb, 1997.		
Forms of teaching	**Lectures, Seminars**		
Teaching type (hours per week) total	**Lectures**	**Seminars**	**Exercises**
	3	2	0
	45	30	0
Methods of testing knowledge and taking exams	Colloquia. Written and oral exam after the finished course. Final grade includes: regular attendance and active participation - 10%, colloquia - 50%, final exam - 40%.		
Language of teaching and possibilities of following in other languages	Croatian (language of teaching).English (possibility of following).		
The method of monitoring the quality and performance of each course and/or module	Anonymous poll.		

Course name	General chemistry practicum 2
Code	K1103
Type	Mandatory

<table>
<tr><td>Level</td><td colspan="3">Undergraduate study</td></tr>
<tr><td>Year</td><td>1st</td><td>Semester</td><td>Summer</td></tr>
<tr><td>ECTS</td><td colspan="3">4</td></tr>
<tr><td>Lecturer</td><td colspan="3">Vlatka Gvozdić, PhD, associate professor</td></tr>
<tr><td>Goal or purpose of the course</td><td colspan="3">Objective: to acquaint students with the basic principles of laboratory work, basic chemical utensils and fundamental chemical experiments.</td></tr>
<tr><td>Prerequisites for enrollment</td><td colspan="3">Completed General chemistry practicum 1</td></tr>
<tr><td>Learning outcome</td><td colspan="3">After successfully completing the course, the student will be able to:
7. Define basic chemical processes, for example hydrolysis, solvation, neutralization.
8. Compare different ways of preparation of gases, inorganic salts and complex compounds
9. Apply learned chemical reactions to other areas of chemistry
10. Apply knowledge to the characterization of the obtained products
11. Determine the chemical reactions that take place in the production of gases, inorganic salts and complex compounds
12. Integrate the learned procedures: assembling the apparatus and performing the experiments correctly with the necessary precautions</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="3">
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Knowledge test (colloquia, seminars)</td><td></td><td>1-6</td><td>Preparation for the entrance exam</td><td>Colloquium before performing the exercise</td><td>20</td><td>30</td></tr>
<tr><td>Final exam</td><td>3</td><td>1-3</td><td>Solving concrete examples</td><td>Written exam</td><td>40</td><td>70</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td colspan="3">An hour after each exercise or an appointment after agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td colspan="3">Acquisition of practical and theoretical knowledge in chemistry that enables successful monitoring of teaching and acquisition of knowledge in the higher years of study.</td></tr>
<tr><td>Content</td><td colspan="3">Chlorine preparation. Preparation of KClO3. HCl preparation. Oxygen preparation. Preparation of sulfur (IV) oxide. Preparation of nitric oxide. Preparation of nitric oxide. Ammonia preparation. Preparation of chrome alum. Preparation of tetraamine copper (II) sulphate monohydrate. Preparation of iron (II) sulphate heptahydrate. Preparation of lead (II) chloride. Preparation of zinc phosphate tetrahydrate. Dependence of chemical reaction rate on concentration. Dependence of the rate of a chemical reaction on temperature. Influence of common ion on equilibrium in solution. Hydrolysis. Influence of common ion on NaCl solubility. Solubility product. Determination of molar mass by cryoscopic method. Preparation of galvanic cell. Electrolysis with insoluble anode. Soluble anode electrolysis. Faraday's laws of electrolysis. Seminar exercise.</td></tr>
<tr><td>Recommended literature</td><td colspan="3">5. M.Sikirica, B.Korpar Čolig, Praktikum iz opće kemije, Školska knjiga Zagreb 2001.
6. I.Filipović, S.Lipanović, Opća i anorganska kemija, I i II dio. Školska knjiga, Zagreb,1955.
7. M.Sikirica, Stehiometrija, Šk. Knjiga Zagreb, 2008.
8. M. Silberberg, Chemistry, 3.izd. Mc Graw-Hill, Inc., New York, 2003.</td></tr>
<tr><td>Additional literature</td><td colspan="3">2. P.W. Atkins i M.J. Clugston, Načela fizikalne kemije, Školska knjiga, Zagreb 1989.</td></tr>
</table>

Forms of teaching	Introductory lecture. Independent and demonstration laboratory exercises. Mandatory entrance exams, keeping a laboratory diary and writing reports.		
Teaching	Lectures	Seminars	Exercises
(Hours per week)	-	-	4
(Total)	-	-	60
Method of testing knowledge and taking exams	Entrance (oral and / or written) colloquium before each exercise. The exercise cannot be performed until the entrance colloquium has been positively graded. The exercise is considered completed when the report for that exercise is signed. The final exam is in writing. In the written exam, students must pass 50% of the exam correctly for a positive grade. Access to the written exam, which will test the knowledge of theory and exercises (tasks), is possible only after all previous obligations have been met. The final grade is the average of positive grades (2-5) of individual exercises (75%) and positive grades (2-5) on the written exam (25%).		
Language of teaching and possibilities of following in other languages	Croatian English		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys		

Course name	**Analytical Chemistry 1**		
Code	K1104		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	1.	**Semester**	Summer
ECTS	6		
Lecturer	Mirela Samardžić Ph. D., Associate professor		
The aim or purpose of the course	Acquisition of basic knowledge necessary for understanding and performing classical methods of chemical analysis.		
Prerequisites for enrollment	Attended the General Chemistry course		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine the importance and role of analytical chemistry. 2. Argue the types of chemical reactions and chemical equilibria. 3. Choose the most suitable way to solve calculation problems related to the curriculum. 4. Compare qualitative and quantitative analysis. 5. Establish the principles of volumetry with examples of practical application and analytical calculations. 6. Identify errors in quantitative analysis, including the basics of statistical processing of analytical results.		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="3">
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance and activity</td><td>2</td><td>1-6</td><td>Class attendance and solving calculation problems</td><td>Records</td><td>10</td><td>20</td></tr>
<tr><td>Knowledge test (written colloquia or final exam)</td><td>4</td><td>1-6</td><td>Repetition of study matter</td><td>Three written colloquia or written exam</td><td>50</td><td>80</td></tr>
<tr><td>Total</td><td>6</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td colspan="3">Consultations are available every week, during which the lectures are held, for 1 hour, in agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td colspan="3">Basic knowledge of analytical chemistry, understanding of basic analytical concepts and processes, recognizing the role of analytical chemistry in science as well as in everyday life. Ability to apply knowledge in practice.</td></tr>
<tr><td>Content</td><td colspan="3">Introduction to analytical chemistry; Sampling; Analytical data processing; Equilibria in electrolyte solutions; Theories of acids and bases; Activity and concentration; Chemical equilibria in acids and bases; Buffers; Hydrolysis; Titrimetry; Acid-base titrations; Complexometric titrations; Precipitation titrations; Oxidation-reduction titrations.</td></tr>
<tr><td>Recommended literature</td><td colspan="3">D. A. Skoog, D. M. West and F. J. Holler, Osnove analitičke kemije, Školska knjiga, Zagreb, 1999.
Nj. Radić, L. Kukoč Modun, Uvod u analitičku kemiju, Školska knjiga, Zagreb, 2016.</td></tr>
<tr><td>Additional literature</td><td colspan="3">M. Kaštelan-Macan, Kemijska analiza u sustavu kvalitete, Školska knjiga, Zagreb , 2003.
Z. Šoljić, Kvalitativna kemijska analiza anorganskih tvari, FKIT, Zagreb, 2003.</td></tr>
<tr><td>Forms of teaching</td><td colspan="3">Lectures with the use of teaching aids (Power Point presentations) and active participation of students.
Seminars, where students solve calculation problems on board.</td></tr>
<tr><td>Teaching type</td><td>Lectures</td><td>Seminars</td><td>Exercises</td></tr>
<tr><td>(hours per week)</td><td>3</td><td>2</td><td>-</td></tr>
<tr><td>total</td><td>45</td><td>30</td><td>-</td></tr>
<tr><td>Methods of testing knowledge and taking exams</td><td colspan="3">Knowledge is tested during classes through three colloquia, the last of which is at the end of the semester. If the student does not pass all three colloquia or is not satisfied with the grades in the colloquia, he / she must take the final written exam.
The final grade consists of: regular class attendance - 10%, active class participation - 10% and three partial colloquia - 80% or final written exam - 80%.</td></tr>
<tr><td>Language of teaching and possibilities of following in other languages</td><td colspan="3">Croatian language (language of teaching) and English language (possibility of following).</td></tr>
<tr><td>The method of monitoring the quality and performance of</td><td colspan="3">Interviews with students and anonymous surveys.</td></tr>
</table>

each course and/or module	

Course name	Mathematics 2		
Code	K1202		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	1.	**Semester**	Summer
ECTS	6		
Lecturer	Prof.dr.sc. Dragan Jukić		
The aim or purpose of the course	To acquaint students with the basic ideas and methods of integral calculus, the theory of ordinary differential equations and linear algebra. Through the lectures, basic concepts will be given in an informal way, illustrating their usefulness and application.		
Prerequisites for enrollment	There are no prerequisites.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Master the basics of integral calculus and the theory of differential equations. 2. Independently apply the integral calculus techniques. 3. Compare and apply different techniques for solving differential equations. 4. Valorize the basics of linear algebra. 5. Argumentatively and independently draw conclusions. 6. Develop the necessary prior knowledge for the application of acquired knowledge in other courses.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	2-5	**Class attendance**	**Attendance records**	9	10
Knowledge test (written colloquia)	3	1-6	**Preparation for the written exam**	**Written colloquium**	25	50
Final exam	2	1-6	**Repetition of study matter**	**Oral exam**	20	40
Total	6	1-6			54	100

Consultations	Fridays at 12:00
Acquired competencies	Students will become familiar with the basic ideas and methods of integral calculus, the theory of ordinary differential equations and linear algebra. Through the lectures, basic concepts will be treated in an informal way, illustrating their usefulness and application. During the exercises, students should master the appropriate technique and be trained to solve specific problems.
Content	**Integral calculus:** Concept and properties of definite integral. The mean value theorem for the integral of a continuous function. Newton - Leibniz formula. Indefinite integral. Integration methods (partial integration, integration by substitution). Integration

	technique. Applications of a definite integral (arc length of a curve, area of a pseudotrapezoid, volume of a rotating body, applications in technology). Improper integrals. **Ordinary differential equations**: General and particular solutions of differential equations. Ordinary differential equations of the first order (separation of variables, homogeneous, linear). Linear differential equation of the second order. Linear differential equation of the second order with constant coefficients **Linear algebra**: Vectors in space. Operations with vectors. Vector space. Linear dependence and independence of vectors. Vector projection. The base of the vector space. Coordinate system. Scalar product. Vector product. Mixed product. Matrices. Matrix operations. Matrix rank. Regular matrices. Determinants. Systems of linear algebraic equations. Gaussian method of elimination. Gauss - Jordan's method. Discussion of solutions of systems of linear equations. Cramer's rule.
Recommended literature	1. D. Jukić, R. Scitovski, Matematika I, Prehrambeno tehnološki fakultet, Odjel za matematiku, Osijek 2000. 2. B. P. Demidović, Zadaci i riješeni primjeri iz više matematike s primjenom na tehničke nauke, Tehnička knjiga, Zagreb, 1986.
Additional literature	1. M. Crnjac, D. Jukić, R. Scitovski, Matematika, Osijek, 1994. 2. J. Pečarić i dr., Matematika za tehnološke fakultete, Zagreb, 1994. 3. S. Kurepa, Matematička analiza 1 i 2, Tehnička knjiga, Zagreb, 1972. 4. V. Devide i dr., Riješeni zadaci iz više matematike, Školska knjiga, Zagreb, 1979.
Forms of teaching	Frontal with the use of technology.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	2	
total	45	30	

Methods of testing knowledge and taking exams	Lectures and exercises are mandatory. The exam consists of a written and an oral part, and is taken after listening to lectures and completing exercises. During the semester, written assignments will be organized that can replace the written and oral part of the exam.
Language of teaching and possibilities of following in other languages	Lectures are in Croatian. There is a possibility of giving lectures in English.
The method of monitoring the quality and performance of each course and/or module	Anonymous survey.

Course name	General Physics 1
Code	K1203

Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	1.	**Semester**	Summer
ECTS	6		
Lecturer	Igor Đerđ, PhD, Full professor		
The aim or purpose of the course	Introduce students to the fundamental premises and laws of physics (mechanics, vibration, waves, and heat science) as a holistic scientific view, that not only explains the most of natural phenomena, but provides a solid foundation for understanding the universe and its laws.		
Prerequisites for enrollment	None		
Learning outcomes	***After successfully completing the course, the student will be able to:*** **1. Define basic physical quantities in mechanics** (displacement, velocity, acceleration, mass, force, momentum, work, force, energy, moment of inertia, moment of force, angular momentum, pressure, temperature, heat, internal energy, specific heat capacity, entropy, …); **2. Show and describe the conditions of applicability of the most important laws in mechanics** (uniform linear motion, uniform accelerated motion and uniformly accelerated rotation, Newton's laws, Law of conservation of momentum, Law of conservation of energy, Kepler's laws, Newton's law of rotation, Archimedes' law, Law of conservation of angular momentum, Huygens principle, gas laws, Avogadro's law, principles of thermodynamics, …); **3. Apply basic laws to solve simple conceptual and numerical problems in mechanics and thermodynamics;** **4. Explain the principles of operation of individual measuring instruments** (dynamometer, open and closed manometer, thermometer, …); **5. Derive mathematical expressions for some derived physical quantities** (centripetal acceleration, moments of inertia for different rigid bodies, maximum height and range of oblique shot, kinetic energy of rotation, hydrostatic pressure and buoyant force, period of harmonic oscillator and mathematical pendulum, speed of transverse wave propagation, ideal gas pressure in molecular kinetic gas theory, specific heat capacity at constant pressure and volume for monoatomic, diatomic and polyatomic gases, …); **6. Derive some derived physical laws from basic laws and principles** (laws of uniform and uniformly accelerated rectilinear motion, parametric equations of oblique shot, work-kinetic energy theorem, theorem on parallel axes, Kepler's 2nd and 3rd laws, Bernoulli's equation; **7. Evaluate the importance and application of basic physical laws in mechanics and thermodynamics in objects and devices that we use in everyday life and analyze the basic principles of work on which these devices operate.**		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance			**Class attendance**	**Attendance records**		
Knowledge test (written colloquia)			**Preparation for the written exam**	**Written colloquium**		
Final exam	6	1-7	**Repetition of study matter**	**Oral exam**	2	5

	Total	6	1-7			2	5
Consultations	Mondays, 12-14 pm.						
Acquired competencies	Students will understand and learn the fundamental premises and laws of physics (mechanics, vibration, waves, and heat science) as a holistic scientific view, that not only explains the most of natural phenomena, but provides a solid foundation for understanding the universe and its laws.						
Content	**Introduction to physics** (physical quantities, units and dimensions of physical quantities, SI system, dimensional analysis, prefixes in SI system). **Motion, velocity** (average and instantaneous velocity), **acceleration, uniform and uniformly accelerated motion, free fall. Complex movements** (projectile motion, horizontal and vertical shot). **Kinematics of circular motion of a material point** (centripetal acceleration, angular velocity and angular acceleration). **Newton's laws. Fundamental forces in nature. Inertial and gravitational mass. Weight and force of gravity. Friction force. Impulse and linear momentum. Law of the conservation of momentum. Dynamics of circular motion of a material point. Centripetal force. Galileo's principle of relativity. Inertial and non-inertial systems. Centrifugal force. Work** (mathematical definition of work). **Force. Energy. Forms of mechanical energy** (kinetic, gravitational potential and elastic potential). **Conservation of mechanical energy. Collision** (elastic and inelastic). **Rotation of a rigid body. Moment of force. Newton's law of rotation. Moment of inertia. Parallel axis theorem. Moments of inertia** (rod, roller, disk (ring), ball). **Angular momentum. Conservation of angular momentum. Newton's law of gravity. Determination of universal gravitational constant. Kepler's laws. Gravitational field** (Inertial and gravitational mass, gravitational potential energy). **The difference between gravitational force and gravity. Cosmic speeds. Fluid statics** (pressure, Pascal's law, hydrostatic pressure, Torricelli test, pressure gauges**). Buoyancy, Archimedes' law. Fluid dynamics** (ideal fluid flow equation - Bernoulli equation, Torricelli's theorem, Venturi and Pitot tube). **Harmonic oscillation** (elastic force, harmonic oscillator, graphical representation of harmonic oscillation, damped oscillation). **Pendulum** (simple gravity pendulum, physical pendulum, mathematical pendulum). **Forced oscillation and resonance. Wave motion** (transverse and longitudinal disturbances, propagation velocities of transverse and longitudinal waves). **Wave propagation phenomena** (interference, reflection and wave transmission). **Huygens principle. Wave equation** (transverse wave). **Standing waves. Sound phenomena** (nature of sound, volume, ultrasound). **Doppler effect. Temperature, thermometers, temperature scales, thermal expansion of matter** (solids and liquids). **Amount of heat and specific heat capacity, measurement of specific heat capacity of solids and liquids** (Richmann's rule). **Thermal properties of gases, gas laws** (Boyle-Mariotte, Charles and Gay-Lussac law), **equation of state of an ideal gas, Avogadro's law. Heath and internal energy. Heat transfer, heat conduction, heat convection, heat radiation** (Stefan-Boltzmann law of radiation). **Kinetic molecular theory of ideal gas, gas temperature. Specific heat capacities in the light of molecular kinetic theory of gases. Heat and work exchange** (work when changing the state of the gas, isotherms and adiabats, Poisson's equation). **Cyclic processes** (reversible and irreversible processes, Carnot cycle, efficiency). **Laws of thermodynamics** (1^{st}, 2^{nd} and 3^{rd} law of thermodynamics). **Entropy** (change in entropy of a closed system, entropy and statistical law).						
Recommended literature	1. P. Kulišić, Mehanika i toplina, Školska knjiga, Zagreb, 2011. 2. P. Kulišić et al., Riješeni zadaci iz mehanike i topline, Školska knjiga, Zagreb, 1986. 3. N. Cindro, Fizika 1, Školska knjiga, Zagreb, 1988. 4. V. Henč-Bartolić et al., Riješeni zadaci iz valova i optike, Školska knjiga, Zagreb, 1992.						

Additional literature	1. J. Planinić, Osnove fizike I. - Mehanika, Školska knjiga, Zagreb, 2006. 2. M. Paić, Osnove fizike I. dio – Gibanja-Sile-Valovi, SNL, Zagreb, 1978. 3. M. Paić, Toplina i termodinamika, Školska knjiga, Zagreb, 1994.		
Forms of teaching	**Lectures** (method of presentation, conversation, demonstration - online experiments). **Seminars** (method of presentation, conversation, graphical method, method of solving numerical problems).		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	2	-
total	45	30	-
Methods of testing knowledge and taking exams	**The exam consists of a written and an oral part: the written part of the exam contains 5 numerical (problem) tasks. Each task carries 1 point. To successfully pass the exam, it is necessary to solve two tasks completely accurately, with the correct solution of each subsequent task brings 1 point more and one grade of the written part of the exam more. The oral part of the exam follows after successfully passing the written part, and consists of checking the knowledge of the course content through exam questions. The final grade is formed by averaging the grade of the written part of the exam and the oral part, unless the oral part of the exam is unsatisfactory.**		
Language of teaching and possibilities of following in other languages	Croatian		
The method of monitoring the quality and performance of each course and/or module	By surveying students.		

Course name	Physical and health culture 1, 2, 3 and 4		
Code	K1210, K1211, K1212, K1213		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	1. and 2.	**Semester**	Winter and Summer
ECTS	1 ECTS point per semester		
Lecturer	Josip Cvenić, senior lecturer		
The aim or purpose of the course	Maintaining motor and functional abilities, and acquiring new motor and theoretical information in the field of physical and health culture		
Prerequisites for enrollment	There are no prerequisites		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare aerobic and anaerobic training. 2. Argument the influence of a particular exercise on a muscle group. 3. Choose the training option and load according to their own capabilities. 4. Measure their results and compare them with norms and other students. 5. Choose their own exercise program.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-5	**Class attendance**	**Attendance records**	15	30
Knowledge test (written colloquia)			**Preparation for the written exam**	**Written colloquium**		
Final exam			**Repetition of study matter**	**Oral exam**		
Total	1				15	30

Consultations	Thursdays 12.00 - 13.00 in cabinet no. 27 in the Department of Mathematics
Acquired competencies	Knowledge of basic forms of physical exercise and application in everyday life. Based on the initial condition, create a program with adapted kinesiology content. Adopt theoretical information about a healthy lifestyle, proper nutrition and the bad influence of a sedentary lifestyle. Acquire habits for daily and regular physical exercise.
Content	The core of the program consists of sets of various kinesiology activities that can be divided into basic and special curriculum. Students choose them based on their interest, level of acquisition of motor skills, level of ability, health status and conditions available at the university or department. The basic program contains the following kinesiology activities (athletics, basketball, football, volleyball, dance structures, swimming, handball, table tennis...) while special programs consist of activities that were less represented in the primary and secondary school curricula (ice skating, fitness, aerobics, beach volleyball, hiking tours, tennis, karate, teakwando, squash, bowling...).
Recommended literature	1. Pearl, B., Moran G. T. (2009). Trening s utezima, Gopal d.o.o, Zagreb
Additional literature	10. Caput – Jogunica, R., Bagarić I., Babić D., Ćurković S., Špehar N., Alikalfić V. Nastavni plan i program tjelesne i zdravstvene kulture u visokom obrazovanju (skripta). Zagreb, 2007. 11. Delija K., K. Pleša (2004). Vrednovanje u području edukacije. U V. Findak (ur.), 13. ljetna škola kineziologa Republike Hrvatske, Rovinj, 2004. (str. 22-28). Hrvatski kineziološki savez 12. Findak, V. (1999). Metodika tjelesne i zdravstvene kulture. Zagreb: Školska knjiga 13. Findak, V. (2004). Vrednovanje u području edukacije, sporta i sportske rekreacije. U V. Findak (ur.), 13. ljetna škola kineziologa Republike Hrvatske, Rovinj, 2004. (str. 12-20). Hrvatski kineziološki savez 14. Janković, V., N. Marelić (1995). Odbojka. Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu. Milanović, D. (ur.) (1996). Fitnes. Zbornik radova međunarodnog znanstveno-stručnog savjetovanja of fitnesu, 5. zagrebački sajam sporta, Fakultet za fizičku kulturu, Zagreb 15. Jukić I., G. Marković (2005). Kondicijske vježbe s utezima. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu. 16. Mišigoj-Duraković, M. (2008). Kinantropologija. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu. 17. Volčanšek, B. (1996). Sportsko plivanje. (Udžbenik)Fakultet za fizičku kulturu, Zagreb. 18. Vukić, Ž., Jančić S., Vukić Ž. (1997). Model ustroja nastave tjelesne i zdravstvene kulture i športa na visokim učilištima (skripta). Osijek, Ekonomski fakultet Osijek.

Forms of teaching	Practical training at different sports locations		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	2
total	-	-	30
Methods of testing knowledge and taking exams	Regular attendance at practical training (80% attendance)		
Language of teaching and possibilities of following in other languages	Croatian language (language of learning and teaching). English and German language (possible for actively monitoring class)		
The method of monitoring the quality and performance of each course and/or module	Anonymous survey		

Course title	Inorganic Chemistry 1		
Code	K1127		
Status	Lectures/seminars		
Level	mandatory		
Year	2.	**Semester**	3.
ECTS	5		
Lecturer	Elvira Kovač-Andrić, Ph.D., Associate Professor		
Course objective	Understand the chemical reactivity of elements, properties and composition of chemical substances, similarities and differences between inorganic compounds and the change of inorganic substances in different physical and chemical conditions.		
Prerequisites	General Chemistry 1 and completed obligations for General Chemistry 2		
Learning outcomes:	1. Integrate knowledge about the atomic structure between the elements of the main groups and their peculiarities. 2. Compare the chemical and physical properties of the first element of the group in relation to the remaining elements. 3. To predict methods of obtaining elements and compounds of *s*- and *p*-blocks. 4. To establish similarities and differences in the structures and properties of hydrides, oxides, carbides, borides and halides of elements. 5. Evaluate the types of bonds and intermolecular interactions in inorganic compounds. 6. Comment on the names of compounds in accordance with inorganic nomenclature. 7. To apply chemical calculus in solving problem tasks.		

<table>
<tr><td>Correlation of learning outcomes, teaching methods and evaluation</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Students activity</th><th rowspan="2">Methods of evaluation</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>0,5</td><td>1-7</td><td>Class attendance</td><td>Evidence list</td><td>9</td><td>10</td></tr>
<tr><td>Knowledge test (preliminary exam)</td><td>2,5</td><td>1-7</td><td>Preparation for written examination</td><td>Written preliminary exam</td><td>25</td><td>50</td></tr>
<tr><td>Final exam</td><td>2</td><td>1-7</td><td>Repetition of teaching materials</td><td>Oral exam (and written exam)</td><td>20</td><td>40</td></tr>
<tr><td>Total</td><td>5</td><td>1-7</td><td></td><td></td><td>54</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>According to the agreement with the students</td></tr>
<tr><td>Gained competencies</td><td>Understanding the chemistry of main group elements and transition metals.</td></tr>
<tr><td>Content (Course curriculum)</td><td>Introduction to inorganic chemistry - origin of elements, representation of elements in nature, classification. Chemistry of elements of the main groups (chemical and physical properties of an individual element, its preparation and compounds, and properties of compounds from the point of view of the structure and nature of the chemical bond): hydrogen, alkaline and alkaline earth elements, boron and elements of group 13, carbon and elements of group 14, nitrogen and elements of group 15, oxygen and elements of group 16, halogen elements and noble gases. Chemistry of transition elements. In the course of the seminar, the lecture material is determined through the solving of tasks.</td></tr>
<tr><td>Recommended reading</td><td>1. F.A. Cotton, G. Wilkinson and P.L. Gaus, Basic Inorganic Chemistry, 3. izd., John Wiley & Sons, New York, 1995.
2. Filipović i S. Lipanović, Opća i anorganska kemija, 9. izd., Školska knjiga, Zagreb, 1995.
3. D. Grdenić, Molekule i kristali, 5. izd., Školska knjiga, Zagreb, 2005.
G. Rayner-Canham, T. Overton, Descriptive Inorganic Chemistry, Freeman & Co., New York, 2006.</td></tr>
<tr><td>Additional reading</td><td>1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6. izd., John Wiley & Sons, New York, 1999.
2. D.F. Shriver, P.W. Atkinson, Inorganic Chemistry, 4. izd., Oxford University Press, Oxford, 2006.
E. Rodgers, Descriptive Inorganic, Coordination, and Solid State Chemistry, 2. izd., Brooks Cole, Belmont, 2002.</td></tr>
<tr><td>Instructional methods</td><td>Lectures and seminars that are obligatory. Quizzes and homework related to the lecture material will be given regularly. Mid-term exam.</td></tr>
<tr><td>Teaching type</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td>2</td><td>2</td><td>-</td></tr>
<tr><td>30</td><td>30</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>(hours per week) total</td><td></td></tr>
<tr><td>Exam formats</td><td>Written and oral exam after completion of all the lectures. The final grade is composed of: attendance and active participation in classes – 10%, mid-term exam – 50% (25 + 25), and final exam – 40%.</td></tr>
<tr><td>Language</td><td>Croatian
English</td></tr>
</table>

Quality control and successfulness follow up	Discussions with students and the anonymous students opinion poll.

Course name	English Language 1		
Code	K1208		
Type	Mandatory		
Level	Undergraduate University Study of Chemistry		
Year	1.	**Semester**	Winter
ECTS	2		
Lecturer	Mr.sc. Lidija obad		
The aim or purpose of the course	The improvement of four language skills with the special focus on reading. Foreign language teaching for special purposes introduces chemistry- related vocabulary and enables students to understand scientific texts and to be able to summerize them.		
Prerequisites for enrollment	Learning English as a foreign language in primary and secondary school.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. To interpret simple scientific texts and their key words 2. To apply different reading techiques 3. To integrate and to apply both language and chemistry knowledge in the understanding of different texts 4. To evaluate the relevant scientific literature 5. To apply the gained knowledge when writing a scientific paper		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0.20		**Class attendance**	**Attendance records**	10	20
Knowledge test (written colloquia)	0.30		**Preparation for the written exam**	**Written colloquium**	20	35
Final exam	1.50		**Repetition of study matter**	**Oral exam**	30	45
Total	2.00				60	100

Consultations	In agreement with students
Acquired competencies	Insight into specialized professional texts; the understanding of the structure and organization of specialized professional texts; the interpretation and the summary of key information
Content	Introduction to Chemistry, Chemical Changes, Acids and bases, The Chemical Laboratory Equipment, The Burner
Recommended literature	Lidija Obad, English for Students of Food Technology I; PTF Osijek, 2012.

Additional literature	Bujas, Englesko-hrvatski rječnik, Globus, 1999.		
Forms of teaching	lectures		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week) total	2		
	30		
Methods of testing knowledge and taking exams	Midterm exams; Written and oral examination		
Language of teaching and possibilities of following in other languages	English		
The method of monitoring the quality and performance of each course and/or module	Student Evaluation Questionnaire		

II. Year

III. Winter semester

Inorganic Chemistry 2 (ECTS 6)

Analytical Chemistry 2 (ECTS 5)

Analytical Chemistry, Laboratory 1 (ECTS 4)

Organic Chemistry 1 (ECTS 5)

Mathematical Methods in Chemistry (ECTS 4)

General Physics 2 (ECTS 6)

Elective Course 1* (ECTS 3)

Physical Education 3 (ECTS 1)

*Elective courses

Toxicology and Environmental Chemistry (ECTS 3)

Chemistry in Everyday Life (ECTS 3)

Introduction to Cell Biology (ECTS 3)

Course name	**Inorganic chemistry 2**		
Code	KD 1128		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Summer
ECTS	5		
Lecturer	Tomislav Balić, Ph.D., associate prof.		
The aim or purpose of the course	Acquaint students with basic knowledge about the structure and properties of complex compounds and organometallic compounds with special reference to the chemical bond between metals and ligands.		
Prerequisites for enrollment	Attended Inorganic Chemistry 1 course, passed General Chemistry 1 and General Chemistry 2 courses		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine the electronic structure of atoms, ions and molecules and the structure of crystalline substances. 2. Comment on the molecular structure of inorganic substances and the symmetry of molecules. 3. Determine the structure of the crystalline substance and the principles of the X-ray diffraction method. 4. Compare the structure of the most important types of complex compounds. 5. Argue the formation of bonds and properties of complex and organometallic compounds.		

	6. Justify the knowledge gained during the preparation of the seminar paper and solving problems tasks.
Relationship between learning outcomes, teaching methods and grading	

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0.5	1-6	**Class attendance**	**Attendance records**	7	10
Knowledge test (written colloquia)	1.5	1-6	**Preparation for the written exam**	**Written colloquium**	15	30
Seminars	1	6	**Seminar preparation**	Oral presentation	10	20
Final exam	2	1-6	**Repetition of study matter**	**Oral exam**	20	40
Total	5				54	100

Consultations	Consultations are held during the semester regarding both lecture and seminar topics, and preparation for written exams.
Acquired competencies	To acquire basic knowledge about the structure and properties of complex compounds, especially complex compounds with transition elements.
Content	Basic concepts of atomic and electronic structure, chemical bonds, molecular structures and crystals. Lewis structures, VSEPR theory, covalent bond and molecular symmetry. Theory of molecular orbitals for homonuclear and heteronuclear inorganic molecules. Structure of a solid, ionic and metallic bond. X-ray structural analysis. HSAB principle. Coordination chemistry, crystal field theory, magnetic and optical properties of complex compounds, nomenclature. Molecular orbital theory for complex compounds. Electronic spectrum of complex compounds. Basic reaction mechanisms in inorganic chemistry. Introduction to the chemistry of organometallic compounds. Coordination polymers and metal-organic frameworks. Introduction to Supramolecular Chemistry with reference to the chemistry of macrocyclic compounds, the fundamentals of ligand design. At seminars current topics in the field of inorganic chemistry are treated based on articles from scientific literature (students report the papers themselves), solving problems in Inorganic chemistry.
Recommended literature	1. C. E. Housecroft, A. G. Sharpe, Inorganic Chemistry, 4. izd., Pearson Edu., Edinburgh, 2012. 2. F.A. Cotton, G. Wilkinson, P.L. Gaus, Basic Inorganic Chemistry, 3. izd., John Wiley & Sons, New York, 1995. 3. G. L. Miessler, P. Fisher, D. Tarr, Inorganic Chemistry 5. izd., Pearson, Edinburgh, 2013. 4. D. Grdenić, Molekule i kristali, 5. izd., Školska knjiga, Zagreb, 2005.
Additional literature	1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6. izd., John Wiley & Sons, New York, 1999. 2. D.F. Shriver, P.W. Atkinson, Inorganic Chemistry, 4. izd., Oxford University Press, Oxford, 2006.

	3. S. Ašperger, Kemijska kinetika i anorganski reakcijski mehanizmi, HAZU, 1999. (or S. Ašperger, Chemical Kinetics and Inorganic Reaction Mechanisms, Springer, 2012.)
Forms of teaching	Lectures, student seminars and homework. Written (partial) exam in the middle of the semester and at the end of the semester.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	1	-
total	45	15	-

Methods of testing knowledge and taking exams	A written and oral exam during and after the lectures. The final grade consists of: regular attendance and active participation in classes - 10%, seminar work - 20%, exams in the middle of the semester and at the end of the semester - 30%, and success in the final exam – 40%.
Language of teaching and possibilities of following in other languages	Croatian, English
The method of monitoring the quality and performance of each course and/or module	Continuous communication between teachers and students, and an anonymous student survey

Course name	Analytical Chemistry 2		
Code	K1105		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	II.	**Semester**	Winter
ECTS	5		
Lecturer	Ružica Matešić-Puač, Ph.D., assistant prof.		
The aim or purpose of the course	Introduction to basic principles and application of separation methods and instrumental chemical analysis.		
Prerequisites for enrollment	Passed the course General Chemistry and completed the course Analytical Chemistry 1		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare the principles of instrumental methods used in the analysis of different samples; 2. Select an instrumental method suitable for the analysis of different samples; 3. Determine which instrumental methods are most commonly used; 4. Apply the adopted concepts to solving computational problems.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-4	**Class attendance**	**Attendance records**	20	30
Knowledge test (written colloquia)	2	1-4	**Preparation for the written exam**	**Written colloquium**	20	30
Final exam	2	1-4	**Repetition of study matter**	**Oral exam**	20	40
Total	5				60	100

Consultations	In agreement with the students.
Acquired competencies	Knowledge of basic features in instrumental analysis, recognition of instrumental analysis in science and everyday life.
Content	Separation techniques: introduction to analytical separations (precipitation, distillation, extraction, ion exchange), gas chromatography, high performance liquid chromatography (HPLC). Spectrochemical methods: introduction to spectrochemical methods, instrumentation for optical spectrometry, molecular absorption spectrometry (UV and VIS spectroscopy, IR spectroscopy), atomic spectroscopy. Electrochemical methods: introduction to electrochemistry, potentiometry, amperometry, voltammetry.
Recommended literature	D.A. Skoog, D.M. West i F.J. Holler,*Osnove analitičke kemije,* Školska knjiga, Zagreb,1999.
Additional literature	D.A. Skoog, F.J. Holler, A. Nieman:*Principles of Instrumental Analysis,*5th Edition, Saunders College Publishing, New York,1998.
Forms of teaching	Lectures, seminars and homework.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week) total	3	1	-
	45	15	-

Methods of testing knowledge and taking exams	The student is required to take 2 partial exams during classes. Passed the partial exam and enter the final grade with the final exam. The final grade consists of: regular attendance and active participation in classes -10%; seminar work and homework 20%, success in partial exams -20%; and success in the final exam-50%.
Language of teaching and possibilities of following in other languages	Croatian

The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	**Analytical Chemistry Laboratory 1**		
Code	K1106		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Winter
ECTS	4		
Lecturer	Mirela Samardžić Ph. D., Associate professor		
The aim or purpose of the course	Introduction to basic analytical techniques and procedures. Methods of separation of cations and anions. Application of classical methods of chemical analysis.		
Prerequisites for enrollment	Attended the Analytical Chemistry 1 course		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare qualitative and quantitative methods of chemical analysis. 2. Argue the methods of qualitative chemical analysis. 3. Select applicable classical methods of qualitative chemical analysis. 4. Choose the option of systematic qualitative analysis to detect cations and / or anions present in the sample, individually and in the mixture. 5. Recommend a successful qualitative analysis of inorganic salts and organic substances. 6. Argue the chemical reactions that take place in qualitative chemical analysis.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Attendance at laboratory exercises	1	1-6	**Class attendance**	**Records**	20	30
Knowledge test (written colloquia)	2	1-6	**Preparation for the written exam**	**Written colloquium**	30	40
Final exam	1	1-6	**Repetition of study matter**	**Oral exam**	10	30
Total	4				60	100

Consultations	Tuesdays, 10-12 pm or in agreement with the students.
Acquired competencies	The student will be able to perform qualitative chemical analyses independently.
Content	1. Qualitative analysis of I. and II. groups of cations, individually; 2. Qualitative analysis of I. and II. groups of cations, in the mixture; 3. Qualitative analysis of III. and IV. groups of cations, individually; 4. Qualitative analysis of V. and VI. groups of cations, individually;

	5. Qualitative analysis of I. — VI. groups of cations, in the mixture; 6. Qualitative analysis of I. — III. groups of anions, individually; 7. Qualitative analysis of IV. and V. groups of anions, individually; 8. Qualitative analysis of solid inorganic salts; 9. Qualitative elemental organic analysis.
Recommended literature	R. Matešić-Puač, Praktikum iz analitičke kemije, internal script, Osijek, 1998., 1.-63.
Additional literature	M. Kaštelan-Macan, Kemijska analiza u sustavu kvalitete, Školska knjiga, Zagreb , 2003. Z. Šoljić, Kvalitativna kemijska analiza anorganskih tvari, FKIT, Zagreb, 2003.
Forms of teaching	Laboratory exercises, entrance colloquia, reports.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60

Methods of testing knowledge and taking exams	- Partial (entrance) colloquia; - Practical performance of the exercise, handling of equipment, adherence to precautionary measures and use of protective equipment, writing of work reports; - final written exam.
Language of teaching and possibilities of following in other languages	Croatian language (language of teaching) English language
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	Organic Chemistry 1		
Code	K1111		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Winter
ECTS	5		
Lecturer	Doc.dr.sc. Aleksandar Sečenji		
The aim or purpose of the course	Acquisition of basic knowledge of organic chemistry, the structure and reactivity of organic molecules, reaction mechanisms and stereochemistry.		
Prerequisites for enrollment	Passed the exam of the course General Chemistry		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare the types of bonds in organic compounds and describe the molecular structure. 2. Compare the hibridization of orbitals (carbon), and state the characteristics of single, double and triple bonds.		

<table>
<tr><td></td><td>3. Predict the physical and chemical properties and reactivity of organic compounds based on their structure.
4. Appoint hydrocarbon representatives based on the structural formula, identify and name functional groups of organic compounds, and draw the appropriate structural formula based on the systematic name.
5. Interpret the IR spectra of simple organic compounds.
6. Compare types of isomers. Identify constitutional isomers, and stereoisomers (enantiomers, diastereoisomers), associate the appropriate configuration labels with the isomers, and display the appropriate configuration and stereochemistry of the compound based on the label.
7. List the types of organic reactions and adopt the way of writing the reaction mechanism.
8. Sketch and explain the energy diagram of each reaction / mechanism.
9. Interpret and compare the reaction mechanisms of substitution (SN1, SN2), addition, elimination (E1, E2) and electrophilic aromatic substitution.
10. Solve problems related to the calculation of yield of organic reaction (calculate the yield; quantities of required reactants).</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>2</td><td>1-10</td><td>Class attendance</td><td>Attendance records</td><td>21</td><td>30</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1,5</td><td>1-10</td><td>Preparation for the written exam</td><td>Two written colloquiums</td><td>(10)
(10)</td><td>20
20</td></tr>
<tr><td>Final exam</td><td>1,5</td><td>1-10</td><td>Repetition of study matter</td><td>Writen exam
Oral exam</td><td>5
10</td><td>10
20</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>56</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students/ Mondays, 12-13 pm</td></tr>
<tr><td>Acquired competencies</td><td>Basic general knowledge in the field of organic chemistry, ability to apply knowledge in practice and to follow other (related) courses (acquired knowledge will be applied in courses of practical teaching of organic chemistry), problem solving (determination and presentation of stereochemistry), understanding of principles (mechanisms of organic reaction) and inference.</td></tr>
<tr><td>Content</td><td>Lectures:
Structure of organic molecules. Hybridization of atomic orbitals. Overview of hydrocarbons and functional groups; IR spectroscopy. Types of reactions of organic compounds. Nomenclature and stereochemistry of carbon compounds. Reaction mechanisms (nucleophilic substitution of SN1 and SN1; elimination of E1, E2, E1cB; addition reactions to alkenes and alkynes). Alkanes and cycloalkanes. Alkyl halides. Alkenes. Alkynes. Alcohols and ethers. Conjugated dienes. Benzene and reactions (electrophilic aromatic substitution).
Seminars:
Calculational examples, examples from the nomenclature of carbon compounds, stereochemistry and writing mechanisms.</td></tr>
<tr><td>Recommended literature</td><td>T.W. Solomons & C.B. Fryhle: Organic chemistry, 9th Edition, John Wiley and Sons, Inc., USA, 2008.
P.Y. Bruice: Organic chemistry, 4th Edition, Prentice Hall, USA, 2003.</td></tr>
</table>

	S. H. Pine: Organic Chemistry, Školska knjiga, Zagreb, 1994. V. Rapić: Nomenclature of Organic Compounds, Školska knjiga, Zagreb, 2004.
Additional literature	J. Clayden, N. Greeves, S. Warren and P. Wothers: Organic Chemistry, Oxford University Press, 2001. FA. Carey: Organic Chemistry, 5th Edition, McGraw-Hill, USA, 2003. Guide to the IUPAC nomenclature of organic compounds, translated by: Bregovec, Horvat, Majerski, Rapić, Školska knjiga, Zagreb, 2002.
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students. Seminars in which homework is discussed and students solve problems and tasks on the board and / or orally.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	1	-
total	45	15	-

Methods of testing knowledge and taking exams	Knowledge is tested during classes through a colloquium (2). The first colloquium is taken in the 8th week of classes, and the second colloquium is taken in the penultimate week of classes. The final exam is taken in writing and orally.
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction). English language.
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	Mathematical methods in chemistry		
Code	K1122		
Type	Lectures (2 hours per week) + Seminar (2 hours per week)		
Level	primary		
Year	2nd	**Semester**	winter
ECTS	5 ECTS points		
Lecturer	Vlatka Gvozdić, PhD, associate professor		
The aim or purpose of the course	Educate students with the mathematical tools needed to understand further study programs in the senior years of Chemistry studies		
Prerequisites for enrollment	Passed exams in the courses Mathematics 1 and Mathematics 2		
Learning outcomes	**After successfully completing the course, the student will be able to:** 1. Apply linear algebra in chemistry; 2. Apply numerical methods in chemistry; 3. Apply probability theory and combinatorics in chemistry; 4. Integrate theoretical knowledge with experimental data processing; 5. Determine the symmetry of molecules;		

	6. Choose ways to solve more mathematically demanding chemical problems with the help of computers.

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-6	**Class attendance**	**Attendance records**	9	10
Knowledge test (written colloquia,)	2	1-6	**Preparation for the written exam**	**Written colloquium 1** **Written colloquium 2**	12 12	25 25
Final exam	2	1-6	**Repetition of study matter**	**Written and Oral exam**	20	40
Total	5				53	100

Consultations	In agreement with the students
Acquired competencies	Knowledge of more advanced mathematical methods in chemistry: 1. Vector algebra; 2. Vector spaces; 3. Matrices and determinants; 4. Solving systems of linear equations; 5. Numerical solution of nonlinear equations; 6. Determination of eigenvalues and eigenvectors of linear operators; 7. Molecule symmetry operators; 8. Fundamentals of probability theory and mathematical statistics; 9. Error progression and processing of numerical results of physical measurements. 10. Applications in chemistry
Content	**Vector spaces**: definition of vector space, dimensions and bases of vector space, linear dependence, representation of vectors in base, coordinate system, vector products, vector projection, Gram-Schmidt orthogonalization. **Matrices and determinants**: matrix concept, linear combination of matrices, transposition and adjunction, matrix representation of vectors and operators, determinant, Laplace development, properties of determinant, permanent. **Rank and inverse matrix:** inverse matrix, elementary operations with matrices, rank of matrix, determination of rank of matrix and inverse matrix. **Systems of linear equations**: homogeneous and inhomogeneous system, vector and matrix notation, system solution, geometric interpretation of the solution, Gauss-Jordan elimination, Cramer's rule, LU decomposition. **Eigenvectors and eigenvalues**: eigenvalue equation, eigenvectors, degeneration, matrix diagonalization, eigenvalue equation in chemistry **Operators**: notion of operator, basic properties of operator, Dirac bracket notation, linear operators, Hermitian operators, Schrödinger equation. **Molecule symmetry:** concept and importance of symmetry, symmetry elements and operators, group points, molecule classification, molecule orientation in the coordinate system, simple applications of symmetry in chemistry. **Approximate numbers**: sources of errors, significant digits, rounding, errors of computational operations and functions, error progression. **Nonlinear equations**: graphical and numerical methods of analysis: solution isolation, halving method, Newton-Raphson method, secant method, successive approximation method. **Probability theory**: classical definitions of probability, axiomatic

	definition of probability, conditional probability, total probability, Bayesian formula, basics of combinatorics, sequential counting theorem, variations, permutations, combinations. **Basics of statistics**: descriptive statistics, measures of central tendency, measures of variability, sampling and graphical presentation of data, applied statistics, parametric tests, nonparametric tests. **Discrete random variables**: random variables, probability function, cumulative distribution function, distribution moments, uniform distribution, Bernoulli experiments, binomial distribution, Poisson distribution, hypergeometric distribution, estimates of distribution parameters. **Continuous random variables**: probability density function, cumulative distribution function, distribution moments, continuous uniform distribution, Gaussian distribution, exponential distribution, estimates of distribution parameters. **Regression analysis**: linear regression and correlation, confidence intervals, nonlinear regression, multiple regression. **Methods of time series analysis**: trend, spectral analysis of time series, Fourier transform. **Applications of linear algebra**: multivariate methods of data analysis.
Recommended literature	1. S. Kurepa: Uvod u linearnu algebru, Školska knjiga, Zagreb 1975. 2. L. Klasinc, Z. Maksić i N. Trinajstić: Simetrija molekula, Školska knjiga, Zagreb 1979. 3. M.Benšić, N.Šuvak:Uvod u vjerojatnost I statistiku, Sveučilište J.J. Strossmayera , Odjel za matematiku, Osijek 2014. 4. P. Atkins, J. de Paula: Physical Chemistry, 8th Ed., Oxford University Press, 2007.
Additional literature	1. P. Atkins and R. Friedman: Molecular Quantum Mechanics, 4th Ed., Oxford University Press, 2005. 2. A.Fulgosi: Faktorska analiza, Školska Knjiga, Zagreb, 1979.

Teaching	Lectures	Seminars	Exercises
(hours per week)	2	2	-
Total	30	30	-

Forms of teaching	Lectures with the use of technical aids and active participation of students in seminars in the computer classroom where students solve problems or tasks on computers.
Method of testing knowledge and taking exams	Knowledge is tested during classes through colloquia (2) and seminars. The first colloquium is taken in the 8th week of classes, and the second in the last week. By taking both colloquia during the semester, the student is released from the written part. The final exam consists of a written and an oral part.
Language of teaching and possibilities of following in other languages	Croatian as a language of instruction and English in the interpretation of specific content.
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys

Course name	General Physics 2
Code	K1204
Type	Mandatory
Level	Undergraduate university study of Chemistry

Year	2.	**Semester**	Winter
ECTS	6		
Lecturer	Igor Đerđ, PhD, Full professor		
The aim or purpose of the course	Introduce students to the fundamental premises and laws of physics (electromagnetism, optics, modern physics) as a holistic scientific view, that not only explains the most of natural phenomena, but also allows the prediction of new laws.		
Prerequisites for enrollment	None		
Learning outcomes	***After successfully completing the course the student will be able to:*** **1. Define basic physical quantities in electromagnetism, optics and modern physics** (electric: charge, force, field, potential, capacity, current, resistance, voltage. Magnetic: force, field, current, induction. Coil inductance, refractive index, …); **2. State and comment on the conditions of applicability of the most important laws in electromagnetism, optics and modern physics** (Coulomb's law, Gauss's law of electrostatics and magnetism, Ohm's law, Kirchoff's rules, Ampere's law, Biot-Savart's law, Faraday's law of electromagnetic induction, Lenz's law, Laws of geometric optics, Fermat's extreme principle, Schrödinger equation, …); **3. Apply basic laws to solve simple conceptual and numerical problems in electromagnetism, optics and modern physics;** **4. Explain the principles of operation of individual measuring instruments** (electroscope, ammeter, voltmeter, mass spectrometer, cyclotron, DC and AC generator, microscope, telescope, camera, diffraction grating, …); **5. Explain some interesting phenomena in the field of electromagnetism, optics and modern physics** (electrification of a body by rubbing and influencing, the formation of eddy currents in a coil, contraction of length and time dilation in relativistic physics, interference, diffraction and polarization of light, absorption and emission spectra, X-rays, waves of matter, …); **6. Derive mathematical expressions for some derived physical quantities** (capacitance for series and parallel connection of capacitors, resistance for series and parallel connection of resistors, magnetic field around a flat, infinitely long conductor, relativistic energy, wavelength of light source in Young's experiment, Bohr radius for hydrogen atom, …); **7. Derive some derived physical laws from the basic laws and principles** (capacity of a plate capacitor from Gauss's law of electrostatics, law of reflection and refraction from Fermat's extreme principle, …); **8. Evaluate the importance and application of basic physical laws in electromagnetism, optics and modern physics in objects and devices that we use in everyday life and to analyze the basic principles on which these devices work.**		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance			**Class attendance**	**Attendance records**		
Knowledge test (written colloquia)			**Preparation for the written exam**	**Written colloquium**		
Final exam	6	1-8	**Repetition of study matter**	**Oral exam**	2	5
Total	6	1-8			2	5

Consultations	Mondays, 10-12 am
Acquired competencies	Students will understand and learn the fundamental premises and laws of physics (electromagnetism, optics, modern physics) as a holistic scientific view, that not only explains the most of natural phenomena, but also allows the prediction of new laws.
Content	Electricity. Electroscope. Electrifying body by rubbing and influencing. Conductors and insulators. Electric force and Coulomb's law. Electric field and electric field current. Gauss's law of electrostatics. Electric potential energy and electric potential. Millikan's experiment. Electric capacity. Capacitors (plate capacitors, capacitor connection, plate capacitor energy, forces between capacitor plates). Electricity. Ohm's law. Electrical resistance. Electromotive force and circuit equation, Kirchhoff rules, RC circuit, measuring instruments (galvanometer, ammeter and voltmeter). Wheatstone bridge and potentiometer. Magnetic field, forces. Oersted's experiment. Force on charge in motion. Movement of an electric charge in a magnetic field. Magnetic force on a current-carrying conductor. Magnetic dipole moment and moment of force on a current loop. Mass spectrometer and cyclotron. Hall effect. Biot-Savart's law. Magnetic field around a straight, infinitely long conductor. Magnetic force between parallel conductors. Ampere's law. Magnetic flux. Gauss's law of magnetism. Displacement current and generalization of Ampere's law. Magnetization vectors and magnetic field strength. Classification of magnetic substances; ferromagnetism, paramagnetism and diamagnetism. Faraday's law of electromagnetic induction. EMI in a conductor moving in a magnetic field. Lenz's rule. Induced EMS and electric field. Eddy currents. Maxwell's equations. Plane electromagnetic waves and their properties. Electromagnetic radiation spectrum. Self-induction and coil inductance. RL circuit. Energy in a magnetic field. LC circuit oscillation. Energy transfer in the LC circuit - an analogy with a harmonic oscillator. RLC circuit. Alternating current generators, resistor, capacitor and coil in alternating current circuit, alternating RLC circuit, resonance in RLC circuit, power in alternating current circuit, current transformer. Motion relativity in classical mechanics, Galilean transformations of coordinates and velocities, Michelson-Morley experiment, Einstein relativity of motion, Lorentz transformations of space-time coordinates, length contraction and time dilation, twin paradox, relativistic energy, mass and energy equivalence. Optics, laws of geometric optics, Fermat's extreme principle, Total reflection, plane diopter, plane-parallel plate, optical prism, Dispersion of light, rainbow, colors. Flat mirror, spherical mirror, concave and convex spherical mirrors, image formation in spherical mirror, Image refraction on transparent diopters, thin lenses, image formation in thin lenses, lens conjugation equation, lens aberration, Optical devices (eye, binoculars, telescope) microscope, camera). Wave optics, Young's experiment, intensity distribution of interference fringes, thin-layer interference, Newtonian rings, diffraction from single slit, optical lattice, X-ray diffraction on crystal lattice, polarization (selective absorption, reflection). Black body radiation, Planck's law, Einstein's explanation of the photoelectric effect, emission and absorption line spectra, hydrogen spectrum, atom models, Rutherford's experiment and the discovery of the atomic nucleus, Bohr's atom model, X-ray discovery, Compton scattering, Fundamentals of wave mechanics, Schrödinger equation, de Broglie's Matter waves, Radioactive decay, Fission, Fusion, Basics of nuclear physics.
Recommended literature	1. P. Kulišić, V. Lopac, Elektromagnetske pojave i struktura tvari, Školska knjiga, Zagreb, 1991. 2. V. Henč-Bartolić et al., Riješeni zadaci iz valova i optike, Školska knjiga, Zagreb, 1992. 3. E. Babić, R. Krsnik, M. Očko, Zbirka riješenih zadataka iz fizike, Školska knjiga, Zagreb, 1985.
Additional literature	1. M. Paić, Osnove fizike II. dio – Elektromagnetizam, SNL, Zagreb, 1978. 2. M. Paić, Osnove fizike IV - Optika, Školska knjiga, Zagreb, 1994.

Forms of teaching	**Lectures** (method of presentation, conversation, demonstration - online experiments). **Seminars** (method of presentation, conversation, graphic method, method of solving numerical problems).		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	2	-
total	45	30	-
Methods of testing knowledge and taking exams	The exam consists of a written and an oral part: the written part of the exam contains 5 numerical (problem) tasks. Each task carries 1 point. To successfully pass the exam, it is necessary to solve two tasks completely accurately, while the accurate solution of each subsequent task brings 1 point more and one grade of the written part of the exam more. The oral part of the exam follows after successfully passing the written part, and consists of checking the knowledge of the course content through exam questions. The final grade is formed as the mean value of the grade of the written part of the exam and the oral part, unless the oral part of the exam is unsatisfactory**.**		
Language of teaching and possibilities of following in other languages	Croatian		
The method of monitoring the quality and performance of each course and/or module	By surveying students.		

Course name	Physical and health culture 1, 2, 3 and 4		
Code	K1210, K1211, K1212, K1213		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	1. and 2.	**Semester**	Winter and Summer
ECTS	1 ECTS point per semester		
Lecturer	Josip Cvenić, senior lecturer		
The aim or purpose of the course	Maintaining motor and functional abilities, and acquiring new motor and theoretical information in the field of physical and health culture		
Prerequisites for enrollment	There are no prerequisites		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare aerobic and anaerobic training. 2. Argument the influence of a particular exercise on a muscle group. 3. Choose the training option and load according to their own capabilities. 4. Measure their results and compare them with norms and other students. 5. Choose their own exercise program.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-5	**Class attendance**	**Attendance records**	15	30
Knowledge test (written colloquia)			**Preparation for the written exam**	**Written colloquium**		
Final exam			**Repetition of study matter**	**Oral exam**		
Total	1				15	30

Consultations	Thursdays 12.00 - 13.00 in cabinet no. 27 in the Department of Mathematics
Acquired competencies	Knowledge of basic forms of physical exercise and application in everyday life. Based on the initial condition, create a program with adapted kinesiology content. Adopt theoretical information about a healthy lifestyle, proper nutrition and the bad influence of a sedentary lifestyle. Acquire habits for daily and regular physical exercise.
Content	The core of the program consists of sets of various kinesiology activities that can be divided into basic and special curriculum. Students choose them based on their interest, level of acquisition of motor skills, level of ability, health status and conditions available at the university or department. The basic program contains the following kinesiology activities (athletics, basketball, football, volleyball, dance structures, swimming, handball, table tennis...) while special programs consist of activities that were less represented in the primary and secondary school curricula (ice skating, fitness, aerobics, beach volleyball, hiking tours, tennis, karate, teakwando, squash, bowling...).
Recommended literature	1. Pearl, B., Moran G. T. (2009). Trening s utezima, Gopal d.o.o, Zagreb
Additional literature	19. Caput – Jogunica, R., Bagarić I., Babić D., Ćurković S., Špehar N., Alikalfić V. Nastavni plan i program tjelesne i zdravstvene kulture u visokom obrazovanju (skripta). Zagreb, 2007. 20. Delija K., K. Pleša (2004). Vrednovanje u području edukacije. U V. Findak (ur.), 13. ljetna škola kineziologa Republike Hrvatske, Rovinj, 2004. (str. 22-28). Hrvatski kineziološki savez 21. Findak, V. (1999). Metodika tjelesne i zdravstvene kulture. Zagreb: Školska knjiga 22. Findak, V. (2004). Vrednovanje u području edukacije, sporta i sportske rekreacije. U V. Findak (ur.), 13. ljetna škola kineziologa Republike Hrvatske, Rovinj, 2004. (str. 12-20). Hrvatski kineziološki savez 23. Janković, V., N. Marelić (1995). Odbojka. Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu. Milanović, D. (ur.) (1996). Fitnes. Zbornik radova međunarodnog znanstveno-stručnog savjetovanja of fitnesu, 5. zagrebački sajam sporta, Fakultet za fizičku kulturu, Zagreb 24. Jukić I., G. Marković (2005). Kondicijske vježbe s utezima. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu. 25. Mišigoj-Duraković, M. (2008). Kinantropologija. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu. 26. Volčanšek, B. (1996). Sportsko plivanje. (Udžbenik)Fakultet za fizičku kulturu, Zagreb. 27. Vukić, Ž., Jančić S., Vukić Ž. (1997). Model ustroja nastave tjelesne i zdravstvene kulture i športa na visokim učilištima (skripta). Osijek, Ekonomski fakultet Osijek.

Forms of teaching	Practical training at different sports locations		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	2
total	-	-	30
Methods of testing knowledge and taking exams	Regular attendance at practical training (80% attendance)		
Language of teaching and possibilities of following in other languages	Croatian language (language of learning and teaching). English and German language (possible for actively monitoring class)		
The method of monitoring the quality and performance of each course and/or module	Anonymous survey		

Course name	**Toxicology and Environmental Chemistry**		
Code	K1304		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	2./3.	**Semester**	Winter/Summer
ECTS	3		
Lecturer	Mirela Samardžić Ph. D., Associate professor		
The aim or purpose of the course	Acquire knowledge about harmful substances and their impact on living beings and the environment.		
Prerequisites for enrollment	Enrolled in the second or third year of undergraduate study.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Argue what poisons are and how they can affect the body. 2. Recommend proper handling of harmful substances, and precautions and protection measures. 3. Classify toxic substances. 4. Recommend proper sampling for toxicological analysis. 5. Select the applicable method of extraction and detection of toxic substances. 6. Identify basic concepts in ecotoxicology. 7. Conclude about the dangers of certain harmful substances independently.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	0.5	1-7	**Class attendance**	**Attendance records**	5	10

	Discussion and seminars	0.5	1-7	**Preparation and solving problems**	**Oral presentation**	10	20
	Knowledge test (colloquia or final exam)	2	1-7	**Repetition of study matter**	**Two written colloquia or written exam**	45	70
	Total	3				60	100

Consultations	Consultations are available every week, during which the lectures are held, for 1 hour, in agreement with the students.		
Acquired competencies	Understanding the impact of harmful substances on living beings and the environment, and the importance of protection and proper handling of poisons, individual and team work, communication skills.		
Content	Lectures: Introduction to toxicology. Historical review of toxicology. Poison classification. Sampling. Extraction of toxins from the analysis material. Poison detection. Absorption, distribution, metabolism and excretion of toxicants. Toxicodynamic. Toxic substances. Inorganic substances. Gaseous poisons. Industrial organic chemicals. Medicines. Drugs. Pesticides. Poisons of living organisms. Ecotoxicology. Military toxicology. During the seminar, students present their seminar papers and assignments and discuss the given topic.		
Recommended literature	F. Plavšić, I. Žuntar, Uvod u analitičku toksikologiju, Školska knjiga, Zagreb, 2006. D. A. Wright, P. Welbourn, Environmental Toxicology, Cambridge Environmental Chemistry Series 11, Cambridge University Press, Cambridge, 2002.		
Additional literature	F. Plavšić, Bojite li se otrova?, Hrvatski zavod za toksikologiju, Zagreb, 2009. Hrvatski zavod za toksikologiju, Bez opasnih kemikalija se ne može, ali paziti se mora, Zagreb, 2008. S. Manahan, Toxicological Chemistry, Lewis publishers, Bocca Raton, 1992. Scientific papers.		
Forms of teaching	Lectures with the use of teaching aids (Power Point presentations) and active participation of students. Seminars where seminar papers and homework are presented and discussed, and students solve problems.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week) total	2	1	-
	30	15	-
Methods of testing knowledge and taking exams	Knowledge is tested during classes through two colloquia, the first of which is in the middle of the semester and the second at the end of the semester. If the student does not pass both colloquia or is not satisfied with the grades in the colloquia, he / she must take the final written exam. The final grade consists of: regular class attendance - 10%, seminar paper - 20% and two partial colloquia - 70% or final written exam - 70%.		
Language of teaching and possibilities of following in other languages	Croatian language.		
The method of monitoring the quality and performance of	Interviews with students and anonymous surveys.		

each course and/or module	

Course name	CHEMISTRY IN EVERYDAY LIFE		
Code	K1309		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Winter/Summer
ECTS	3		
Lecturer	Astrid Gojmerac Ivšić, Ph.D., associate prof.		
The aim or purpose of the course	Better understanding of living organisms, the environment and the world in which we live.		
Prerequisites for enrollment	Passed exams General Chemistry, Organic Chemistry 1 and Inorganic Chemistry 1		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare the daily activities of man with the chemical processes that take place in his environment; 2. Assess man's positive and negative impact on nature and natural processes; 3. Analyze relevant scientific literature; 4. Apply the adopted concepts to solve simpler problem tasks.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	0,5	1-4	**Class attendance**	**Attendance records**	8	10
Discussion, seminars and homework	1	1-4	Preparation and problem solving	Oral presentation	10	20
Knowledge test (written colloquia)	1	1-4	**Preparation for the written exam**	**Written colloquium**	15	30
Final exam	0,5	1-4	**Repetition of study matter**	**Oral exam**	20	40
Total	3				53	100

Consultations	In agreement with the students.
Acquired competencies	Knowledge of the properties and reactivity of materials, knowledge of the importance and methods of obtaining modern products used daily. Influence of material processing methods on use properties. Individual and group work, communication skills and independent literature search.
Content	Through examples from everyday life (medicines, detergents, plastics, food additives, cosmetics, fertilizers), selected problems and solutions, the importance

	and role of chemistry in criminology, ecology, technological processes, traffic, waste disposal and recycling, production will be presented. food and other activities. Better knowledge and understanding of chemistry and chemical laws, allows you to control the use of chemicals with maximum benefit and minimal harm associated with their use.
Recommended literature	J.W.Hill, *Chemistry for Changing Times,* McMillan Publishing Company, 1988 *Chemistry in context - Applying Chemistry to Society*, American Chemical Society ,1994.
Additional literature	H.C.Lee, R.E.Gaensslen, *Advances in Fingerprint Technology,* CRC Press, New York, 2001 *Svjetska iskustva u zbrinjavanju otpada*, Ministarstvo za zaštitu okoliša, Zagreb 1991. *Journal of Chemical Education*
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students (discussion and problem solving). Seminar papers.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-

Methods of testing knowledge and taking exams	Oral exam taken after the lectures. The final grade consists of: regular attendance and active participation in classes - 10%, seminar paper - 30%, and success in the final exam - 60%.
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction). English language.
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	**Introduction to cell biology**		
Code	K1310		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Winter/Summer
ECTS	3		
Lecturer	Assist. prof. Martina Šrajer Gajdošik, PhD		
The aim or purpose of the course	Introducing students to basic terms and knowledge about the structure and function of cells, the basic building blocks of all living organisms.		
Prerequisites for enrollment	None		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Propose the structure and function of cellular components 2. Distinguish the structure of prokaryotic and eukaryotic cells 3. Analyze the connection between structure and processes within cells and between individual cell organelles 4. Analyze individual phases of the cell cycle and their processes 5. Categorize different forms of membrane transport		

	6. Connect the acquired knowledge with biochemical processes in cells

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-6	**Class attendance**	**Attendance records**	10	20
Knowledge test (written colloquia)	1	1-6	**Preparation for the written exam**	**Written colloquium**	20	30
Final exam	1	1-6	**Repetition of study matter**	**Oral exam**	35	50
Total	3				65	100

Consultations	Wednesdays, 10 am-12 pm
Acquired competencies	Basic knowledge of the structure of prokaryotic and eukaryotic cells and the differences between them. Knowledge of the structure and function of individual cellular components as well as an understanding of their mutual relationships.
Content	Levels of biological organization, cellular organization in prokaryotes and eukaryotes. Cell compartmentalization, structure of biological membranes and their role. Forms of transport through the biomembrane. Structure and function of cellular organelles (ribosome, mitochondrion, endoplasmic reticulum, Golgi body, lysosomes, peroxisomes, chloroplast, vacuoles). Structure and function of the interphase nucleus: chromosomes, DNA and genes. Cell cycle. Cellular signaling.
Recommended literature	Alberts, A., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P., 2007: Molecular biology of the cell. 5th ed. Garland Science, New York – Abingdon. Cooper, G.M., Hausman, R.E., 2010: Stanica – molekularni pristup. Peto izdanje. (Urednik hrvatskog izdanja: Lauc, G.) Medicinska naklada Zagreb. Berg, J.M., Tymoczko, J.L., Stryer, L., prevoditelji: Weygand-Đurašević, I., Jernej, B., Kućan, Ž., 2013: Biokemija, 6. izd. (englesko), Školska knjiga, Zagreb.
Additional literature	Berg, J.M., Tymoczko, J.L., Stryer, L., 2006: Biochemistry, 6th ed., Freeman & Comp., New York. Nelson, D.L., Cox, M.M., 2000: Lehninger Principles of Biochemistry, 3rd ed., Worth Publishers, New York
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	-	-
total	45	-	-

Methods of testing knowledge and taking exams	Written and oral exam.
Language of teaching and possibilities of following in other languages	Croatian (language of teaching), English (possibility of following)

The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys

II. Year

IV. Summer semester

Inorganic Chemistry Laboratory 1 (ECTS 4)

Organic Chemistry 2 (ECTS 8)

Organic Chemistry, Laboratory 1 (ECTS 4)

Analytical Chemistry, Laboratory 2 (ECTS 4)

Physics Laboratory (ECTS 3)

Elective Course 2* (ECTS 3)

Physical Education 4 (ECTS 1)

*Elective courses

Toxicology and Environmental Chemistry (ECTS 3)

Chemistry in Everyday Life (ECTS 3)

Introduction to Cell Biology (ECTS 3)

Course name	Inorganic Chemistry Laboratory 1		
Code	K1110		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Summer
ECTS	4		
Lecturer	Anamarija Stanković, PhD, assistant prof.		
The aim or purpose of the course	To enable students for independent work in a laboratory through application of basic synthesis and analytical procedures and to predict the possible course of chemical reactions by consulting literature data.		
Prerequisites for enrollment	Passed exams from courses General Chemistry Laboratory 1 and 2, taken courses Inorganic Chemistry 1 and 2		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. explain possible coordinations of complex compounds based on oxido-reduction changes which take place in chemical reactions of inorganic compounds 2. compare observed changes which take place during coordination of ligand to metal cation 3. evaluate applicability of methods used for solving experimental problems and to be able to apply them in other areas of chemistry 4. analyze obtained products with analytical methods especially FTIR and TGA/DSC 5. correctly and independently perform experiment with taking care of all the regulatory precautions		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1,5	2-5	**Class attendance, independent participation with questions and suggestions, experimental work**	**Attendance records, evaluation of laboratory reports, analysis of obtained samples**	5	10
Periodical knowledge test (colloquia, oral and practical work)	2,5	1-5	**Preparation for performing laboratory exercises, taking part in written/oral/practical knowledge test during or before laboratory work**	**Written colloquium, records of completed exercises**	45	90
Final exam*	2,5	1-5	**Repetition of study matter and written and/or oral knowledge test**	**Written and/or Oral exam**	45*	90*
Total	4	1-5				

*This teaching activity takes place only if minimum number of points is not achieved in a certain time period in teaching activity : Periodical knowledge test.

Consultations

One hour after each exercise or according to previous agreement with the student.

Acquired competencies

Gathering practical and theoretical knowledge in Inorganic Chemistry which enables succesfull participation in similar courses and obtaining knowledge in higher years of study.

Content

1. METAL HALIDES
1.1. Preparation of copper (I) chloride, CuCl
1.2. Preparation of iron (III) chloride, $FeCl_3$
2. OXIDES; PEROXIDES AND PHOSPHATES
2.1. Preparation of barium peroxide octahydrate, $BaO_2 \cdot 8H_2O$
2.2. Preparation of calcium dihydrogenphosphate monohydrate, $Ca(H_2PO_4)_2 \cdot H_2O$
3. CARBOXYLATE METAL COMPOUNDS AND COMPLEXES WITH AMINO ACIDS
3.1. Preparation of tetrakis (μ-acetato)diaquadicopper (II), $[Cu(OCOCH_3)_2(H_2O)]_2$
3.2. Preparation of basic zinc acetate, $Zn_4O(OCOCH_3)_6$
4. CLATHRATES AND ION EXCHANGERS
4.1. Preparation of hydroquinone-sulphur (IV) oxide, $xC_6H_4(OH)_2 \cdot ySO_2$
4.2. Preparation of chloride hexahydrate, $Cl_2 \cdot 6H_2O$
4.3. Preparation of thiocyanic acid, HSCN
4.3.1. Determination of thiocyanic acid concentration by titration with mercuric (II) nitrate solution, $Hg(NO_3)_2$
5. β-DIKETO COMPLEXES OF TRANSITION METALS
5.1. Preparation of oxobis(2,4-pentanedionato)vanadium(IV), $[VO(C_5H_7O_2)_2]$

	5.2. Preparation of bis(2,4-pentanedionato)manganese (II), $[Mn(C_5H_7O_2)_2]_3$ 6. IDENTIFICATION OF COMPLEXES WITH INFRARED SECTROSCOPY
Recommended literature	1. M. Cindrić, Z. Popović, V. Vrdoljak, Priprava anorganskih spojeva (Upute za internu upotrebu u praktikumu iz anorganske kemije), Zagreb 2007. 2. F. A. Cotton, G. Wilkinson, P. L. Gaus, *Basic Inorganic Chemistry*, 3rd. ed., John Wiley & Sons., New York, 1995. 3. C. E. Housecroft and A. G. Sharpe, *Inorganic Chemistry*, Pearson Education Limited, 2nd Ed., Harlow, England, 2005, str. 922–924. 4. D. A. Johnson, *Some thermodynamic aspects of inorganic chemistry*, Cambridge University Press, 2nd Ed., Cambridge, England, 1982.
Additional literature	1. D. Grdenić, Molekule i kristali, 4. izd., Školska knjiga, Zagreb, 1987.
Forms of teaching	Independent and group laboratory excersises. Mandatory entering colloquium, reports of completed exercises.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60

Methods of testing knowledge and taking exams	Written exam after completing all exercises. Final grade consits of average value of grades for each exercise (colloquia, results and experimental work - 70%) and result on final exam (30 %).
Language of teaching and possibilities of following in other languages	Croatian (language of teaching). English (possibility of following).
The method of monitoring the quality and performance of each course and/or module	Talking to students and anonymous questionnaires.

Course name	Organic Chemistry 2		
Code	K1112		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Summer
ECTS	8		
Lecturer	Nela Malatesti, Ph.D., Assist. prof.		
The aim or purpose of the course	Acquiring basic knowledge of organic chemistry, the structure and reactivity of organic molecules, reaction mechanisms and stereochemistry with greater emphasis on natural compounds. Preparation for following courses in biochemistry and related fields.		
Prerequisites for enrollment	Confirmed attendance of the course Organic Chemistry 1.		

Learning outcomes

After successfully completing the course, the student will be able to:

1. Review spectroscopic methods that are important for the identification and characterization of organic compounds, interpret NMR (^{1}H and ^{13}C), MS and IR spectra.
2. Integrate physical and chemical properties and reactivity of organic compounds based on their structure.
3. Critically consider the reaction mechanisms of carbonyl compounds, review the most important reactions, and plan the mechanisms of pericyclic reactions, rearrangement reactions, free radicals and polymerization.
4. Compare amines, heterocyclic compounds, phenols and aryl halides, and predict their characteristics and reactions.
5. Review important natural compounds, their main characteristics, and critically evaluate (bio) synthesis reactions, significance and application.
6. Plan a simple organic synthesis of an organic compound based on retrosynthetic analysis, application of name reactions, and functional group transformations.
7. Analyze and self-evaluate the results published in the scientific literature.
8. Argument and present your independent work.

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	3	1-8	**Class attendance**	**Attendance records**	14	20
Presentation	1	5-8	**Preparation and production of Oral presentation**		6	10
Knowledge test (written colloquia)	2	1-8	**Preparation for the written exam**	**Written colloquium**	(10)	
Final exam	2	1-8	**Repetition of study matter**	**Oral exam**	(10)	20
Total	8				20	

Consultations

In agreement with the students/ Fridey, 12-14 pm

Acquired competencies

Basic general knowledge in the field of organic chemistry, ability to apply knowledge in practice and to follow other (related) courses (acquired knowledge will be applied in courses of practical teaching of organic chemistry), problem solving (determination and presentation of stereochemistry), understanding of principles (mechanisms of organic reaction) and reasoning, independent work, communication skills.

Content

Lectures:
NMR spectroscopy and mass spectrometry. Aldehydes and ketones. Reactions to the carbonyl group. Carboxylic acids and functional acid derivatives (nucleophilic acyl substitution). Enols and enolates. Amine. Diazonium salts. Phenols and aryl halides (nucleophilic aromatic substitution). Heterocyclic compounds. Polymers. Remodeling and cycloaddition reactions. Carbohydrates. Amino acids and proteins. Nucleic acids. Lipids.
Seminars:
Computational examples, examples from the nomenclature of carbon compounds, stereochemistry and reaction mechanisms. Student presentations.

Recommended literature	T.W. Solomons & C.B. Fryhle: Organic chemistry, 9th Edition, John Wiley and Sons, Inc., USA, 2008. P.Y. Bruice: Organic chemistry, 4th Edition, Prentice Hall, USA, 2003. S. H. Pine: Organska kemija, Školska knjiga, Zagreb, 1994. V. Rapić: Nomenklatura organskih spojeva, Školska knjiga, Zagreb, 2004.
Additional literature	J. Clayden, N. Greeves, S. Warren and P. Wothers: Organic Chemistry, Oxford University Press, 2001. F.A. Carey: Organic Chemistry, 5th Edition, McGraw-Hill, USA, 2003. Vodič kroz IUPAC-ovu nomenklaturu organskih spojeva, preveli: Bregovec, Horvat, Majerski, Rapić, Školska knjiga, Zagreb, 2002.
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students. Seminars in which homework is discussed and students solve problems and tasks on the board and / or orally. As part of the seminar, students will prepare and hold a presentation on one of the topics covered during the semester

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	4	2	-
total	60	30	-

Methods of testing knowledge and taking exams	Knowledge is tested during classes through a colloquium (2). The first colloquium is taken in the 8th week of classes, and the second colloquium is taken in the penultimate week of classes. Final exam is written and oral.
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction). English language (traceability).
The method of monitoring the quality and performance of each course and/or module	Discussions with students and the anonymous students opinion poll.

Course name	Organic Chemistry Practicum 1.		
Code	K1113		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Summer
ECTS	4		
Lecturer	Doc.dr.sc. Aleksandar Sečenji		
The aim or purpose of the course	Acquisition of basic knowledge and skills in the laboratory, introduction and application of methods of synthesis, isolation, purification and identification of organic compounds.		
Prerequisites for enrollment	Attend course Organic chemistry 1		

<table>
<tr><td>Learning outcomes</td><td>After successfully completing the course, the student will be able to:
1. Apply safety and precautionary measures when working in the (organic) laboratory and implement them.
2. Perform laboratory exercises independently according to regulations.
3. Set up apparatus for performing certain techniques and actions during organic synthesis, isolation and purification of products.
4. To connect theoretical knowledge acquired during lectures in organic chemistry with experimental work.
5. To conclude on the basis of the obtained results.
6. Record and interpret IR spectra.
7. Take notes and keep a laboratory diary.
8. Write reports on the performed exercises, present and explain the obtained results.
9. Calculate reaction yields.</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>2</td><td>1-7</td><td>Class attendance and successfully performed exercises</td><td>Records + Evaluation of results</td><td>26</td><td>50</td></tr>
<tr><td>Knowledge test (enterance colloquia)</td><td>1</td><td>1-9</td><td>Preparation for the entrance colloquium</td><td>Oral exam before performing the exercise</td><td>13</td><td>25</td></tr>
<tr><td>Reports</td><td>1</td><td>7-9</td><td>Writing and preparation of Reports</td><td>Report evaluation</td><td>13</td><td>25</td></tr>
<tr><td>Total</td><td>4</td><td></td><td></td><td></td><td>52</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students/ Friday, 12-14 pm</td></tr>
<tr><td>Acquired competencies</td><td>Application of theoretical knowledge of organic chemistry in practice, skills of performing experimental work in the laboratory, ability to solve problems, reasoning based on the obtained results, independent work, team work (group work) and responsibility, communication skills.</td></tr>
<tr><td>Content</td><td>Introductory exercises (extraction, recrystallization, determination of melting temperature; steam distillation; chromatography). Determination of the rate constant of a chemical reaction. Esterification. Electrophilic aromatic substitution (nitrosation, sulfonation). Reduction. Oxidation.</td></tr>
<tr><td>Recommended literature</td><td>S. H. Pine: Organic Chemistry, Školska knjiga, Zagreb, 1994.

V. Rapić: Methods of preparation and isolation of natural compounds, Školska knjiga, Zagreb, 1994.

O. Kronja and S. Borčić: Practicum of Preparative Organic Chemistry, Školska knjiga, Zagreb, 2004.</td></tr>
<tr><td>Additional literature</td><td>J. Clayden, N. Greeves, S. Warren and P. Wothers: Organic Chemistry, Oxford University Press, 2001.

FA. Carey: Organic Chemistry, 5th Edition, McGraw-Hill, USA, 2003.

Guide to IUPAC nomenclature of organic compounds, translated by: Bregovec, Horvat, Majerski, Rapić, Školska knjiga, Zagreb, 2002</td></tr>
</table>

Forms of teaching	Laboratory exercises that include entrance colloquia before performing each exercise, performing the exercise itself, and writing a paper after successfully completing the exercise.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60
Methods of testing knowledge and taking exams	Knowledge is tested during classes through entrance exams and assessment of papers. The exercise cannot be performed until the entrance colloquium has been positively graded. The exercise is considered completed when the report for that exercise is positively evaluated. The student is required to do all the planned exercises. There is no final exam.		
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction). English language.		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.		

Course name	Analytical Chemistry 2 Practice		
Code	K1107		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	II.	**Semester**	Summer
ECTS	4		
Lecturer	Milan Sak-Bosnar, Ph.D., full prof.		
The aim or purpose of the course	Introduce students to the methods of quantitative chemical analysis.		
Prerequisites for enrollment	Analytical Chemistry 1 Practice completed.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Select a method suitable for sample analysis. 2. Apply methods of quantitative chemical analysis. 3. Compare the results obtained by analyzing the samples. 4. Apply the adopted concepts to solve computational problems.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	1	1-4	**Class attendance**	**Attendance records**	9	10

	Knowledge test (written colloquia)	2	1-4	**Preparation for the written exam**	**Written colloquium**	24	40
	Final exam	1	1-4	**Repetition of study matter**	**Oral exam**	30	50
	Total	4				65	100

Consultations	In agreement with the students/ Tuesday, 10-12 am
Acquired competencies	The student will be able to independently conduct qualitative chemical analyzes.
Content	Gravimetry: Gravimetric determination of sulphate, Volumetry: Neutralization reactions: Preparation and standardization of HCl, Determination of NaOH, Determination of NaOH and Na_2CO_3, Preparation and standardization of NaOH, Determination of acid in vinegar; Complexometry: Determination of Ca and Mg compl. titration with EDTA, Determination of zinc; Redox reactions: Zimmerman-Reinhardt determination of iron, H_2O_2 determination, Iodometric determination of copper, Iodimetric determination of arsenic; Precipitation reactions: Determination of bromide according to the Volhard method; Potentiometric titrations: Determination of H_3PO_4, Determination of halides, Spectrophotometry: Spectrophotometric determination of copper.
Recommended literature	Analytical Chemistry Practicum - Script for Internal Use
Additional literature	1. M. Kaštelan-Macan, *Kemijska analiza u sustavu kvalitete*, Školska knjiga, Zagreb, 2003. 2. D.A.Skoog, D.M.West i F.J.Holler, *Osnove analitičke kemije*, Školska knjiga, Zagreb
Forms of teaching	Laboratory exercises, Partial (entrance) colloquia, writing work diaries

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60

Methods of testing knowledge and taking exams	- Partial (entrance) colloquia, - Practical performance of the exercise, handling of accessories, observance of precautionary measures and use of protective equipment, writing work diaries, - Written final exam.
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction), English language.
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	Physics Laboratory		
Code	K1205		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	2nd	Semester	Summer
ECTS	2		
Lecturer	izv.prof.dr.sc. Vanja Radolić		
The aim or purpose of the course	The aim of this general physics laboratory course is to gain basic experimental skills by performing experiments relevant to the corresponding courses, learning about the interpretation and analysis of the measured data and writing lab reports. Computers are used in data analysis.		
Prerequisites for enrollment	To take this laboratory course, K1205, a student must have previously taken the lecture courses, *General Physics I* and *General Physics II*, K1203 and K1204, respectively.		
Learning outcomes	*After successfully completing the course:* 1st Students will be able to explain basic physical quantities in electromagnetism, optics and modern physics. 2nd Students will be able to discuss applicability of the relevant physical laws. 3rd Students will apply basic laws of physics for solving conceptual and numerical problems in electromagnetism, optics and modern physics. 4th Students will be able to describe basic principles of how the relevant experimental instruments operate. 5th Students will be able to explain selected phenomena of interest in the field of electromagnetism, optics and modern physics. 6th Students will derive equations for selected physical quantities. 7th Students will derive selected applications from the basic laws of physics. 8th Students will evaluate importance and applications of basic laws of physics in electromagnetism, optics and physics in the devices used in daily life.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	/	Performing the experiments	Class attendance	Attendance records	all	/
Oral knowledge test and written report	1.8	Conceptual and analytical knowledge	Preparation for the oral exam and written report	oral colloquim and marking the written report	45%	90%

	Final exam	0.2	Basic princil es.	Repetition of study matter	Written exam	5%	10%
	Total	2				50%	100%
Consultations	TBD						

Course name	Physical and health culture 1, 2, 3 and 4		
Code	K1210, K1211, K1212, K1213		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	1. and 2.	**Semester**	Winter and Summer
ECTS	1 ECTS point per semester		
Lecturer	Josip Cvenić, senior lecturer		
The aim or purpose of the course	Maintaining motor and functional abilities, and acquiring new motor and theoretical information in the field of physical and health culture		
Prerequisites for enrollment	There are no prerequisites		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare aerobic and anaerobic training. 2. Argument the influence of a particular exercise on a muscle group. 3. Choose the training option and load according to their own capabilities. 4. Measure their results and compare them with norms and other students. 5. Choose their own exercise program.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-5	**Class attendance**	**Attendance records**	15	30
Knowledge test (written colloquia)			**Preparation for the written exam**	**Written colloquium**		
Final exam			**Repetition of study matter**	**Oral exam**		
Total	1				15	30

Consultations	Thursdays 12.00 - 13.00 in cabinet no. 27 in the Department of Mathematics
Acquired competencies	Knowledge of basic forms of physical exercise and application in everyday life. Based on the initial condition, create a program with adapted kinesiology content. Adopt theoretical information about a healthy lifestyle, proper nutrition and the bad influence of a sedentary lifestyle. Acquire habits for daily and regular physical exercise.
Content	The core of the program consists of sets of various kinesiology activities that can be divided into basic and special curriculum. Students choose them based on their interest, level of acquisition of motor skills, level of ability, health status and conditions available at the university or department. The basic program contains the following kinesiology activities (athletics, basketball, football, volleyball, dance structures, swimming, handball, table tennis...) while special programs consist of activities that were less represented in the

	primary and secondary school curricula (ice skating, fitness, aerobics, beach volleyball, hiking tours, tennis, karate, teakwando, squash, bowling...).
Recommended literature	1. Pearl, B., Moran G. T. (2009). Trening s utezima, Gopal d.o.o, Zagreb
Additional literature	28. Caput – Jogunica, R., Bagarić I., Babić D., Ćurković S., Špehar N., Alikalfić V. Nastavni plan i program tjelesne i zdravstvene kulture u visokom obrazovanju (skripta). Zagreb, 2007. 29. Delija K., K. Pleša (2004). Vrednovanje u području edukacije. U V. Findak (ur.), 13. ljetna škola kineziologa Republike Hrvatske, Rovinj, 2004. (str. 22-28). Hrvatski kineziološki savez 30. Findak, V. (1999). Metodika tjelesne i zdravstvene kulture. Zagreb: Školska knjiga 31. Findak, V. (2004). Vrednovanje u području edukacije, sporta i sportske rekreacije. U V. Findak (ur.), 13. ljetna škola kineziologa Republike Hrvatske, Rovinj, 2004. (str. 12-20). Hrvatski kineziološki savez 32. Janković, V., N. Marelić (1995). Odbojka. Zagreb: Fakultet za fizičku kulturu Sveučilišta u Zagrebu. Milanović, D. (ur.) (1996). Fitnes. Zbornik radova međunarodnog znanstveno-stručnog savjetovanja of fitnesu, 5. zagrebački sajam sporta, Fakultet za fizičku kulturu, Zagreb 33. Jukić I., G. Marković (2005). Kondicijske vježbe s utezima. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu. 34. Mišigoj-Duraković, M. (2008). Kinantropologija. Zagreb: Kineziološki fakultet Sveučilišta u Zagrebu. 35. Volčanšek, B. (1996). Sportsko plivanje. (Udžbenik)Fakultet za fizičku kulturu, Zagreb. 36. Vukić, Ž., Jančić S., Vukić Ž. (1997). Model ustroja nastave tjelesne i zdravstvene kulture i športa na visokim učilištima (skripta). Osijek, Ekonomski fakultet Osijek.
Forms of teaching	Practical training at different sports locations

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	2
total	-	-	30

Methods of testing knowledge and taking exams	Regular attendance at practical training (80% attendance)
Language of teaching and possibilities of following in other languages	Croatian language (language of learning and teaching). English and German language (possible for actively monitoring class)
The method of monitoring the quality and performance of each course and/or module	Anonymous survey

Course name	**Toxicology and Environmental Chemistry**
Code	K1304
Type	Elective

<table>
<tr><td>Level</td><td colspan="3">Undergraduate university study of Chemistry</td></tr>
<tr><td>Year</td><td>2./3.</td><td>Semester</td><td>Winter/Summer</td></tr>
<tr><td>ECTS</td><td colspan="3">3</td></tr>
<tr><td>Lecturer</td><td colspan="3">Mirela Samardžić Ph. D., Associate professor</td></tr>
<tr><td>The aim or purpose of the course</td><td colspan="3">Acquire knowledge about harmful substances and their impact on living beings and the environment.</td></tr>
<tr><td>Prerequisites for enrollment</td><td colspan="3">Enrolled in the second or third year of undergraduate study.</td></tr>
<tr><td>Learning outcomes</td><td colspan="3">After successfully completing the course, the student will be able to:
8. Argue what poisons are and how they can affect the body.
9. Recommend proper handling of harmful substances, and precautions and protection measures.
10. Classify toxic substances.
11. Recommend proper sampling for toxicological analysis.
12. Select the applicable method of extraction and detection of toxic substances.
13. Identify basic concepts in ecotoxicology.
14. Conclude about the dangers of certain harmful substances independently.</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="3">
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>0.5</td><td>1-7</td><td>Class attendance</td><td>Attendance records</td><td>5</td><td>10</td></tr>
<tr><td>Discussion and seminars</td><td>0.5</td><td>1-7</td><td>Preparation and solving problems</td><td>Oral presentation</td><td>10</td><td>20</td></tr>
<tr><td>Knowledge test (colloquia or final exam)</td><td>2</td><td>1-7</td><td>Repetition of study matter</td><td>Two written colloquia or written exam</td><td>45</td><td>70</td></tr>
<tr><td>Total</td><td>3</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td colspan="3">Consultations are available every week, during which the lectures are held, for 1 hour, in agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td colspan="3">Understanding the impact of harmful substances on living beings and the environment, and the importance of protection and proper handling of poisons, individual and team work, communication skills.</td></tr>
<tr><td>Content</td><td colspan="3">Lectures: Introduction to toxicology. Historical review of toxicology. Poison classification. Sampling. Extraction of toxins from the analysis material. Poison detection. Absorption, distribution, metabolism and excretion of toxicants. Toxicodynamic. Toxic substances. Inorganic substances. Gaseous poisons. Industrial organic chemicals. Medicines. Drugs. Pesticides. Poisons of living organisms. Ecotoxicology. Military toxicology.
During the seminar, students present their seminar papers and assignments and discuss the given topic.</td></tr>
<tr><td>Recommended literature</td><td colspan="3">F. Plavšić, I. Žuntar, Uvod u analitičku toksikologiju, Školska knjiga, Zagreb, 2006.
D. A. Wright, P. Welbourn, Environmental Toxicology, Cambridge Environmental Chemistry Series 11, Cambridge University Press, Cambridge, 2002.</td></tr>
<tr><td>Additional literature</td><td colspan="3">F. Plavšić, Bojite li se otrova?, Hrvatski zavod za toksikologiju, Zagreb, 2009.
Hrvatski zavod za toksikologiju, Bez opasnih kemikalija se ne može, ali paziti se mora, Zagreb, 2008.
S. Manahan, Toxicological Chemistry, Lewis publishers, Bocca Raton, 1992.</td></tr>
</table>

	Scientific papers.		
Forms of teaching	Lectures with the use of teaching aids (Power Point presentations) and active participation of students. Seminars where seminar papers and homework are presented and discussed, and students solve problems.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	Knowledge is tested during classes through two colloquia, the first of which is in the middle of the semester and the second at the end of the semester. If the student does not pass both colloquia or is not satisfied with the grades in the colloquia, he / she must take the final written exam. The final grade consists of: regular class attendance - 10%, seminar paper - 20% and two partial colloquia - 70% or final written exam - 70%.		
Language of teaching and possibilities of following in other languages	Croatian language.		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.		

Course name	CHEMISTRY IN EVERYDAY LIFE		
Code	K1309		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Winter/Summer
ECTS	3		
Lecturer	Astrid Gojmerac Ivšić, Ph.D., associate prof.		
The aim or purpose of the course	Better understanding of living organisms, the environment and the world in which we live.		
Prerequisites for enrollment	Passed exams General Chemistry, Organic Chemistry 1 and Inorganic Chemistry 1		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare the daily activities of man with the chemical processes that take place in his environment; 2. Assess man's positive and negative impact on nature and natural processes; 3. Analyze relevant scientific literature; 4. Apply the adopted concepts to solve simpler problem tasks.		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>0,5</td><td>1-4</td><td>Class attendance</td><td>Attendance records</td><td>8</td><td>10</td></tr>
<tr><td>Discussion, seminars and homework</td><td>1</td><td>1-4</td><td>Preparation and problem solving</td><td>Oral presentation</td><td>10</td><td>20</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td>1-4</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>15</td><td>30</td></tr>
<tr><td>Final exam</td><td>0,5</td><td>1-4</td><td>Repetition of study matter</td><td>Oral exam</td><td>20</td><td>40</td></tr>
<tr><td>Total</td><td>3</td><td></td><td></td><td></td><td>53</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td>Knowledge of the properties and reactivity of materials, knowledge of the importance and methods of obtaining modern products used daily. Influence of material processing methods on use properties. Individual and group work, communication skills and independent literature search.</td></tr>
<tr><td>Content</td><td>Through examples from everyday life (medicines, detergents, plastics, food additives, cosmetics, fertilizers), selected problems and solutions, the importance and role of chemistry in criminology, ecology, technological processes, traffic, waste disposal and recycling, production will be presented. food and other activities. Better knowledge and understanding of chemistry and chemical laws, allows you to control the use of chemicals with maximum benefit and minimal harm associated with their use.</td></tr>
<tr><td>Recommended literature</td><td>J.W.Hill, Chemistry for Changing Times, McMillan Publishing Company, 1988
Chemistry in context - Applying Chemistry to Society, American Chemical Society ,1994.</td></tr>
<tr><td>Additional literature</td><td>H.C.Lee, R.E.Gaensslen, Advances in Fingerprint Technology, CRC Press, New York, 2001
Svjetska iskustva u zbrinjavanju otpada, Ministarstvo za zaštitu okoliša, Zagreb 1991.
Journal of Chemical Education</td></tr>
<tr><td>Forms of teaching</td><td>Lectures with the use of technical aids (Power Point presentations) and active participation of students (discussion and problem solving). Seminar papers.</td></tr>
<tr><td>Teaching type</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td>2</td><td>1</td><td>-</td></tr>
<tr><td>30</td><td>15</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>(hours per week) total</td><td></td></tr>
<tr><td>Methods of testing knowledge and taking exams</td><td>Oral exam taken after the lectures. The final grade consists of: regular attendance and active participation in classes - 10%, seminar paper - 30%, and success in the final exam - 60%.</td></tr>
<tr><td>Language of teaching and possibilities of</td><td>Croatian language (language of instruction). English language.</td></tr>
</table>

following in other languages	
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	**Introduction to cell biology**		
Code	K1310		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	2.	**Semester**	Winter/Summer
ECTS	3		
Lecturer	Assist. prof. Martina Šrajer Gajdošik, PhD		
The aim or purpose of the course	Introducing students to basic terms and knowledge about the structure and function of cells, the basic building blocks of all living organisms.		
Prerequisites for enrollment	None		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Propose the structure and function of cellular components 2. Distinguish the structure of prokaryotic and eukaryotic cells 3. Analyze the connection between structure and processes within cells and between individual cell organelles 4. Analyze individual phases of the cell cycle and their processes 5. Categorize different forms of membrane transport 6. Connect the acquired knowledge with biochemical processes in cells		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	1	1-6	**Class attendance**	**Attendance records**	10	20
Knowledge test (written colloquia)	1	1-6	**Preparation for the written exam**	**Written colloquium**	20	30
Final exam	1	1-6	**Repetition of study matter**	**Oral exam**	35	50
Total	3				65	100

Consultations	Wednesdays, 10 am-12 pm
Acquired competencies	Basic knowledge of the structure of prokaryotic and eukaryotic cells and the differences between them. Knowledge of the structure and function of individual cellular components as well as an understanding of their mutual relationships.
Content	Levels of biological organization, cellular organization in prokaryotes and eukaryotes. Cell compartmentalization, structure of biological membranes and their role. Forms of transport through the biomembrane. Structure and function of cellular organelles (ribosome, mitochondrion, endoplasmic reticulum, Golgi body, lysosomes, peroxisomes,

	chloroplast, vacuoles). Structure and function of the interphase nucleus: chromosomes, DNA and genes. Cell cycle. Cellular signaling.		
Recommended literature	Alberts, A., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P., 2007: Molecular biology of the cell. 5th ed. Garland Science, New York – Abingdon. Cooper, G.M., Hausman, R.E., 2010: Stanica – molekularni pristup. Peto izdanje. (Urednik hrvatskog izdanja: Lauc, G.) Medicinska naklada Zagreb. Berg, J.M., Tymoczko, J.L., Stryer, L., prevoditelji: Weygand-Đurašević, I., Jernej, B., Kućan, Ž., 2013: Biokemija, 6. izd. (englesko), Školska knjiga, Zagreb.		
Additional literature	Berg, J.M., Tymoczko, J.L., Stryer, L., 2006: Biochemistry, 6th ed., Freeman & Comp., New York. Nelson, D.L., Cox, M.M., 2000: Lehninger Principles of Biochemistry, 3rd ed., Worth Publishers, New York		
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	-	-
total	45	-	-
Methods of testing knowledge and taking exams	Written and oral exam.		
Language of teaching and possibilities of following in other languages	Croatian (language of teaching), English (possibility of following)		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys		

III. Year

V. Winter semester

Organic Chemistry, Laboratory 2 (ECTS 4)

Physical Chemistry 1 (ECTS 6)

Physical Chemistry, Laboratory 1 (ECTS 4)

Biochemistry 1 (ECTS 4)

Inorganic Chemistry Laboratory 2 (ECTS 4)

History of Chemistry (ECTS 3)

Elective Course 3* (ECTS 3)

Final Exam (ECTS 2)

*Elective Courses

Atmospheric Chemistry (ECTS 3)

Chemistry of Natural Organic Compounds (ECTS 3)

Active Substances in Madicinal Herbs (ECTS 3)

Course name	Atmospheric Chemistry		
Code	K1305		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Summer
ECTS	3		
Lecturer	Elvira Kovač-Andrić, Ph.D., Assistant Professor		
The aim or purpose of the course	Acquisition of basic knowledge about the atmosphere around us, pollution and consequences		
Prerequisites for enrollment			
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Integrate concepts about the development and properties of the atmosphere. 2. Assess the significance of the chemical species present in the air and their interdependence. 3. Predict the mechanisms of chemical reactions that affect the level of chemical species present in the atmosphere. 4. Assess what causes atmospheric pollution and what are the consequences for the environment.		

	5. Critically judge how man can affect the atmosphere and the environment. 6. Critically evaluate the relevant scientific literature.

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0,5	1-6	**Class attendance**	**Attendance records**	8	10
Knowledge test (written colloquia)	1	1-6	**Preparation for the written exam**	**Written colloquium**	20	40
Final exam	1,5	1-6	**Repetition of study matter**	**Oral exam**	30	50
Total	3				58	100

Consultations	In agreement with the students/ Mondays, 8-10 pm
Acquired competencies	Knowledge of the properties and reactivity of atmospheric microconstituents, to know their significance and interdependence. Influence of meteorological parameters on microconstituents in the atmosphere. Individual and group work, communication skills and independent literature search.
Content	Lectures - units according to teaching weeks: 1. Evolution and changes in the atmosphere and climate. Chemical composition. 2. Colloids, aerosols, clouds. 3. Cyclic processes (carbon, oxygen, nitrogen, sulfur). 4. The connection between the biosphere and the atmosphere. 5. Photochemical processes, chemical kinetics applied to the atmosphere. 6. Ozone in the Earth's atmosphere. 7. Catalytic cycles. 8. Sources and consequences of atmospheric pollution. 9. Earth's troposphere. Transport. Chemical and photochemical reactions. 10. Ozone formation in the troposphere. 11. Impacts of ozone in the troposphere and consequences. 12. Air pollution. Sources of pollution, types of pollutants and their impact (climate, environment, health, etc.). 13. Polar ozone holes. Global warming. Acid rain. 14. Human impact on air pollution, consequences, prevention (legislation). Ions in the atmosphere. 15. Radon and descendants. Monitoring. Seminar: 1. Chemical composition of the atmosphere 2 Colloids, aerosols, clouds 3. Greenhouse gases 4. The connection between the biosphere and the atmosphere 5. Cyclic processes (carbon, oxygen, nitrogen, sulfur) 6. Impacts of ozone in the troposphere and consequences

Recommended literature	1. R.P. Wayne, Chemistry of Atmospheres, 3. izd., Oxford, New York, 2001. 2. P. Fabian, environmental Science XIV, Atmosphäre und Umwelt, 4. izd., Springer Verlag, Berilin, 1992.		
Additional literature	1. L. Theodore and A. Buincore, Air Pollution Control Equipment, Springer Verlag, Berlin, 1994. 2. L.C. Jones, Topics in Environmental and Safety Aspects of Combustion Technology, Whittles Publishing, 1997. 3. R.L. Murray and J.A. Powell, Understanding Radioactive Waste, 4. izd., Batelle Press, 1994.		
Forms of teaching	Lectures and seminars are obligatory. Homework		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week) total	2	1	-
	30	15	-
Methods of testing knowledge and taking exams	Oral exam after completion of all the lectures and seminars.		
Language of teaching and possibilities of following in other languages	Croatian English		
The method of monitoring the quality and performance of each course and/or module	Discussions with students and the anonymous students opinion poll.		

Course name	Organic Chemistry Practicum 2.		
Code	K1114		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Wintter
ECTS	4		
Lecturer	Doc.dr.sc. Aleksandar Sečenji		
The aim or purpose of the course	Acquisition of basic knowledge and skills in the laboratory, introduction and application of methods of synthesis, isolation, purification and identification of organic compounds.		
Prerequisites for enrollment	Attend course Organic chemistry 2, and passed the courses Practicum of Organic Chemistry 1 and Organic Chemistry 1.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Apply safety and precautionary measures when working in the (organic) laboratory and implement them. 2. Perform laboratory exercises independently according to regulations. 3. Set up apparatus for performing certain techniques and actions during organic synthesis, isolation and purification of products. 4. To connect theoretical knowledge acquired during lectures in organic chemistry with experimental work. 5. To conclude on the basis of the obtained results. 6. Record and interpret IR spectra.		

	7. Take notes and keep a laboratory diary. 8. Write reports on the performed exercises, present and explain the obtained results. 9. Calculate reaction yields.

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	2	1-7	**Class attendance and successfully performed exercises**	**Records + Evaluation of results**	26	50
Knowledge test (enterance colloquia)	1	1-9	**Preparation for the entrance colloquium**	**Oral exam before performing the exercise**	13	25
Reports	1	7-9	**Writing and preparation of Reports**	**Report evaluation**	13	25
Total	4				52	100

Consultations	In agreement with the students/ Friday, 12-14 pm
Acquired competencies	Application of theoretical knowledge of organic chemistry in practice, skills of performing experimental work in the laboratory, ability to solve problems, reasoning based on the obtained results, independent work, team work (group work) and responsibility, communication skills.
Content	Grignard reaction. Cannizzar's reaction. Aldol condensation. Beckmann's remodeling. Isolation and conversion of natural compounds (Isolation of casein, lactose and albumin from milk; isolation of oleic acid from olive oil). Diels-Alder reaction.
Recommended literature	S. H. Pine: Organic Chemistry, Školska knjiga, Zagreb, 1994. V. Rapić: Methods of preparation and isolation of natural compounds, Školska knjiga, Zagreb, 1994. O. Kronja and S. Borčić: Practicum of Preparative Organic Chemistry, Školska knjiga, Zagreb, 2004.
Additional literature	J. Clayden, N. Greeves, S. Warren and P. Wothers: Organic Chemistry, Oxford University Press, 2001. FA. Carey: Organic Chemistry, 5th Edition, McGraw-Hill, USA, 2003. Guide to IUPAC nomenclature of organic compounds, translated by: Bregovec, Horvat, Majerski, Rapić, Školska knjiga, Zagreb, 2002
Forms of teaching	Laboratory exercises that include entrance colloquia before performing each exercise, performing the exercise itself, and writing a paper after successfully completing the exercise.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60

Methods of testing knowledge and taking exams	Knowledge is tested during classes through entrance exams and assessment of papers. The exercise cannot be performed until the entrance colloquium has been positively graded. The exercise is considered completed when the report for that exercise is positively evaluated. The student is required to do all the planned exercises. There is no final exam.
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction). English language.
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	Physical Chemistry 1		
Code	K1115		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	winter
ECTS	5		
Lecturer	Ph.D. Martina Medvidović-Kosanović, associate professor		
The aim or purpose of the course	Understanding the basics of thermodynamics and electrochemistry.		
Prerequisites for enrollment	Passed courses General Chemistry, Mathematics 1 and 2, Physiscs 1. Completed course Physics 2		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Distinguish ideal and real gases and be able to apply the perfect gas equation and the van der Waals equation, 2. Define expansion work, heat capacity, internal energy and enthalpy, 3. Calculate reaction enthalpies by using thermochemical laws, define entropy and Gibbs energy 4. Interpret phase diagrams (H_2O, He, CO_2) 5. Explain colligative properties 6. Calculate equilibrium constant value in chemical reactions, 7. Define basic electrochemical concepts and apply Nernst equation		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Knowledge test (written colloquia)	2,5	1-7	**Preparation for the written exam**	**Written colloquium**	40	50
Final exam	2,5	1-7	**Repetition of study matter**	**Oral exam**	20	50
Total	5				60	100

Consultations	In agreement with the students.

Acquired competencies	Application of the perfect gas equation and van der Waals equation on ideal and real gases. Applying chemical thermodynamics on chemical equilibrium to lead a chemical reaction in a wanted direction (e.g. the increase of a yield of wanted products). Understanding of the electrochemical concepts, application of the Nernst equation.
Content	The properties of gases, the first and the second law of thermodynamics, physical transformations of pure substances, phase diagrams, the properties of solutions, simple mixtures, thermodynamics of mixing, activity, chemical equilibrium, equilibrium electrochemistry, electrochemical cells, standard potentials.
Recommended literature	1. P.W. Atkins, J. de Paula, Physical Chemistry, Oxford University Press, Oxford, 2002., 2. R. Chang, J.W. Thoman, jr, Physical Chemistry for the Chemical Sciences, 1st Ed., University Science Books, Canada, 2014. 3. P.W. Atkins, M.J. Clugston, Načela fizikalne kemije, Školska knjiga, Zagreb, 1989
Additional literature	1. V. Simeon, Termodinamika, Školska knjiga, Zagreb, 1980., 2. T. Cvitaš, Temelji kvantne kemije i spektroskopije, Sveučilišna naklada Liber, Zagreb, 1976. 3. M. Herak, Lj. Kušec, M. Marković, A. Petreski, K. Škorić, D. Galas, Osnove fizikalne kemije, Školska knjiga, Zagreb, 1989.
Forms of teaching	Lectures with the active participation of students and seminars which include independent solving of numerical problems.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	2	-
total	45	30	-

Methods of testing knowledge and taking exams	Two colloquims are written during the course. The first coloquium is written in mid-semester and the second one at the end of semester. The final grade consists of: regular attendance and active participation in classes - 10%, two colloquiums - 40% (20 % + 20 %) and final exam – 50 % (25 % wriiten and 25 % oral exam).
Language of teaching and possibilities of following in other languages	Croatian English
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course title	**Physical chemistry practicum 1**		
Code	K1117		
Status	Laboratory excersises (4 hours per week)		
Level	elementary		
Year	III.	**Semestar**	the 5th
ECTS	4		
Lecturer	Ph. D. Martina Medvidović-Kosanović		

Course objective	Students should get familiar with some terms and laws of physical chemistry through individual practical work.
Prerequisites	General chemistry practicum 1 and 2, Analytical chemistry practicum 1 and 2
Learning outcomes:	**After successfully completed course, student will be able to:** 1. Plan and conduct experiments independently from the areas included in practicum 2. Process the experimentally obtained data (numerically and graphically) 3. Describe a certain experiment in a form of laboratory report 4. Make a conclusion regarding the investigated physical process

Correlation of learning outcomes, teaching methods and evaluation

Teaching activity	ECTS	Learning outcome	Students activity	Methods of evaluation	Points	
					min	max
Class attendance	1	1-4	**Class attendance**	**Evidence list**	-	-
Knowledge test (preliminary exam)	3	1-4	**Preparation for written examination**	**Written preliminary exam**	-	100
Total	4					100

Consultations	During laboratory excersises
Gained competencies	Usage of the necessary measuring instruments and data processing methods and presentation of the experimentally obtained results.
Content (Course curriculum)	Conductometry 1 (conductometric cell). Conductometry 2 (electrolyte conductivity). Potentiometry 1 (measuring pH). Potentiometry 2 (potentiometric titration NaOH with HCl). Spectrophotometry (Lambert-Beer law). Transition number (Hittorf). Calorimetry (enthalpy of neutralisation). Chemical kinetics (decay of hydrogen peroxide). Physical properties of liquids 1 (viscosity). Physical properties of liquids 2 (surface tension).
Recommended reading	1. Internal script 2. Laboratory reports for physical chemistry practicum 1
Additional reading	1. P.W. Atkins & J. de Paula, Atkins' Physical Chemistry, Oxford University Press, Oxford, 2002. 2. P.W. Atkins & M.J. Clugston, Načela fizikalne kemije, Školska knjiga, Zagreb, 1989. 3. M. Sikirica, Stehiometrija, Školska knjiga, Zagreb, 1985. 4. T. Cvitaš & N. Kallay, Fizičke veličine i jedinice Međunarodnog sustava, Školska knjiga, Zagreb, 1980.
Instructional methods	Individual laboratory excersises. Obligatory oral preliminary exams, fulfilling of the laboratory reports during laboratory work.
Exam formats	Oral preliminary exam before each excersise. Final mark is the result of the arithmetic mean of the average marks of each excersise. The average mark includes the result of oral preliminary exam, experimental laboratory work and fulfilled laboratory report for each excersise.
Language	Croatian (English)
Quality control and successfulness follow up	Student interviews and anonymous questionnaires

Course name	**Biochemistry 1**

Code	K1119		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Winter
ECTS	4		
Lecturer	Assist. prof. Martina Šrajer Gajdošik, PhD		
The aim or purpose of the course	To master the knowledge of the composition, structure and function including mutual connection of basic biological molecules - proteins and nucleic acids.		
Prerequisites for enrollment	Passed courses General Chemistry and Organic Chemistry 1. Attended course Organic Chemistry 2.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Connect the functional groups of biomolecules with their role. 2. Analyze levels in the structure of amino acids and proteins. 3. Predict the ionization state of amino acids and simple peptides in dependence on pH. 4. Propose the type of enzymatic catalysis and its mechanism. 5. Calculate and graphically present the parameters of the enzyme-catalyzed reaction. 6. Differentiate between types of inhibition and ways of regulating enzyme activity. 7. Determine the connection between the structure of informational macromolecules and the transmission of genetic information. 8. Analyze the processes of replication, transcription and translation.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-8	**Class attendance**	**Attendance records**	10	20
Knowledge test (written colloquia)	1	1-8	**Preparation for the written exam**	**Three written colloquium**	25	40
Final exam	2	1-8	**Repetition of study matter**	**Written exam Oral exam**	25	40
Total	4				60	100

Consultations	Wednesdays, 10 am-12 pm
Acquired competencies	Basic general knowledge in biochemistry. Understanding the relationship between structure and function of biological macromolecules. Knowledge of basic biochemical processes in the transmission of genetic information. Ability to apply knowledge in practice.
Content	Reversible molecular interactions, amino acids, peptide bonds, levels in the protein structure, prediction of spatial structure and possibilities of protein modification. Methods of protein isolation and purification. Catalytic properties of enzymes, free energy, activation energy, basic principles of enzyme kinetics, allosteric enzymes, enzyme inhibition, structure and function of enzyme cofactors and their vitamin precursors, catalytic (chymotrypsin, trypsin, carbonic anhydrase, restriction enzymes) and regulatory (cooperative transfer of oxygen by hemoglobin , isoenzymes, covalent modification, enzyme activation by proteolytic cleavage, blood clotting process) strategies. Structure of nucleotides and nucleic acids, flow of genetic information, genetic code, structure of

	eukaryotic genes, replication, recombination and DNA repair, RNA synthesis and splicing, protein synthesis, control of gene expression.		
Recommended literature	Berg, J.M., Tymoczko, J.L., Stryer, L., prevoditelji: Weygand-Đurašević, I., Jernej, B., Kućan, Ž., 2013: Biokemija, 6. izd. (englesko), Školska knjiga, Zagreb. Berg, J.M., Tymoczko, J.L., Stryer, L., 2006: Biochemistry, 6th ed., Freeman & Comp., New York.		
Additional literature	Berg, J.M., Tymoczko, J.L., Stryer, L., 2002: Biochemistry, 5th ed., Freeman & Comp., New York. Nelson, D.L., Cox, M.M., 2000: Lehninger Principles of Biochemistry, 3rd ed., Worth Publishers, New York		
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students. Seminars where students solve problems and tasks on the board and/or orally.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	1	–
total	45	15	–
Methods of testing knowledge and taking exams	Knowledge is exemined through 3 partial colloquia during classes. The final exam is taken in written form (if the student did not pass the partial colloquia) and orally.		
Language of teaching and possibilities of following in other languages	Croatian (language of teaching), English (possibility of following)		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys		

Course name	Inorganic Chemistry Laboratory 2		
Code	K1111		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Winter
ECTS	4		
Lecturer	Assist. prof. Anamarija Stanković		
The aim or purpose of the course	To enable students for independent work in a laboratory through application of basic synthesis and analytical procedures and to predict the possible course of chemical reactions by consulting literature data.		
Prerequisites for enrollment	Passed exam from course Inorganic Chemistry Laboratory 1		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. advise possible coordinations of complex compounds based on oxido-reduction changes which take place in chemical reactions 2. compare observed changes which take place during coordination of ligand to metal cation 3. evaluate applicability of methods used for solving experimental problems and to		

	be able to apply them in other areas of chemistry 4. analyze obtained products with analytical methods especially FTIR and TGA/DSC 5. correctly and independently perform complex synthesis with taking care of all the regulatory precautions
Relationship between learning outcomes, teaching methods and grading	

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1,5	2-5	**Class attendance, independent participation with questions and suggestions, experimental work**	**Attendance records, evaluation of laboratory reports, analysis of obtained samples**	5	10
Periodical knowledge test (colloquia, oral and practical work)	2,5	1-5	**Preparation for performing laboratory exercises, taking part in written/oral/practical knowledge test during or before laboratory work**	**Written colloquium, records of completed exercises**	45	90
Final exam*	2,5	1-5	**Repetition of study matter and written and/or oral knowledge test**	**Written and/or Oral exam**	45*	90*
Total	4	1-5				
*This teaching activity takes place only if minimum number of points is not achieved in a certain time period in teaching activity : Periodical knowledge test.						

Consultations	One hour after each exercise or according to previous agreement with the student.
Acquired competencies	Gathering practical and theoretical knowledge in Inorganic Chemistry which enables succesfull participation in similar courses and obtaining knowledge in higher years of study.
Content	1. METAL COMPLEXES WITH NITROGEN LIGANDS 1.1. Preparation of hexaminecobalt (III) nitrate, $[Co(NH_3)_6](NO_3)_3$ 1.1.1. Determination of the composition of the complex $[Co(NH_3)_6](NO_3)_3$ 1.2. Preparation of hexamminenickel (II) chloride, $[Ni(NH_3)_6]Cl_2$ 1.2.1. Determination of the composition of the complex $[Ni(NH_3)_6]Cl_2$ 2. THIOCYANATE COMPLEXES OF TRANSITION METALS 2.1. Preparation of tetramethylammonium dioxo tetrakis (tiocianato-*N*) molybdate (VI), $[(CH_3)_4N]_2[MoO_2(NCS)_4]$ 3. PREPARATION OF COMPLEXES Cr(II), Cr(V), Mo(V) AND Cu(I) WITH REDUCTION REACTIONS 3.1. Preparation of potassium tetraperoxochromate (V), $K_3[Cr(O_2)_4]$ 3.1.1. Determination of the composition of the complex $K_3[Cr(O_2)_4]$

	3.2. Preparation of tris (thiourea) copper (I) sulphate monohydrate, $[Cu\{SC(NH_2)_2\}_3]_2\ SO_4 \cdot H_2O$ 4. OXALATE METAL COMPLEXES 4.1. Preparation of potassium tris (oxalato) chromate (III) trihydrate, $K_3\ [Cr(C_2O_4)_3] \cdot 3H_2O$ 6.1.1. Determination of the composition of the complex $K_3[Cr(C_2O_4)_3] \cdot 3H_2O$ 5. IDENTIFICATION OF COMPLEXES WITH INFRARED SPECTROSCOPY 6. THERMAL ANALYSIS
Recommended literature	1. M. Cindrić, Z. Popović, V. Vrdoljak, Priprava anorganskih spojeva (Upute za internu upotrebu u praktikumu iz anorganske kemije), Zagreb 2007. 2. F. A. Cotton, G. Wilkinson, P. L. Gaus, *Basic Inorganic Chemistry*, 3rd. ed., John Wiley & Sons., New York, 1995. 3. C. E. Housecroft and A. G. Sharpe, *Inorganic Chemistry*, Pearson Education Limited, 2nd Ed., Harlow, England, 2005, str. 922–924. 4. D. A. Johnson, *Some thermodynamic aspects of inorganic chemistry*, Cambridge University Press, 2nd Ed., Cambridge, England, 1982.
Additional literature	1. D. Grdenić, Molekule i kristali, 4. izd., Školska knjiga, Zagreb, 1987.
Forms of teaching	Independent and group laboratory excersises. Mandatory entering colloquium, reports of completed exercises.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60

Methods of testing knowledge and taking exams	Written exam after completing all exercises. Final grade consits of average value of grades for each exercise (colloquia, results and experimental work - 70%) and result on final exam (30 %).
Language of teaching and possibilities of following in other languages	Croatian (language of teaching). English (possibility of following).
The method of monitoring the quality and performance of each course and/or module	Talking to students and anonymous questionnaires.

Course name	History of Chemistry		
Code	K1124		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	I.	**Semester**	Winter
ECTS	3		
Lecturer	Anamarija Stanković, PhD, assistant prof.		

The aim or purpose of the course	Knowledge of the development of ideas, theories and experimental methods throughout the history of chemistry. Based on historical examples, develop knowledge and sensitivity to connect modern ideas, theories and methods in chemistry.
Prerequisites for enrollment	there are no prerequisites
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. To establish the most important approaches in the development of chemistry (epistemological, epistemological and sociological) in a certain civilization environment. 2. Comment on the contributions of chemistry in the development of European civilization. 3. Assess a certain paradigm in the scientific community, recognize the reasons for abandoning that paradigm and the features of scientific revolutions. 4. Distinguish the creative connection of experimental results up to a specific discovery using examples from the history of chemistry. 5. To review the importance of the genesis of research in achieving a certain result in chemistry. 6. Compare the level of a certain scientific environment with the scientific contribution in that environment (Croatian chemists and Nobel laureates).

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0,5	1-6	**Class attendance**	**Evidence list**	10	20
Knowledge test (written colloquia)	1,5	1-6	**Preparation for the written exam**	**Written colloquium**	15	30
Final exam	1	1-6	**Repetition of study matter**	**Oral exam**	40	50
Total	3	1-6			65	100

Consultations	In agreement with the students
Acquired competencies	After knowing the ideas, theories and experimental methods through the history of chemistry and the genesis of the work and activities of famous chemists, the student acquires the ability to connect experimental results within the official theory, but also the possibility of upgrading or growing the same theory based on new experiments. It develops its creative potential. They also learn why "old" claims and problems began to be re-investigated only after many decades had passed and why the role of experiments in chemistry is important.
Content	Chemistry in the age of Egyptian and Greek civilization. The combination of Egyptian technology and Greek philosophy in the Hellenistic era in the Alexandrian scientific circle. The development of protochemistry until the Arab conquests. Chinese, Indian and Arabic alchemy. European alchemy. Iatrochemistry and mineralogical chemistry (practical alchemy). Chemistry at the dawn of the modern age. Phlogiston theory and revolution in chemistry. Atoms, molecules, symbols, masses and chemical laws. Periodic table of elements. Beginnings and development of organic and physical chemistry. Brief development of Croatian chemistry: alchemists, phlogistonists, founding of the University and Croatian Nobel laureates.

Recommended literature	S. PAUŠEK-BAŽDAR, Povijest kemije (skripta), Zagreb, 2002. S. PAUŠEK-BAŽDAR, Flogistonska teorija u Hrvata, HAZU, Zagreb, 1994. S. PAUŠEK-BAŽDAR, Paracelsus, Filozofija renesanse, sv. 3, ŠK, Zagreb, 1996 T. BURCKHARDT, Alkemija (prijevod E. Kukavica), Lingua Patria, Sarajevo, 2005. J. BRONOWSKI, Porijeklo znanja i imaginacije (prijevod), Stvarnost, Zagreb, 1978 D. GRDENIĆ, Povijest kemije, ŠK i Novi Liber, Zagreb, 2001.		
Additional literature	M. BAIGENT, R. LEIGH, Eliksir i kamen Kovači i alkemičari (prijevod), Stari grad, Zagreb, 2000. M. ELIADE, Kovači i alkemičari (prijevod), Zora, Zagreb, 1983. J. EVOLA, Hermetička tradicija i Kraljevsko umijeće (prijevod), Fabula nova, Zagreb, 2008. J. R. PARTINGTON, A History of Chemistry, 4. vol., II. izdanje New York, 1996. V. RABINOVIč, Alkemija kao fenomen srednjovjekovne kulture (prijevod), Beograd, 1989. R. TATON (ed.), Histoire Généra le des Sciences, II. izdanje, Pariz, 1998.		
Forms of teaching	**Lectures, Seminars**		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week) total	2	-	-
	30	-	-
Methods of testing knowledge and taking exams	Oral exams		
Language of teaching and possibilities of following in other languages	Croatian (language of teaching). English (possibility of following).		
The method of monitoring the quality and performance of each course and/or module	Survey, oral reviews and questions during lectures, motivation for choosing a final paper from the history of chemistry in general and from the history of Croatian chemistry.		

Course name	**Chemistry of natural organic compounds**		
Code	K1306		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Summer
ECTS	3		
Lecturer	Valentina Bušić, PhD, assistant professor		
The aim or purpose of the course	Acquiring knowledge about natural organic compounds and basic methods of isolation and purification of biologically active substances from natural sources		
Prerequisites for enrollment	Passed chemistry courses in the first two years of study		
Learning outcomes	***After successfully completing the course, the student will be able to:*** ***1. Determine and classify natural organic compounds*** ***2. Comment on functional groups in natural compounds*** ***3. Compare the properties of individual compounds depending on the structure*** ***4. Propose a method for the isolation of certain natural organic compounds***		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>0</td><td>1-4</td><td>Class attendance</td><td>Attendance records</td><td>5</td><td>10</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td>1-4</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>35</td></tr>
<tr><td>Final exam</td><td>2</td><td>1-4</td><td>Repetition of study matter</td><td>Oral exam</td><td>25</td><td>65</td></tr>
<tr><td>Total</td><td>3</td><td></td><td></td><td></td><td>50</td><td>100</td></tr>
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</td></tr>
<tr><td>Consultations</td><td>In agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td>Knowledge of basic natural compounds, understanding of their action. Creation of suitable methods for the isolation of natural organic compounds.</td></tr>
<tr><td>Content</td><td>Introduction. Bioactive molecules present in natural material. Basic insulation techniques. Extraction. Chromatographic techniques (column chromatography, preparative thin-layer chromatography, ion exchange methods, high-performance liquid chromatography). Crystallization and final stage of purification. Problems related to the extraction of plant material. Isolation of natural products in semi-industrial and industrial scales.</td></tr>
<tr><td>Recommended literature</td><td>1. Natural Product Isolation. R.J.P. Cannell (ed.),Humana Press, Totowa, New Yersey, 1998.
2. C.F. Poole, S.K. Poole: Chromatography today. Elsevier, Amsterdam, Oxford, New York, Tokio, 1991.
Z.Kniewald i sur: Priručnik za pripravu i izolaciju biološki djelatnih supstancija. Alfej, Zagreb, 2000.</td></tr>
<tr><td>Additional literature</td><td>1. High – Speed Countercurrent Chromatography. Y. Ito, W. D. Conway (ed.), John Wiley&Sons, New York, Chichester, Brisbane, Toronto, Singapore, 1996.
High performance Liquid Chromatography of peptides and proteins: Separation, Analysis and Conformation. (C.T. Mant, R.S. Hodges, ed.) CRC Press, Boca Raton, Ann Arbor, Boston, London, 1991.</td></tr>
<tr><td>Forms of teaching</td><td>Lectures with the use of technical aids, active involvement of students in discussions and debates. Oral presentation of seminar papers.</td></tr>
<tr><td>Teaching type</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td rowspan="2">(hours per week)</td><td>2</td><td>-</td><td>1</td></tr>
<tr><td>30</td><td>-</td><td>15</td></tr>
</table>
total</td></tr>
<tr><td>Methods of testing knowledge and taking exams</td><td>Oral exam</td></tr>
<tr><td>Language of teaching and possibilities of following in other languages</td><td>Croatian</td></tr>
</table>

The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys

Course name	Active components of medicinal herbs		
Code	K1307		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Winter/Summer
ECTS	3		
Lecturer	Prof. Nikola Sakač		
The aim or purpose of the course	Student introduction to medicinally significant chemical compounds and their presence in plants and herbs.		
Prerequisites for enrollment	Passed General chemistry exam.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine basic types of active components in medicinal herbs. 2. Determine mechanisms of their activity. 3. Determine the effect of medicinal herbs on health. 4. Determine significance of usage of active components of medicinal herbs in everyday life. 5. Re-evaluate the usage of specific medicinal herbs.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-5	**Class attendance**	**Attendance records**	20	30
Seminar	1	1-5	**Preparation for the written exam**	**Written colloquium**	20	30
Final exam	1	1-5	**Repetition of study matter**	**Oral exam**	25	40
Total	3				65	100

Consultations	In agreement with the students.
Acquired competencies	Introduction to an overview of basic medicinal herbs and active components of herbs, usage of herbs and plants with active components in everyday life.
Content	Medicinal herbs and its usage in history. Chemical composition of herbs. Impact of chemical compounds form herbs on human organism. External and internal application of herbs. Illnesses and diseases curable with medicinal herbs. Collecting and preserving of medicinal herbs. Medicinal herbs as spices. Medicinal herbs of our area and from cultivation. Medicinal herbs od the world. Poisonous plants. Signs of poisoning and first aid. Rare, endangered and protected medicinal plants.

Recommended literature	1. Breindl, E., 1997. Velika knjiga o zdravlju svete Hildegarde iz Bingena.Karitativni fond UTP, Đakovo 2. Duke, J. A. 2002.Zelena ljekarna.»Marjan», Split. 3. Gelenčir, N., 1974.,Prirodno liječenje biljem i ostalim sredstvima. Nakladni zavod Znanje, Zagreb. 4. Grlić, Lj.,1984.99 jestivih i otrovnih boba. Prosvjeta, Zagreb. 5. Grlić Lj.,1986, Enciklopedija samoniklog jestivog bilja. August Cesarec, Zagreb. 6. Gurski, Z 1985., Zlatna knjiga ljekovitog bilja. Nakladni zavod Matice hrvatske, Zagreb.		
Additional literature	1. Marčinković, J. 2001. Božja biljna ljekarna. Školska knjiga, Zagreb. 2. Martić, I., 2003.Čovjek i ljekovito bilje.Školska knjiga, Zagreb. 3. Opletal, K., i Volak, J., 2001.Bilje i zdravlje.»Stanek d.o.o.» Varaždin. 4. Pahlov, M. 1989.Velika knjiga ljekovitog bilja. Cankarjeva založba, LjubljanaZagreb.		
Forms of teaching	Lectures with the use of technical aid, active participation of students.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	Project presentation in written and oral form, as a short lecture and written report, written exam.		
Language of teaching and possibilities of following in other languages	Croatian, possibly English and German.		
The method of monitoring the quality and performance of each course and/or module	Anonymous questionnaire after exam.		

III. Year

VI. Summer semester

Physical Chemistry 2 (ECTS 6)

Physical Chemistry, Laboratory 2 (ECTS 4)

Biochemistry 2 (ECTS 5)

Biochemistry Laboratory (ECTS 4)

Elective Course 3* (ECTS 3)

Final Exam (ECTS 8)

*Elective courses

Atmospheric Chemistry (ECTS 3)

Chemistry of Natural Organic Compounds (ECTS 3)

Active Substances in Madicinal Herbs (ECTS 3)

Course name	Physical Chemistry 2		
Code	K1115		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	summer
ECTS	6		
Lecturer	Ph.D. Martina Medvidović-Kosanović, associate professor		
The aim or purpose of the course	Understanding the basics of quantum theory for understanding molecular spectroscopy, and the basics of chemical kinetics.		
Prerequisites for enrollment	Passed courses General Chemistry, Mathematics 1 and 2, Physiscs 1. Completed course Physics 2 and Physical Chemistry 1.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Connect basics of quantum theory with molecular structure, 2. Explain the theoretical basis of molecular spectra (IR, UV-VIS, NMR), 3. Understand concepts of reaction rate, reaction rate constant and molecularity 4. Describe the effect of different factors on the rate of chemical reactions, 5. Understand the kinetics of complex chemical reactions, 6. Apply characteritics of adsorption which are important for heterogenous catalysis.		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Knowledge test (written colloquia)</td><td>3</td><td>1-6</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>40</td><td>50</td></tr>
<tr><td>Final exam</td><td>3</td><td>1-6</td><td>Repetition of study matter</td><td>Oral exam</td><td>20</td><td>50</td></tr>
<tr><td>Total</td><td>6</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td>Understanding the basis of quantum theory. Theoretical understanding of molecular spectra (IR, UV-VIS, NMR) and fundamental relations of chemical kinetics. Possible application of chemical kinetics in the numerical and graphical determination of reaction rate constant to achieve the optimal rate of the chemical reaction.</td></tr>
<tr><td>Content</td><td>Kvantna teorija, Schröedingerova jednadžba, atomska struktura i atomski spektri. Molekulske strukture, Born-Oppenheimerova aproksimacija, molekulska simetrija. Spektroskopija: rotacijski i vibracijski spektri, elektronski prijelazi, laseri, nuklearna magnetska rezonancija.
Promjene tvari:kinetička teorija plinova, difuzija, otopine elektrolita, red kemijskih reakcija, kinetika složenih reakcija, kataliza-homogena, autokataliza i heterogena, fotokemija, dinamika molekulskih interakcija, rekcije na površinama, adsorpcija.</td></tr>
<tr><td>Recommended literature</td><td>1. P. Atkins & J. De Paula, Physical Chemistry, Oxford University Press, Oxford, 10th Ed., Oxford University Press, Oxford, 2014.

2. R. Chang, J. W. Thoman, jr, Physical Chemistry for the Chemical Sciences, 1st Ed., University Science Books, Canada, 2014.

3. P.W. Atkins, M.J. Clugston, Načela fizikalne kemije, Školska knjiga, Zagreb, 1989</td></tr>
<tr><td>Additional literature</td><td>1. T. Cvitaš, Temelji kvantne kemije i spektroskopije, Sveučilišna naklada Liber, Zagreb, 1976.</td></tr>
<tr><td>Forms of teaching</td><td>Lectures with the active participation of students and seminars which include independent solving of numerical problems.</td></tr>
<tr><td>Teaching type</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td>4</td><td>2</td><td>-</td></tr>
<tr><td>60</td><td>30</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>(hours per week) total</td><td></td></tr>
<tr><td>Methods of testing knowledge and taking exams</td><td>Two colloquiums are written during the course. The first colloquium is written in mid-semester and the second one at the end of semester. The final grade consists of: regular attendance and active participation in classes - 10%, two colloquiums - 40% (20 % + 20 %) and final exam – 50 % (25 % wriiten and 25 % oral exam).</td></tr>
<tr><td>Language of teaching and possibilities of following in other languages</td><td>Croatian
English</td></tr>
</table>

The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	**Physical Chemistry Practicum 2**		
Code	K1118		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Summer
ECTS	4		
Lecturer	Martina Medvidović-Kosanović, assistant professor		
The aim or purpose of the course	To learn some of the concepts and laws of physical chemistry through practical work.		
Prerequisites for enrollment	General Chemistry Practicum 1 and 2; Analytical Chemistry Practicum 1 and 2; Physical Chemistry Practicum 1		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Select an experiment from the areas covered in the practicum 2. Independently experimentally measure the values of physical quantities from the areas covered in the practicum 3. Evaluate the experimentally obtained data 4. Critically judge the results of the experiment compared to literature expectations 5. Make a conclusion about the examined physical process 6. Critically evaluate the relevant scientific literature.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-6	**Class attendance**	**Attendance records**	–	–
Knowledge test (written colloquia)	3	1-6	**Preparation for the written exam**	**Written colloquium**	–	100
Final exam	4		**Repetition of study matter**	**Oral exam**		
Total						100

Consultations	During experimental work
Acquired competencies	Use of the necessary measuring instruments and methods of data processing and presentation of experimentally obtained results.
Content	Reaction calorimetry (enthalpies of reaction in Daniell cell and protonation of glycine). Dissociation equilibrium (deprotonation of methyl red in aqueous solution). Equilibrium constant (Nernst law of distribution). Gas solubility (oxygen dissolution equilibrium constant in water). Colligative properties (freezing point decrease, boiling point increase). Adsorption (adsorption of acetic acid on activated carbon). Chemical kinetics (hydrolysis of ethyl acetate). Kinetics of ionic reactions 1 (reaction of iodide and persulfate ions of the

	second order). Kinetics of ionic reactions 2 (reaction of iodide and persulfate ions of pseudo first order). Conductometric titration (neutralization of NaOH with HCl).
Recommended literature	Text Book with forms.
Additional literature	1. P.W. Atkins & J. de Paula, Atkins' Physical Chemistry, Oxford University Press, Oxford, 2002. 2. P.W. Atkins & M.J. Clugston, Načela fizikalne kemije, Školska knjiga, Zagreb, 1989. 3. M. Sikirica, Stehiometrija, Školska knjiga, Zagreb, 1985. 4. T. Cvitaš & N. Kallay, Fizičke veličine i jedinice Međunarodnog sustava, Školska knjiga, Zagreb, 1980.
Forms of teaching	Individual experimental work. Obligatory colloquia. Form filling during experimental work.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	–	–	4
total	–	–	60

Methods of testing knowledge and taking exams	Oral colloquia before experimental work. Final grade is determined from the average grades of individual exercises (with included grades from oral colloquia, experimental work and filled forms)
Language of teaching and possibilities of following in other languages	Croatian language (mandatory). English language (optional).
The method of monitoring the quality and performance of each course and/or module	Communication with students and anonymous polls.

Course name	**Biochemistry 2**		
Code	K1120		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Summer
ECTS	5		
Lecturer	Assist. prof. Martina Šrajer Gajdošik, PhD		
The aim or purpose of the course	Acquiring and mastering modern knowledge about the main metabolic processes in cells.		
Prerequisites for enrollment	Attended course Biochemistry 1		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Assess energy changes in cellular metabolic processes. 2. Analyze basic catabolic and anabolic cycles. 3. Propose the intracellular location of the metabolism of nutrients and the routes of their transport in or between cell organelles.		

	4. Differentiate between complex regulatory mechanisms whose action is necessary to maintain homeostasis. 5. Connect the interconversion of different types of biomolecules (carbohydrates, proteins and fats). 6. Propose the fate of a metabolite or food ingredient from resorption to complete breakdown or transformation into new compounds. 7. Highlight the key differences in the metabolism of animal, plant and bacterial organisms.

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-7	**Class attendance**	**Attendance records**	10	20
Knowledge test (written colloquia)	2	1-7	**Preparation for the written exam**	**Three written colloquium**	25	40
Final exam	2	1-7	**Repetition of study matter**	**Oral exam**	25	40
Total	5				60	100

Consultations	Wednesdays, 10 am-12 pm
Acquired competencies	Knowledge and understanding of basic metabolic processes in cells and mechanisms of their regulation. Ability to apply knowledge in practice.
Content	General presentation of metabolism, catabolism and anabolism, regulation of metabolism. Carbohydrate metabolism: transport of glucose into cells, glycolysis, gluconeogenesis, pentose-phosphate pathway, metabolism of disaccharides and polysaccharides (glycogen - glycogenesis and glycogenolysis, and starch). Generation of metabolic energy: citric acid cycle and oxidative phosphorylation. Metabolism of fats: triacylglycerols, phospholipids and cholesterol. Decomposition (ß-oxidation) and synthesis of fatty acids, synthesis of phospholipids, ceramides and gangliosides, synthesis of cholesterol and compounds formed from cholesterol (steroid hormones, bile salts, vitamin D). Decomposition of amino acids and synthesis of urea, synthesis of amino acids and cofactors, mobilization of nitrogen from the air for the incorporation into biomolecules, complex regulation of the enzyme glutamine synthetase. Biosynthesis and degradation of purine and pyrimidine nucleotides. Photosynthesis. Integration of metabolism.
Recommended literature	Berg, J.M., Tymoczko, J.L., Stryer, L., prevoditelji: Weygand-Đurašević, I., Jernej, B., Kućan, Ž., 2013: Biokemija, 6. izd. (englesko), Školska knjiga, Zagreb. Berg, J.M., Tymoczko, J.L., Stryer, L., 2006: Biochemistry, 6th ed., Freeman & Comp., New York.
Additional literature	Berg, J.M., Tymoczko, J.L., Stryer, L., 2002: Biochemistry, 5th ed., Freeman & Comp., New York. Nelson, D.L., Cox, M.M., 2000: Lehninger Principles of Biochemistry, 3rd ed., Worth Publishers, New York

Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students. Seminars where students solve problems and tasks on the board and/or orally.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	2	–
total	45	30	–
Methods of testing knowledge and taking exams	Knowledge is exemined through 3 partial colloquia during classes. The final exam is taken in written form (if the student did not pass the partial colloquia) and orally.		
Language of teaching and possibilities of following in other languages	Croatian (language of teaching), English (possibility of following)		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys		

Course name	Biochemistry laboratory		
Code	K1121		
Type	Mandatory		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Summer
ECTS	4		
Lecturer	Prof. Elizabeta Has-Schön		
The aim or purpose of the course	Introduction with modern biochemical technics for the study of amino acids and proteins, and especially enzyme activity.		
Prerequisites for enrollment	Passed General chemistry and Organic chemistry 1. Enrolled Organic chemistry 2.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Integrate theoretical knowledge of biochemistry with experimental work. 2. Determine parameters necessary for biochemical experiment organisation. 3. Foresee the way and possibility of biochemical reactions occurring in defined conditions. 4. Confirm impact of selected parameters on enzymatic reactions rate. 5. Recommend methods of protein isolation and purification and isolation of nucleic acids from biological samples. 6. Analyse experimental results.		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance, lab work and reports</td><td>2</td><td>1-6</td><td>Class attendance</td><td>Attendance records</td><td>30</td><td>50</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td>1-6</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>10</td><td>20</td></tr>
<tr><td>Final exam</td><td>1</td><td>1-6</td><td>Repetition of study matter</td><td>Oral exam</td><td>20</td><td>30</td></tr>
<tr><td>Total</td><td>4</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
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</td></tr>
<tr><td>Consultations</td><td>In agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td>Organisation of biochemical laboratory. General principles with handling biological material. Basic methods of purification and isolation of biomolecules. Self-sufficiency in laboratory work.</td></tr>
<tr><td>Content</td><td>Acid-base properties of amino acids, purification of proteins based on their solubility, size, charge, identification and quantification of proteins, study of conditions of enzyme reactivity – impact of incubation time, temperature, concentration of enzyme or substrate, pH of puffer, determination of basic kinetic constants (Km and Vmax), impact of effectors (activators and inhibitors) on enzyme activity.

Practical laboratory work will be completed with additional calculations. Some contents will be studied in the form of seminars, for example determination of amino acid sequence in proteins, determination of 3D structure of proteins with nuclear magnetic resonance and x-ray crystallography.</td></tr>
<tr><td>Recommended literature</td><td>BERG, J.M., TYMOCZKO, J.L., STRYER, L., 2006: Biochemistry, 6th ed., Freeman & Comp., New York.</td></tr>
<tr><td>Additional literature</td><td>BERG, J.M., TYMOCZKO, J.L., STRYER, L., 2002: Biochemistry, 5th ed., Freeman & Comp., New York.
VOET, D., VOET, J.G., 1995: Biochemistry, 2nd ed. J.Wiley & Sons Iinc., New York.
NELSON, D.L., COX, M.M., 2000: Lehninger Principles of Biochemistry, 3rd ed., Worth Publishers, New York</td></tr>
<tr><td>Forms of teaching</td><td>Laboratory exercises comprised of entrance colloquium before every exercise, the exercise itself and report writing and submitting after every exercise.</td></tr>
<tr><td>Teaching type</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td>-</td><td>-</td><td>4</td></tr>
<tr><td>-</td><td>-</td><td>60</td></tr>
</table>
</td></tr>
<tr><td>(hours per week) total</td><td></td></tr>
<tr><td>Methods of testing knowledge and taking exams</td><td>Entrance colloquium, report grading, written final colloquium at the end of the subject.</td></tr>
<tr><td>Language of teaching and possibilities of</td><td>Croatian, possibly English.</td></tr>
</table>

following in other languages	
The method of monitoring the quality and performance of each course and/or module	Discussion with students and anonymous questionnaire.

Course name	Atmospheric Chemistry		
Code	K1305		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Summer
ECTS	3		
Lecturer	Elvira Kovač-Andrić, Ph.D., Assistant Professor		
The aim or purpose of the course	Acquisition of basic knowledge about the atmosphere around us, pollution and consequences		
Prerequisites for enrollment			
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Integrate concepts about the development and properties of the atmosphere. 2. Assess the significance of the chemical species present in the air and their interdependence. 3. Predict the mechanisms of chemical reactions that affect the level of chemical species present in the atmosphere. 4. Assess what causes atmospheric pollution and what are the consequences for the environment. 5. Critically judge how man can affect the atmosphere and the environment. 6. Critically evaluate the relevant scientific literature.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	0,5	1-6	**Class attendance**	**Attendance records**	8	10
Knowledge test (written colloquia)	1	1-6	**Preparation for the written exam**	**Written colloquium**	20	40
Final exam	1,5	1-6	**Repetition of study matter**	**Oral exam**	30	50
Total	3				58	100

Consultations	In agreement with the students/ Mondays, 8-10 pm
Acquired competencies	Knowledge of the properties and reactivity of atmospheric microconstituents, to know their significance and interdependence. Influence of meteorological parameters on microconstituents in the atmosphere. Individual and group work, communication skills and independent literature search.

Content	Lectures - units according to teaching weeks: 1. Evolution and changes in the atmosphere and climate. Chemical composition. 2. Colloids, aerosols, clouds. 3. Cyclic processes (carbon, oxygen, nitrogen, sulfur). 4. The connection between the biosphere and the atmosphere. 5. Photochemical processes, chemical kinetics applied to the atmosphere. 6. Ozone in the Earth's atmosphere. 7. Catalytic cycles. 8. Sources and consequences of atmospheric pollution. 9. Earth's troposphere. Transport. Chemical and photochemical reactions. 10. Ozone formation in the troposphere. 11. Impacts of ozone in the troposphere and consequences. 12. Air pollution. Sources of pollution, types of pollutants and their impact (climate, environment, health, etc.). 13. Polar ozone holes. Global warming. Acid rain. 14. Human impact on air pollution, consequences, prevention (legislation). Ions in the atmosphere. 15. Radon and descendants. Monitoring. Seminar: 1. Chemical composition of the atmosphere 2 Colloids, aerosols, clouds 3. Greenhouse gases 4. The connection between the biosphere and the atmosphere 5. Cyclic processes (carbon, oxygen, nitrogen, sulfur) 6. Impacts of ozone in the troposphere and consequences		
Recommended literature	1. R.P. Wayne, Chemistry of Atmospheres, 3. izd., Oxford, New York, 2001. 2. P. Fabian, environmental Science XIV, Atmosphäre und Umwelt, 4. izd., Springer Verlag, Berilin, 1992.		
Additional literature	1. L. Theodore and A. Buincore, Air Pollution Control Equipment, Springer Verlag, Berlin, 1994. 2. L.C. Jones, Topics in Environmental and Safety Aspects of Combustion Technology, Whittles Publishing, 1997. 3. R.L. Murray and J.A. Powell, Understanding Radioactive Waste, 4. izd., Batelle Press, 1994.		
Forms of teaching	Lectures and seminars are obligatory. Homework		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	Oral exam after completion of all the lectures and seminars.		
Language of teaching and possibilities of following in other languages	Croatian English		
The method of monitoring the quality and performance of	Discussions with students and the anonymous students opinion poll.		

each course and/or module	

Course name	**Chemistry of natural organic compounds**		
Code	K1306		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Summer
ECTS	3		
Lecturer	Valentina Bušić, PhD, assistant professor		
The aim or purpose of the course	Acquiring knowledge about natural organic compounds and basic methods of isolation and purification of biologically active substances from natural sources		
Prerequisites for enrollment	Passed chemistry courses in the first two years of study		
Learning outcomes	***After successfully completing the course, the student will be able to:*** ***1. Determine and classify natural organic compounds*** ***2. Comment on functional groups in natural compounds*** ***3. Compare the properties of individual compounds depending on the structure*** ***4. Propose a method for the isolation of certain natural organic compounds***		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0	1-4	**Class attendance**	**Attendance records**	5	10
Knowledge test (written colloquia)	1	1-4	**Preparation for the written exam**	**Written colloquium**	20	35
Final exam	2	1-4	**Repetition of study matter**	**Oral exam**	25	65
Total	3				50	100

Consultations	In agreement with the students.
Acquired competencies	Knowledge of basic natural compounds, understanding of their action. Creation of suitable methods for the isolation of natural organic compounds.
Content	Introduction. Bioactive molecules present in natural material. Basic insulation techniques. Extraction. Chromatographic techniques (column chromatography, preparative thin-layer chromatography, ion exchange methods, high-performance liquid chromatography). Crystallization and final stage of purification. Problems related to the extraction of plant material. Isolation of natural products in semi-industrial and industrial scales.
Recommended literature	3. Natural Product Isolation. R.J.P. Cannell (ed.),Humana Press, Totowa, New Yersey, 1998. 4. C.F. Poole, S.K. Poole: Chromatography today. Elsevier, Amsterdam, Oxford, New York, Tokio, 1991.

	Z.Kniewald i sur: Priručnik za pripravu i izolaciju biološki djelatnih supstancija. Alfej, Zagreb, 2000.
Additional literature	2. High – Speed Countercurrent Chromatography. Y. Ito, W. D. Conway (ed.), John Wiley&Sons, New York, Chichester, Brisbane, Toronto, Singapore, 1996. High performance Liquid Chromatography of peptides and proteins: Separation, Analysis and Conformation. (C.T. Mant, R.S. Hodges, ed.) CRC Press, Boca Raton, Ann Arbor, Boston, London, 1991.
Forms of teaching	Lectures with the use of technical aids, active involvement of students in discussions and debates. Oral presentation of seminar papers.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	-	1
total	30	-	15

Methods of testing knowledge and taking exams	Oral exam
Language of teaching and possibilities of following in other languages	Croatian
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys

Course name	Active components of medicinal herbs		
Code	K1307		
Type	Elective		
Level	Undergraduate university study of Chemistry		
Year	3.	**Semester**	Winter/Summer
ECTS	3		
Lecturer	Prof. Nikola Sakač		
The aim or purpose of the course	Student introduction to medicinally significant chemical compounds and their presence in plants and herbs.		
Prerequisites for enrollment	Passed General chemistry exam.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine basic types of active components in medicinal herbs. 2. Determine mechanisms of their activity. 3. Determine the effect of medicinal herbs on health. 4. Determine significance of usage of active components of medicinal herbs in everyday life. 5. Re-evaluate the usage of specific medicinal herbs.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-5	**Class attendance**	**Attendance records**	20	30
Seminar	1	1-5	**Preparation for the written exam**	**Written colloquium**	20	30
Final exam	1	1-5	**Repetition of study matter**	**Oral exam**	25	40
Total	3				65	100

Consultations	In agreement with the students.
Acquired competencies	Introduction to an overview of basic medicinal herbs and active components of herbs, usage of herbs and plants with active components in everyday life.
Content	Medicinal herbs and its usage in history. Chemical composition of herbs. Impact of chemical compounds form herbs on human organism. External and internal application of herbs. Illnesses and diseases curable with medicinal herbs. Collecting and preserving of medicinal herbs. Medicinal herbs as spices. Medicinal herbs of our area and from cultivation. Medicinal herbs od the world. Poisonous plants. Signs of poisoning and first aid. Rare, endangered and protected medicinal plants.
Recommended literature	1. Breindl, E., 1997. Velika knjiga o zdravlju svete Hildegarde iz Bingena.Karitativni fond UTP, Đakovo 2. Duke, J. A. 2002.Zelena ljekarna.»Marjan», Split. 3. Gelenčir, N., 1974.,Prirodno liječenje biljem i ostalim sredstvima. Nakladni zavod Znanje, Zagreb. 4. Grlić, Lj.,1984.99 jestivih i otrovnih boba. Prosvjeta, Zagreb. 5. Grlić Lj.,1986, Enciklopedija samoniklog jestivog bilja. August Cesarec, Zagreb. 6. Gurski, Z 1985., Zlatna knjiga ljekovitog bilja. Nakladni zavod Matice hrvatske, Zagreb.
Additional literature	1. Marčinković, J. 2001. Božja biljna ljekarna. Školska knjiga, Zagreb. 2. Martić, I., 2003.Čovjek i ljekovito bilje.Školska knjiga, Zagreb. 3. Opletal, K., i Volak, J., 2001.Bilje i zdravlje.»Stanek d.o.o.» Varaždin. 4. Pahlov, M. 1989.Velika knjiga ljekovitog bilja. Cankarjeva založba, LjubljanaZagreb.
Forms of teaching	Lectures with the use of technical aid, active participation of students.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-

Methods of testing knowledge and taking exams	Project presentation in written and oral form, as a short lecture and written report, written exam.
Language of teaching and possibilities of following in other languages	Croatian, possibly English and German.

The method of monitoring the quality and performance of each course and/or module	Anonymous questionnaire after exam.

GRADUATE UNIVERSITY STUDY PROGRAMME CHEMISTRY;
SPECIALIZATION IN: RESEARCH

Graduate University Study Programme Chemistry;
Specialization in: Research: 120 ECTS, 2 years

I. Year

I. Winter semester

Instrumental Methods of Analytical Chemistry (ECTS 5)

Chemistry of Materials (ECTS 5)

Cell biochemistry (ECTS 5)

Senior Laboratory of Biochemistry (ECTS 5)

Senior Laboratory of Inorganic Chemistry (ECTS 5)

Elective Course I* (ECTS 5)

Elective Course II* (ECTS 5)

Elective Course III*(ECTS 5)

Course name	INSTRUMENTAL METHODS OF ANALYTICAL CHEMISTRY		
Code	KD1101		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program		
Year	I.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Milan Sak-Bosnar, Ph.D., full prof.		
The aim or purpose of the course	Understand instrumental methods in analytical chemistry. Learn to select and implement the most appropriate instrumental method for a particular system. Acquire basic knowledge necessary for research work.		
Prerequisites for enrollment	No.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare the principles of instrumental methods used in analytical chemistry; 2. Explain the mode of operation of each analytical method; 3. Apply the adopted concepts to solve computational problems; 4. Conclude which instrumental methods are most often used; 5. Critically evaluate the relevant scientific literature.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-5	**Class attendance**	**Attendance records**	8	10
Discussion, seminars and homework	1	1-5	Preparation and problem solving	Oral presentation	10	20
Knowledge test (written colloquia)	1	1-4	**Preparation for the written exam**	**Written colloquium**	15	30
Final exam	2	1-4	**Repetition of study matter**	Written exam Oral exam	10 10	20 20
Total	5				53	100

Consultations	Consultations are available every week, during which the lecture is held, for 1 hour.
Acquired competencies	Understanding the principles of instrumental methods of analysis, most commonly used in industry and research laboratories.
Content	Lectures: Overview of instrumental methods of chemical analysis: Types of analysis instruments; Instrument components; Calibration; Measurement features; Signal-to-noise ratio. Atomic spectroscopy: Atomic absorption and atomic fluorescence spectroscopy; Atomic emission spectrometry; Inductively coupled plasma optical emission spectrometry. Molecular spectroscopy: UV-Vis absorption spectrometry; Infrared spectrometry, Raman spectroscopy. Electroanalytical methods: Potentiometry; Coulometry; Electrogravimetry; Voltammetry. Chromatographic methods: Principles of chromatography; Gas chromatography, Liquid chromatography During the seminar, students present their seminar papers and assignments and discuss the given topic.
Recommended literature	I. Piljac, *Elektroanalitičke metode: Teorijske osnove, mjerne naprave i primjena*, RMC, Zagreb, 1995. F. Scholz, *Electroanalytical Methods*, Springer Verlag GmbH, 2005.
Additional literature	D.A. Skoog, F.J.Holler, A. Nieman, *Principles of Instrumental Analysis*, 5th Edition, Saunders College Publishing, New York, 1998. Sceintific papers.
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students. Seminars where seminar papers and homework are presented and discussed, and students solve problems.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-

Methods of testing knowledge and taking exams	Knowledge is tested during classes through a colloquium. The final exam is taken in writing and orally.

Language of teaching and possibilities of following in other languages	Croatian.
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	MATERIAL CHEMISTRY		
Code	KD2101		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program		
Year	1.	**Semester**	Summer
ECTS	5		
Lecturer	Doc.dr.sc. Aleksandar Sečenji		
The aim or purpose of the course	The course is designed as an introduction to the field of material chemistry and to provide a foundation for understanding the importance of the influence of modern chemical science on the development of new classes of materials. Material chemistry is an interdisciplinary field that unites, in addition to chemistry, significant parts of physics, biology, technology and mathematics.		
Prerequisites for enrollment	Non		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Integrate knowledge of material types and their chemical structure. 2. Apply methods of qualitative determination of types and characteristics of chemical bonds in a particular material. 3. Identify experimental techniques most suitable for testing a particular material. 4. Understand surface chemistry and its influence on the properties of nano-materials. 5. Apply methods of synthesis and characterization of certain types of materials. 6. Understand the practical requirements of modern materials including multicomponent systems (composite materials). 7. Recognize the relationship of structures-morphology-properties in various materials ranging from ceramics to polymers. 8. Experiences necessary for oral and written presentation of scientific work.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-7	**Class attendance**	**Attendance records**	7	10
Preparation and presentation of seminar	1	7-8	**Preparation and making a presentation**	**Oral presentation**	10	20

	Knowledge test (written colloquia)	1	1-7	**Preparation for writtwn exam**	**Writen exam**	20	30
	Final exam	1	1-7	**Repetition of study matter**	**Oral exam**	23	40
	Total	5				60	100

Consultations	In agreement with the students/ Mondays, 12-13 pm
Acquired competencies	The successful student is competent in understanding some important material properties, characteristics and bonding in crystals, studying crystals by diffraction methods and key chemical mechanisms that determine crystal growth, properties and catalytic activity of materials. Students develop the ability of critical evaluation, problem solving, reasoning, individual and group work and communication skills
Content	1. Material structure a. Solid materials - ionic, covalent and metal crystals; 3-D crystal structures; polymorphism; determination of crystal structures (diffraction methods); defects in crystals and their role; nano-effect; phase diagrams; phase transformations; glass and composite materials. b. Soft materials - polymers (synthesis, processing, properties); liquid crystals; gels; self-organizing materials. 2. Material properties a. Mechanical and thermal properties b. Electrical properties c. Optical properties d. Magnetic properties 3. Techniques of preparation, processing and analysis of materials with special reference to nanomaterial technology. 4. Application of materials (case studies)
Recommended literature	1. H.R. Allcock, Introduction to Materials Chemistry, 21st Ed., John Wiley & Sons, New York, 2008. 2. W.D. Callister, D.G. Rethwisch, Materials Science and Engineering: An Introduction, John Wiley and Sons, 8th ed., 2010..
Additional literature	1. B.D. Fahlman, Materials Chemistry, 2nd E., Springer, 2011. 2. W. Smith, J. Hashemi, Foundations of Materials Science and Engineering, 5th Ed., McGraw-Hill, 2009
Forms of teaching	Lectures, consultations, seminars with selected topics based on original scientific and journal papers. The processed topic should be orally referred to and written material and presentation made.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-

Methods of testing knowledge and taking exams	Knowledge is tested through a mid-term test, which is taken in the middle of the semester. The final exam is taken orally.
Language of teaching and	Croatian language (language of instruction). English language.

possibilities of following in other languages	
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	**CELL BIOCHEMISTRY**		
Code	KD104		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program		
Year	1.	**Semester**	Winter
ECTS	5		
Lecturer	Assist. prof. Martina Šrajer Gajdošik, PhD		
The aim or purpose of the course	Understand the biochemical basis of the basic physiological processes in a living organism, including the response to environmental stimuli, transport and signaling within and between cells, and the processes that lead to the development of tumors.		
Prerequisites for enrollment	None		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Comment the influence of structure on modes of transport through biological membranes. 2. Analyze different mechanisms of signal transmission. 3. To connect the biological responses of the organism with the mechanisms of activation of signaling pathways. 4. Predict the outcomes of gene expression regulation 5. To compare the processes of the cell cycle and cell death as well as their influence on the development of the disease. 6. Explain the processes that lead to the formation of tumors.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	1	1-6	**Class attendance**	**Attendance records**	5	10
Discussion and seminars)	1	1-6	**Preparation and writting of seminars and presentations**	**Oral presentation**	15	30
Final exam	3	1-6	**Repetition of study matter**	**Written exam Oral exam**	40	60
Total	**5**	1-6			**60**	**100**

Consultations	In agreement with the students

Acquired competencies	Understanding of fundamental molecular mechanisms such as substance transport, cell signaling, gene expression and post-translational modifications, and application of acquired knowledge in critical thinking and problem solving.		
Content	Biological membranes. Transport of substances in the cell. Cell motility and molecular motors (actin, myosin and microtubules). Gene expression and regulation of gene expression in prokaryotes and eukaryotes. Basics of genetic engineering. Post-translational modifications of proteins. Intercellular and intracellular communication. Pathways of signal conduction. Signal transmission mediated by hormones, receptors and growth factors. Neurotransmitters. The senses of sight, hearing, smell and taste. The body's immune response. Regulation of the cell cycle and cell death (apoptosis). Tumor cell development processes, oncogenes, tumor suppressor genes.		
Recommended literature	1. H. Lodish, C. A. Kaiser, A. Bretscher, A. Amon, A. Berk, M. Krieger, H. Ploegh, M. P. Scott: Molecular Cell Biology, Macmillan and W. H. Freeman and Company, New York, 2013, 7th edition. 2. Berg, J.M., Tymoczko, J.L., Stryer, L., prevoditelji: Weygand-Đurašević, I., Jernej, B., Kućan, Ž., 2013: Biokemija, 6. izd. (englesko), Školska knjiga, Zagreb.		
Additional literature	1. Nelson, D.L., Cox, M.M., 2000: Lehninger Principles of Biochemistry, 3rd ed., Worth Publishers, New York 2. Alberts A.J., Lewis J., Raff M., Roberts K., Walter P. (2008) Molecular Biology of the Cell (5. izdanje). Garland Science, New York.		
Forms of teaching	Lecture, discussion and independent processing of the topic		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	Written and oral exam		
Language of teaching and possibilities of following in other languages	Croatian		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys		

Course name	**SENIOR LABORATORY OF BIOCHEMISTRY**		
Code	KD3103		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program		
Year	1.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Assist. prof. Martina Šrajer Gajdošik, PhD		
The aim or purpose of the course	Introducing students to advanced experimental methods in biochemistry and molecular biology.		
Prerequisites for enrollment	None		

Learning outcomes

After successfully completing the course, the student will be able to:

1. Independently perform a part of DNA, RNA and protein analysis methods
2. Comment on the experimentally obtained results
3. Analyze the results in relation to the available literature
4. Choose possible procedures for the analysis of biological samples
5. Design the course of biochemical analyte analysis
6. Present a seminar paper on a given topic

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-5	**Class attendance**	**Attendance records**	10	15
Project asignment	2	3-5	**Preparation of a seminar on a given topic**	**Oral presentation**	20	35
Final exam	2	1-5	**Repetition of study matter**	**Oral exam**	30	50
Total	**5**				**60**	**100**

Consultations

In agreement with the students

Acquired competencies

Knowledge of specific methods of DNA, RNA and protein analysis.

Content

Familiarization with the work in a biochemical laboratory (specific requirements and equipment related to the analysis of nucleic acids, proteins). Sample preparation, DNA, RNA and protein isolation methods, determination of concentration, purity and quality of the sample. Application of the PCR method. Electrophoretic techniques in the separation of macromolecules. Data analysis, quantification. Connection with certain biochemical disorders in the human body. Solving problem tasks on the latest research methods in biochemistry and molecular biology.

Recommended literature

1. Berg, J.M., Tymoczko, J.L., Stryer, L., prevoditelji: Weygand-Đurašević, I., Jernej, B., Kućan, Ž., 2013: Biokemija, 6. izd. (englesko), Školska knjiga, Zagreb
2. Pećina-Šlaus, N., 2009: Odabrane metode molekularne biologije. Medicinska naklada, Zagreb.
3. Ambriović Ristov, A., Brozović, A., Bruvo Mađarić, B., Ćetković, H., Herak Bosnar, M., Hranilović, D., Katušić Hećimović, S., Meštrović Radan, N., Mihaljević, S., Slade, N., Vujaklija, D., Metode u molekularnoj biologiji, Institut Ruđer Bošković, Zagreb, 2007.

Additional literature

1. Boyer, B., 2012: Biochemistry laboratory. Modern theory and techniques. 2nd edition, Prentice Hall, SAD.

Forms of teaching

Independent laboratory exercises under the mentorship of assistants and/or lecturers. Solving project tasks on a given topic at seminars with a computer.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	1	3
total	-	15	45

Methods of testing knowledge and taking exams

Writing a laboratory diary and a report on an independently conducted exercise. Written test and seminar presentation with a given topic from advanced and recent biochemical methods.

Language of teaching and possibilities of following in other languages	Croatian (language of teaching), English (possibility of following)
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys

Course name	Advanced inorganic chemistry laboratory		
Code	KD2103		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program		
Year	1.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Tomislav Balić, PhD, assistant professor		
The aim or purpose of the course	To introduce modern methods of synthesis and characterization of inorganic compounds with the use of modern laboratory techniques.		
Prerequisites for enrollment	-		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. To determine laboratory skills in handling solids, liquids and gases. 2. Propose the method of sample preparation and the use of instrumental techniques such as: FTIR spectroscopy, UV-Vis spectrophotometry, X-ray diffraction for sample identification. 3. Integrate the concepts of planning and efficient use of experiments. 4. Determine the method of keeping a laboratory notebook and the skill of interpreting the collected experimental data. 5. Apply the acquired knowledge in organizing independent work in the laboratory. 6. To acquire the ability of self-assessment and self-criticism (the ability to notice errors and deviations during experimental work as well as to determine the necessary procedures for their correction).		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	1	1	**Class attendance**	**Attendance records**	20	30
Knowledge test (written colloquia)	2	1 – 6	**Preparation for the written exam**	**Written colloquium**	20	30

	Final exam	2	1 - 6	**Repetition of study matter**	**Oral exam**	20	40
	Total	5				60	100

Consultations	In agreement with the students/ Thursday, 10-12 pm
Acquired competencies	A successful student achieves competencies in the field of experimental work in the laboratory using advanced techniques of synthesis and analysis of inorganic compounds. Students develop the ability of critical evaluation, problem solving, reasoning, individual and group work and communication skills.
Content	Experimental work in a higher laboratory involves self-introduction to advanced synthesis and analysis techniques used in inorganic chemistry. List of exercises: 1. Synthesis of organic ligands: a) Preparation of 2- [5- (2-formylphenoxy) pentoxy] benzaldehyde b) Preparation of 1,5-diaza-2,4: 7,8: 16,17-tribenzo-9,15-dioxa-cyclooctadeca-1,5-diene c) Oxidation of 2- [5- (2-formylphenoxy) pentoxy] benzaldehyde d) IR spectroscopy of prepared ligands. 2. Macrocyclic effect and template synthesis: a) Preparation of [5,7,12,14-Me4-2,3: 9,10-benzo2 [14] hexaenato (2-) N4] nickel (II) b) Demethalization of [5,7,12,14-Me4-2,3: 9, 10-benzo2 [14] hexaenato (2-) N4] nickel (II) c) IR spectroscopy of the prepared compounds 3. Spectrochemical series of ligands: a) Preparation of diaquabis (ethylenediamine) copper (II) [Cu (en) 2 (H2O) 2] I2 b) Spectrophotometric determination of complex compounds with Cu (II) ion 4. Methods of preparation of unit crystals: a) Preparation of unit crystals from aqueous solutions b) Seminar exercise: Preparation of unit crystals with selected organic ligands (Exercise 1) c) Solving and refining crystal structures 5. Metal-organic frameworks: a) Preparation of MOF-5 b) Characterization of MOF-5 by X-ray diffraction c) Characterization of MOF-5 by thermal analysis 6. Preparation of perovskite: a) Preparation of CaMnO3 b) Characterization by CaMnO3 by X-ray diffraction c) Characterization of CaMnO3 by thermal analysis At the beginning of the lab-work, each student, in agreement with the assistant, chooses a series of syntheses / analyzes beyond the proposed list, independently finds literature sources that help him create the experiment, and selects appropriate techniques for conducting the experiment and appropriate techniques for product characterization.
Recommended literature	1. Internal script. 2. J.D. Woollins, Inorganic Experiments, J. Wiley & Sons, 2010.
Additional literature	1. A.D. Garnovskii, B.I. Kharissov, Synthetic Cooridination and Organometallic Chemistry, Taylor & Francis, 2003.
Forms of teaching	Practical work in the laboratory, keeping a laboratory notebook and writing and presentation of experimental results.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60

Methods of testing knowledge and taking exams	Entrance exams (before each exercise) and a final exam that is taken in writing and orally.
Language of teaching and possibilities of following in other languages	Croatian, possibly English
The method of monitoring the quality and performance of each course and/or module	Continuous communication of teachers with students, and anonymous student survey

I. Year

II. Summer semester

Analytical Environmental Chemistry (ECTS 5)

Senior Analytical Chemistry Laboratory (ECTS 5)

Solid State Chemistry (ECTS 5)

Methods of Organic Synthesis (ECTS 5)

Elective Course IV* (ECTS 5)

Elective Course V* (ECTS 5)

Elective Course VI* (ECTS 5)

<table>
<tr><td>Course name</td><td colspan="3">Environmental Analytical Chemistry</td></tr>
<tr><td>Code</td><td colspan="3">KD1102</td></tr>
<tr><td>Type</td><td colspan="3">Mandatory</td></tr>
<tr><td>Level</td><td colspan="3">Graduate university study of Chemistry-research program</td></tr>
<tr><td>Year</td><td>1.</td><td>Semester</td><td>Winter/Summer</td></tr>
<tr><td>ECTS</td><td colspan="3">5</td></tr>
<tr><td>Lecturer</td><td colspan="3">Mirela Samardžić Ph. D., Associate professor</td></tr>
<tr><td>The aim or purpose of the course</td><td colspan="3">Understand the issues of environmental analysis and develop skills and ideas required for solving these problems by using analytical methods. Acquire the basic knowledge which is necessary for research.</td></tr>
<tr><td>Prerequisites for enrollment</td><td colspan="3">-</td></tr>
<tr><td>Learning outcomes</td><td colspan="3">After successfully completing the course, the student will be able to:
1. Argue the basic concepts of environmental analytical chemistry.
2. Compare the types of analytical methods used in environmental analysis and their principles.
3. Recommend the application of certain methods used in environmental analysis.
4. Predict solutions of problems in the field of application of analytical chemistry in environmental analysis.
5. Support the claims about the main environmental pollutants.
6. Conclude on the importance and role of environmental analytical chemistry.</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="3">
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1</td><td>1-6</td><td>Class attendance</td><td>Attendance records</td><td>5</td><td>10</td></tr>
<tr><td>Discussion and seminars</td><td>1</td><td>1-6</td><td>Preparation and solving problems</td><td>Oral presentation</td><td>10</td><td>20</td></tr>
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	Knowledge test (colloquia or final exam)	3	1-6	**Repetition of study matter**	**Two written colloquia or written exam**	45	70
	Total	5				**60**	**100**

Consultations	Consultations are available every week, during which the lectures are held, for 1 hour.		
Acquired competencies	Understanding the principles and methodologies which are used in environmental analysis, individual and group work, communication skills.		
Content	Lectures: Basic principles and methods of analytical chemistry which are used in environmental chemistry. Specific applications of methods used in environmental analysis. Biological indicators. The analysis of atmospheric samples. Trace elements in the environment and their determination. Pollutants of air, waters, soils, sediments and living organisms. Sampling and sample preparation. Environmental radiation and radioactivity. Contaminated environment. The analysis of water. Ecotoxicology. During the seminars, students present their seminar papers and assignments and discuss given topics.		
Recommended literature	M. Kaštelan-Macan, M. Petrović: Analitika okoliša, HINUS & Fakultet kemijskog inženjerstva i tehnologije, 2013. F. W Fifield, P. J. Haines: Environmental Analytical Chemistry, Blackwell Science, 2nd ed., 2000. D. A. Skoog, D. M. West, F. J. Holler: Osnove analitičke kemije, Školska knjiga, Zagreb, 1999.		
Additional literature	D. A. Skoog, F. J. Holler, A. Nieman: Principles of Instrumental Analysis, 5th ed., Saunders College Publishing, New York, 1998. C. Baird, M. Cann: Environmental Chemistry, 5th ed., W.H. Freeman and Company, New York, 2012. Scientific papers.		
Forms of teaching	Lectures with the use of teaching aids (Power Point presentations) and active participation of students. Seminars where seminar papers and homework are presented and discussed, and students solve problems.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	Knowledge is tested during classes through two colloquia, the first of which is in the middle of the semester and the second at the end of the semester. If the student does not pass both colloquia or is not satisfied with the grades in the colloquia, he / she must take the final written exam. The final grade consists of: regular class attendance - 10%, seminar paper - 20% and two partial colloquia - 70% or final written exam - 70%.		
Language of teaching and possibilities of following in other languages	Croatian language.		

The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	**Advanced Analytical Chemistry Laboratory**		
Code	K1103		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program		
Year	1.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Doc. dr. sc. Mateja Budetić		
The aim or purpose of the course	Application of previously acquired knowledge in analytical chemistry.		
Prerequisites for enrollment	-		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Compare methods of analysis of soil, water, fertilizers and food products. 2. Argue the chemical reactions that take place during chemical analyses. 3. Argue analytical methods applicable to real samples. 4. Provide a systematic solution to the problem of complex samples analysis. 5. Recommend a successful analysis of a real sample.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance and activity	1	1-5	**Class attendance**	**Records**	-	-
Knowledge test (written colloquia, final exam)	3	1-5	**Preparation for partial (entrance) colloquia and final exam**	**Written colloquium, final exam**	60	100
Laboratory exercise report	1	1-5	**Preparation and writing laboratory exercise report**	**Records**	-	-
Total	5				60	100

Consultations	Consultations are available every week, during the laboratory exercises, for 1 hour each.
Acquired competencies	The student will be able to solve current analytical problems individually or in groups under the supervision of a leader. The ability to work in teams is acquired.
Content	Work with smaller groups of students. Application of the totality of previously acquired knowledge, and the combination of classical analytical and instrumental methods and techniques in the analysis of complex samples of different origins. Application of various procedures and methods (spectroscopic methods, chromatographic methods, selective electrodes, IR, HPLC). The content is variable, which means it depends on the types of

	samples, as well as on laboratory conditions and available instrumentation. Examples of complex analyses are the analysis of water (natural and drinking), cosmetic preparations, fertilizers, food products, pharmaceutical products etc.		
Recommended literature	Viši praktikum analitičke kemije, internal script		
Additional literature	D. A. Skoog, D. M. West,F. J. Holler, Osnove analitičke kemije, Školska Knjiga, Zagreb 1999.		
Forms of teaching	Laboratory exercises, partial (entrance) colloquia, reports.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60
Methods of testing knowledge and taking exams	The student is obliged to pass the partial (entrance) colloquia before each laboratory exercise. If the student is not satisfied with the final result, with the grade of the colloquium, he/she can take the final written exam. The final grade consists of: 100% success in partial (entrance) colloquia or 50% success in entrance exams and success in the final written exam 50% (if the student wants to take the final exam).		
Language of teaching and possibilities of following in other languages	Croatian		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.		

Course name	**Solid state chemistry**		
Code	KD 2201		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program		
Year	1.	**Semester**	Winter
ECTS	5		
Lecturer	Tomislav Balić, Ph.D., associate prof.		
The aim or purpose of the course	Acquiring knowledge about substances that appear in crystalline form. Studying the properties of solids substances and characteristic phenomena related to them, and an overview of their technological applicability.		
Prerequisites for enrollment	-		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Recognize the basic chemical and physical properties of solids. 2. Analyze relationships and phenomena that are characteristic of substances that are in a solid state. 3. Explain the electronic theory of metals and theories that describe chemical bonds in semiconductors and insulators. 4. Explain the preparative methods applicable to the solid state. 5. Analyze Interstitial phases.		

	6. Evaluate materials that show special properties (electrical, magnetic, optical, refractory, etc.), as well as cements and glasses. 7. To conclude how the chemical and physical properties of the compound depend on the structure of the compound in the solid state. 8. Propose the relationship between the composition, structure and properties of compounds found in the solid state.
Relationship between learning outcomes, teaching methods and grading	

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0	1-8	**Class attendance**	**Attendance records**	6	10
Seminars	1	1-8	**Seminar preparation**	Oral presentation	10	20
Knowledge test (written colloquia)	1	1-8	**Preparation for the written exam**	**Written colloquium**	20	30
Final exam	2	1-8	**Repetition of study matter**	**Oral exam**	24	40
Total	2				60	100

Consultations	Consultations are held during the semester regarding both lecture and seminar topics, and preparation for written exams.
Acquired competencies	A successful student is competent in the field of phenomena that are characteristic of substances that are in a solid state. Having such competencies, students will have a better understanding of phenomena in crystal chemistry, phenomena in transition metals, material chemistry, analysis monocrystals and polycrystals using X-rays, as well as many technological processes.
Content	Presentation of the development of solid state chemistry. Study of the properties of substances in the solid state. Structure, chemical bond and properties of crystalline and amorphous substances. Electronic theory of metals (Drude-Lorentz, Sommerfeld, zonal theory, bands of energy levels). Theory of semiconductors and insulators. Superconductivity (BCS theory, types of superconductors). Electrical properties of matter (thermoelectric effect, piezo-, pyro-, and ferroelectricity). Magnetic properties of substances (para-, ferro-, ferri- and antiferromagnetism). Optical properties of matter (luminescence, lasers). Crystal defects and non-stoichiometry (atomic, line and planar defects, color centers). Diffusion (mechanisms, Fick's law). Ionic conductivity (solid electrolytes). Phase transformations and interpretation of phase diagrams. Preparative methods (types of reactions, obtaining thin films, growth of single crystals). Interstitial phases and refractory materials. Amorphous materials (glass, glass-ceramics, metallic glasses). Cements (Portland, aluminate and Sorel cement).
Recommended literature	1. R. West: *Solid State Chemistry and its Applications*, Wiley, New York, 1998. 2. D. Grdenić: Molekule i kristali, Školska knjiga, Zagreb
Additional literature	1. M. Hudson: Crystals and Crystal Structure, Longman, London, 1971 2. J.D. Wright: Molecular Crystals, Cambridge Univ. Press, 1987

Forms of teaching	Lectures, student seminars and homework.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	Within each lecture, the level of acquired knowledge is checked in different ways. In the end of semester there is a written exam and an oral examination of the results of the written exam.		
Language of teaching and possibilities of following in other languages	Croatian, possibly English		
The method of monitoring the quality and performance of each course and/or module	Continuous communication between teachers and students, and an anonymous student survey		

Course name	METHODS OF ORGANIC SYNTHESIS		
Code	KD3101		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program/ Graduate university study of Chemistry-teaching program		
Year	1.	**Semester**	Summer
ECTS	5		
Lecturer			
The aim or purpose of the course	Get to know the basic principles of retrosynthetic analysis and synthesis planning and their application.		
Prerequisites for enrollment	None		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Comment on the concepts of retrosynthetic analysis and independently propose meaningful retrosynthetic analyzes for simple organic compounds (target molecules). 2. Write the correct reaction mechanisms used in organic syntheses. 3. Propose reactions for interconversions of functional groups and describe the conditions of these reactions. 4. Predict the stereochemical outcomes of reactions. 5. Critically evaluate the relevant scientific literature.		

<table>
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<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td></td><td>1-5</td><td>Class attendance</td><td>Attendance records</td><td></td><td></td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>2</td><td>1-5</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>40</td></tr>
<tr><td>Final exam</td><td>3</td><td>1-5</td><td>Repetition of study matter</td><td>Oral exam</td><td>40</td><td>60</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Consultations</td><td>Immediately after the lecture, 2 hours of consultation are available.</td></tr>
<tr><td>Acquired competencies</td><td>Knowledge of important reactions and methods used in organic syntheses, ability to apply knowledge in practice (performance of retrosynthetic analyzes and planning of organic syntheses), critical evaluation, problem solving, understanding of organic reaction mechanisms.</td></tr>
<tr><td>Content</td><td>Lectures include:
1. Introduction to organic synthesis.
2. Retrosynthetic analysis
3. Interconversion of functional groups.
4. Chemoselectivity and protecting groups.
5. Regioselectivity and stereoselectivity.
6. Asymmetric synthesis.
7. Examples of synthesis of complex organic compounds.
During the seminar, students solve tasks related to certain organic syntheses, strategies and retrosyntheses.</td></tr>
<tr><td>Recommended literature</td><td>J. Clayden, N. Greeves, S. Warren and P. Wothers: Organic Chemistry, Oxford University Press, 2001.
M. B. Smith and J. March: March's Advanced Organic Chemistry, Reactions, Mechanisms, and Structure, 5th Edition, John Wiley & Sons, Inc., New York 2001.
S. H. Pine: Organska kemija, Školska knjiga, Zagreb, 1994.</td></tr>
<tr><td>Additional literature</td><td>S. Warren and P. Wyatt: Organic Synthesis: the disconnection approach, 2nd Edition, John Wiley & Sons, Inc., UK, 2008.
C. Bittner, A. S. Busemann, U. Griesbach, F. Haunert, W.-R. Krahnert, A. Modi, J. Olschimke and P. L. Steck: Organic Synthesis Workbook II, Wiley-VCH Verlag GmbH, 2001.
T. W. Greene and P. G. M. Wuts: Protective Groups in Organic Synthesis, 3rd Edition, John Wiley & Sons, Inc., New York, 1999</td></tr>
<tr><td>Forms of teaching</td><td>Lectures with the use of technical aids (Power Point presentations) and active participation of students. As part of the seminar, each student will prepare and give a presentation on an organic synthesis from a published scientific paper</td></tr>
<tr><td>Teaching type</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td>2</td><td>1</td><td></td></tr>
<tr><td>30</td><td>15</td><td></td></tr>
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</td></tr>
<tr><td>(hours per week) total</td><td></td></tr>
</table>

Methods of testing knowledge and taking exams	The final exam is taken in writing and orally.
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction). English language (tracking possible).
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

II. Year

III. Winter semester

Senior Laboratory of Inorganic Chemistry (ECTS 5)

Elective Course VII* (ECTS 5)

Elective Course VIII* (ECTS 5)

Elective Course IX* (ECTS 5)

Elective Course X* (ECTS 5)

Diploma Thesis (ECTS 10)

Course name	Advanced inorganic chemistry laboratory		
Code	KD2103		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program		
Year	1.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Tomislav Balić, PhD, assistant professor		
The aim or purpose of the course	To introduce modern methods of synthesis and characterization of inorganic compounds with the use of modern laboratory techniques.		
Prerequisites for enrollment	-		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. To determine laboratory skills in handling solids, liquids and gases. 2. Propose the method of sample preparation and the use of instrumental techniques such as: FTIR spectroscopy, UV-Vis spectrophotometry, X-ray diffraction for sample identification. 3. Integrate the concepts of planning and efficient use of experiments. 4. Determine the method of keeping a laboratory notebook and the skill of interpreting the collected experimental data. 5. Apply the acquired knowledge in organizing independent work in the laboratory. 6. To acquire the ability of self-assessment and self-criticism (the ability to notice errors and deviations during experimental work as well as to determine the necessary procedures for their correction).		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1</td><td>1</td><td>Class attendance</td><td>Attendance records</td><td>20</td><td>30</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>2</td><td>1 – 6</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>30</td></tr>
<tr><td>Final exam</td><td>2</td><td>1 - 6</td><td>Repetition of study matter</td><td>Oral exam</td><td>20</td><td>40</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
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</td></tr>
<tr><td>Consultations</td><td>In agreement with the students/ Thursday, 10-12 pm</td></tr>
<tr><td>Acquired competencies</td><td>A successful student achieves competencies in the field of experimental work in the laboratory using advanced techniques of synthesis and analysis of inorganic compounds. Students develop the ability of critical evaluation, problem solving, reasoning, individual and group work and communication skills.</td></tr>
<tr><td>Content</td><td>Experimental work in a higher laboratory involves self-introduction to advanced synthesis and analysis techniques used in inorganic chemistry.
List of exercises:
1. Synthesis of organic ligands: a) Preparation of 2- [5- (2-formylphenoxy) pentoxy] benzaldehyde b) Preparation of 1,5-diaza-2,4: 7,8: 16,17-tribenzo-9,15-dioxa-cyclooctadeca-1,5-diene c) Oxidation of 2- [5- (2-formylphenoxy) pentoxy] benzaldehyde d) IR spectroscopy of prepared ligands.
2. Macrocyclic effect and template synthesis: a) Preparation of [5,7,12,14-Me4-2,3: 9,10-benzo2 [14] hexaenato (2-) N4] nickel (II) b) Demethalization of [5,7,12,14-Me4-2,3: 9, 10-benzo2 [14] hexaenato (2-) N4] nickel (II) c) IR spectroscopy of the prepared compounds
3. Spectrochemical series of ligands: a) Preparation of diaquabis (ethylenediamine) copper (II) [Cu (en) 2 (H2O) 2] I2 b) Spectrophotometric determination of complex compounds with Cu (II) ion
4. Methods of preparation of unit crystals: a) Preparation of unit crystals from aqueous solutions b) Seminar exercise: Preparation of unit crystals with selected organic ligands (Exercise 1) c) Solving and refining crystal structures
5. Metal-organic frameworks: a) Preparation of MOF-5 b) Characterization of MOF-5 by X-ray diffraction c) Characterization of MOF-5 by thermal analysis
6. Preparation of perovskite: a) Preparation of CaMnO3 b) Characterization by CaMnO3 by X-ray diffraction c) Characterization of CaMnO3 by thermal analysis
At the beginning of the lab-work, each student, in agreement with the assistant, chooses a series of syntheses / analyzes beyond the proposed list, independently finds literature sources that help him create the experiment, and selects appropriate techniques for conducting the experiment and appropriate techniques for product characterization.</td></tr>
<tr><td>Recommended literature</td><td>1. Internal script.
2. J.D. Woollins, Inorganic Experiments, J. Wiley & Sons, 2010.</td></tr>
</table>

Additional literature	2. A.D. Garnovskii, B.I. Kharissov, Synthetic Cooridination and Organometallic Chemistry, Taylor & Francis, 2003.		
Forms of teaching	Practical work in the laboratory, keeping a laboratory notebook and writing and presentation of experimental results.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week) total	-	-	4
	-	-	60
Methods of testing knowledge and taking exams	Entrance exams (before each exercise) and a final exam that is taken in writing and orally.		
Language of teaching and possibilities of following in other languages	Croatian, possibly English		
The method of monitoring the quality and performance of each course and/or module	Continuous communication of teachers with students, and anonymous student survey		

II. Year

IV. Summer semester

Elective Course XI* (ECTS 5)

Elective Course XII* (ECTS 5)

Diploma Thesis (ECTS 20)

***List of elective courses**

Branch - Analytical chemistry

Quality Assurance in the Analytical Laboratory (ECTS 5)

Microanalytical Methods (ECTS 5)

The Basic Principles of Forensic Chemistry (ECTS 5)

Branch - Inorganic chemistry

Bioinorganic Chemistry (ECTS 5)

Advanced Laboratory and Synchrotron Methods in Structural Research (ECTS 5)

Chemistry of Transition Elements (ECTS 5)

Fundamentals of Radiochemistry and Radiation Chemistry (ECTS 5)

Sedimentation Processes (ECTS 5)

Branch: Organic chemistry and Biochemistry

Green Chemistry (ECTS 5)

Senior Laboratory of Organic Chemistry (ECTS 5)

Chemistry of Food (ECTS 5)

Biochemistry of Micronutrients (ECTS 5)

Out of Branches

Photo Atmospheric Chemistry (ECTS 5)

Introduction to Computer Chemistry (ECTS 5)

Senior Laboratory of Physical Chemistry (ECTS 5)

Colloid and Interfacial Chemistry (ECTS 5)

<table>
<tr><td>Course name</td><td colspan="3">Quality assurance in the analytical laboratory</td></tr>
<tr><td>Code</td><td colspan="3">KD1205</td></tr>
<tr><td>Type</td><td colspan="3">elective</td></tr>
<tr><td>Level</td><td colspan="3">Graduate university study of Chemistry-research program</td></tr>
<tr><td>Year</td><td>II.</td><td>Semester</td><td>Winter/Summer</td></tr>
<tr><td>ECTS</td><td colspan="3">5</td></tr>
<tr><td>Lecturer</td><td colspan="3">Dr.sc. Suzana Ćavar, znanstveni suradnik</td></tr>
<tr><td>The aim or purpose of the course</td><td colspan="3">Students will learn the basics of quality assurance in the analytical laboratory, that is, the regulations that are applied in the laboratory to ensure reliable and credible analysis results.</td></tr>
<tr><td>Prerequisites for enrollment</td><td colspan="3">Passed mandatory courses in the field of analytical chemistry.</td></tr>
<tr><td>Learning outcomes</td><td colspan="3">After successfully completing the course, the student will be able to:
1. Comment on the quality management system in the laboratory.
2. Critically assess the individual requirements of the HRN EN ISO/IEC 17025 standard. 3. Conduct quality control in the laboratory.
4. Write standard operating procedures.
5. Evaluate analytical methods.
6. To identify defects in the quality assurance.</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="3">
<table>
<tr><th rowspan="2">Nastavna aktivnost</th><th rowspan="2">ECTS</th><th rowspan="2">Ishod učenja</th><th rowspan="2">Aktivnost studenata</th><th rowspan="2">Metode procjenjivanja</th><th colspan="2">Bodovi</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1</td><td>1-6</td><td>Class attendance</td><td>Attendance records</td><td>10</td><td>15</td></tr>
<tr><td>Discussion, seminars and homework</td><td>1</td><td>1-6</td><td>Preparation and problem solving</td><td>Oral presentation</td><td>10</td><td>15</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td>1-6</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>30</td></tr>
<tr><td>Final exam</td><td>2</td><td>1-6</td><td>Repetition of study matter</td><td>Written exam
Oral exam</td><td>20</td><td>40</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
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</td></tr>
<tr><td>Consultations</td><td colspan="3">Consultations are available every week, during which a lecture is held, for 1 hour.</td></tr>
<tr><td>Acquired competencies</td><td colspan="3">The application of the requirements of the HRN EN ISO/IEC 17025 standard in the laboratory, that is, the measures applied in the laboratory to ensure quality work in order to achieve reliable and credible analysis results.</td></tr>
<tr><td>Content</td><td colspan="3">Lectures - Introduction: standards and standardization (application of the HRN EN ISO/IEC 17025 standard). Quality management system in the laboratory and accreditation. Staff and education in the laboratory. Sample and sampling. Standard operating procedure. Management of laboratory test equipment. Choice of analyte determination methods and validation of method. Assessment of measurement uncertainty. Internal and external quality control of test results.</td></tr>
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Recommended literature	1. HRN EN ISO/IEC 17025:2007- Opći zahtjevi za osposobljenost ispitnih i umjernih laboratorija (ISO/IEC 17025:2005+Cor.1:2006; EN ISO/IEC 17025:2005+AC:2006) 2. M. Kaštelan-Macan, Kemijska analiza u sustavu kvalitete, Školska knjiga Zagreb, 2003.		
Additional literature	1. EURACHEM/CITAC Guide: Terminology in Analytical Measurement: Introduction to VIM 3, first edition, 2011. 2. EURACHEM/CITAC Guide : Guide to Quality in Analytical Chemistry (2002)		
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students. Seminars where seminar papers and homework are presented and discussed, and students solve problems.		
Teaching type	**Predavanja**	**Seminari**	**Vježbe**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	A written exam that is taken after the lectures. The final grade consists of: attendance and active participation in classes - 10%, completion of assignments/seminars - 10%, final exam - 50%.		
Language of teaching and possibilities of following in other languages	Croatian.		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.		

Course name	MICROANALYTICAL TECHNIQUES		
Code	KD2103		
Type	Elective		
Level	Graduate university study of Chemistry--teaching program		
Year	2.	**Semester**	Winter
ECTS	5		
Lecturer	Doc.dr.sc. Aleksandar Sečenji		
The aim or purpose of the course	Understand microanalytical techniques in analytical chemistry. Learn to select and implement the most suitable microanalytical technique for a particular analytical method. Acquire basic knowledge necessary for research work.		
Prerequisites for enrollment	Passed mandatory courses in analytical chemistry.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Integrating basic concepts and knowledge from analytical chemistry into microanalytical techniques. 2. Compare classical analytical and microanalytical techniques and their principles. 3. Assess the advantages and disadvantages of individual microanalytical techniques. 4. Independently decide when and how to apply a particular miroanalytical technique. 5. Discuss the advantages of microanalytical techniques in analytical chemistry. 6. Critically review and evaluate the literature and scientific papers related to microanalytical techniques		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-6	**Class attendance**	**Attendance records**	8	10
Discussion, seminars and homework	1	1-6	**Preparation and problem solving**	**Oral presentation**	10	20
Knowledge test (written colloquia)	1	1-5	**Preparation for writtwn exam**	**Writen exam**	15	30
Final exam	2	1-5	**Repetition of study matter**	**Writen exam** **Oral exam**	10 10	20 20
Total	5				53	100

Consultations	Consultations are available every week, during which the lecture is held, for 1 hour.
Acquired competencies	Understanding the principles of microanalytical analysis techniques, ability to choose microanalytical techniques.
Content	Lectures: Miniaturization in analytical chemistry (classification, miniaturization as a trend in analytical chemistry, definitions and terms, miniaturization theory, advantages of miniaturization of analytical systems). Design of miniaturized analytical systems. Automation and miniaturization of sample processing (solid phase microextraction, liquid phase microextraction, continuous flow system). Miniaturized systems for analytical separation (System based on hydrodynamic flow; System based on electroosmotic flow). Detection in miniaturized analytical systems. Micro (nano) sensors: development and nanotechnology. Portable miniaturized analytical systems.
Recommended literature	A. Rios, A. Escarpa, B. Simonet: *Miniaturisation of Analytical Systems: Principles, designs and Application*, J. Wiley & Sons Ltd., Chichester, UK, 2009.
Additional literature	D.Li (Ed.): *Encyclopedia of Microfluidics and Nanofluidics*, Springer, Heidelberg, Germany, 2008. O. Geschke, H. Klank, P. Telleman (Eds.): Microsystem Engineering of Lab-on-a-Chip Devices, 2nd ed., Wiley-VCH, Weinheim, Germany, 2009.
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students. Seminars where seminar papers and homework are presented and discussed, and students solve problems.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-

Methods of testing knowledge and taking exams	Knowledge is tested through a mid-term test, which is taken in the middle of the semester. The final exam is taken orally.
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction). English language.
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.

Course name	BASIC PRINCIPLES OF FORENSIC CHEMISTRY		
Code	K1206		
Type	Elective		
Level	Graduate university study of Chemistry-research program / Graduate university study of Chemistry-teaching program		
Year	1./2.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Nikola Sakač, Ph.D., Assist. prof.		
The aim or purpose of the course	During the course students will learn about forensic chemistry from the perspective of analytical chemistry, sampling, type of samples and matrices, instrumentation, chemical concepts and practice from a forensic perspective (including multivariate statistics, quality assurance, quality control, and protocols in the forensic laboratory) Students will be able to independently search the literature related to a given topic and critically evaluate them.		
Prerequisites for enrollment	Completed compulsory courses in analytical chemistry.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Review the basic principles of forensic chemistry 2. Critically evaluate principles in finding solutions in forensic chemistry 3. Evaluate the principles and methodology of sampling and analysis in forensic chemistry 4. Review the instrumentation used in forensic chemistry 5. Critically evaluate approaches when selecting the most appropriate methods of analysis 6. Argue the opinion on sensory solutions for problem tasks from		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-6	**Class attendance**	**Attendance records**	20	30
Knowledge test (written colloquia)	2	1-6	**Preparation for the written exam**	**Written colloquium**	20	30

	Final exam	2	1-6	**Repetition of study matter**	**Oral exam**	25	40
	Total	5				65	100

Consultations	Wednesday, 10-12		
Acquired competencies	Introduction to the main parts of forensic chemistry. Adopting the interdisciplinary approach needed for solving and analysis in forensic chemistry. Solving problem tasks related to the application of forensic chemistry.		
Content	Environmental forensic chemistry, principles and analysis of explosives, shell analysis, forensic soil analysis, color analysis as evidence, analytical techniques in ink analysis, role of vibrational spectroscopy in forensic chemistry, forensic serology, forensic DNA analysis, use of DNA microassays in forensic science, drugs with emphasis on GHB, forensics in alcohol analysis, entomotoxicology: drugs, toxins and insects.		
Recommended literature	Bell Suzanne: Forensic Chemistry (2nd Edition), Prentice Hall, 2012. Khan JaVed I., Kennedy Thomas J., Christian Jr. Donnell R.: Basic Principles of Forensic Chemistry, Humana Press, 2012. Ho Mat H.: Analytical Methods in Forensic Chemistry (Ellis Horwood Series in Analytical Chemistry), Ellis Horwood Ltd, 1990.		
Additional literature	Stuart Barbara H.: Forensic Analytical Techniques (Analytical Techniques in the Sciences (AnTs), Wiley, 2013.		
Forms of teaching	Lectures (obligatory), seminars and assignments. The seminars are included in the overall grade together with the final exam at the end of the course.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	3	-	-
total	45	-	-
Methods of testing knowledge and taking exams	Written and oral exam taken after the lectures. The final grade consists of: regular attendance and active participation in classes - 30%, preparation of seminars and assignments - 30%, and success in the final exam - 40%.		
Language of teaching and possibilities of following in other languages	Croatian, English		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous opinion poll.		

Course name	**BIOINORGANIC CHEMISTRY**		
Code	K2301		
Type	Elective		
Level	Graduate university study of Chemistry-research program/ Graduate university study of Chemistry-teaching program		
Year	2.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Prof.dr.sc. Dubravka Matković-Čalogović		

<table>
<tr><td>The aim or purpose of the course</td><td>Understanding the role of metal ions in biological molecules. Encouraging students to familiarize themselves with the structure of biomolecules independently and interactively using computers.</td></tr>
<tr><td>Prerequisites for enrollment</td><td>Passed compulsory courses in Inorganic and Structural Chemistry.</td></tr>
<tr><td>Learning outcomes</td><td>After successfully completing the course, the student will be able to:
1. Recognize the binding modes of metal ions in biologically important molecules.
2. Predict the coordination of metal ions in relation to ligands.
3. Explain the electronic theory of metals and theories that describe chemical bonds in complexes with organic ligands.
4. Differentiate the role and method of binding alkali and sub-alkali metals as opposed to those of transition elements.
5. Explain the basic mechanisms of action of active groups of biologically important molecules.
6. To conclude why different metal ions come in different oxidation states in different biological molecules.
7. Propose the potential use of model systems in research on biological macromolecules.
8. Propose the potential use of malate ions in medicine (diagnosis and treatment).</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1</td><td>1-8</td><td>Class attendance</td><td>Attendance records</td><td>7</td><td>10</td></tr>
<tr><td>Presentation and assignments</td><td>1</td><td>1-8</td><td>Preparation and creation of the presentation and related problems</td><td>Oral presentation, written assignments</td><td>10</td><td>20</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td></td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>30</td></tr>
<tr><td>Final exam</td><td>2</td><td>1-8</td><td>Repetition of study matter</td><td>Oral exam</td><td>23</td><td>40</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
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</td></tr>
<tr><td>Consultations</td><td>Consultations are held at a pre-announced time per week (1 hour) during the semester regarding both lecture and seminar topics, as well as preparation for written exams.</td></tr>
<tr><td>Acquired competencies</td><td>A successful student is competent in the field of phenomena that are characteristic of the role of metals in biologically important molecules. By having such competences, phenomena and processes in biochemistry, medicine, and pharmacology can be understood much more deeply. Students develop the ability of critical evaluation, problem-solving, reasoning, independent and group work, and communication skills.</td></tr>
<tr><td>Content</td><td>Significance and basic principles of bioinorganic chemistry. Relationship between structure and properties of metalloproteins. Intake, transport and storage of metals and non-metals in organisms (metalloproteins and non-proteins in the role of transport and storage; tetrapyrrole ligands, ionophores, siderophores, transferrins, metallothioneins, ferritin, hemoglobin, myoglobin, hemerythrin, hemocyanin). Biomineralization. Catalysis by hemoproteins. Cytochromes. Peroxidases. Cobalt, nickel, and copper in biological systems (vitamin B12, urease, superoxide dismutase, plastocyanin, azurin, ascorbate oxidase, tyrosinase). The role of zinc in the body (carbonic anhydrase, carboxypeptidase, endopeptidase, alkaline phosphatase, alcohol dehydrogenase, insulin). The biological role</td></tr>
</table>

	of Mo, W, V Cr, and Mn in metalloproteins. Alkaline earth metal ions; catalysis and regulation (enolase, calmodulin). Alkaline and alkaline earth cations as electrolytes. Toxic metals and non-metals. Inorganic radionuclides in diagnostics and therapy. Chemotherapy with compounds of non-essential elements. During the seminar, students present their seminar papers (presentations), and problem tasks (problems) related to certain areas that are covered in the lectures are solved.
Recommended literature	1. W. Kaim, B. Schwederski: *Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life*, Wiley, Chichester, 1994, ISBN 0-471-94369-x.
Additional literature	1. J.J.R. Frausto da Silva, R.J.P. Williams: *The Biological Chemistry of the Elements: the Inorganic Chemistry of Life*, Oxford Univ. Press, Oxford 1994, ISBN 0 19 855598 3. 2. L. Stryer: *Biochemistry*, 4. Ed., W.H. Freeman, New York 1995., ISBN 0-7167-2009-4.
Forms of teaching	Lectures, consultations, and seminars with selected topics that are outside, but close to, the planned program, based on original scientific and review papers. The treated topic should be referenced orally and written material and presentation should be prepared. Solving (individual and group) problem tasks at home and at seminars.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-

Methods of testing knowledge and taking exams	Knowledge is checked through assignments and one colloquium (mid-term) which is taken in the middle of the semester. The final exam is taken orally.
Language of teaching and possibilities of following in other languages	Croatian, possibly English
The method of monitoring the quality and performance of each course and/or module	Continuous communication between teachers and students, and an anonymous student survey.

Course name	**ADVANCED LABORATORY AND SYNCHROTRON STRUCTURAL CHARACTERIZATION TECHNIQUES**		
Code	KD1203		
Type	Elective		
Level	Graduate university study of Chemistry		
Year	I. or II.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Igor Đerđ, PhD, Full Professor		
The aim or purpose of the course	Students will obtain the knowledge about the physical basis of the interaction of electromagnetic radiation and matter and, based on the laws of quantum physics, will fully understand methods of obtaining useful structural information of various investigated functional materials. As part of the course, they will get to know and acquire adequate knowledge of various radiation analytical techniques: X-ray diffraction (XRD), X-ray absorption spectroscopy (XAS), X-ray photoelectron spectroscopy (XPS), Small-angle X-ray		

<table>
<tr><td></td><td>scattering (SAXS), Small-angle grazing incidence x-ray diffraction (GIXRD) and neutron diffraction.</td></tr>
<tr><td>Prerequisites for enrollment</td><td>No prerequisites, but the recommendation is to attended course: Solid state Chemistry</td></tr>
<tr><td>Learning outcomes</td><td>1. Understanding and knowing the possibilities of X-ray structural analysis in comparison with other non-destructive methods of determining the crystal structure and the basis of radiation protection.
2. Knowledge of the concepts of symmetry, crystal lattice, and diffraction.
3. Independent refinement of the crystal structure of the investigated compound using the Rietveld method of X-ray powder diffraction analysis.
4. Understanding how to obtain information about the oxidation state and chemical composition of the investigated compound using XPS.
5. Analyzing atomic coordination, chemical bonds lengths, oxidation states of amorphous, nanocrystalline and crystalline materials using XAS.
6. Understanding the structural analysis of thin films using SAXS and GIXRD.
7. Understanding the possibility of obtaining structural information and resolving the magnetic structure using neutron diffraction.</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>0</td><td>1-7</td><td>Class attendance</td><td>Attendance records</td><td>6</td><td>10</td></tr>
<tr><td>Knowledge test</td><td>2</td><td>1-7</td><td>Seminar presentation</td><td>Seminar</td><td>25</td><td>40</td></tr>
<tr><td>Final exam</td><td>3</td><td>1-7</td><td>Repetition of study matter</td><td>Oral exam</td><td>29</td><td>50</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
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</td></tr>
<tr><td>Consultations</td><td>Consultations are held during the semester and they include lecture and seminar topics.</td></tr>
<tr><td>Acquired competencies</td><td>A successful student is competent in the field of understanding the analysis of crystal structures of materials and the advanced methods used to determine them. They will gain knowledge of laboratory and synchrotron methods of analysis of functional materials and fully understand XRD, XPS, XAS and neutron diffraction from a physical point of view. From a practical point of view, the student will be able to analyze X-ray diffractograms using the Rietveld method and obtain appropriate structural and microstructural information about the tested material. They will be able to entirely follow the relevant scientific and professional literature.</td></tr>
<tr><td>Content</td><td>Basic principles of crystal structure. Symmetry in crystals (symmetry elements, Bravais lattices, crystal systems, points and space groups). Crystal structure of metals, alloys and solid solutions. Diffraction of X-ray radiation in a crystal. Refinement of the crystal structure using the Rietveld method. Basics of X-ray photoelectron spectroscopy (XPS). Basics of X-ray absorption spectroscopy (XAS). Basics of analysis of porous materials using small angle X-ray scattering (SAXS). Analysis of thin films by small-angle grazing incidence X-ray diffraction (GIXRD). Basics of neutron diffraction.</td></tr>
<tr><td>Recommended literature</td><td>1. C. Giacovazzo et al., Fundamentals of Crystallography, Oxford University Press, 1992.</td></tr>
</table>

Additional literature	1. Basic Principles and Applications of EXAFS, Chapter 10 in Handbook of Synchrotron Radiation, pp 995–1014. E. A. Stern and S. M. Heald, E. E. Koch, ed., North-Holland, 1983. 2. XANES, in Chemical Analysis 92, D. C. Koningsberger and R. Prins, ed., John Wiley & Sons, 1988. 3. Principles and Applications of EXAFS, Chapter 10 in Handbook of Synchrotron Radiation, pp 995–1014. E. A. Stern and S. M. Heald, E. E. Koch, ed., North- Holland, 1983. 4. B.K. Teo, EXAFS: Basic principles and Data Analysis, Springer, Berlin, Heidelberg, 1986. 5. EXAFS as powerful analytical tool for the investigation of organic-inorganic hybrid materials, S. Gross, M. Bauer, Advanced Functional Materials 20 (2010) 4026-4047. 6. X-ray Absorption Spectroscopy (Principles, Applications, Techniques of EXAFS, SEXAFS, and XANES), (Eds: D. C. Koningsberger, R. Prins), John Wiley and Sons, New York 1988.		
Forms of teaching	Lectures (mandatory). During the course, students will hold seminars with topics from the course content, the grade of which will be counted in the final grade, together with the final exam.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	Knowledge is tested by constructive discussion during the thematic seminar and a final oral exam. The final grade consists of: regular attendance and active participation in classes - 10%, preparation and presentation of seminars - 45%, and success in the final exam - 45%.		
Language of teaching and possibilities of following in other languages	Croatian, English		
The method of monitoring the quality and performance of each course and/or module	Continuous communication of lecturer with students and anonymous questionnaire.		

Course name	TRANSITION METALS CHEMISTRY		
Code	KD2207		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program/ Graduate university study of Chemistry-teaching program		
Year	I.	**Semester**	Summer
ECTS	5		
Lecturer	Elvira Kovač-Andrić, Ph.D., Assistant Professor		
The aim or purpose of the course	Understand the basic concepts of the properties of transition metals and their compounds, their characteristic, technological applicability and their role in metabolic processes.		
Prerequisites for enrollment	Completed obligations for Inorganic Crystallochemistry		

<table>
<tr><td>Learning outcomes</td><td>After successfully completing the course, the student will be able to:
1. Determine the basic chemical and physical properties of transition metals.
2. Examine the properties of the elements for each group of transition metals in the periodic table.
3. Evaluate the role of transition metals in metabolic processes.
4. Compare chemical bonds in crystal structures of transition metals and their complex compounds.
5. Conclude how the chemical and physical properties depend on the structure of the compound with the transition metal.
6. Propose the relationship of composition, structure and properties of compounds containing transition metals.</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1</td><td>1-6</td><td>Class attendance</td><td>Attendance records</td><td>10</td><td>20</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td>1-6</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>30</td><td>40</td></tr>
<tr><td>Final exam</td><td>3</td><td>1-6</td><td>Repetition of study matter</td><td>Oral exam</td><td>30</td><td>40</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>70</td><td>100</td></tr>
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</td></tr>
<tr><td>Consultations</td><td>In agreement with the students/ Mondays, 8-10 pm</td></tr>
<tr><td>Acquired competencies</td><td>To determine the properties of the elements and understand the basic chemical and physical properties of transition metals.</td></tr>
<tr><td>Content</td><td>Review of the periodic table from the aspect of electronic configuration of the ground state. Term transition metals. Character of bonds in transition metal compounds. Properties of the individual transition metal (atomic radius, ionization energy, atomization enthalpy, reduction potential, electronegativity, oxidation numbers, crystal lattice, density, hardness, melting and boiling points, heat and electricity conductivity, mechanical, electrical and magnetic properties, color, reactivity). Solutions and complex compounds of transition metals.
Alloying of transition metals - with each other and with other metals. Technological importance transition metals. Biological importance of transition metals.</td></tr>
<tr><td>Recommended literature</td><td>1. D. F. Shriver, P. W. Atkins, C. H. Langford, Inorganic Chemistry, 5. izd., Oxford University Press, Oxford 2010.
2. I. Filipović i S. Lipanović, Opća i anorganska kemija, II dio, VIII. izdanje, Školska knjiga, Zagreb, (1991).
3. D. Grdenić, Molekule i kristali, 5. izd., Školska knjiga, Zagreb 2005.
4. C. E. Housecroft, A. G. Sharpe, 2. izd. Inorganic Chemistry, izd. Pearson Ed., 2005.</td></tr>
<tr><td>Additional literature</td><td>1. F. Albert Cotton, G. Wilkison, P. Gauss, Basic Inorganic Chemistry,. izd., John Willey& Sons, New York.
2. W.H. Bragg, W-L- Bragg: The crystalline State, Vol I., A General Survey , G. Bell and Sons, London, 1955
3. R.C.Evans: An Introduction to Crystal Chemistry, Cambridge Univ. Press, 1964</td></tr>
</table>

Forms of teaching	Lectures, seminars and homework.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	2	-
total	30	30	-
Methods of testing knowledge and taking exams	Written and oral exam after completion of all the lectures.		
Language of teaching and possibilities of following in other languages	Croatian English		
The method of monitoring the quality and performance of each course and/or module	Discussions with students and the anonymous students opinion poll.		

Course name	**Radiochemistry and Radiation Chemistry**		
Code	KD2209		
Type	Elective		
Level	Graduate university study of Chemistry-research program/ Graduate university study of Chemistry-teaching program		
Year	1.or 2.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Assistant professor Berislav Marković, PhD Brunislav Matasović		
The aim or purpose of the course	Introducing to students the basic concepts of radiochemistry and radiation chemistry, with the principles of nuclear reactions and chemical reactions induced by radiation and with the applications of ionizing radiation in practice.		
Prerequisites for enrollment	None.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Define basic concepts in radiochemistry and radiation chemistry. 2. Judge and determine the differences between radiochemistry and radiation chemistry. 3. Judge and determine the differences between different radiation sources. 4. To determine and predict the ways of radical formation and their reactions. 5. Judge and recommend the use of radionuclides and ionizing radiation. 6. Critically evaluate the relevant scientific literature.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0.5	1 – 6	**Class attendance**	**Attendance records**	9	10
Seminars	1	1 – 6	**Seminar preparation**	**Seminar presentation**	10	20
Knowledge test (written colloquia)	1	1 – 6	**Preparation for the written exam**	**Written colloquium**	10	20
Final exam	2.5	1 – 6	**Repetition of study matter**	**Oral exam**	25	50
Total	5				54	100

Consultations	In agreement with the students
Acquired competencies	Acquisition of basic knowledge about the nature of radioactivity, the properties of ionizing radiation, the chemical changes it causes; useful application (especially in chemistry); why this type of radiation is harmful to health and what are the methods and controls of protection.
Content	Ionizing radiation - what is it and what does it have to do with chemistry? Why and how harmful is it to human health? What are the useful applications? Students will be introduced to the types, origins and sources of radiation. The structure of the atomic nucleus, isotopes, radioactivity, modes and kinetics of radioactive decay. Which radioactive isotopes are natural and which are artificially created and in what way (nuclear machines, accelerators/particle accelerators, reactors). How and when a nuclear reaction occurs. On the principles of radiation measurement, which instruments and in which units the results are expressed. How radiation and the material exposed interact. What is radiolysis, how are radicals formed, what are their properties and what chemical changes do they cause. What are antioxidants and how do they work. Where radionuclides and ionizing radiation are applied (chemistry, medicine, industry). Peculiarities of techniques and methods of work in radiochemistry and radiation chemistry. The principles of a modern approach to protection and control against the harmful effects of ionizing radiation will be explained.
Recommended literature	1. G.R. Choppin, J. Rydberg, J.-O. Liljenzin and C. Ekberg, Radiochemistry and Nuclear Chemistry, Butterwoth-Heinemamm, 2012. 2. J.W.T. Spinks and R.J. Woods, Introduction to Radiation Chemistry, J. Wiley&Sons, 1990.
Additional literature	1. W.D. Ehman and D.E. Vance, Radiochemistry and Nuclear Methods of Analysis, J. Wiley&Sons, 1993. 2. C. von Sonntag, The Chemical Basis of Radiation Biology, Taylor&Francis, 1987. 3. International Basic Safety Standards for Protection against Ionizing Radiation and for Safety of Radiation Sources, IAEA Safety Series No. 115, 1996.
Forms of teaching	Mandatory lectures and student's seminars. Mid-term written colluquium.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	–
total	30	15	–

Methods of testing knowledge and taking exams	Written and oral exam that is taken after the lectures. The final grade consists of: regular attendance and active participation in classes - 10%, seminar paper - 20%, success in the exam in the middle of the semester - 20%, and success in the final exam - 50%.
Language of teaching and possibilities of following in other languages	Croatian, English
The method of monitoring the quality and performance of each course and/or module	Communication with students and anonymous polls.

Course name	Precipitation processes		
Code	KD2213		
Type	Elective		
Level	Graduate university study of Chemistry-research program/ Graduate university study of Chemistry-teaching program		
Year	1./2.	**Semester**	Summer/Winter
ECTS	5		
Lecturer	Anamarija Stanković, PhD, assistant prof.		
The aim or purpose of the course	The course enables students to become familiar with the widespread distribution of precipitation processes, their characterization and importance in everyday life.		
Prerequisites for enrollment	there are no prerequisites		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 6. Integrate different types of precipitation processes. 7. Determine the basic chemical and physical terms that characterize the relevant terms that directly and indirectly affect depositional processes 8. Propose suitable methods for determining precipitation processes. 9. Argue the terms: precipitation, crystallization, biomineralization, pathological biomineralization 10. Critically judge the importance and role of biomineralization and pathological biomineralization in everyday life 11. Critically evaluate relevant scientific literature and present a seminar paper		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-5	**Class attendance**	**Evidence list**	5	10
Preparation and seminars presentation	2	1-5	**Preparation and creation of the presentation**	**Oral presentation**	15	30
Knowledge test (written colloquia)	1	1-5	Preparation for the written exam	Written colloquium	10	30

	Final exam	1	1-5	**Repetition of study matter**	**Written/oral exam**	20	30
	Total	5				50	100
Consultations	In agreement with the students.						
Acquired competencies	A successful student is competent in understanding the processes of precipitation, their characteristics and specific properties, and can apply them to everyday life.Students develop the ability of critical evaluation, problem solving, reasoning, independent and group work, and communication skills. They independently search recent literature.						
Content	1. Precipitation (When? How? Why? Where? Equilibrium in liquid/solid systems - conditions that must be met 2. Elementary processes before, during and after precipitation 3. Properties of precipitation products: shape and size distribution of the product, chemical properties, precipitation diagrams 4. Precipitation with the addition of additives. (What are additives? Inhibitors/promoters of selected deposition processes) 5. The importance of studying the deposition process. (chemistry, biology, geography, metallurgy, industry,...) 6. Biomineralization. (What is it? How is it formed? Types of biominerals, their properties, distribution, application) 7. Pathological biomineralization. (What is it? How is it formed? Types of biominerals and their properties) 8. Modern methods of studying depositional processes. 9. Seminar papers/presentation of selected chapters. Students present their seminar papers and discuss the chosen topic.						
Recommended literature	1. Noviji članci iz područja biomineralizacije i patološke mineralizacije 2. M. S. Silberberg, Chemistry – The molecular Nature of Matter and Change, Fourth Edition, McGrow-Hill, 2006 3. Lj. Brečević, D. Kralj: Kinetics and Mechanisms of Crystal Growth in Aqueous Systems, u: N. Kallay (ur.): Interfacial Dynamics, Marcel Dekker, New York 1999. A. E. Nielsen: Kinetics of Precipitation, Pergamon Press, Oxford 1964.						
Additional literature	- review papers 1. D. Gebauer, M. Kellermeier, J.D. Gale, L. Bergstrom and H. Colfen: Chem. Soc. Rev., 2014, 43, 2348-2371. 2. A. E. Nielsen, Croat. Chem. Acta 42 (1970) 319; Pure Appl. Chem. 53 (1981) 2025.						
Forms of teaching	Lectures, consultations, seminars with selected topics based on original scientific and review papers. The covered topic should be referenced orally and written material and a presentation should be created (with the use of PowerPoint or another relevant program)						
Teaching type	**Lectures**		**Seminars**		**Exercises**		
(hours per week)	2		1		-		
total	30		15		-		
Methods of testing knowledge and taking exams	An oral and/or written exam that is taken after lectures and seminar papers. The final grade consists of: regular attendance and active participation in classes - 40%, seminar work - 30%, and success in the final exam - 30%.						
Language of teaching and possibilities of	Croatian (language of teaching), English (possibility of following).						

following in other languages	
The method of monitoring the quality and performance of each course and/or module	Anonymous questionnaire after passing the course.

Course name	**GREEN CHEMISTRY**		
Code	K2309		
Type	Elective		
Level	Graduate university study of Chemistry-research program/ Graduate university study of Chemistry-teaching program		
Year	1./2.	**Semester**	Summer
ECTS	5		
Lecturer	Associate professor Dajana Gašo-Sokač		
The aim or purpose of the course	The goal is to show methods and teach students how green chemistry reduces the negative impact of chemical processes and technology on the environment. By adopting green chemistry procedures, both ecological and economic improvement is achieved.		
Prerequisites for enrollment			
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Define and group the principles of ecologically acceptable synthesis 2. Recognize alternative methods of organic synthesis 3. Clarify the mechanisms of reactions under the influence of microwaves		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	0	1-3	**Class attendance**	**Attendance records**	5	10
Knowledge test (written colloquia)	2	1-3	**Preparation for the written exam**	**Written colloquium**	20	25
Final exam	3	1-3	**Repetition of study matter**	**Oral exam**	35	65
Total	5				60	100

Consultations	In agreement with the students
Acquired competencies	Knowledge of the basic principles of environmentally friendly synthesis.
Content	Introduction: green chemistry, the path towards clean, environmentally friendly chemical processes and products. Twelve principles of green chemistry. Green

	chemistry in the basic reactions of organic synthesis (halogenation, oxidation, alkylation, nitration and sulfonation). Catalysis - the basis of green chemistry. Green alternative reaction media (water, supercritical and ionic liquids). Green alternative reaction conditions. Biocatalytic processes - products created by biomass conversion and bioprocesses from renewable raw materials. Biocatalytic reactions in altern. media (ionic liquids and sc-CO2), biocatalytic deracemization. Photocatalytic reactions. Green processes and products in the food and pharmaceutical industry as well as in the synthesis of special chemicals. Chemistry without solvents - reactions activated by microwave radiation. Green processes in chemo-, regio- and enantioselective biocataly tic transformations of synthetic and natural materials.
Recommended literature	1. Green Chemistry, Theory and Practice, Paul T. Anastas, John C. Warner, Oxford University Press, 1998. 2. Green Organic Chemistry: Strategies, Tools, and Laboratory Experiments,"Kenneth M. Doxsee, James E. Hutchison, Brooks/Cole, ISBN: 0-759-31418-7 (2004). 3. K. Faber,: Biotransformations in Organic Chemistry, Springer, Berlin, 2000.
Additional literature	1. Microwave and High Frequency Heating Principles and Chemical Applications, A. Breccia, A. C. Metaxas (ur.), UCISCRM, Bologna, Italy, 1997. 2. Collection of lectures, Summer Schools on Green Chemistry, Venice 1998-2000, Green Chemistry Series No.1, P. Tundo (ur.) INCA, 2001. 3. Environmental Education from an Industrial Perspective, J. C.- Tully, ACS Preprints, Division of Environmental Chemistry 34, 1994 No 2, 2003
Forms of teaching	Lectures with the use of technical aids, active involvement of students in discussions and debates. Oral presentation of seminar papers

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	

Methods of testing knowledge and taking exams	Oral exam
Language of teaching and possibilities of following in other languages	Croatian
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys

Course name	CHEMISTRY OF FOOD
Code	K1112
Type	Elective
Level	Graduate university study of Chemistry-research program / Graduate university study of Chemistry-teaching program

<table>
<tr><td>Year</td><td>1./2.</td><td>Semester</td><td>Winter/Summer</td></tr>
<tr><td>ECTS</td><td colspan="3">5</td></tr>
<tr><td>Lecturer</td><td colspan="3">Dajana Sokač-Gašo, Ph.D., Assist. prof.</td></tr>
<tr><td>The aim or purpose of the course</td><td colspan="3">Introduce students to the basic ingredients of food, their chemical and biochemical changes and interactions.</td></tr>
<tr><td>Prerequisites for enrollment</td><td colspan="3">None</td></tr>
<tr><td>Learning outcomes</td><td colspan="3">After successfully completing the course, the student will be able to:

1. Examine and group the basic ingredients of food
2. To determine the connection between chemical, physical and biochemical reactions in food and the interaction of ingredients and food additives
3. Review and self-assess the suitability and impact of individual food additives
4. Critically evaluate harmful ingredients and their impact on health
5. Anticipate changes during food processing and storage, select appropriate processing and storage methods
6. Critically evaluate the relevant scientific literature.</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="3">
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>0</td><td>1-6</td><td>Class attendance</td><td>Attendance records</td><td>5</td><td>10</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>2</td><td>1-6</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>25</td></tr>
<tr><td>Final exam</td><td>3</td><td>1-6</td><td>Repetition of study matter</td><td>Oral exam</td><td>35</td><td>65</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td colspan="3">In agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td colspan="3">Knowledge of basic chemical processes that take place during food preparation and processing Knowledge of the interaction of individual food ingredients and their changes during processing and storage.</td></tr>
<tr><td>Content</td><td colspan="3">Chemical and physical interactions between food ingredients during processing and storage. Water and ice. Carbohydrates (structure and changes), lipids in food (structure, functional properties and changes). Amino acids, peptides and proteins (structure, functional properties and changes). Vitamins. Vitamin losses in food. Substances for plant and animal tissue color. Food flavoring substances and changes during food processing and storage. Inorganic substances. Influence of processing on the content of inorganic substances. Food additives: antioxidants, sweeteners, preservatives, emulsifiers, dyes, flavors. Harmful and medicinal ingredients of food.</td></tr>
<tr><td>Recommended literature</td><td colspan="3">1. H.-D. Belitz, W. Grosch, P. Schieberle: Food Chemistry, 3 rd revised ed, Springer-Verlag, Berlin, Heildelberg, 2004
2. John M.De Man, Principles of Food Chemistry, III ed., New York, 1999.</td></tr>
</table>

Additional literature	1. O.R. Fennema, Food Chemistry, 3 rd ed., by Marcel Dekker, Inc, N.Y., 1996. 2. Norman N. Potter, Joseph H. Hotchkiss, Food Science (3th ed.), Chapman&Hall, New York, 1995. W. Baltes, Lebensmittelchemie (Dritte Auflage), Springer-Verlag Berlin, Heildelberg, 1992.		
Forms of teaching	Lectures with the use of technical aids, active involvement of students in discussions and debates. Laboratory exercises to monitor chemical and biochemical reactions that may occur in food during processing and storage.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week) total	2	-	1
	30	-	15
Methods of testing knowledge and taking exams	Oral exam		
Language of teaching and possibilities of following in other languages	Croatian		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous opinion pull.		

Course name	**Atmospheric Photochemistry**		
Code	KD4205		
Type	Elective		
Level	Graduate university study of Chemistry-research program/ Graduate university study of Chemistry-teaching program		
Year	1. or 2.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Assistant professor Anita Blagus Garin; Assistant professor Elvira Kovač-Andrić		
The aim or purpose of the course	To learn about the properties and reactivity of microconsituents of the atmosphere and their significance and interdependence.		
Prerequisites for enrollment	None.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine the physical properties of the atmosphere 2. Predict microconstituents in the atmosphere 3. Compare, review and confirm the transport of gases in the atmosphere 4. Judge and conclude on the mechanisms of chemical reactions in the troposphere and stratosphere 5. Determine the influence of meteorological parameters on individual gases in the troposphere 6. Critically evaluate the relevant scientific literature.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1 – 6	**Class attendance**	**Attendance records**	8	10
Seminar	1	1 – 6	**Seminar preparation**	**Seminar presentation**	10	20
Knowledge test (written colloquia)	1	1 – 6	**Preparation for the written exam**	**Written colloquium**	15	30
Final exam	2	1 – 6	**Repetition of study matter**	**Oral exam**	20	40
Total	5				53	100

Consultations

In agreement with the students

Acquired competencies

Knowledge of the properties and reactivity of atmospheric microconstituents, to know their significance and interdependence. Influence of meteorological parameters on microconstituents in the atmosphere. Individual and group work, communication skills and independent literature search.

Content

1. History and evolution of the Earth's atmosphere.
2. Physical properties of the atmosphere (atmospheric layers, pressure and temperature profile in the atmosphere).
3, 4. Microconstituents in the atmosphere (ozone, carbon; nitrogen; sulfur and compounds, PM).
5. Chemical kinetics.
6. Atmospheric radiation.
7. Photochemistry (photodissociation).
8, 9. Stratosphere chemistry (Chapman mechanism, nitrogen oxide cycle, (cycle) hydroxyl radicals, halogen compound cycle, ozone layer, stratospheric gas transport).
10, 11. Troposphere chemistry (hydroxyl radicals, nitrogen oxide and ozone cycle in the troposphere).
12. Transport of gases in the troposphere.
13. Ozone budget in the troposphere (changes in the surface layer of the atmosphere).
14. Tropospheric chemistry of organic compounds (non-methane and biogenic hydrocarbons).
15. Influence of meteorological parameters on the concentration of micro-ingredients in the atmosphere.

Seminars:
1. Urban and rural air pollutants
2. Lifespan of microconstituents in the atmosphere
3. Greenhouse gases
4. Aerosols
5. Troposphere - reservoir of molecules (peroxide, PAN)
6. Tropospheric chemistry of CFCs

Recommended literature

J. H. Seinfeld, S. N. Pandis: Atmospheric Chemistry and Phisics, John Wiley and Sons, Inc., New Jersey, 2006.

	J. H. Seinfeld: Atmospheric Chemistry and Phisics of Air Pollution, John Wiley and Sons, Inc., New York, 1986. R.P. Wayne, Chemistry of Atmospheres, Oxford University Press, Oxford 2000.
Additional literature	B. J. Finlayson-Pitts, J. N. Pitts, Jr., Atmospheric Chemistry, John Wiley, New York, 1986.
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students (discussion and problem solving).

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	–
total	30	15	–

Methods of testing knowledge and taking exams	Knowledge is tested during classes through a mid-term colloquium, which is taken in the 8th week of classes. The final exam is taken in writing and orally.
Language of teaching and possibilities of following in other languages	Croatian, English.
The method of monitoring the quality and performance of each course and/or module	Communication with students and anonymous polls.

Course name	Introduction to computational chemistry		
Code	KD4213		
Type	Elective		
Level	Graduate university study of Chemistry-research program		
Year	1./2.	**Semester**	Winter
ECTS	5		
Lecturer	Prof. Vlatka Gvozdić		
The aim or purpose of the course	Introduction with basic knowledge necessary for study and research of inorganic, organic, physical and organometallic chemistry with the implementation of molecular mechanic and quantum -mechanic methods.		
Prerequisites for enrollment	None.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine basics of computational chemistry. 2. List computational methods and distinguish differences among them (advantages and disadvantages). 3. Determine basics of structure and activity prediction and of molecular modelling. 4. Determine basics of quantum-mechanic methods, principles of *ab initio* computations, semiempirical approach and DFT. 5. Apply new knowledge in thermodynamic calculations, study of solvent effect and prediction of spectrum.		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th>Teaching activity</th><th>ECTS</th><th>Learning outcome</th><th>Student activity</th><th>Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th></th><th></th><th></th><th></th><th></th><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td></td><td>1-5</td><td>Class attendance</td><td>Attendance records</td><td>20</td><td>30</td></tr>
<tr><td>Final exam</td><td>5</td><td>1-5</td><td>Repetition of study matter</td><td>Oral exam</td><td>45</td><td>70</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>65</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td>Understanding basic theoretical postulates of computational chemistry necessary for successful study and research of inorganic, organic, physical and organometallic chemistry with the implementation of molecular mechanic and quantum -mechanic methods.</td></tr>
<tr><td>Content</td><td>Introduction with computational chemistry, methods used for interpretation and prediction of structure and reactivity of molecules. Concept of potential energy surface. Molecular mechanics. Introduction to quantum-mechanical methods. Ab initio calculations. Semiempirical methods. DFT. Basics of thermodynamic calculations. Transition states. NMR spectra. Solvation.</td></tr>
<tr><td>Recommended literature</td><td>1. E. Lewars, Computational Chemistry, Kulwer Academic Publishers, Dordrecht, 2003.
2. F. Jensen, Introduction to Computational Chemistry, Wiley, New York, 1998.</td></tr>
<tr><td>Additional literature</td><td>1. F. Weinhold, C.R. Landis, Discovering Chemistry With Natural Bond Orbitals, Wiley, New Jersey, 2012.
2. A.R. Leach, Molecular Modelling, Principles and Aplications, Longman, London, 2003.
3. P.W. Atkins, R. S. Friedman, Molecular Quantum Mechanics, Oxford Univ. Press, Oxford, 1997.</td></tr>
<tr><td>Forms of teaching</td><td>Lectures with use of technical aids, active participation of students in discussions.</td></tr>
<tr><td>Teaching type</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td>3</td><td>-</td><td>-</td></tr>
<tr><td>45</td><td>-</td><td>-</td></tr>
</table>
(hours per week) total</td></tr>
<tr><td>Methods of testing knowledge and taking exams</td><td>Written and oral exam.</td></tr>
<tr><td>Language of teaching and possibilities of following in other languages</td><td>Croatian, possibly English.</td></tr>
<tr><td>The method of monitoring the quality and performance of each course and/or module</td><td>Discussion with students and anonymous questionnaires.</td></tr>
</table>

Course name	Biochemistry of Micronutrients

<table>
<tr><td>Code</td><td colspan="3">KD3214</td></tr>
<tr><td>Type</td><td colspan="3">Elective</td></tr>
<tr><td>Level</td><td colspan="3">Graduate university study of Chemistry-research program</td></tr>
<tr><td>Year</td><td>1./2.</td><td>Semester</td><td>Winter</td></tr>
<tr><td>ECTS</td><td colspan="3">5</td></tr>
<tr><td>Lecturer</td><td colspan="3">Ana Amić</td></tr>
<tr><td>The aim or purpose of the course</td><td colspan="3">The aim of this subject is to give students a specific insight and knowledge regarding the meaning of the term micronutrients, and meaning and role of micronutrients in biochemical processes and metabolism. Another aim is to broaden previous biochemical and metabolism knowledge, with additional review of available information regarding usage of micronutrients and their significance in food chemistry.</td></tr>
<tr><td>Prerequisites for enrollment</td><td colspan="3">None.</td></tr>
<tr><td>Learning outcomes</td><td colspan="3">After successfully completing the course, the student will be able to:
1. Determine classification of nutrients on macro- and micronutrients, understand the difference between them.
2. Determine sources of micronutrients in food, needs, structure and general characteristics for every micronutrient.
3. Analyse metabolism, absorption, transport and storage, elimination and physiological impact of micronutrients.
4. Determine positive and negative impact of micronutrients on the organism, if there are any, and determine potential impact of food supplements on health.
5. Critically use acquired knowledge in the preparation of a seminar paper, in solving problems and tasks, and in searching contemporary scientific literature.</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="3">
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1</td><td>1 – 5</td><td>Class attendance</td><td>Attendance records</td><td>5</td><td>10</td></tr>
<tr><td>Seminar</td><td>1</td><td>5</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>30</td></tr>
<tr><td>Final exam</td><td>3</td><td>1 - 5</td><td>Repetition of study matter</td><td>Oral exam</td><td>35</td><td>60</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>60</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td colspan="3">In agreement with the students.</td></tr>
<tr><td>Acquired competencies</td><td colspan="3">Understanding biochemistry and mechanisms underlying activity of micronutrients and their impact on metabolism and health. Critical understanding of significance and impact of micronutrients on health.</td></tr>
<tr><td>Content</td><td colspan="3">Macro- and micronutrients. Classification of micronutrients, sources and daily need. Role in the metabolism, digestion, absorption, transport, storage and elimination of micronutrients. Functions and mechanism of activity of micronutrients, mechanisms of regulation of ion concentration in the organism. Interactions with other nutrients and medications. Illnesses related to excess and deficit of micronutrients, toxicity. Positive and negative side of food supplements.</td></tr>
<tr><td>Recommended literature</td><td colspan="3">1. C. Cox (Ed.), Nutritional Biochemistry, Apple Academic Press, 2015. 2. D.A. Bender, Nutritional Biochemistry of the Vitamins, 2nd Ed., University College London, 2003. 3. D.A. Bender, Introduction to Nutrition and Metabolism, 5th Ed., CRC Press, 2014.</td></tr>
</table>

Additional literature	1. T. Brody, Nutritional Biochemistry, 2nd. Ed., Academic Press, San Diego, 1999. 2. M.H. Stipanuk, Biochemical, Physiological, and Molecular Aspects of Human Nutrition, W.B. Saunders Co., 2019. 3. J.F. Spallholz, M. Boylan, Nutrition Chemistry and Biology, 2nd Ed., CRC Press, 1999.		
Forms of teaching	Lectures with the use of technical aid, active participation of students in the form of seminars. Consultations.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	0
total	30	15	0
Methods of testing knowledge and taking exams	Written and oral exam in the form of a seminar paper, in the form of presentation. Final oral exam.		
Language of teaching and possibilities of following in other languages	Croatian, possibly English.		
The method of monitoring the quality and performance of each course and/or module	Grading by teachers and students. Questionnaire after finished classes and exam.		

Course name	Advanced physical chemistry laboratory		
Code	KD4209		
Type	Elective		
Level	Graduate university study of Chemistry-research/teaching		
Year	1.	**Semester**	Summer
ECTS	5		
Lecturer	Ph.D. Martina Medvidović-Kosanović, associate professor		
The aim or purpose of the course	Getting deeper insight in one area of physical chemistry through independent laboratory work.		
Prerequisites for enrollment	-		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Independently plan and perform the experiment from the selected area 2. Analyze experimentally obtained data (numerically and graphically) 3. Describe studied topic in a form of a seminar 4. Bring to a conclusion regarding the studied physical process		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-4	**Class attendance**	**Attendance records**	-	-
Knowledge test (written colloquia)	3	1 – 4	**Preparation for the written exam**	**Written colloquium**	-	100
Total	4					100

Consultations	Wednesdays 10-12 h
Acquired competencies	Independent literature survey. Application of needed instruments and methods of data analysis and presentation of the experimentally obtained results.
Content	The advanced physical chemistry laboratory is organized in such a way that a student chooses some of the experiments from a certain area of physical chemistry suggested at the beginning of the semester and he or /she performs independently that experiment under the mentorship of one teacher or one assistant from the beginning till the end. The mentioned includes a literature survey, an introduction with one experimental method which will be used in the experiment (e.g. conductometry, potentiometry, UV-Vis spectrophotometry), preparing the solutions, performing the experiments, analysis of the obtained data, and writing the laboratory report.
Recommended literature	1. M. Medvidović-Kosanović, Praktikum fizikalne kemije, Osijek, 2012.
Additional literature	1. P.W. Atkins & J. de Paula, Atkins' Physical Chemistry, Oxford University Press, Oxford, 2002. 2. P.W. Atkins & M.J. Clugston, Načela fizikalne kemije, Školska knjiga, Zagreb, 1989. 3. M. Sikirica, Stehiometrija, Školska knjiga, Zagreb, 1985. 4. T. Cvitaš & N. Kallay, Fizičke veličine i jedinice Međunarodnog sustava, Školska knjiga, Zagreb, 1980
Forms of teaching	Independent laboratory work under the mentorship of an assistant and/or teacher.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60

Methods of testing knowledge and taking exams	Laboratory reports written in accordance to the literature survey and based on experimentally obtained and analyzed data are graded.
Language of teaching and possibilities of following in other languages	Croatian, possibly English

The method of monitoring the quality and performance of each course and/or module	Continuous communication of teachers with students, and anonymous student survey

GRADUATE UNIVERSITY STUDY PROGRAMME CHEMISTRY;
SPECIALIZATION IN: TEACHING

Graduate University Study Programme Chemistry;
Specialization in: Teaching: 120 ECTS, 2 years

I. Year

I. Winter semester

Pedagogy 1 (ECTS 3)

Educational Psychology 1 (ECTS 3)

Elective Course I* (ECTS 5)

Elective Course II* (ECTS 5)

Elective Course III* (ECTS 5)

Elective Course IV* (ECTS 5)

Course name	Pedagogy 1		
Code	K2201		
Type	Mandatory		
Level	Graduate university study		
Year	1.	**Semester**	Winter (1.)
ECTS	3		
Lecturer	doc.dr.sc. Goran Livazović		
The aim or purpose of the course	Students will gain a comprehensive understanding of pedagogical science, critical examination of the problems of modern educational theory and practice.		
Prerequisites for enrollment	Completed undergraduate studies.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Summarize and define pedagogical science, its foundation and terminology and alternative pedagogical concepts. 2. Explain and analyze the structure and extended school activities and classes 3. Describe and critically analyze contemporary educational theory and practice associated with the school 4. Independently prepared and implemented educational workshop 5. Define and analyze educational problems in teaching practice 6. Independently create a seminar with smaller research effectiveness practiced forms of upbringing and education.		

Relationship between learning outcomes, teaching methods and grading	

Teaching activity	ECTS	Learning	Students activity	Methods of evaluation	Points	
					min	max
Class attendance	0,75	1-6	**Class attendance**	**Evidence list**	–	–
Class activity	0,5	1-6	**Homework and assignments**	**Evidence list**	0	5
Knowledge test (preliminary exam)	0,75	1-6	**Preparation for written examination**	**Written preliminary exam**	36	60
Practical assignment	0,5	1-6	**Preparation for the practical assignment; Seminar; Workshop**	**Written practical assignment**	12	20
Final exam	0,5	1-6	**Repetition of teaching materials**	**Oral exam (and written exam)**	12	50
Total	3	1-6			60	100

Consultations	At the time of consultation and individually upon; writing and verbally.
Acquired competencies	Knowing and demonstrating the general level of knowledge and understanding and the ability to analyze, synthesis and evaluation in the field of educational theory and practice. Ability to teamwork and learning issues in the framework of a broader multi-cultural context in teaching and school culture. Ability to constructive problem solving in the classroom and school environment and decision-making within their ethical and professional roles. Distinguishing models of alternative schools. Understanding personal values, prejudices and influences on education, culture, school and classroom processes, including the identification of factors such as modern teaching strategies, learning styles, discipline and leadership style class. The application of different forms of dialogue, oral communications and productive issues in teaching with the aim and successful teaching and learning activities of students, and evaluate the impact of your communication in a variety of professional situations. The breakdown and analysis of indicators of our own education, strengthening links learning outcomes and assessment of student achievement and the use of reflection and action for the improvement of their own teaching / quality management in their daily work.
Content	The subject of pedagogical science. The system of educational discipline. Historical development of pedagogy. Theories of educational practice in the world and in Croatia. Socialization. Acculturation. Education. The educational system. The philosophical and anthropological starting point of education, theory, process and factors of education. The student – an active participant in education. The personality of the teacher and the teaching profession. Methods and tools for education. Power and Powerlessness of educational methods and resources. Theories. Learning and teaching. Methods and styles of learning and teaching. Family upbringing. Education in homes. Education in their free time. Philosophy of modern information and communication technologies. Educational Social Work. Preventive work in education. The methodology of pedagogy. Types of educational research. Quantitative and qualitative paradigm of educational research.
Recommended literature	Gudjons H. (1994). Pedagogija. Temeljna znanja. Zagreb: Educa. Mijatović, A. (ur.) (1998). Osnove suvremene pedagogije. Zagreb:HKZ “MI” HPKZ. Vukasović, A. (2001). Pedagogija. Zagreb: HKZ “MI”.

Additional literature	Armstrong, T.(2008), Najbolje škole. Zagreb:Educa König, E. i Zedler, P. (2001). Znanosti o odgoju. Zagreb: Educa. Mlinarević, V., Brust Nemet, M. (2012), Izvannastavne aktivnosti u školskom kurikulumu. Osijek: Sveučilište J. J. Strossmayera u Osijeku, Učiteljski fakultet u Osijeku.		
Forms of teaching	Classes will be conducted through lectures, seminars and workshops.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	1	1	1
total			
Methods of testing knowledge and taking exams	Regular assessment during the semester (assignments, homework). The exam consists of a written exam and problematic task during the year and the final oral examination.		
Language of teaching and possibilities of following in other languages	Croatian.		
The method of monitoring the quality and performance of each course and/or module	Continuous communication of teachers with students, and an anonymous student survey.		

Course name	PSYCHOLOGY OF EDUCATION I		
Code	K2203		
Type	Mandatory		
Level	Graduate university study of Chemistry-teaching program		
Year	1.	**Semester**	Winter
ECTS	3		
Lecturer	Professor Silvija Ručević		
The aim or purpose of the course	Introduce students to the practical aspects of psychology of education.		
Prerequisites for enrollment	Completed undergraduated study		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Define the basic concepts of psychology of education 2. Describe the biological basis of behavior 3. Differentiate and compare the developmental stages of the individual 4. Explain the relationship between the teaching process, memory process and learning outcomes 5. Explain the relationship between the individual development (cognitive), personality traits and education process 6. Describe the specifics of teaching students with learning difficulties 7. Describe the specifics of teaching students with special needs 8. Describe the specifics of teaching students with behavioral disorders.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	**1,5**	**1-8**	**Class attendance**	**Attendance records**	-	-
Activity in class	**0,5**	**1-8**	**Homework and assignments**	**Evidence list**	**0**	**5**
Knowledge test (preliminary exam)	**1,5**	**1-8**	**Preparation for the written exam**	**Written colloquium**	**36**	**60**
Knowledge test (practical assignment)	**0,75**	**1-8**	**Preparation for practical assignment**	**Written practical assignment**	**12**	**20**
Final exam	**0,75**	**1-8**	**Repetition of study matter**	**Oral exam (and written exam)**	**12**	**20**
Total	**3**	**1-8**			**60**	**100**

Students are evaluated and graded according to all of these elements of monitoring their work, according to elaborated mode of assessment for each element, with which they are familiar and which are publicly available.

In the formation of the final grade are taken into account continuous monitoring and knowledge assessment (verification in the form of written and practical assignment) and the final exam. Activity in class is not part of the total grade but add to the total number of points accomplished on the remaining elements of monitoring and testing. Student activity is recorded every class.

An example of shaping the final grade for students:

- The final score value is calculated according to the formula: written exam + practical assignment + final exam = **total number of points** + **acticity in the class**
- For passing final grade students are required to achieve a minimum of 60% for each element of monitoring and verification which is assessed.

Rating scale is as follows: 60% - 69.9% = sufficient (2), 70% - 79.9% = good (3), 80% - 89.9% = very good (4), 90% - 100% = excellent (5).

Consultations

At the time of consultation and according to the individual agreement; in written and oral form.

Acquired competencies

Primary knowledge in the field of psychology of education; knowledge of the biological basis of behavior; understanding individual stages of development and relation between intellectual development, personality and education process; knowledge of basic processes related to memory, important learning models and their application in education systems; knowledge of the specifics of working with students with learning difficulties, behavioral disorders and students with special needs.

Content	1. Introduction to scientific psychology 2. Defining fields of psychology of education 3. The biological basis of behavior 4. The development of the individual 5. Cognitive abilities and creativity 6. Personality and individual differences 7. Memory 8. Learning 9. Students with learning difficulties and special educational needs
Recommended literature	Vizek-Vidović, V., Vlahović-Štetić, V., Rijavec, M. i Miljković, D., (2003). *Psihologija obrazovanja.* Zagreb*:* IEP- VERN. Zarevski, P. (2007). *Psihologija učenja i pamćenja (5. izdanje).* Jastrebarsko: Naklada Slap.
Additional literature	Atkinson i Hilgard (2007). *Uvod u psihologiju*. Jastrebarsko: Naklada Slap Beck, M. (2004). *Motivacija*. Jastrebarsko: Naklada Slap. Čorkalo Biruški, D. (2009). *Primijenjena psihologija: pitanja i odgovori*. Zagreb: Školska knjiga. Čudina-Obradović, , M. (1991). *Nadarenost: razumijevanje, prepoznavanje, razvijanje*. Zagreb: Školska knjiga. Gardner, H. Kornhaber, M.L. i Wake, W. K. (1999). *Inteligencija*. Jastrebarsko: Naklada Slap. Grgin, T. (2004). *Edukacijska psihologija (2. izdanje).* Jastrebarsko: Naklada Slap. Grgin, T. (2001). *Školsko ocjenjivanje znanja (4. Izdanje)*. Jastrebarsko: Naklada Slap. Hock, R.R. (2004). *Četrdeset znanstvenih studija koje su promijenile psihologiju.* Jastrebarsko: Naklada Slap. Rathus S.A. (2001). *Temelji psihologije*. Jastrebarsko: Naklada Slap. Ribić, K. (1991). Psihofizičke razvojne poteškoće. Zadar: ITP Forum. Slavin, R.E. (2012). *Educational psychology: Theory and practice (10th ed.)*. New York: Pearson. Vasta, R, Haith, M. M. i Miller, S. A. (2004). *Dječja psihologija (3. izdanje).* Jastrebarsko: Naklada Slap. Articles from current periodicals
Forms of teaching	Classes will be conducted through lectures, seminars and discussion groups.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	1	1	1
total	15	15	15

Methods of testing knowledge and taking exams	Regular assessment during the classes (assignments, homework). The exam consists of a written examination and of the practical assignment during the year and the final oral examination.

Language of teaching and possibilities of following in other languages	Croatian
The method of monitoring the quality and performance of each course and/or module	Continuous communication of teacher with students and an anonymous student survey.

I. Year

II. Summer semester

Pedagogy 2 (ECTS 3)

Didactics 1 (ECTS 3)

Educational Psychology 2 (ECTS 3)

Teaching Methods in Chemistry 1 (ECTS 6)

Teaching Methods in Chemistry Laboratory 1 (ECTS 5)

Chemistry Methodology Exercises 1 (ECTS 9)

Elective Course V* (ECTS 5)

Course name	Pedagogy 2		
Code	K2205		
Type	Mandatory		
Level	Graduate university study		
Year	1.	**Semester**	(2.)
ECTS	3		
Lecturer	doc.dr.sc. Goran Livazović		
The aim or purpose of the course	Sensitize students to become people / students who, for whatever reason, require additional support in social integration. The subject explains the causes and manifestations of difficulties in social integration and enables students to customize their approach to each student in the class, depending on its needs and capabilities, and is focused on developing ideas about the need for inclusive education in students and critical thinking of students through practical examples, debates and hypothetical problem situations. Students will gain a comprehensive understanding of pedagogical science, critical examination of the problems of modern educational theory and practice.		
Prerequisites for enrollment	Completed undergraduate studies.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Itemize, explain and apply in their work provisions of laws, regulations and other documents governing the education system, teaching profession and regulating integrated education. 2. Explain the differences between the key approaches to students with behavioral disorders, gifted, students with developmental disabilities and learning difficulties as well as the needs of students from different socio-cultural groups and to develop and apply the techniques and tools that will enable the student to independently verify their progress and adjusts teaching strategies. 3. Demonstrate sensitivity for the special needs of students, social and cultural characteristics of people with whom he comes in contact and know how effectively the educational and training work to establish understanding and student success. 4. Identify and explain the importance of the family in learning and overall development of the child and adopt forms of cooperation with parents.		

	5. Identify and analyze unfavorable circumstances and obstacles to learning and initiate activities aimed at improving the stimulating and safe school atmosphere and improving the quality of teaching. 6. Explain and analyze the management of the school and grade, recognize and apply ethical and professional values in learning community through the promotion of lifelong learning.
Relationship between learning outcomes, teaching methods and grading	

Teaching activity	ECTS	Learning	Students activity	Methods of evaluation	Points	
					min	max
Class attendance	0,75	1-6	**Class attendance**	**Evidence list**	–	–
Class activity	0,5	1-6	**Homework and assignments**	**Evidence list**	0	5
Knowledge test (preliminary exam)	0,75	1-6	**Preparation for written examination**	**Written preliminary exam**	36	60
Practical assignment	0,5	1-6	**Preparation for the practical assignment; Seminar; Workshop**	**Written practical assignment**	12	20
Final exam	0,5	1-6	**Repetition of teaching materials**	**Oral exam (and written exam)**	12	50
Total	3	1-6			60	100

Consultations	At the time of consultation and individually upon; writing and verbally.
Acquired competencies	Use of modern pedagogical insights for the design of democratic school environment and focus on active status of students in the classroom. Recognizing the special needs and specificity of educational work of the gifted students, students with developmental disabilities and learning difficulties as well as the needs of students from different socio-cultural groups. Cooperation with experts, parents and the community in professional work and participation in the planning, implementation and evaluation of programs for students with special needs. The introduction of the teaching of modern social priority topics such as sustainable development, entrepreneurship, lifelong learning, social justice. Using the results of monitoring of student achievement in order to develop a plan of support in learning and adapting teaching methods to student needs. Implementation of strategies for encouraging parents to participate in school life. Skills building learning organizations on humanistic principles and presentation skills inventiveness, flexibility, teamwork, creativity and criticism. Understand and analyze the management of educational institutions and work on documents. Representing professional values, standards and reputation of the teaching profession in contact with other members of the professional and the wider community and involve the available programs and lifelong learning activities.
Content	General characteristics, educational needs and problems of children with special needs. Definitions and terminology specific needs. Classification and etiology of special needs. Historic sites and attitudes towards people with special needs. The legal stipulations and the importance of early detection and early professional treatment of children with developmental disabilities. Teamwork in the process of diagnosis, education and rehabilitation. The system of education and rehabilitation. Stereotyped attitudes. The philosophy of inclusion. Integrated education of children and youth with disabilities. Marginalized groups, modern tendencies and civics. Social and legal care for children with disabilities. Practical problems of inclusion of

	children with disabilities in regular schools. Aptitude, personality, creativity. Gifted child in the family and school. Enrichment programs for monitoring and management of gifted children and adolescents. Elements of a comprehensive system of support to gifted. The concept of marginal groups, processes and dimensions of marginality. Competence contemporary teachers. School management and leadership classes. The rules and disciplines. Cooperation between the school, parents and the community. Lifelong learning and professional development.
Recommended literature	Bouillet, D. and Uzelac, S. (2007). Fundamentals of social pedagogy. Zagreb: School books. Jensen, E. (2004). Different brains, different learners – How to reach out to those which are difficult to reach. Zagreb: EDUCA. Bouillet, D. (2010). The challenges of integrated education. Zagreb: School books.
Additional literature	Senge, P. M. (2001). The Fifth Discipline: principles and practice of learning organizations. Zagreb: Mosaic books. Šprljan, K. A. and Rosandić, A. (2008). The circle of knowledge. Handbook for teachers and professors. UNESCO (2009). Policy guidelines on inclusion in education. Paris: UNESCO.
Forms of teaching	Classes will be conducted through lectures, seminars, workshops and field classes.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week) total	1	1	1

Methods of testing knowledge and taking exams	Regular assessment during the semester (assignments, homework). The exam consists of a written exam and problematic task during the year and the final oral examination.
Language of teaching and possibilities of following in other languages	Croatian.
The method of monitoring the quality and performance of each course and/or module	Continuous communication of teachers with students, and an anonymous student survey.

Course name	**Didactics 1**		
Code	K2202		
Type	Mandatory		
Level	Graduate university study of Chemistry-teaching program		
Year	1.	**Semester**	Summer
ECTS	3		
Lecturer	Associate Professor Vesna Buljubašić-Kuzmanović, Ph. D.		
The aim or purpose of the course	Students will learn about theoretical and practical aspects of teaching and education.		
Prerequisites for enrollment	Completed undergraduate studies		

<table>
<tr><td>Learning outcomes</td><td>After successfully completing the course, the student will be able to:

1. correctly interpret and describe the basic concepts of didactics, various didactic theories, schools and models.
2. develop and analyze the syllabi taking into account the curricular approach to teaching
3. design a lesson plan using modern teaching strategies
4. create materials for independent learning
5. make choices regarding teaching technology
6. devise and apply techniques for assessing and grading student achievement
7. conduct and interpret simpler research tasks in the field of didactics</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1,5</td><td>1-7</td><td>Class attendance</td><td>Attendance records</td><td>-</td><td>-</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>2</td><td>1-7</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>0</td><td>60</td></tr>
<tr><td>Final exam</td><td>1</td><td>1-7</td><td>Repetition of study matter</td><td>Oral exam</td><td>0</td><td>40</td></tr>
<tr><td>Total</td><td>3</td><td></td><td></td><td></td><td>0</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students/ Thursdays, 11:30-13 pm</td></tr>
<tr><td>Acquired competencies</td><td>The student acquires didactic competences regarding planning and preparation, leading and organizing teaching/instruction, as well as assessment and improvement of teaching practices and evaluation of their professional development and pupils' development.</td></tr>
<tr><td>Content</td><td>Basic terms. Didactics, education, upbringing, teaching, training, schooling. Instruction as a communication-based process. Interactivity of instruction. Nonverbal classroom communication. The goal(s) of classroom communication. Bipolar nature of teaching. The theory of curriculum. Purpose, goals and tasks of education and instruction. General goals of education, individual goals, monitoring the achievement of educational goals. Taxonomy of goals and educational outcomes. Teaching goals and tasks. Teaching contents. School curriculum. National curriculum. Scope, depth and sequence of the educational program. Organization of instruction. Teaching sources. Teaching methods. Teaching techniques. Social forms of pupils' activities in classroom. Group work, pair work, individual work, whole class. Collaborative learning. Project-based teaching.
The stages in the teaching process. Preparation, reception and processing of content, practice, repetition, evaluation. Recording and analysing teaching. Evaluation of education. Teaching strategies - conceptual definitions and types. Simulation and play in teaching. Individualized instruction. From teaching to self-regulated learning. Equipping students for self-education. Teaching and learning outside of school. Instruction and training.</td></tr>
<tr><td>Recommended literature</td><td>

Bognar, L., Matijević, M., Didaktika. Zagreb: Školska knjiga, 2002.
Pranjić, M., Didaktika. Zagreb: Golden marketing, 2005.
Meyer, H., Što je dobra nastava? Zagreb: Erudita, 2005.
Peko, A., Obrazovanje, U: Osnove suvremene pedagogije (ur.: Mijatović, A., Vrgoč, H., Peko, A., Mrkonjić, A., Ledić, J.), Hrvatsko pedagoško-književni zbor, Zagreb, 1999., str. 203.-223.
Jelavić, F., Didaktičke osnove nastave. Jastrebarsko: Naklada Slap, 1995.

</td></tr>
</table>

	• Terhart, E., Metode poučavanja i učenja. Zagreb: Educa, 2001.
Additional literature	• Desforges, C., Uspješno učenje i poučavanje: psihologijski pristupi. Zagreb: Educa, 2001. • Dryden, G., Vos, J., Revolucija u učenju. Zagreb: Educa, 2001. • Klippert, H., Kako uspješno učiti u timu. Zagreb: Educa, 2001. • Meyer, H., Didaktika razredne kvake. Zagreb: Educa, 2002.
Forms of teaching	• lectures • seminars • exercises

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	1	1	1
total	15	15	15

Methods of testing knowledge and taking exams	seminar paper, individual and group tasks, quizzes (mid-term exam) final exam
Language of teaching and possibilities of following in other languages	Croatian
The method of monitoring the quality and performance of each course and/or module	constant communication between teacher and students, final evaluation of students and teacher's work and an anonymous survey conducted by the Department and/or the University

Course name	PSYCHOLOGY OF EDUCATION 2		
Code	K2207		
Type	Mandatory		
Level	Graduate university study of Chemistry-teaching program		
Year	1.	**Semester**	Summer
ECTS	3		
Lecturer	Professor Silvija Ručević		
The aim or purpose of the course	Introduce students to the practical aspects of psychology of education.		
Prerequisites for enrollment	Completed undergraduated study; completed course Psychology of education I (or its equivalent)		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 8. Define the basic concepts from various theories of motivation and emotions 9. Describe and compare alternative approaches to education 10. Analyze and select procedures for motivating students in class 11. Describe and critically analyze the various factors of school (no) success 12. Describe and compare various group processes and group dynamic 13. Describe and critically analyze classroom processes and select appropriate methods for classroom management and discipline		

	14. Select and plan various methods of measurement and evaluation of knowledge in specific academic domains
Relationship between learning outcomes, teaching methods and grading	

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	**1,5**	**1-7**	**Class attendance**	**Attendance records**	-	-
Activity in class	**0,5**	**1-7**	**Homework and assignments**	**Evidence list**	**0**	**5**
Knowledge test (preliminary exam)	**1,5**	**1-7**	**Preparation for the written exam**	**Written colloquium**	**36**	**60**
Knowledge test (practical assignment)	**0,75**	**1-7**	**Preparation for practical assignment**	**Written practical assignment**	**12**	**20**
Final exam	**0,75**	**1-7**	**Repetition of study matter**	**Oral exam (and written exam)**	**12**	**20**
Total	**3**	**1-7**			**60**	**100**

Students are evaluated and graded according to all of these elements of monitoring their work, according to elaborated mode of assessment for each element, with which they are familiar and which are publicly available.

In the formation of the final grade are taken into account continuous monitoring and knowledge assessment (verification in the form of written and practical assignment) and the final exam. Activity in class is not part of the total grade but add to the total number of points accomplished on the remaining elements of monitoring and testing. Student activity is recorded every class.

An example of shaping the final grade for students:

- The final score value is calculated according to the formula: written exam + practical assignment + final exam = **total number of points** + **acticity in the class**
- For passing final grade students are required to achieve a minimum of 60% for each element of monitoring and verification which is assessed.

Rating scale is as follows: 60% - 69.9% = sufficient (2), 70% - 79.9% = good (3), 80% - 89.9% = very good (4), 90% - 100% = excellent (5).

Consultations	At the time of consultation and according to the individual agreement; in written and oral form.
Acquired competencies	Knowledge of various factors of motivated behavior and understanding the nature of motivation through the perspective of different motivational theories; distinguish various

	factors of school (no) success; knowledge, preparation and implementation of strategies for improving motivation in the classroom; identification, preparation and implementation of appropriate teaching methods, measurements and evaluation of knowledge; knowledge and critical understanding of different influences on classroom processes, including identification of factors of productive teaching such as strategy and class leadership style, characteristics of groups and group processes, and their application in classroom management.
Content	1. Motivation 2. Understanding of emotions - the role of emotions in the learning process 3. Teaching 4. Planning the educational process 5. Measurement and assessment of knowledge 6. Teacher evaluation 7. Group processes and group dynamic 8. Classroom management and discipline 9. Maladjusted behavior 10. Alternative approaches to education
Recommended literature	Vizek-Vidović, V., Vlahović-Štetić, V., Rijavec, M. i Miljković, D., (2003). *Psihologija obrazovanja.* Zagreb*:* IEP- VERN.
Additional literature	Barth, B. M. (2004). Razumjeti što djeca razumiju. Zagreb: Profil International. Beck, M. (2000). *Motivacija*. Jastrebarsko: Naklada Slap. Čudina-Obradović, , M. (1991). *Nadarenost: razumijevanje, prepoznavanje, razvijanje*. Zagreb: Školska knjiga. Gossen, D. C. (2011). Restitucija - preobrazba školske discipline (2. izdanje). Zagreb: Alineja. Grgin, T. (2004). *Edukacijska psihologija (2. izdanje)*. Jastrebarsko: Naklada Slap. Grgin, T. (2001). *Školsko ocjenjivanje znanja (4. Izdanje)*. Jastrebarsko: Naklada Slap. Matijević, M. (2004). *Ocjenjivanje u osnovnoj školi.* Zagreb: Tipex Woolfolk, A. (2012). *Educational psychology* (12th ed.). New York: Allyn and Bacon (chapters 10, 11, 12). Vlahović-Štetić, V.(ur.), Vizek Vidović, V., Arambašić, L., Vojnović, N. (2005). *Daroviti učenici: Teorijski pristup i primjena u školi*. Zagreb: Institut za društvena istraživanja. Articles from current periodicals
Forms of teaching	Classes will be conducted through lectures, seminars and discussion groups.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	1	1	1
total	15	15	15

Methods of testing knowledge and taking exams	Regular assessment during the classes (assignments, homework). The exam consists of a written examination and of the practical assignment during the year and the final oral examination.

Language of teaching and possibilities of following in other languages	Croatian
The method of monitoring the quality and performance of each course and/or module	Continuous communication of teacher with students and an anonymous student survey.

Course name	Practice methods in chemistry 1		
Code	K2105		
Type	Mandatory		
Level	Graduate university study of Chemistry-teaching program		
Year	1.	**Semester**	Summer
ECTS	9		
Lecturer	Elvira Kovač-Andrić, Ph.D., Assistant Professor		
The aim or purpose of the course	Insight into the organization of work and other activities through observations and held trial and evaluation lectures in primary school.		
Prerequisites for enrollment	completed obligations for Pedagogy 1 and Psychology of Education		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Assess the organization and work of the school, planning and implementation of the educational program of primary school. 2. Manage pedagogical documentation in school. 3. Anticipate the issues of parent meetings and consultations, the type and level of cooperation between parents and the school, the obligations of teachers and the obligations of class teachers in the school. 4. Evaluate student work and test and evaluation lectures by fellow students. 5. Analyze the structural elements and stages of the school lesson, which was acquired through the obligation to listen to and analyze a series of lectures by mentors and all test and evaluation lectures by fellow students. 6. Select clear and measurable learning objectives in chemistry teaching in accordance with the curriculum. 7. Design, prepare and conduct a lesson in primary school in accordance with the curriculum and principles of modern research-oriented teaching of chemistry, 8. Develop practical experience in direct teaching in the classroom.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	2	1-8	**Class attendance**	**Attendance records**	30	60
Knowledge test	3	1-8	**Preparation for the written exam**	**Written colloquium**	20	40

	(written colloquia)						
	Final exam	4	1-8	**Repetition of study matter**	**Oral exam**		0
	Total	9	1-8			50	100

Consultations	In agreement with the students/ Mondays, 8-10 pm		
Acquired competencies	Students are acquainted with the specifics of work in primary school and are trained for independent teaching and taking on the responsibilities of teachers.		
Content	In primary school, students are required to participate in 30 hours of regular tutoring, including a trial and assessment lecture in front of the mentor, class and fellow students, and to actively participate in the work of the school in accordance with the mentor's recommendations. Through writing the preparation and holding a trial and assessment lecture accompanied by an experiment, they gain experience in the immediate teaching of chemistry in the classroom. Students follow the work of mentors in elementary school classes; get acquainted with the pedagogical documentation, the content of the directory, diary and registry book, with the way in which the lesson is entered and the presence of pupils in class is recorded; get acquainted with the issue of parent meetings and consultations with pupils and parents; gain insight into the organization of the school, the school calendar, professional services in the school, the type and level of cooperation between parents and the school, the obligations of teachers and the obligations of teachers; participate in the analysis of the structural elements and stages of the lesson, and the analysis of pupil achievement in individual performance, as well as the final success at the end of the semester.		
Recommended literature	1. M. Sikirica: Metodika nastave kemije, Školska knjiga, Zagreb, 2003 2. N. Raos (urednik): Nove slike iz kemije, Školska knjiga, Zagreb, 2004 3. M. Sikirica: Zbirka kemijskih pokusa za osnovnu i srednju školu, Školska knjiga, Zagreb, 2011 4. I. de Zan: Metodika nastave prirode i društva, Školska knjiga, Zagreb, 1999 5. S.K.Hall, Safety in the Laboratory, Lewis Publishers, 1994 6. Udžbenici i priručnici iz kemije i srodnih predmeta za osnovne škole		
Additional literature	1. D. Grdenić: Povijest kemije, Školska knjiga, Zagreb, 2001 2. J.D.Heron: The Chemical Classroom: Formulas for Successful Teaching, American Chemical Society, 1996 Periodika: 1. Journal of Chemical Education, Division of Chemical Education of the American Chemical Society, New York 2. Education i Chemistry, The Chemical Society, Burlington House, London 3. Praxis der Naturwissenschaften, Aulis Verlag Eubner und co. KG, Koeln		
Forms of teaching	Classes are entirely done in elementary school with small groups of students with the help of a mentor-teacher and school.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	6

total	-	-	90
Methods of testing knowledge and taking exams	Individual monitoring of the student through mentoring in primary school, participation in regular teaching of mentors, held at least one trial and one assessment lecture/lecture for assessment (ocjensko predavanje) accompanied by written preparation and experiment in primary school. At the final exam, the student writes a free composition about his experience gained through Laboratory Teaching Methods in Chemistry 1, assessing not only professional knowledge, but also the style of expression and literacy of the student.		
Language of teaching and possibilities of following in other languages	Croatian English		
The method of monitoring the quality and performance of each course and/or module	Discussions with students and the anonymous students opinion poll.		

Course name	Laboratory Teaching Methods in Chemistry 1		
Code	K2103		
Type	Mandatory		
Level	Graduate university study of Chemistry-teaching program		
Year	1.	**Semester**	Winter
ECTS	5		
Lecturer	Elvira Kovač-Andrić, Ph.D., Assistant Professor		
The aim or purpose of the course	Acquisition of practical experience necessary for quality performance of experimental teaching in primary and secondary school		
Prerequisites for enrollment			
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine the basic rules of laboratory work, precautions and protection measures in the chemical laboratory and the basic rules of handling chemicals and reagents. 2. Develop the skill of improvising performing an experiment in an unadopted environment. 3. Choose learning and teaching with a research approach while developing critical and creative thinking. 4. Confirm understanding of basic chemical concepts and independent and methodologically correct experiments. 5. Select appropriate experiments to develop pupils science literacy. 6. Integrate professional, methodological and pedagogical knowledge in the planning of direct educational work in chemistry teaching. 7. Self-evaluate experimental work (identify deviations and errors during experimental work and suggest procedures for their removal).		

<table>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>2</td><td>1-7</td><td>Class attendance</td><td>Attendance records</td><td>50</td><td>60</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td>1-7</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>30</td></tr>
<tr><td>Final exam</td><td>2</td><td>1-7</td><td>Repetition of study matter</td><td>Oral exam</td><td>5</td><td>10</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>75</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students/ Mondays, 8-10 pm</td></tr>
<tr><td>Acquired competencies</td><td>Practical, i.e. laboratory experience required for quality performance of experiments in primary and secondary school.</td></tr>
<tr><td>Content</td><td>Selection of practical exercises from the teaching contents of the chemistry of primary and secondary education and environmental pollution, including modern techniques of demonstration individual experiments. Introducing students to the methodology and techniques of independent demonstration experiments in the field of general, inorganic and physical chemistry.
List of exercises:
1. Safety measures, first aid, indicators, gas handling
2. Separation of mixtures
3. Basic chemical laws
4. Hydrogen and water
5. Oxygen and ozone
6. Obtaining and properties of chlorine
7. Sulfur
8. Nitrogen, ammonia and nitric acid
9. Electrochemistry
10. Air pollution
11. Water pollution</td></tr>
<tr><td>Recommended literature</td><td>3. Sikirica, M., Mrvoš-Sermek, D. i Mayer, V. (2000) Praktikum iz metodike nastave kemije, Skripta za internu upotrebu. PMF, Zagreb.
4. Mayer, V. (1991) Eksperimentalna nastava kemije. Školska knjiga, Zagreb.
5. Sikirica, M. i Korpar-Čolig, B. (2005) Praktikum iz opće kemije. Školska knjiga, Zagreb.</td></tr>
<tr><td>Additional literature</td><td>Skripta za internu uporabu:
1. V.Majer: Eksperimentalna nastava kemije, Školska knjiga, Zagreb, 1991
2. Perina, B. Mihanović: Ispitivanje onečišćenja zraka. SKTH/Kemija u industriji, Zagreb, 1998
3. B. Mihanović, I. Perina: Fizikalno i kemijsko ispitivanje zagađenosti vode, Školska knjiga, Zagreb, 1982</td></tr>
<tr><td>Forms of teaching</td><td>Lectures and seminars are obligatory. Homework</td></tr>
</table>

Teaching type	Lectures	Seminars	Exercises
(hours per week)	-	-	4
total	-	-	60
Methods of testing knowledge and taking exams	Oral exam after completion of all the lectures and seminars.		
Language of teaching and possibilities of following in other languages	Croatian English		
The method of monitoring the quality and performance of each course and/or module	Discussions with students and the anonymous students opinion poll.		

II. Year

III. Winter semester

Teaching Methods in Chemistry 2 (ECTS 6)

Teaching Methods in Chemistry Laboratory 2 (ECTS 5)

Didactics 2 (ECTS 3)

Chemistry Methodology Exercises 2 (ECTS 2)

Elective Course VI*(ECTS 5)

Seminar with Research Project (ECTS 1)

Diploma Thesis (ECTS 8)

Course name	Practice methods in chemistry 2		
Code	K2016		
Type	Mandatory		
Level	Graduate university study of Chemistry-teaching program		
Year	2.	**Semester**	Winter
ECTS	2		
Lecturer	Elvira Kovač-Andrić, Ph.D., Assistant Professor		
The aim or purpose of the course	Insight into the organization of work and other activities through observations and held trial and evaluation lectures in primary school.		
Prerequisites for enrollment	completed obligations for Pedagogy 1 and Psychology of Education		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Design and conduct a lesson in high school on a given topic within the performance plan of the mentor (teacher), apply educational and upbringing forms of work and modern teaching methods during the performance of the lesson. 2. Anticipate and prevent possible accidents during the lesson, communicate positively with students (verbally and non-verbally). 3. Evaluate student achievement at the end of the class. 4. Critically evaluate the own lesson held and the lesson held by fellow students and analyze the structural elements and stages of the school lesson. 5. Support and participate in work with gifted children and with children taught under a special program. 6. Organize extracurricular activities including preparations for chemistry competitions. 7. To valorize the practical experience in direct teaching in the classroom on the basis of a test and evaluation lecture followed by preparation and experimentation in front of a group of students, mentor and class, both in primary and secondary school.		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0,5	1-7	**Class attendance**	**Attendance records**	30	60
Knowledge test (written colloquia)	0,5	1-7	**Preparation for the written exam**	**Written colloquium**	20	40
Final exam	1	1-7	**Repetition of study matter**	**Oral exam**		0
Total	2	1-7			50	100

Consultations	In agreement with the students/ Mondays, 8-10 pm
Acquired competencies	Students are acquainted with the specifics of work in primary school and are trained for independent teaching and taking on the responsibilities of teachers.
Content	In secondary school, students are required to participate in 30 hours of regular tutoring, including a trial and assessment lecture in front of the mentor, class and fellow students, and to actively participate in the work of the school in accordance with the mentor's recommendations. Through writing the preparation and holding a trial and assessment lecture accompanied by an experiment, they gain experience in the immediate teaching of chemistry in the classroom. Students follow the work of mentors in high school classes; get acquainted with the pedagogical documentation, the content of the directory, diary and registry book, with the way in which the lesson is entered and the presence of pupils in class is recorded; get acquainted with the issue of parent meetings and consultations with pupils and parents; gain insight into the organization of the school, the school calendar, professional services in the school, the type and level of cooperation between parents and the school, the obligations of teachers and the obligations of teachers; participate in the analysis of the structural elements and stages of the lesson, and the analysis of pupil achievement in individual performance, as well as the final success at the end of the semester.
Recommended literature	1. M. Sikirica: Metodika nastave kemije, Školska knjiga, Zagreb, 2003 2. N. Raos (urednik): Nove slike iz kemije, Školska knjiga, Zagreb, 2004 3. M. Sikirica: Zbirka kemijskih pokusa za osnovnu i srednju školu, Školska knjiga, Zagreb, 2011 4. Svi od MZOS-a odobreni udžbenici, priručnici za nastavnike, radne bilježnice i zbirke zadataka za srednje škole 5. Važeći Nastavni plan i program iz kemije za osnovne i srednje škole (MZOS) 6. Ispitni katalog za državnu maturu iz kemije (NCVVO) 7. Jokić (ur.) i sur. (2007.): Ključne kompetencije "učiti kako učiti" i "poduzetništvo" u osnovnom školstvu Republike Hrvatske, Istraživački izvještaj. Institut za društvena istraživanja, Zagreb 8. Bezinović, P., Marušić, I., Ristić Dedić, Z. (2012.): Opažanje i unapređivanje školske nastave. Agencija za odgoj i obrazovanje, Institut za društvena istraživanja u Zagrebu.
Additional literature	1. Marzano, R. J. i sur. (2006.):Nastavne strategije. Educa, Zagreb 2. Mattes, W. (2007), Nastavne metode, Naklada Ljevak, Zagreb.

	3. Miljković, D., M. Rijavec, (2010) Pozitivna disciplina u razredu, Zagreb Sahlberg, P. (2012.): Lekcije iz Finske: Što svijet može naučiti iz obrazovne reforme u Finskoj, Školska knjiga, Zagreb. Periodika: 1. Journal of Chemical Education, Division of Chemical Education of the American Chemical Society, New York 2. Education i Chemistry, The Chemical Society, Burlington House, London 3. Praxis der Naturwissenschaften, Aulis Verlag Eubner und co. KG, Koeln		
Forms of teaching	Classes are entirely done in elementary school with small groups of students with the help of a mentor-teacher and school.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60
Methods of testing knowledge and taking exams	Individual monitoring of the student through mentoring in primary school, participation in regular teaching of mentors, held at least one trial and one assessment lecture/lecture for assessment (ocjensko predavanje) accompanied by written preparation and experiment in primary school. At the final exam, the student writes a free composition about his experience gained through Laboratory Teaching Methods in Chemistry 1, assessing not only professional knowledge, but also the style of expression and literacy of the student.		
Language of teaching and possibilities of following in other languages	Croatian English		
The method of monitoring the quality and performance of each course and/or module	Discussions with students and the anonymous students opinion poll.		

Course name	Teaching Methods in Chemistry Laboratory 2		
Code	K2104		
Type	Mandatory		
Level	Graduate university study of Chemistry-teaching program		
Year	2.	**Semester**	Summer
ECTS	5		
Lecturer	Elvira Kovač-Andrić, Ph.D., Assistant Professor		
The aim or purpose of the course	Acquisition of practical experience necessary for quality performance of experimental teaching in primary and secondary school		
Prerequisites for enrollment			
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine the basic rules of laboratory work, precautions and protection measures in the chemical laboratory and the basic rules of handling chemicals and reagents. 2. Develop the skill of improvising performing an experiment in an unadopted environment. 3. Choose learning and teaching with a research approach while developing critical and creative thinking.		

<table>
<tr><td></td><td>4. Confirm understanding of basic chemical concepts and independent and methodologically correct experiments.
5. Select appropriate experiments to develop pupils science literacy.
6. Integrate professional, methodological and pedagogical knowledge in the planning of direct educational work in chemistry teaching.
7. Self-evaluate experimental work (identify deviations and errors during experimental work and suggest procedures for their removal).</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td>
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<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>2</td><td>1-7</td><td>Class attendance</td><td>Attendance records</td><td>50</td><td>60</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td>1-7</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>20</td><td>30</td></tr>
<tr><td>Final exam</td><td>2</td><td>1-7</td><td>Repetition of study matter</td><td>Oral exam</td><td>5</td><td>10</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>75</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students/ Mondays, 8-10 pm</td></tr>
<tr><td>Acquired competencies</td><td>Practical, i.e. laboratory experience required for quality performance of experiments in primary and secondary school.</td></tr>
<tr><td>Content</td><td>Selection of practical exercises from the teaching contents of the chemistry of primary and secondary education and environmental pollution, including modern techniques of demonstration individual experiments. Introducing students to the methodology and techniques of independent demonstration experiments in the field of general, inorganic and physical chemistry.
List of exercises:
1. Carbon
2. Saturated and unsaturated hydrocarbons
3. Aromatic hydrocarbons
4. Alcohols, aldehydes and ketones
5. Carboxylic acids and derivatives
6. Fats and oils
7. Soaps and detergents
8. Sugars
9. Amino acids, proteins and enzymes</td></tr>
<tr><td>Recommended literature</td><td>6. Sikirica, M., Mrvoš-Sermek, D. i Mayer, V. (2000) Praktikum iz metodike nastave kemije, Skripta za internu upotrebu. PMF, Zagreb.
7. Mayer, V. (1991) Eksperimentalna nastava kemije. Školska knjiga, Zagreb.
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<tr><td>Additional literature</td><td>Skripta za internu uporabu:
1. V.Majer: Eksperimentalna nastava kemije, Školska knjiga, Zagreb, 1991
2. Perina, B. Mihanović: Ispitivanje onečišćenja zraka. SKTH/Kemija u industriji, Zagreb, 1998</td></tr>
</table>

	3. B. Mihanović, I. Perina: Fizikalno i kemijsko ispitivanje zagađenosti vode, Školska knjiga, Zagreb, 1982		
Forms of teaching	Lectures and seminars are obligatory. Homework		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60
Methods of testing knowledge and taking exams	Oral exam after completion of all the lectures and seminars.		
Language of teaching and possibilities of following in other languages	Croatian English		
The method of monitoring the quality and performance of each course and/or module	Discussions with students and the anonymous students opinion poll.		

Course name	**Didactics 2**		
Code	K2206		
Type	Mandatory		
Level	Graduate university study of Chemistry-teaching program		
Year	2.	**Semester**	Winter
ECTS	3		
Lecturer	Associate Professor Vesna Buljubašić-Kuzmanović, Ph. D.		
The aim or purpose of the course	Students will learn about theoretical and practical aspects of teaching and education.		
Prerequisites for enrollment	Completed first year of graduate studies		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1.define, correctly interpret and describe the basic concepts of the curriculum, different curriculum starting points, theories and methodological approaches to curriculum development 2. analyze and critically reflect on curriculum issues and evaluation models 3. implement the curriculum in the educational institution 4. analyze the curriculum taking into account the different approaches 5. on the basis of the acquired insight into theoretical-methodological approaches to curriculum, conduct and interpret simpler research tasks in the field of curriculum studies		

<table>
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<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1,5</td><td>1-7</td><td>Class attendance</td><td>Attendance records</td><td>-</td><td>-</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>2</td><td>1-7</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>0</td><td>60</td></tr>
<tr><td>Final exam</td><td>1</td><td>1-7</td><td>Repetition of study matter</td><td>Oral exam</td><td>0</td><td>40</td></tr>
<tr><td>Total</td><td>3</td><td></td><td></td><td></td><td>0</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students/ Thursdays, 11:30-13 pm</td></tr>
<tr><td>Acquired competencies</td><td>The student acquires didactic competences regarding planning and realization of curriculum, as well as assessment and improvement of curriculum dimensions on all levels of the national education system.</td></tr>
<tr><td>Content</td><td>Multi-tiered meaning of the term curriculum. Main theoretical and methodological approaches to curriculum development (curriculum concepts, ways of legitimation and types of curriculum). Socio-political, economic, cultural and legal aspects of the curriculum. Permanent innovation or curriculum development in response to new trends in the labor market and general culture (comparative analysis at the global and national level). Curriculum planning and design methodology (goal-oriented theory, formulation models, concept of learning outcomes, content selection criteria, lesson study and content design methodology, planning and implementation, criteria and methods of evaluating educational effects).</td></tr>
<tr><td>Recommended literature</td><td>

Marsch, J.C., Kurikulum: Temeljni pojmovi, Zagreb:Educa, 1994.
Previšić, V. (ur.), Kurikulum: Teorije, metodologija, sadržaj, struktura. Zagreb: Zavod za pedagogiju; Školska knjiga, 2007.
Peko A., Varga R., Mlinarević, V., Munjiza E., Lukaš M., Kulturom nastave (p)o učeniku,Osijek:Sveučilište J. J. Strossmayera u Osijeku, 2014.
Didaktičke teorije, (ured. Gudjons et.al.), Zagreb: Educa, 1992.

</td></tr>
<tr><td>Additional literature</td><td>

Moon, B., A Guide to the national Curriculum. Oxford, New York:Oxford University Press, 2001.
Ornstein, A.C.& Hunkins,F.P. Curriculum: Fundations, Principies, and Issues. Boston: Allan&Bacon Publishers, 1998.
Hameyer,E./Hrsg./(1983.): Hdb. der Curriculumforschung, darin: Strukturtheoretisch e Konzepte
Schröder,
H.(2002.): Lernen, Lehren, Unterricht: lernpsychologische und didaktische Grundlage. München: Oldenbourg

</td></tr>
<tr><td>Forms of teaching</td><td>

lectures
seminars
exercises

</td></tr>
<tr><td>Teaching type</td><td>
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<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td>1</td><td>1</td><td>1</td></tr>
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<tr><td>(hours per week) total</td><td></td></tr>
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Methods of testing knowledge and taking exams	seminar paper, individual and group tasks, quizzes (mid-term exam) final exam
Language of teaching and possibilities of following in other languages	Croatian
The method of monitoring the quality and performance of each course and/or module	constant communication between teacher and students, final evaluation of students and teacher's work and an anonymous survey conducted by the Department and/or the University

II. Year

IV. Summer semester

Elective Course VII* (ECTS 5)

Seminar with Research Project (ECTS 3)

Diploma Thesis (ECTS 22)

***List of elective courses**

Microanalytical Methods (ECTS 5)

Chemistry of Transition Elements (ECTS 5)

Fundamentals of Radiochemistry and Radiation Chemistry (ECTS 5)

Green Chemistry (ECTS 5)

Chemistry of Food (ECTS 5)

Senior Laboratory of Physical Chemistry (ECTS 5)

Colloid and Interfacial Chemistry (ECTS 5)

Course name	TRANSITION METALS CHEMISTRY		
Code	KD2207		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program/ Graduate university study of Chemistry-teaching program		
Year	I.	**Semester**	Summer
ECTS	5		
Lecturer	Elvira Kovač-Andrić, Ph.D., Assistant Professor		
The aim or purpose of the course	Understand the basic concepts of the properties of transition metals and their compounds, their characteristic, technological applicability and their role in metabolic processes.		
Prerequisites for enrollment	Completed obligations for Inorganic Crystallochemistry		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Determine the basic chemical and physical properties of transition metals. 2. Examine the properties of the elements for each group of transition metals in the periodic table. 3. Evaluate the role of transition metals in metabolic processes. 4. Compare chemical bonds in crystal structures of transition metals and their complex compounds. 5. Conclude how the chemical and physical properties depend on the structure of the compound with the transition metal. 6. Propose the relationship of composition, structure and properties of compounds containing transition metals.		

<table>
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<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>1</td><td>1-6</td><td>Class attendance</td><td>Attendance records</td><td>10</td><td>20</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td>1-6</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>30</td><td>40</td></tr>
<tr><td>Final exam</td><td>3</td><td>1-6</td><td>Repetition of study matter</td><td>Oral exam</td><td>30</td><td>40</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>70</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td>In agreement with the students/ Mondays, 8-10 pm</td></tr>
<tr><td>Acquired competencies</td><td>To determine the properties of the elements and understand the basic chemical and physical properties of transition metals.</td></tr>
<tr><td>Content</td><td>Review of the periodic table from the aspect of electronic configuration of the ground state. Term transition metals. Character of bonds in transition metal compounds. Properties of the individual transition metal (atomic radius, ionization energy, atomization enthalpy, reduction potential, electronegativity, oxidation numbers, crystal lattice, density, hardness, melting and boiling points, heat and electricity conductivity, mechanical, electrical and magnetic properties, color, reactivity). Solutions and complex compounds of transition metals.
Alloying of transition metals - with each other and with other metals. Technological importance transition metals. Biological importance of transition metals.</td></tr>
<tr><td>Recommended literature</td><td>5. D. F. Shriver, P. W. Atkins, C. H. Langford, Inorganic Chemistry, 5. izd., Oxford University Press, Oxford 2010.
6. I. Filipović i S. Lipanović, Opća i anorganska kemija, II dio, VIII. izdanje, Školska knjiga, Zagreb, (1991).
7. D. Grdenić, Molekule i kristali, 5. izd., Školska knjiga, Zagreb 2005.
8. C. E. Housecroft, A. G. Sharpe, 2. izd. Inorganic Chemistry, izd. Pearson Ed., 2005.</td></tr>
<tr><td>Additional literature</td><td>4. F. Albert Cotton, G. Wilkison, P. Gauss, Basic Inorganic Chemistry,. izd., John Willey& Sons, New York.
5. W.H. Bragg, W-L- Bragg: The crystalline State, Vol I., A General Survey , G. Bell and Sons, London, 1955
6. R.C.Evans: An Introduction to Crystal Chemistry, Cambridge Univ. Press, 1964</td></tr>
<tr><td>Forms of teaching</td><td>Lectures, seminars and homework.</td></tr>
<tr><td>Teaching type</td><td>
<table>
<tr><th>Lectures</th><th>Seminars</th><th>Exercises</th></tr>
<tr><td>2</td><td>2</td><td>-</td></tr>
<tr><td>30</td><td>30</td><td>-</td></tr>
</table>
</td></tr>
<tr><td>(hours per week) total</td><td></td></tr>
<tr><td>Methods of testing knowledge and taking exams</td><td>Written and oral exam after completion of all the lectures.</td></tr>
<tr><td>Language of teaching and possibilities of</td><td>Croatian
English</td></tr>
</table>

following in other languages	
The method of monitoring the quality and performance of each course and/or module	Discussions with students and the anonymous students opinion poll.

Course name	MICROANALYTICAL TECHNIQUES		
Code	KD2103		
Type	Elective		
Level	Graduate university study of Chemistry--teaching program		
Year	2.	**Semester**	Winter
ECTS	5		
Lecturer	Doc.dr.sc. Aleksandar Sečenji		
The aim or purpose of the course	Understand microanalytical techniques in analytical chemistry. Learn to select and implement the most suitable microanalytical technique for a particular analytical method. Acquire basic knowledge necessary for research work.		
Prerequisites for enrollment	Passed mandatory courses in analytical chemistry.		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Integrating basic concepts and knowledge from analytical chemistry into microanalytical techniques. 2. Compare classical analytical and microanalytical techniques and their principles. 3. Assess the advantages and disadvantages of individual microanalytical techniques. 4. Independently decide when and how to apply a particular miroanalytical technique. 5. Discuss the advantages of microanalytical techniques in analytical chemistry. 6. Critically review and evaluate the literature and scientific papers related to microanalytical techniques		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	1	1-6	**Class attendance**	**Attendance records**	8	10
Discussion, seminars and homework	1	1-6	**Preparation and problem solving**	**Oral presentation**	10	20
Knowledge test (written colloquia)	1	1-5	**Preparation for writtwn exam**	**Writen exam**	15	30
Final exam	2	1-5	**Repetition of study matter**	**Writen exam** **Oral exam**	10 10	20 20
Total	5				53	100

Consultations	Consultations are available every week, during which the lecture is held, for 1 hour.		
Acquired competencies	Understanding the principles of microanalytical analysis techniques, ability to choose microanalytical techniques.		
Content	Lectures: Miniaturization in analytical chemistry (classification, miniaturization as a trend in analytical chemistry, definitions and terms, miniaturization theory, advantages of miniaturization of analytical systems). Design of miniaturized analytical systems. Automation and miniaturization of sample processing (solid phase microextraction, liquid phase microextraction, continuous flow system). Miniaturized systems for analytical separation (System based on hydrodynamic flow; System based on electroosmotic flow). Detection in miniaturized analytical systems. Micro (nano) sensors: development and nanotechnology. Portable miniaturized analytical systems.		
Recommended literature	A. Rios, A. Escarpa, B. Simonet: *Miniaturisation of Analytical Systems: Principles, designs and Application*, J. Wiley & Sons Ltd., Chichester, UK, 2009.		
Additional literature	D.Li (Ed.): *Encyclopedia of Microfluidics and Nanofluidics*, Springer, Heidelberg, Germany, 2008. O. Geschke, H. Klank, P. Telleman (Eds.): Microsystem Engineering of Lab-on-a-Chip Devices, 2nd ed., Wiley-VCH, Weinheim, Germany, 2009.		
Forms of teaching	Lectures with the use of technical aids (Power Point presentations) and active participation of students. Seminars where seminar papers and homework are presented and discussed, and students solve problems.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	Knowledge is tested through a mid-term test, which is taken in the middle of the semester. The final exam is taken orally.		
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction). English language.		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.		

Course name	**Radiochemistry and Radiation Chemistry**
Code	KD2209
Type	Elective
Level	Graduate university study of Chemistry-research program/ Graduate university study of Chemistry-teaching program

<table>
<tr><td>Year</td><td>1.or 2.</td><td>Semester</td><td>Winter/Summer</td></tr>
<tr><td>ECTS</td><td colspan="3">5</td></tr>
<tr><td>Lecturer</td><td colspan="3">Assistant professor Berislav Marković, PhD Brunislav Matasović</td></tr>
<tr><td>The aim or purpose of the course</td><td colspan="3">Introducing to students the basic concepts of radiochemistry and radiation chemistry, with the principles of nuclear reactions and chemical reactions induced by radiation and with the applications of ionizing radiation in practice.</td></tr>
<tr><td>Prerequisites for enrollment</td><td colspan="3">None.</td></tr>
<tr><td>Learning outcomes</td><td colspan="3">After successfully completing the course, the student will be able to:
1. Define basic concepts in radiochemistry and radiation chemistry.
2. Judge and determine the differences between radiochemistry and radiation chemistry.
3. Judge and determine the differences between different radiation sources.
4. To determine and predict the ways of radical formation and their reactions.
5. Judge and recommend the use of radionuclides and ionizing radiation.
6. Critically evaluate the relevant scientific literature.</td></tr>
<tr><td>Relationship between learning outcomes, teaching methods and grading</td><td colspan="3">
<table>
<tr><th rowspan="2">Teaching activity</th><th rowspan="2">ECTS</th><th rowspan="2">Learning outcome</th><th rowspan="2">Student activity</th><th rowspan="2">Assessment methods</th><th colspan="2">Points</th></tr>
<tr><th>min</th><th>max</th></tr>
<tr><td>Class attendance</td><td>0.5</td><td>1 – 6</td><td>Class attendance</td><td>Attendance records</td><td>9</td><td>10</td></tr>
<tr><td>Seminars</td><td>1</td><td>1 – 6</td><td>Seminar preparation</td><td>Seminar presentation</td><td>10</td><td>20</td></tr>
<tr><td>Knowledge test (written colloquia)</td><td>1</td><td>1 – 6</td><td>Preparation for the written exam</td><td>Written colloquium</td><td>10</td><td>20</td></tr>
<tr><td>Final exam</td><td>2.5</td><td>1 – 6</td><td>Repetition of study matter</td><td>Oral exam</td><td>25</td><td>50</td></tr>
<tr><td>Total</td><td>5</td><td></td><td></td><td></td><td>54</td><td>100</td></tr>
</table>
</td></tr>
<tr><td>Consultations</td><td colspan="3">In agreement with the students</td></tr>
<tr><td>Acquired competencies</td><td colspan="3">Acquisition of basic knowledge about the nature of radioactivity, the properties of ionizing radiation, the chemical changes it causes; useful application (especially in chemistry); why this type of radiation is harmful to health and what are the methods and controls of protection.</td></tr>
<tr><td>Content</td><td colspan="3">Ionizing radiation - what is it and what does it have to do with chemistry? Why and how harmful is it to human health? What are the useful applications? Students will be introduced to the types, origins and sources of radiation. The structure of the atomic nucleus, isotopes, radioactivity, modes and kinetics of radioactive decay. Which radioactive isotopes are natural and which are artificially created and in what way (nuclear machines, accelerators/particle accelerators, reactors). How and when a nuclear reaction occurs. On the principles of radiation measurement, which instruments and in which units the results are expressed. How radiation and the material exposed interact. What is radiolysis, how are radicals formed, what are their properties and what chemical changes do they cause. What are antioxidants and how do they work. Where radionuclides and ionizing radiation are applied (chemistry, medicine, industry). Peculiarities of techniques and methods of work in radiochemistry and radiation</td></tr>
</table>

	chemistry. The principles of a modern approach to protection and control against the harmful effects of ionizing radiation will be explained.
Recommended literature	1. G.R. Choppin, J. Rydberg, J.-O. Liljenzin and C. Ekberg, Radiochemistry and Nuclear Chemistry, Butterwoth-Heinemamm, 2012. 2. J.W.T. Spinks and R.J. Woods, Introduction to Radiation Chemistry, J. Wiley&Sons, 1990.
Additional literature	1. W.D. Ehman and D.E. Vance, Radiochemistry and Nuclear Methods of Analysis, J. Wiley&Sons, 1993. 2. C. von Sonntag, The Chemical Basis of Radiation Biology, Taylor&Francis, 1987. 3. International Basic Safety Standards for Protection against Ionizing Radiation and for Safety of Radiation Sources, IAEA Safety Series No. 115, 1996.
Forms of teaching	Mandatory lectures and student's seminars. Mid-term written colluquium.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	–
total	30	15	–

Methods of testing knowledge and taking exams	Written and oral exam that is taken after the lectures. The final grade consists of: regular attendance and active participation in classes - 10%, seminar paper - 20%, success in the exam in the middle of the semester - 20%, and success in the final exam - 50%.
Language of teaching and possibilities of following in other languages	Croatian, English
The method of monitoring the quality and performance of each course and/or module	Communication with students and anonymous polls.

Course name	CHEMISTRY OF FOOD		
Code	K1112		
Type	Elective		
Level	Graduate university study of Chemistry-research program / Graduate university study of Chemistry-teaching program		
Year	1./2.	**Semester**	Winter/Summer
ECTS	5		
Lecturer	Dajana Sokač-Gašo, Ph.D., Assist. prof.		
The aim or purpose of the course	Introduce students to the basic ingredients of food, their chemical and biochemical changes and interactions.		
Prerequisites for enrollment	None		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Examine and group the basic ingredients of food 2. To determine the connection between chemical, physical and biochemical reactions in food and the interaction of ingredients and food additives 3. Review and self-assess the suitability and impact of individual food additives		

	4. Critically evaluate harmful ingredients and their impact on health 5. Anticipate changes during food processing and storage, select appropriate processing and storage methods 6. Critically evaluate the relevant scientific literature.

Relationship between learning outcomes, teaching methods and grading

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Points	
					min	max
Class attendance	0	1-6	**Class attendance**	**Attendance records**	5	10
Knowledge test (written colloquia)	2	1-6	**Preparation for the written exam**	**Written colloquium**	20	25
Final exam	3	1-6	**Repetition of study matter**	**Oral exam**	35	65
Total	5				60	100

Consultations	In agreement with the students.
Acquired competencies	Knowledge of basic chemical processes that take place during food preparation and processing Knowledge of the interaction of individual food ingredients and their changes during processing and storage.
Content	Chemical and physical interactions between food ingredients during processing and storage. Water and ice. Carbohydrates (structure and changes), lipids in food (structure, functional properties and changes). Amino acids, peptides and proteins (structure, functional properties and changes). Vitamins. Vitamin losses in food. Substances for plant and animal tissue color. Food flavoring substances and changes during food processing and storage. Inorganic substances. Influence of processing on the content of inorganic substances. Food additives: antioxidants, sweeteners, preservatives, emulsifiers, dyes, flavors. Harmful and medicinal ingredients of food.
Recommended literature	1. H.-D. Belitz, W. Grosch, P. Schieberle: Food Chemistry, 3 rd revised ed, Springer-Verlag, Berlin, Heildelberg, 2004 2. John M.De Man, Principles of Food Chemistry, III ed., New York, 1999.
Additional literature	1. O.R. Fennema, Food Chemistry, 3 rd ed., by Marcel Dekker, Inc, N.Y., 1996. 2. Norman N. Potter, Joseph H. Hotchkiss, Food Science (3th ed.), Chapman&Hall, New York, 1995. 3. W. Baltes, Lebensmittelchemie (Dritte Auflage), Springer-Verlag Berlin, Heildelberg, 1992.
Forms of teaching	Lectures with the use of technical aids, active involvement of students in discussions and debates. Laboratory exercises to monitor chemical and biochemical reactions that may occur in food during processing and storage.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	-	1
total	30	-	15

Methods of testing knowledge and taking exams	Oral exam
Language of teaching and possibilities of following in other languages	Croatian
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous opinion pull.

Course name	Advanced physical chemistry laboratory		
Code	KD4209		
Type	Elective		
Level	Graduate university study of Chemistry-research/teaching		
Year	1.	**Semester**	Summer
ECTS	5		
Lecturer	Ph.D. Martina Medvidović-Kosanović, associate professor		
The aim or purpose of the course	Getting deeper insight in one area of physical chemistry through independent laboratory work.		
Prerequisites for enrollment	-		
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Independently plan and perform the experiment from the selected area 2. Analyze experimentally obtained data (numerically and graphically) 3. Describe studied topic in a form of a seminar 4. Bring to a conclusion regarding the studied physical process		

Relationship between learning outcomes, teaching methods and grading

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	1	1-4	**Class attendance**	**Attendance records**	-	-
Knowledge test (written colloquia)	3	1 – 4	**Preparation for the written exam**	**Written colloquium**	-	100
Total	4					100

Consultations	Wednesdays 10-12 h
Acquired competencies	Independent literature survey. Application of needed instruments and methods of data analysis and presentation of the experimentally obtained results.

Content	The advanced physical chemistry laboratory is organized in such a way that a student chooses some of the experiments from a certain area of physical chemistry suggested at the beginning of the semester and he or /she performs independently that experiment under the mentorship of one teacher or one assistant from the beginning till the end. The mentioned includes a literature survey, an introduction with one experimental method which will be used in the experiment (e.g. conductometry, potentiometry, UV-Vis spectrophotometry), preparing the solutions, performing the experiments, analysis of the obtained data, and writing the laboratory report.
Recommended literature	1. M. Medvidović-Kosanović, Praktikum fizikalne kemije, Osijek, 2012.
Additional literature	1. P.W. Atkins & J. de Paula, Atkins' Physical Chemistry, Oxford University Press, Oxford, 2002. 2. P.W. Atkins & M.J. Clugston, Načela fizikalne kemije, Školska knjiga, Zagreb, 1989. 3. M. Sikirica, Stehiometrija, Školska knjiga, Zagreb, 1985. 4. T. Cvitaš & N. Kallay, Fizičke veličine i jedinice Međunarodnog sustava, Školska knjiga, Zagreb, 1980
Forms of teaching	Independent laboratory work under the mentorship of an assistant and/or teacher.

Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	-	-	4
total	-	-	60

Methods of testing knowledge and taking exams	Laboratory reports written in accordance to the literature survey and based on experimentally obtained and analyzed data are graded.
Language of teaching and possibilities of following in other languages	Croatian, possibly English
The method of monitoring the quality and performance of each course and/or module	Continuous communication of teachers with students, and anonymous student survey

Course name	Colloid and Interface Chemistry		
Code	KD4204		
Type	Mandatory		
Level	Graduate university study of Chemistry-research program		
Year	1. and 2.	**Semester**	Summer
ECTS	5		
Lecturer	Doc.dr.sc Berislav Marković		
The aim or purpose of the course	The course enables students to get acquainted with the properties and wide application of various colloidal systems as well as the basics of reactions on interfaces.		

Prerequisites for enrollment	Non
Learning outcomes	***After successfully completing the course, the student will be able to:*** 1. Integrate knowledge of different types of colloidal systems. 2. To determine the possibility of using colloidal systems in the whole spectrum of different applications. 3. Establish the specific properties of different colloidal systems in different applications. 4. Understand the thermodynamics of interfaces: surface tension, surface energy, adsorption on surfaces. 5. Apply appropriate methods to determine the characteristics of colloids. 6. Experiences necessary for oral and written presentation of scientific work.
Relationship between learning outcomes, teaching methods and grading	

Teaching activity	**ECTS**	**Learning outcome**	**Student activity**	**Assessment methods**	**Points**	
					min	**max**
Class attendance	1	1-5	**Class attendance**	**Attendance records**	7	10
Preparation and presentation of seminar	1	1-6	**Preparation and making a presentation**	**Oral presentation**	10	20
Knowledge test (written colloquia)	1	1-6	**Preparation for writtwn exam**	**Writen exam**	20	30
Final exam	1	1-6	**Repetition of study matter**	**Oral exam**	23	40
Total	5				60	100

Consultations	Consultations are held at a pre-announced time per week (1 hour) during the semester regarding both lectures and seminar topics, and preparation for written exams
Acquired competencies	A successful student is competent in understanding disperse and colloidal systems, their characteristics, specific properties, possibilities of various uses in technology and everyday life. Students develop the ability of critical evaluation, problem solving, reasoning, individual and group work and communication skills
Content	1 1. Colloidal systems: colloid division, diffusion and Brownian motion, technological and biological significance of colloids. 2. Thermodynamics of surfaces: surface energy, Gibbs equation of state, nucleation, contact angle and surface tension. 3. Sedimentation and viscosity of suspensions. 4. Particles and their characterization: particle size and shape, measurement methods. 5. Adsorption on intermediate surfaces: adsorption isotherms, polymer adsorption. 6. Surface electricity: surface potential generation, electrical bilayer, electrokinetics and zeta potential. 7. Association colloids: micelles, liquid crystal and membranes. 8. Colloidal particle interactions: coagulation kinetics, influence of polymers on colloidal stability.

	9. Modern methods of studying colloidal dispersions. 10. Colloidal chemistry today and tomorrow - nano-chemistry and nano-technology		
Recommended literature	1. R.J. Hunter, Foundations of Colloid Science, 2. izd., Oxford University Press, New York, 2001. 2. T. Cosgrove, Colloid Science: Principles, Methods and Applications, Willey-Blackwell, Chichester, 2010.		
Additional literature	1. R.J. Hunter, Introduction to Modern Colloid Science, 2. izd., Oxford University Press, Oxford, 1994. 2. P.C. Hiemenz i R. Rajagopalan, Principles of Colloid and Surface Chemistry, 3. izd., Marcel Dekker, New York, 1997 3. Selected papers from the primary literature on the application of colloidal chemistry in modern technologies		
Forms of teaching	Lectures, consultations, seminars with selected topics based on original scientific and journal papers. The processed topic should be orally referred to and written material and presentation made.		
Teaching type	**Lectures**	**Seminars**	**Exercises**
(hours per week)	2	1	-
total	30	15	-
Methods of testing knowledge and taking exams	Knowledge is tested through a mid-term test, which is taken in the middle of the semester. The final exam is taken orally.		
Language of teaching and possibilities of following in other languages	Croatian language (language of instruction). English language.		
The method of monitoring the quality and performance of each course and/or module	Interviews with students and anonymous surveys.		