

**UNIVERSITY OF ZAGREB
FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS
Bijenička cesta 32, Zagreb**

PROPOSAL
Of the university joined study of
EDUCATIONAL PHYSICS AND CHEMISTRY
TEACHER OF PHYSICS AND CHEMISTRY

Zagreb, January/February 2005.

University joined study of EDUCATIONAL PHYSICS AND CHEMISTRY

according to "Instructions for composing the proposal of study programmes for educational profiles" – issued by the Committee for educational studies, December 29, 2004

1. INTRODUCTION

Physics and chemistry are fundamental natural sciences and are implemented in education: primary school (two final years of study), secondary school (four years), various vocational schools (two to four years). Besides, the subject Science, taught in the primary school, includes topics related to these natural sciences.

Physics is a fundamental natural science. It is the basis for understanding and explanation of natural phenomena and processes which take place in our environment, as well as at most distant points of the Universe. Physics contributes to the development of other natural sciences, biomedicine and technology very much. Recently the physics methods are successfully applied in other fields such as economy and sociology.

Chemistry is the basis for understanding of the processes in all sorts of matter including living beings, at the atomic/molecular level. The topics belonging to chemistry are in a great deal included in the programmes of biology, geology, mineralogy. A very extensive knowledge, based on chemistry is necessary for production of almost all goods in our environment; chemistry is the main natural science strongly linked with its own industry.

The processes taking place in the environment are mainly of the chemical nature. The knowledge of chemistry is essential for a reasonable governing and sustainable development, nowadays and in the future. The quality inspection of drugs, food, plastics and most of industrial products is based on the knowledge of chemistry. Chemistry know-how is extremely important in construction and use of power systems and, in connection with that, in the protection of the environment.

The university study programmes of educational physics and chemistry can be found in many prominent universities, for instance, in our neighbourhood: the universities in Split, Ljubljana, Vienna, Budapest, Novi Sad, Belgrade, Sarajevo.

The university study of chemistry and physics has existed in Zagreb since 1876. The edifice of Department of Chemistry was built in 1884. The Department of Chemistry will be moved soon into a new modern building, adjacent to the Department of Physics and the Department of Mathematics, which were moved to their new buildings in 1991. In 1946 some departments were separated from the Faculty of Arts and established as the Faculty of Science, starting an intense research activity. Since then, the university study programmes of physics and chemistry were included in the frame of the Faculty of Science.

The professors of physics and chemistry with the Faculty of Science have been elected to their positions according to the highest criteria, on the basis of their achievements in science, which have been internationally recognized. At the same time, they always try their best to improve education of physics and chemistry, by implementation of modern ideas in teaching methods, and by publishing papers in recognized international journals.

The university study proposed here **is not a new one**; the existing study is harmonized according to the demands of the Bologna declaration and is modernized in the approach to teaching, in order to achieve a better studying efficiency and compatibility with the related studies in Europe. The students graduated in these two close fields of natural sciences acquire the needed competence in physics and chemistry.

The study of the educational physics and chemistry is open to students of related studies, if the differential exams are passed. The study lasts for five years and demands a deep knowledge of the two fields of natural sciences, as well as the basic knowledge of mathematics, pedagogy, psychology and didactics. Therefore, the undergraduate three-year study is not sufficient to achieve the required competence; a full expertise can be achieved in an integral five-year study.

2. GENERAL

2.1. The term of study:	The University study of educational PHYSICS AND CHEMISTRY
2.2. The institution performing the study:	University of Zagreb, Faculty of Science, Department of Physics, Department of Chemistry
2.3. The duration of study:	Five years
2.4. Conditions for enrolment:	Secondary school, chemical vocational school, similar school with at least three-year programmes of mathematics, physics and chemistry; the priority enrolment list is based on the classification procedure; the secondary school certificate in the future.
2.5. Undergraduate study:	—
2.6. Graduate study:	<p>The graduate study for the degree of teacher of physics and chemistry is an integral five-year study. The study demands the competence in physics and chemistry and the basic knowledge of mathematics, pedagogy, psychology and didactics.</p> <p>Therefore, the undergraduate three-year study is not sufficient to achieve the required competence; a full expertise can be achieved in an integral five-year study.</p>
2.7. The graduation degree achieved at the end of study:	Teacher of physics and chemistry

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FACULTY OF SCIENCE
Ul. kralja Zvonimira 8
10000 Zagreb

University study of educational physics and chemistry:
TEACHER OF PHYSICS AND CHEMISTRY
3.1 Curriculum

Year 1

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Mathematics 1	4+3+0+0	9		
Fundamentals of Physics 1	4+2+2+0	10		
General Chemistry	4+2+0+0	8		
General Chemistry Laboratory 1 and 2	0+0+0+4	3	0+0+0+4	3
Mathematics 2			4+2+0+0	8
Computers and Operating Systems			2+1+0+0	3
Fundamentals of Physics 2			4+2+0+0	8
Analytical Chemistry			3+2+0+0	8
** Physical and Health Education 1	0+2+0+0		0+2+0+0	
*** English 1	2+0+0+0		2+0+0+0	
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS::	12+7+2+4	30	13+7+0+4	30
	25		24	

Year 2

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P+V+S+L)	ECTS CREDITS	CONTACT HOURS (P+V+S+L)	ECTS CREDITS
Mathematics 3	3+2+0+0	6		
Fundamentals of Physics 3	4+2+1+0	9		
Physics Laboratory A	1+0+0+4	4		
Inorganic Chemistry	4+2+0+0	8		
Elective Course - chemistry 1	2+1+0+0	3		
Mathematics 4			3+2+0+0	6
Fundamentals of Physics 4			4+2+1+0	9
Physics Laboratory B			0+0+0+4	3
Physical Chemistry			4+2+0+0	8
Analytical and Physical Chemistry Laboratory			0+0+0+4	4
** Physical and Health Education 2	0+2+0+0		0+2+0+0	
*** English 2	2+0+0+0		2+0+0+0	
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:	14+7+1+4	30	11+6+1+8	30
	26		26	

Year 3

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P+V+S+L)	ECTS CREDITS	CONTACT HOURS (P+V+S+L)	ECTS CREDITS
Quantum Physics	4+2+0+0	10		
Astronomy and Astrophysics	2+1+0+0	4		
Elective Course – physics 1	2+1+0+0	3		
Chemical Synthesis Laboratory	0+0+0+4	4		
Elective Course – chemistry 2	2+1+0+0	3		
Organic Chemistry	4+1+0+0	6	4+1+0+0	6
Electrodynamics			4+2+0+0	8
Statistical Physics			2+1+0+0	3
Elective Course – physics 2			2+1+0+0	3
Biochemistry			5+2+0+0	8
Biochemistry Laboratory			0+0+0+2	2
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:	14+6+0+4	30	17+7+0+2	30
	24		26	

Elective Course – Physics 1 and 2

History of Physics	2+0+1+0			
Biophysics	2+0+1+0			
Fundamentals of Physics of Materials	2+1+0+0			
Physics of the Earth and Atmosphere	2+1+0+0			
Physics and Philosophy			2+0+1+0	
Medical Physics			2+1+0+0	
Power Production			2+0+1+0	

Elective Course – Chemistry 1 and 2

Environmental Chemistry	2+1+0+0			
Mineralogy 1	2+1+0+0			
History and Philosophy of Chemistry	2+0+0+0			
Selected Topics in Organic Chemistry	2+1+0+0			
Selected Topics in Inorganic Chemistry	2+1+0+0			
Selected Topics in Physical Chemistry	2+1+0+0			

Year 4

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P+V+S+L)	ECTS CREDITS	CONTACT HOURS (P+V+S+L)	ECTS CREDITS
Educational Psychology	4+2+0+0	8		
Fundamentals of Solid State Physics	2+1+0+0	6		
Elective Course - chemistry 3	2+1+0+0	4		
Advanced Laboratory	0+0+0+4	6		
Laboratory in Physics Education	0+0+0+4	6	0+0+0+4	5
Didactics			4+0+0+0	4
General Pedagogy			4+0+0+0	4
Elective Course – physics 3			2+1+0+0	3
Teaching Methods in Chemistry			2+2+0+0	6
Undergraduate research work			0+0+1+0	8
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:	8+4+0+8	30	12+3+1+4	30
	20		20	

Elective Course – Physics 3

Fundamentals of Atomic and Molecular Physics			2+1+0+0	
Fundamentals of Electronics			2+2+0+0	
Physics of Disordered Systems			2+0+1+0	

Elective Course – Chemistry 3

Radioanalytical Methods	2+1+0+0			
Crystallochemistry	2+1+0+0			
Molecular Spectroscopy	2+1+0+0			
Colloid and Interfacial Chemistry	2+1+0+0			
Selected Topics in Analytical Chemistry	2+1+0+0			
Selected Topics in Biochemistry	2+1+0+0			

Year 5

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Elective Course – physics 4	2+1+0+0	3		
Teaching Methods in Chemistry	2+0+2+0	6		
Laboratory of Teaching Methods in Chemistry	0+0+0+4	4	0+0+0+4	4
Teaching Methods in Physics	2+0+2+0	6	2+0+2+0	6
Teaching Practice in Physics			0+0+1+3	4
Teaching Practice in Chemistry			0+0+1+3	4
Undergraduate Research Project	0+0+1+0	11	0+0+1+8	12
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:	6+1+5+8	30	2+0+5+14	30
	20		21	

Elective Course – Physics 4

Fundamentals of Nuclear Physics and Elementary Particle Physics	2+1+0+0			
Low-Temperature Physics and Superconductivity	2+1+0+0			
Physics of Nanomaterials	2+1+0+0			
Laboratory in Fundamentals of Electronics	0+0+0+3			

**University study of educational physics and chemistry:
TEACHER OF PHYSICS AND CHEMISTRY
3.2 Curriculum**

COURSE TITLE: Fundamentals of Physics 1		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 1		
SEMESTER/TERM: 1		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	4	Professor
Exercises	2	Assistant
Seminars	1	Professor, Assistant
ECTS credits: 10		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</p> <p>Physics is a fundamental natural science and is the basis for understanding and explanation of processes and phenomena which take place in macroscopic and microscopic worlds, as well as at most distant points of the Universe. The subjects Fundamentals of Physics 1, 2, 3 and 4 make an integral course, through which the students achieve the basic knowledge of physics indispensable for a successful continuation of the study and graduation.</p>		
<p>DESCRIPTION OF THE COURSE:</p> <p>Physics and other natural sciences. Physical quantities, vectors, scalars. International system of units. Kinematics of a particle. Independence principle of particle motions. Dynamics of a particle. Impulse and linear momentum. Newton's laws of motion. Gravitational field. Mass and weight. Inertial and gravitational mass. Work, power, energy. Rotational motion, torque, angular momentum, rotational inertia. Laws of motion in accelerating frames of reference. Galileian and Lorentzian transformations. Harmonic oscillations. Resonance. Statics and dynamics of fluids.</p>		
<p>STUDENT OBLIGATIONS DURING THE COURSE: Students are supposed to attend lectures and exercises, and to perform obligatory oral and written tests during the term.</p>		
<p>METHODS TO EVALUATE STUDENT PERFORMANCE: The course consists of lectures, exercises and seminars. The lectures are adapted to students who are trained to be teachers of physics. During lectures, basic laws of nature are demonstrated through a number of experiments. Exercises and seminars are a continuation of lectures, containing check points and problems helping students to achieve necessary knowledge in physics. The student autonomously submits a given topic in physics to other students. The performance of students is followed during the term by written and oral tests.</p>		
<p>EXAMINATION METHODS: The exam includes a written part and an oral part. The</p>		

students, who successfully solve obligatory tests during the term, are to pass only the oral part of the exam.

COURSE(s) NEEDED FOR THIS COURSE:

COMPULSORY LITERATURE:

M. Paić, Fundamentals of Physics (in Croatian), Motions, Forces, Waves, Školska knjiga, Zagreb, 1997

C. Kittel, W.D. Knight, M.A. Ruderman, Mechanics (translation to Croatian), Tehnička knjiga, Zagreb, 1982

D. Halliday, R. Resnik, J. Walker, Fundamentals of Physics, John Wiley, New York, 1997 (or new editions)

ADDITIONAL READING:

COURSE TITLE: Fundamentals of Physics 2		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 1		
SEMESTER/ TERM: 2		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	4	Professor
Exercises	2	Assistant
Seminars		
ECTS credits: 8		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</p> <p>Physics is a fundamental natural science and the basis for understanding and explanation of processes and phenomena which take place in macroscopic and microscopic worlds, as well as at most distant points of the Universe. The subjects Fundamentals of Physics 1, 2, 3 and 4 make an integral course, through which the students achieve the basic knowledge of physics indispensable for a successful continuation of the study and graduation.</p>		
<p>DESCRIPTION OF THE COURSE:</p> <p>Electric charge. Electric field, electric potential. Gauss' law. Dielectrics, electric capacitance. Electric current. Conductors, semiconductors, superconductors. Magnetic field of a moving charged particle. Magnetic force on a current-carrying wire and on a moving charged particle. The phenomena during the rise and decay of the current. Alternating current. Electromagnetic induction. Self-induction. Measuring instruments. Electric generators and motors. Electroacoustics. Magnetic properties of matter. Maxwell equations.</p>		
<p>STUDENT OBLIGATIONS DURING THE COURSE: Students are supposed to attend lectures and exercises, and to perform obligatory oral and written tests during the term.</p>		
<p>METHODS TO EVALUATE STUDENT PERFORMANCE: The course consists of lectures and exercises. The lectures are adapted to students who are trained to be teachers of physics. During lectures, basic laws of nature are demonstrated through a number of experiments. Exercises are a continuation of lectures, containing check points and problems helping students to achieve necessary knowledge in physics. The student autonomously submits a given topic in physics to other students. The performance of students is followed by written and oral tests during the term.</p>		
<p>EXAMINATION METHODS: The exam includes a written part and an oral part. The</p>		

students, who successfully solve obligatory tests during the term, are to pass only the oral part of the exam.

COURSE(S) NEEDED FOR THIS COURSE:

COMPULSORY LITERATURE:

M. Paić, Fundamentals of Physics, Electricity, Magnetism (in Croatian), Liber, Zagreb, 1989

M. Purcell, Electricity and Magnetism (translation to Croatian), Tehnička knjiga, Zagreb, 1988

D. Halliday, R. Resnik, J. Walker, Fundamentals of Physics, John Wiley, New York, 1997 (or new editions)

ADDITIONAL READING:

COURSE TITLE: Mathematics 3		
COURSE TEACHER: Dijana Ilišević, PhD, Assistant Professor, Department of Mathematics, University of Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2		
SEMESTER: 3		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY
Lectures	3	Teacher
Exercises	2	Assistant
Seminars	0	-
Laboratory	0	-
ECTS credits: 6		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Acquainting with classical vector algebra, analytic space geometry and bases of matricial calculus.		
DESCRIPTION OF THE COURSE:		
<ol style="list-style-type: none"> 1. Vectors in space. Definition. Addition of vectors. Scalar multiplication. Colinear and coplanar vectors. Linear dependence. Scalar, vector and mixed product. Concept of a group, a vector space, and an algebra. Coordinate system. Coordinate representation of vectors and operations. 2. Analytic space geometry. Cartesian coordinate system. Plane equation. Line equation. Mutual positions of a line and a plane. 3. Matrices. Definition. Addition of matrices. Product of a scalar and a matrix. Product of matrices. Regular matrices. Determinants. 		
STUDENT OBLIGATIONS DURING THE COURSE: Attending the lectures and exercises, solving the homework assignments and taking an active part in exercises. There will be preliminary exams during the semester for grading the achievements.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Homework assignments. Preliminary exams.		
EXAMINATION METHODS: The final exam is written and/or oral. The final grade is formed on the basis of homework assignments, preliminary exams and the final exam.		

COURSE(s) NEEDED FOR THIS COURSE: None

COMPULSORY LITERATURE: K. Horvatić, Linearna algebra 1 i 2, skripta, PMF-Matematički odjel, Zagreb, 1995.

ADDITIONAL READING: N. Bakić, A. Milas, Zbirka zadataka iz linearne algebre s rješenjima, skripta, PMF-Matematički odjel, Zagreb, 1995.

L. Čaklović, Zbirka zadataka iz linearne algebre, Školska knjiga, Zagreb, 1985.

V. Devide, Riješeni zadaci iz više matematike, Svezak I, Školska knjiga, Zagreb, 1989.

N. Elezović, A. Aglič, Linearna algebra, zbirka zadataka, Element, Zagreb, 1995.

S. Kurepa, Kvadratne matrice drugog i trećeg reda, Školska knjiga, Zagreb, 1979.

S. Kurepa, Uvod u linearnu algebru, Školska knjiga, Zagreb, 1975.

V.P. Minorski, Zbirka zadataka više matematike, Tehnička knjiga, Zagreb, 1972.

I.V. Proskuryakov, Problems in Linear Algebra, Mir Publishers, Moscow, 1978.

COURSE TITLE: Fundamentals of Physics 3		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2		
SEMESTER/TERM: 3		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	4	Professor
Exercises	2	Assistant
Seminars	1	Professor/Assistant
ECTS credits: 9		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</p> <p>Physics is a fundamental natural science and is the basis for understanding and explanation of processes and phenomena which take place in macroscopic and microscopic worlds, as well as at most distant points of the Universe. The subjects Fundamentals of Physics 1, 2, 3 and 4 make an integral course, through which the students achieve the basic knowledge of physics indispensable for a successful continuation of the study and graduation.</p>		
<p>DESCRIPTION OF THE COURSE:</p> <p>Wave phenomena. Transverse and longitudinal waves. Travelling wave in an infinite medium. Standing wave (modes) in a finite medium. Differential equation of the wave motion. Waves in fluids. Impedance of the medium and reflexion of waves. Phase and group speed. Doppler effect. Ultrasounds. Electromagnetic waves. The Poynting vector. Photometric quantities. Geometrical optics. Dispersion of light. Optical instruments. Wave nature of light. Interference, diffraction and polarization of light. Interference filters. Diffraction grating. Polaroids. Double refraction in crystals. X-ray diffraction in crystalline solids.</p>		
<p>STUDENT OBLIGATIONS DURING THE COURSE: Students are supposed to attend lectures, exercises and seminars, and to perform obligatory oral and written tests during the term.</p>		
<p>METHODS TO EVALUATE STUDENT PERFORMANCE: The course consists of lectures, exercises and seminars. The lectures are adapted to students who are trained to be teachers of physics. During lecture, basic laws of nature are demonstrated through a number of experiments. Exercises and seminars are a continuation of lectures, containing check points and problems helping students to achieve necessary knowledge in physics. The student autonomously submits a given topic in physics to other students. The performance of students is followed during the term by written and oral tests.</p>		

EXAMINATION METHODS: The exam includes a written part and an oral part. The students, who successfully solve obligatory tests during the term, are to pass only the oral part of the exam.

COURSE(s) NEEDED FOR THIS COURSE: Fundamentals of Physics 1, Fundamental of Physics 2

COMPULSORY LITERATURE:

M. Paić, Fundamentals of Physics (in Croatian), Motions, Forces, Waves, Školska knjiga, Zagreb, 1997

M. Paić, Fundamentals of Physics (in Croatian), Light, Holography, Lasers, Liber, Zagreb, 1991

D. Halliday, R. Resnik, J. Walker, Fundamentals of Physics, John Wiley, New York, 1997 (or new editions)

ADDITIONAL READING:

COURSE TITLE: Physics Laboratory A		
COURSE TEACHER/TEACHERS: Prof. Dr. Sc. Mirko Stubičar, Department of Physics, Faculty of Science, University of Zagreb Dr. Sc. Gorjana Jerbić-Zorc, lecturer; Department of Physics, Faculty of Science, University of Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2		
SEMESTER: 3		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	0	%
Exercises	0	%
Seminars	0	0
Laboratory	4	Assistant under supervision of teacher
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The main goal is to provide the student with simple experiments in physics (mainly in Mechanics) which illustrates fundamental principles or the applications of these principles. Such exercises fulfil other purposes, such as: the realization of the importance of making precise measurements by making all measurements with as much care as possible; the choice of the best available technique; the care necessary in the design and completion of the experiment; the collection, tabulation and handling of data; and finally the final report writing (or its presentation.).		
DESCRIPTION OF THE COURSE: Physics is an experimental science and, as such, it is largely a science of measurements. The laboratory provides a unique opportunity to validate physical theories in a quantitative manner. So, in the course are included the standard experiments that have been used by many physics departments. Most of the equipments has been supplied by the PHYWE-The Manufacturer of University Laboratory Equipments. The use of rather sophisticated data analysis are major features of the course including the repeated use of the mean and standard deviation calculations, and the linear least squares fit analysis. At the beginning of the course four introductory themes are connected with the subjects such as:		
<ol style="list-style-type: none"> 1. The Nature of Measurements. Definitions and Related Concepts: Types of Measurement, Measurement as a Relation, Sources of Variability in Measurement, Scales of Measurement. 2. The Precision and Accuracy of Measurements. The Concepts of Precision and Accuracy; The Measurement of Accuracy; Statistical Measures of Precision. 		

3. The Method of Least Squares. Definitions and Related Concepts; Linear and Non-linear Relations; The Fitting of Curves and the Fitting of Straight Lines.
4. The Design of Experiments.

The experiments have been selected so that in general they can be completed in four-hour period. The List of Laboratory Exercises included in the course is following:

(i)

1. Determination of volume and density of a given solid object (available tools: Vernier's caliper: classic and digital, micrometer and analytical balance).
2. Viscosity measurements of liquid (tool: Phywe falling-ball viscometer).
3. Determination of density of liquid (tool: Phywe Mohr-Westphal balance).
4. Determination of surface tension (tools: platinum ring and tensometer; capillary and «mm» scale).
5. Study of free, damped and forced oscillations (tools:Phywe equipment, power supplies and electronic timer).
6. Study on mechanical conservation of energy (tools: Maxwell disc and electronic timer).
7. Mathematical pendulum (tools: ball hanging on a cooton tread and electronic timer).
8. Determination of Young's modulus (tools: Phywe apparatus consisting of metal flat bar, slotted weight, 2m-tape and comparator gauge).
9. Torsional vibrations and torsion modulus (tools: Phywe torsion apparatus, spring balance and electronic watch).

(ii)

1. Lenses and Optical Instruments.
2. Interference of Light
3. Diffraction of Light at a Slit and an Edge
4. Two-electron Spectra with the Prism Spectrometer
5. Atomic Spectra of Two-Electron Systems with the Diffraction Grating.
6. Measuring the Velocity of Light

Remak: Student has to perform 7 exercises selected from part (i) and 3 exercises taken from part (ii).

STUDENT OBLIGATIONS DURING THE COURSE: For each laboratory exercise student has to pre-prepare and study the theoretical background for given experiment. Before starting with the performing of experiments he must answer (orally or in written manner) to questions connected with experiment included in the exercise. Questions and description of experiments for each exercise will be displayed on Internet site of the Department of Physics. After finishing planed measurements in laboratory, student will, at home, evaluate the results, and finally for each exercise will write the final report.

METHODS TO EVALUATE STUDENT PERFORMANCE: Theoretical pre-preparation and correct answers to questions before starting the planed measurements, skills and knowledge shown during performing measurements and quality of written final report, as well as the final written and oral exams will be combined together to estimate a student's final score.

EXAMINATION METHODS: Final exam will be performed in written and oral manner.
COURSE(S) NEEDED FOR THIS COURSE: Fundamentals of Physics 1
<p>OBAVEZNA LITERATURA (<i>navesti detaljne podatke o izdavaču i godini izdanja, voditi računa o tome da obavezna literatura mora biti dostupna studentima u našoj knjižnici i što je moguće novijeg datuma</i>):</p> <p>M. Požek i A. Dulčić: Fizički praktikum I i II (Sunnypress, Zagreb, 1999); M. Paić: Fizička mjerenja I dio (Liber, Zagreb, 1985); PHYWE: University Laboratory Experiments in Physics, 3rd ed. (Phywe Systeme GMBH, Goettingen, 1995); B. Marković, D. Miler, A. Rubčić: Račun pogrešaka i statistika (Liber, Zagreb, 1987); D.C. Baird: Experimentation-An Introduction to Measurement Theory and Experiment Design (Prentice-Hall, New Jersey, 1979).</p>
<p>DOPUNSKA LITERATURA (<i>navesti detaljne podatke o izdavaču i godini izdanja i voditi računa o tome da bude što je moguće novijeg datuma</i>):</p> <p>M. Paić: Osnove fizike, 1. dio, Gibanja-sile-valovi (Školska knjiga, Zagreb, 1997).</p> <p>Grupa autora: Riješeni zadaci iz opće fizike-Mehanika, Elektricitet i magnetizam, u redakciji prof. K. Ilakovca (Školska knjiga, Zagreb, 1989).</p>

COURSE TITLE: Mathematics 4		
COURSE TEACHER: Dijana Ilišević, PhD, Assistant Professor, Department of Mathematics, University of Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY
Lectures	3	Teacher
Exercises	2	Assistant
Seminars	0	-
Laboratory	0	-
ECTS credits: 6		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Acquainting with standard techniques of linear algebra and fundamentals of the structure of a vector space.		
DESCRIPTION OF THE COURSE:		
<ol style="list-style-type: none"> 1. Systems of linear equations. Basic concepts. Rank of a matrix. Elementary transformations. Existence of a solution. Structure of a solution. Gauss elimination method. 2. Vector spaces. Definition, examples and basic properties. Linear combination. Linear dependence. Generators of a vector space. Basis and dimension. Subspaces. Transition matrix from one basis to another. 3. Linear operators. Definition, basic properties and examples. Eigenvalues of a linear operator. Isomorphism of vector spaces. Rank and defect. Vector space of linear operators. Characteristic and minimal polynomial. Invariant subspaces. Diagonalization. 4. Curves and surfaces of the second order. 		
STUDENT OBLIGATIONS DURING THE COURSE: Attending the lectures and exercises, solving the homework assignments and taking an active part in exercises. There will be preliminary exams during the semester for grading the achievements.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Homework assignments. Preliminary exams.		
EXAMINATION METHODS: The final exam is written and/or oral. The final grade is		

formed on the basis of homework assignments, preliminary exams and the final exam.
COURSE NEEDED FOR THIS COURSE: Mathematics 3
COMPULSORY LITERATURE: K. Horvatić, Linearna algebra 1 i 2, skripta, PMF-Matematički odjel, Zagreb, 1995.
ADDITIONAL READING: N. Bakić, A. Milas, Zbirka zadataka iz linearne algebre s rješenjima, skripta, PMF-Matematički odjel, Zagreb, 1995. L. Čaklović, Zbirka zadataka iz linearne algebre, Školska knjiga, Zagreb, 1985. N. Elezović, A. Aglič, Linearna algebra, zbirka zadataka, Element, Zagreb, 1995. S. Kurepa, Konačnodimenzionalni vektorski prostori i primjene, SNL, Zagreb, 1986. S. Kurepa, Kvadratne matrice drugog i trećeg reda, Školska knjiga, Zagreb, 1979. S. Kurepa, Uvod u linearnu algebru, Školska knjiga, Zagreb, 1975. V.P. Minorski, Zbirka zadataka više matematike, Tehnička knjiga, Zagreb, 1972. I.V. Proskuryakov, Problems in Linear Algebra, Mir, Publishers, Moscow, 1978.

COURSE TITLE: Fundamentals of Physics 4		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	4	Professor
Exercises	2	Assistant
Seminars	1	Professor/Assistant
ECTS credits: 9		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</p> <p>Physics is a fundamental natural science and is the basis for understanding and explanation of processes and phenomena which take place in macroscopic and microscopic worlds, as well as at most distant points of the Universe. The subjects Fundamentals of Physics 1, 2, 3 and 4 make an integral course, through which the students achieve the basic knowledge of physics indispensable for a successful continuation of the study and graduation.</p>		
<p>DESCRIPTION OF THE COURSE:</p> <p>Temperature. Heat as an energy that is transferred between two systems. Calorimetry. Heat capacity. Transition between states of a substance. Phase diagram. The triple point of a substance, the critical temperature. The ideal gas law. Isothermal, adiabatic, constant-pressure and constant volume processes. Kinetic theory of heat. Internal energy of a system. Conduction, convection and radiation of heat. The Planck law of radiation of the black body. Reversible processes. The zeroth and first laws of thermodynamics. Enthalpy. The second law of thermodynamics. Dithermal cyclical processes. The entropy change in an irreversible process. Statistical thermodynamics. Entropy and the non-accessible energy. The Helmholtz and Gibbs energy. The change of thermodynamic energies during a phase transition. The third law of thermodynamics. Heat engines.</p>		
<p>STUDENT OBLIGATIONS DURING THE COURSE: Students are supposed to attend lectures, exercises and seminars and to perform obligatory oral and written tests during the terms.</p>		
<p>METHODS TO EVALUATE STUDENT PERFORMANCE: The course consists of lectures, exercises and seminars. The lectures are adapted to students who are trained to be teachers of physics. During lectures, basic laws of nature are demonstrated through a number of experiments. Exercises and seminars are a continuation of lectures, containing check points and problems helping students to achieve necessary knowledge in physics. The student</p>		

autonomously submits a given topic in physics to other students. The performance of students is followed during the term by written and oral tests.

EXAMINATION METHODS: The exam includes a written part and an oral part. The students, who successfully solve obligatory tests during the term, are to pass only the oral part of the exam.

COURSE(s) NEEDED FOR THIS COURSE: Fundamentals of Physics 1, Fundamentals of Physics 2

COMPULSORY LITERATURE:

M. Paić, Fundamentals of Physics (in Croatian),Heat, Thermodynamics, Energy, Školska knjiga, Zagreb, 1994

D. Halliday, R. Resnik, J. Walker, Fundamentals of Physics, John Wiley, New York, 1997 (or new editions)

ADDITIONAL READING:

COURSE TITLE: Physics Laboratory B		
COURSE TEACHER/TEACHERS: Prof. Dr. Sc. Mirko Stubičar, Department of Physics, Faculty of Science, University of Zagreb Dr. Sc. Gorjana Jerbić-Zorc, Lecturer; Department of Physics, Faculty of Science, University of Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	0	
Exercises	0	
Seminars	0	
Laboratory	4	Assistant under supervision of teacher
ECTS credits: 3		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The course Laboratory Exercises in Physics B (abbr. LEP B) is continuation of the course Laboratory Exercises in Physics A (LEP A). However, laboratory experience will teach student the limitations inherent in the applications of physical theories to real physical situations and the role that experimental uncertainty plays in physical measurements and introduce ways to minimize experimental uncertainty, as well. The main goal is similar like in LEP A, i.e. the measurements of physical quantities and their statistical joint dependence. In this course student will carry-out experiments selected mainly from the Fundamentals of Physics 2 (Electricity and Magnetism). Stress will be given to the fundamental principles and practical operations of AVO-meter and oscilloscope apparatus. Also, a number of experiments will involve a computer-assisted data acquisition and will allow sophistication of data manipulation and analysis. The use of this resource is simply inescapable; the computer-interfaced apparatus can teach student a lot about the capabilities of contemporary laboratory methods in the context of physics. Many problems in physics are analyzed with approximations or idealizations that make the mathematics of the analysis less complicated or that offer a more discernible physical picture, and thus, experimental data and analysis offer a validation or a rejection of the approximation.</p>		
<p>DESCRIPTION OF THE COURSE:</p> <p>At the beginning of the course two introductory themes will be connected with the subjects such as:</p> <ol style="list-style-type: none"> 1. The fundamental principles and practical operation of: AVO-meter instrument and oscilloscope apparatus. 		

2. Use of a personal computer in: computer-assisted data acquisition, data manipulation, and evaluation of the results by means of statistical methods.

The experiments have been selected so that in general they can be completed in four-hour period. The List of Laboratory Exercises included is following:

(i)

- 1) AVO-meter Study of the dc Electrical Circuits suitable for Continuous Change of: a) Current and b) Voltage.
- 2) Oscilloscope Study of the Influence of: (a) R and C Components in the ac Circuit and (b) R and L Components in the ac Circuits.
- 3) Oscilloscope Study of the Influence of R, L and C Components in the ac Circuit.
- 4) The Wheatstone's Bridge.
- 5) The Transformer.
- 6) RLC measuring Bridge.
- 7) Magnetic Induction.
- 8) Magnetic Moment in the Magnetic Field.
- 9) Electrical Fields and Equipotential Lines in the Plate Capacitor.

(ii)

- 1) Coupled Pendula.
- 2) Equation of State of Ideal Gas (a) or Heat Capacity of Metals (b).
- 3) Determination of Planck's «Quantum of Action» from Photoelectric Effect.

Remark: Student has to perform 7 exercises selected from part (i) and 3 from part (ii).

STUDENT OBLIGATIONS DURING THE COURSE: For each laboratory exercise student has to pre-prepare and study the theoretical background for given experiment. Before starting with the performing of experiments he must answer (orally or in written manner) to questions connected with experiment included in the exercise. Questions and description of experiments for each exercise will be displayed on Internet site of the Department of Physics. After finishing planned measurements in laboratory, student will, at home, evaluate the results, and finally will write the final report for each exercise.

METHODS TO EVALUATE STUDENT PERFORMANCE: Theoretical pre-preparation and correct answers to questions before starting the planned measurements, skills and knowledge shown during performing measurements and quality of written final report, as well as the final written and oral exams will be combined together to estimate a student's final score.

EXAMINATION METHODS: Final exam will be performed in written and oral manner.

COURSE(S) NEEDED FOR THIS COURSE: Fundamentals of Physics 1
Laboratory Exercises in Physics A

OBAVEZNA LITERATURA (*navesti detaljne podatke o izdavaču i godini izdanja, voditi računa o tome da obavezna literatura mora biti dostupna studentima u našoj knjižnici i što je moguće novijeg datuma*):

M. Požek i A. Dulčić: Fizički praktikum I i II (Sunnypress, Zagreb, 1999);
M. Paić: Fizička mjerenja I dio (Liber, Zagreb, 1985);
PHYWE: University Laboratory Experiments in Physics, 3rd ed. (Phywe Systeme GMBH, Goettingen, 1995);
B. Marković, D. Miler, A. Rubčić: Račun pogrešaka i statistika (Liber, Zagreb, 1987);
D.C. Baird: Experimentation-An Introduction to Measurement Theory and Experiment Design (Prentice-Hall, New Jersey, 1979).

DOPUNSKA LITERATURA (*navesti detaljne podatke o izdavaču i godini izdanja i voditi računa o tome da bude što je moguće novijeg datuma*):

M. Paić: Osnove fizike, 1. dio, Gibanja-sile-valovi (Školska knjiga, Zagreb, 1997).

Grupa autora: Riješeni zadaci iz opće fizike-Mehanika, Elektricitet i magnetizam, u redakciji prof. K. Ilakovca (Školska knjiga, Zagreb, 1989).

COURSE TITLE: Quantum physics		
COURSE TEACHER/TEACHERS: Prof.dr. Slobodan Brant		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	4	teacher
Exercises	2	assistant
Seminars		
Laboratory		
ECTS credits: 10		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</p> <p>The course is designed for understanding the principles and essential ideas of quantum physics. The applications are limited to simple systems. The aim of the course is not to develop practical skills in solving problems beyond those illustrated in exercises. Therefore, the written exam is not required.</p>		

DESCRIPTION OF THE COURSE:

1. Thermal radiation and Planck's postulate.
2. The photoelectric effect. The Compton effect.
3. Bohr's and Sommerfeld's model of the atom.
4. De Broglie's postulate. Wavelike properties of particles.
5. Schroedinger's equation.
6. Born's interpretation of wave functions. Required properties of eigenfunctions.
7. Expectation values.
8. One-dimensional problems:
Well potentials.
Barrier potentials.
Simple harmonic oscillator potential.
9. Angular momentum and magnetic moment.
10. One-electron atom.
11. Multiparticle systems (general ideas only).
12. Approximate methods for solving the Schroedinger's equation (general ideas only).

STUDENT OBLIGATIONS DURING THE COURSE:

Course attendance is controlled. During exercises students are encouraged to take part in solving problems that illustrate the topics. Two colloquia are offered.

METHODS TO EVALUATE STUDENT PERFORMANCE:

Results of colloquia and the result of the final examination.

EXAMINATION METHODS:

The final exam is oral, but the students can make a draft of their answers before they present them. The results of the colloquia are added to the result of the final examination.

COURSE(S) NEEDED FOR THIS COURSE:

Physics 1-4, mathematical courses.

COMPULSORY LITERATURE:

R.Eisberg and R.Resnick, Quantum Physics, John Wiley and Sons, New York, 1974.

ADDITIONAL READING:

I.Supek, Teorijska fizika i struktura materije II, Skolska knjiga, Zagreb, 1990.

COURSE TITLE: Astronomy and Astrophysics		
COURSE TEACHER/TEACHERS: Prof. Krešimir Pavlovski		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	Teacher
Exercises		
Seminars	1	Assistant
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Introduction to the basic knowledge of astronomy and astrophysics (diurnal and annual movement, fundamental astrophysical quantities and stellar properties, formation and evolution of stars, structure of Milky Way galaxy, properties of galaxies, large-scale structure of the Universe, introduction to cosmology (origin and expansion of the Universe).		
DESCRIPTION OF THE COURSE: 1) Historical development of astronomy and astro-physics, 2) Celestial coordinate systems, 3) Solar and sidereal time, calendars, 4) Precession, aberration and nutation, 5) Astrophysical quantities, stellar brightness, colors and luminosity, 6) Spectral classification, effective temperature, 7) Hertzsprung-Russel diagram, 8) Binary stars, stellar masses and radii, 9) Equations of the internal structure of stars, 10) Formation and stellar evolution, 11) Final stages of stellar evolution, white dwarfs, neutron stars, and black holes, 12) Structure and rotation of Milky Way galaxy, 13) Properties of spiral and elliptical galaxies, 14) Clusters of galaxies and large-scale of the Universe, 15) Origin of the Universe		
STUDENT OBLIGATIONS DURING THE COURSE: seminar paper		
METHODS TO EVALUATE STUDENT PERFORMANCE: seminar paper		
EXAMINATION METHODS: written and oral		
COURSE(S) NEEDED FOR THIS COURSE: none		
COMPULSORY LITERATURE: V. Vujnović, <i>Astronomija I and II</i> , Školska knjiga, Zagreb 1990		
ADDITIONAL READING: M. Zeilik, <i>Astronomy – the evolving universe</i> , John Wiley & Sons, New York, 1997		

COURSE TITLE: Fundamentals of Physics of Materials (hr: Osnove fizike materijala)		
COURSE TEACHER/TEACHERS: Prof. Dr. Sc. Mirko Stubičar, Department of Physics, Faculty of Science, University of Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3		
SEMESTER:		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (teacher or assistant)
Lectures	2	Teacher
Exercises	%	%
Seminars	1	Teacher
Laboratory	%	%
ECTS credits: 3		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: <i>Primary objective in the course is to present the basic fundamentals of physics of materials on a level appropriate for university students who are encountering the discipline for the first time, and also to define and explain all unfamiliar terms, such as: superconductivity, superplasticity, the shape memory effect, etc. Coverage of materials is ranged from pure elements to superalloys, from glasses to engineering ceramics, and from everyday plastics to in situ composites. The proposed course will also serve to focus the attendant toward the goals of developing and perfecting new materials and new applications for existing materials. Recent and continuing advances in the design and manipulation of materials atom by atom to create artificial structures are revolutionary steps in the development of materials for specific applications. Finally, it is interesting to note that the world population and the depletion of resources both continue to increase, therefore, it is clear that the availability of optimum materials will play an important role in maintaining our quality of life.</i></p>		
<p>DESCRIPTION OF THE COURSE: <i>The Lecture Themes or the Core Titles in Contemporary Course «Fundamentals of Physics of Materials»:</i></p> <p><i>1) Introduction to the Realm of Materials; Historical Perspective; Why to Study Course «Fundamentals of Physics of Materials»; Natural and Scientific Classification of Materials.</i></p> <p><i>2) Atomic Structure and Interatomic Bonding. Fundamental Concepts of Atomic Structure; Electrons in Free Atoms and the Four Electron Quantum Numbers; Bonding and Energy Levels; The Periodic Table.</i></p> <p><i>3) Atomic Arrangements in Materials. The Real and Reciprocal Crystal Lattice and Information on the Structure of Crystals Contained (Hidden!?) in the Diffraction Patterns; Structures of Metals and Ceramics; Crystal Structures and Unit Cells; Metallic Crystal Structures; Ceramic Crystal Structures;</i></p>		

Silicate Ceramics, Carbon; Polymorphism and Allotropy; Crystal Systems; Crystallographic Directions and Planes; Crystalline, Partially Crystalline and Noncrystalline Materials; Single Crystals and Polycrystalline Materials.

Polymer Structures. Introduction; Hydrocarbon Molecules; Polymer Molecules; The Chemistry of Polymer Molecules; The Thermoplastic and Thermosetting Polymers; Elastomers (Rubbers); Copolymers; Polymer Single Crystals.

Composite Materials; Definitions and Basic Concepts; Particle-Reinforced Composites; Fiber-Reinforced Composites.

4) Imperfections in Solids. Point Defects in Materials; Miscellaneous Imperfections: Linear, Interfacial and Volume

Defects.

5) Methods of Characterization of Materials: Structural and Physical Properties.

6) Diffusion. Definitions and Basic Concepts; Diffusion Mechanisms; The Random Walk Theory of Diffusion; Fick's Laws

for Diffusion.

7) Phase Diagrams. Definitions and Basic Concepts: Solubility limit, Phase, Microstructure, Phase Equilibria; Types of

the Equilibrium Binary Phase Diagrams: Isomorphous Alloy Systems, Eutectic, Peritectic, Monotectic, and with Intermediate Phases; The Metastable Phase Diagrams and Metastable States of Alloys; Methods of the Formation of Metastable Phases in Materials.

8) Phase Transformations. Definitions and Basic Concepts: Structural Phases, Their Formation and Transitions; The

Mechanisms and Kinetics of Solid State Transformations; Diffusive and Non-diffusive (Martensitic) Phase Transformations in the Solid State; Ordering /Disordering Transformations; Gibbs Free Energy Changes in the Phase Transformations; Isothermal Transformation (TTT) Diagrams; Continuous Cooling Transformation (CCT) Diagrams; Precipitation Hardening; Ordering in Alloys: Long-Range and Short-Range Order; Heat Treatments and Mechanisms of Hardening.

9) Mechanical Properties of Materials. Concepts of Stress and Strain; Elastic and Plastic Deformation; Plastic

Deformation of Materials; Deformation Mechanisms and Kinetics of Changes; Basic Concepts of Dislocations; Characteristics of Dislocations; Slip Systems in Single Crystals; Strengthening and Toughening Mechanisms in Materials; Types of Mechanical Tests: Tension, Compression, Shear, Torsion, etc.

10) Failure. Definitions and Basic Concept; Griffith Micro-Crack Criterion; Fundamental Principles of Fracture Mechanics;

Brittle and Ductile Fracture; Cleavage and Ductile/Brittle Transition; Fatigue; Crack Formation and Propagation; Creep.

11) Electrical and Magnetic Properties. Electrical conduction; Energy Band Structures in Solids; Dielectric Materials;

Polarization; Semiconductivity: Intrinsic and Extrinsic Effect; Ferroelectricity, Pyroelectricity and Piezoelectricity; Superconductive Materials; Diamagnetic, Paramagnetic, Ferromagnetic, Antiferromagnetic and Ferrimagnetic Materials; Soft and Hard Magnetic Materials.

The Supplement Themes or Themes prepared and orally presented by Students during the Seminar:

12) Synthesis, Fabrication and Processing of Materials.

13) Selection of Materials According to Engineering Purposes.

14) Experimental Methods for Testing Materials Under Unusual Conditions (High and Low Temperatures, High and Low Pressures, High Electric and Magnetic Fields, etc.).

15) Modern Alloy and New Materials Developments.

16) Materials for the Advanced Technologies.

On the Seminar the students will orally present the particular subjects, selected in advance, that are connected to the Supplement Themes (Topics: 12), 13), 14), 15) and 16)). Titles of Themes will be displayed on the Internet site (<http://www.phy.hr>) of the Department of Physics.

STUDENT OBLIGATIONS DURING THE COURSE: *To attend to the lectures and to answers the questions appearing in two written tests. Also, he needs to prepare and orally present one seminar theme.*

METHODS TO EVALUATE STUDENT PERFORMANCE:

Oral presentation one seminar theme and more than 65% correct answers to questions, appearing in the list of questions, prepared for two written tests during the course.

EXAMINATION METHODS: *The final exam will consist of written and oral answers to questions connected with the contents of the course.*

COURSE(s) NEEDED FOR THIS COURSE: *Fundamentals of Physics 1, 2, 3 and 4.
Laboratory Exercises in Physics 1, 2, 3 and 4.*

COMPULSORY LITERATURE: *W.F. Smith: Foundations of Materials Science and Engineering, 3rd ed. (McGraw-Hill, New York, 2004).*

W.D. Callister, Jr.: Fundamentals of Materials Science and Engineering (An interactive e-text, CD-ROM included), (Wiley and Sons, New York, 2001).

ADDITIONAL READING: *R.E. Hummel: Understanding Materials Science; History-Properties-Applications; (Springer, New York, 1998).*

G.I. Epifanov: Solid State Physics (Mir Publisher, Moscow, 1979).

T. Filetin, F. Kovačiček, J. Indof: Svojstva i primjena materijala (FSB, Zagreb, 2002).

T. Filetin, K. Grilec: Postupci modificiranja i prevlačenja površina (HDMT, Zagreb, 2004).

COURSE TITLE: History of Physics		
COURSE TEACHER/TEACHERS: Tihomir Vukelja, Ph.D.		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	teacher
Exercises	0	
Seminars	1	assistant
ECTS credits: 3		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The objective of the course is to introduce students briefly with the development of physics within wider historical context and to teach them how to use particular historical episodes for a more successful physics teaching. The course offers fundamental insight into changes of the worldviews and the methodology of physics, into dependence of the development of physics on social, religious, technological and other circumstances, as also into the origin of the fundamental physical methods and concepts. By doing this, modern physics is considered from the time perspective, as a human achievement shaped by efforts of many generations, which consequently enables its more complete understanding. A special emphasize is on the intuitive elements, founded in everyday experience and presented in particular stages of the development of physics, and which can interfere with students' acquisition of modern conceptions. Programme devotes more attention to the antic, medieval and renaissance physics than to modern physics, in order to familiarise students with methods and modes of phenomenological explanations presented in physics of these periods, regarding the fact that many aspects and details of the development of modern physics are analysed in other courses. In the context of each course subject, elements which are especially emphasized and analysed are those that can be used in teaching, in order to achieve a more successful acquisition and illustration of the contents of modern physics.</p>		
<p>DESCRIPTION OF THE COURSE:</p> <p>Week 1: Introduction: physics as a historical phenomenon. Natural philosophy and modern physics: comparison (the subject and aims of the investigation, methods and world view). The question of the beginnings of physics. Mythical world view of early civilisations, the nature of Egyptian and Babylonian mathematics and astronomy.</p> <p>Part one: Natural philosophy</p>		

- Week 2: Ancient Greek: general historical, social, intellectual, educational, material and economic circumstances in the Greek civilization. The Milesians and the concept of nature: the new world view and the beginnings of philosophy. The early cosmological theories, specific problems (magnetism, light, atmospheric phenomena), the new explanation of phenomena. The natural experience and mind. Motives for the investigation of nature.
The problem of change and the structure of matter: Parmenides and Zeno, Pythagoreans, Empedocles, Anaxagoras, the atomists. The sophists and Socrates.
- Week 3: Plato's natural philosophy. The early Greek astronomy and the Pythagorean cosmology. Plato and the beginnings of theoretical astronomy. Eudoxus. Heraclides of Pontus.
Aristotle's natural philosophy, general characteristics: the definition of physics, metaphysics, methodology. The elements: definitions, properties, and transformations.
- Week 4: Aristotle's natural philosophy: cosmology, natural and enforced movements, description and the laws of the change of place, the mover, optics. Aristotle's natural philosophy and the contemporary education in physics. Hellenism: general historical circumstances, Alexandrian Museum and Library. Hellenistic natural philosophy: Lyceum after Aristotle, Epicureans, Stoics, Neoplatonists, John Philoponus.
- Week 5: Hellenistic applications of mathematics in natural philosophy: statics (Archimedes), optics (Euclides, Ptolemy). Applied mechanics.
Hellenistic astronomy: heliocentric world model (Aristarchus), advancement of the observational astronomy (Hipparchus), development of the geocentric world model (Apollonius and Ptolemy). Achievements and the role of the ancient natural philosophy.
- Week 6: Decline of the natural philosophy in the late-Hellenism. General characteristics of the Roman civilization and natural philosophy in Rome (popularizers, encyclopedists, translations). Early Middle Ages (from 5th to 10th century): general historical circumstances, social, intellectual, educational, material and economical foundations. Philosophy of nature and Christianity. Carolingian Renaissance. Natural philosophy in the Early Middle Ages: Isidore of Seville, Bede, John Scotus Erigena, Gerbert of Aurillac. Shaping of the medieval world view.
The Islamic civilization, general characteristics. The place of the Greek science in Islamic society. Islamic astronomy, statics, optics (Alhazen) and natural philosophy (Avicenna, Averroes).
- Week 7: Christian Europe in 11th and 12th century: economic renewal and its consequences. The Medieval symbolic mentality and natural philosophy. The translation movement. Restoration of the cities and emergence of the universities, scholastics. Material life and the technology in the Middle Ages and consequences for the natural philosophy. Natural philosophy in 12th century urban schools: naturalism and deism.
Incursion of the Aristotelianism in 13th century and the problem of the relationship between faith and reason. Natural philosophy in the late Middle Ages (13th and 14th century): nature and methodology. Research areas: cosmology and astronomy, structure of the matter, kinematics (Mertonians and Oresme), dynamics (Buridan and the impetus theory), statics, optics (Roger Bacon, Vitello, explanation of the rainbow), magnetism (Peter the Pilgrim). Mathematics and experiment in medieval

natural philosophy. Achievements and the role of medieval natural philosophy, the continuity problem.

Part two: Modern physics

Week 8: The Renaissance: general historical, social, intellectual, educational, material and economic circumstances. Renaissance science as a destructive phase of the scientific revolution. Interweaving of art, technology and natural philosophy, a new attitude toward experiment and science.

Restoration of Neoplatonic and Stoic ideas (Petrić and Bruno) and interest for Archimedes' approach to physics (Soto, Tartaglia, Benedetti, del Monte, Stevin, Cardano). Optics, magnetism and atomism in the Renaissance.

Week 9: Renaissance astronomy and consequences for the natural philosophy: Copernicus, Brache, Kepler.

Week 10: Scientific revolution in 17th century: general historical, social, intellectual, educational, material and economic circumstances. Shaping of the new worldview and research methodology regarding nature (instrumental experience, mathematical description of the phenomena).

Galilei, Descartes, Gilbert.

Week 11: Newton and the development of classical mechanics.

Thermodynamics: development of the experimental methods and concepts. Heat theory. Energy and entropy, laws of thermodynamics. Kinetic gas theory and statistical physics.

Week 12: Modern optics: completing the development in geometrical optics, velocity of light, theories of light (Newton, Huygens, Descartes). Development of the wave optics in 19th century.

Electrodynamics: Coulomb's law, electric currents, electromagnetic induction, Faraday's conception of the field.

Week 13: Maxwell's electrodynamics, electromagnetic waves. Theory of relativity.

Modern atomic theory of matter: mechanical, chemical and electric atom.

New experimental devices: radioactivity, electron and atomic nucleus.

First models of the complex atom.

Week 14: Planck's law of the black body radiation, Einstein's work on radiation, Bohr's model of atom. The old quantum mechanics.

Compton's effect, de Broglie's hypothesis. Correspondence principle, Heisenberg's matrix mechanics and Schrödinger's wave mechanics.

Quantum mechanics and classical physics. Quantum mechanics and technology: nature of the experience with atomic objects.

STUDENT OBLIGATIONS DURING THE COURSE: Student is obliged to complete an essay and to pass preliminary exams.

METHODS TO EVALUATE STUDENT PERFORMANCE: Classes are organized in lectures (2 hours per week) and seminars (1 hour per week). In seminars students present their essays accompanying lectures, in which particular lecture topics are elaborated and commented in more details. Essays are prepared individually or in a group (depending on the number of students). After 7th and 14th week, an obliged written preliminary exam is expected, by which the knowledge of the first and the second part of the lectures (Natural philosophy and Modern physics, respectively) should be evaluated.

EXAMINATION METHODS: The exam is oral, in the form of an individual conversation with a student. The accent of the exam is on checking student's abilities

to apply the acquired knowledge in physics teaching. A student is evaluated on the basis of the knowledge demonstrated at the exam, grades of the preliminary exams and grade of the essay.

COURSE(S) NEEDED FOR THIS COURSE:

COMPULSORY LITERATURE:

I. Supek, *Povijest fizike*, Školska knjiga, Zagreb, 1990.

Z. Faj, *Pregled povijesti fizike*, Sveučilište J. J. Strossmayera, Osjek, 1999.

The main studying aid for preparing the preliminary and final exam(s) would be lecture notes, available at the URL pages of the Department.

ADDITIONAL READING:

D. C. Lindberg, *The Beginnings of Western Science: The European Scientific Tradition in Philosophical, Religious, and Institutional Context, 600 B.C. to A.D. 1450*, University of Chicago Press, Chicago, 1992.

R. Sorabji, *Matter, Space, and Motion: Theories in Antiquity and Their Sequel*, Cornell University Press, Ithaca, 1988.

P. Rossi, *The Birth of Modern Science*, Blackwell, Oxford, 2001.

S. Shapin, *The Scientific Revolution*, University of Chicago Press, Chicago, 1998.

M. Jammer: *The Conceptual Development of Quantum Mechanics*, McGraw-Hill, New York, 1966.

M. Mladenović, *Razvoj fizike: mehanika i gravitacija, optika, elektromagnetizam, termodinamika, o atomu*, (5 svezaka), Građevinska knjiga, Beograd, 1986. – 1989.

COURSE TITLE: Biophysics		
COURSE TEACHER/TEACHERS: Dr. sc. Selma Supek, Assistant Professor, Department of Physics, Faculty of Science, University of Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3.		
SEMESTER: V.		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	2	teacher
Exercises		
Seminars	1	teacher
ECTS credits: 3.		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To introduce the students to interdisciplinary biophysics research. To give an insight into the basic concepts of the structure and function of biological systems from molecule to the brain and to give an overview of the latest experimental methods. To emphasize the close connection between biophysics and biotechnologies of the future. To stimulate students to present some of the latest biophysics research in the seminars on the topics of their interest.		
DESCRIPTION OF THE COURSE:		
Subject, role, and importance of biophysics. Biophysics – biotechnology. Cellular organization of life. Biosynthesis, structure and functions of nucleic acids and proteins. Protein folding and dynamics. Overview of experimental methods in examining structure and dynamics of biological systems. Solute transport through biological membranes. Ion transport and rest potential. Molecular and cellular imaging. Noninvasive imaging of neurodynamic, hemodynamic, and metabolic brain activity. Neurobiology and biophysics of cognitive processes and emotions. Biosensors. Neuroimplants.		
STUDENT OBLIGATIONS DURING THE COURSE: Lectures, discussions, written exams, seminars.		
METHODS TO EVALUATE STUDENT PERFORMANCE:		
Participation at lectures and seminars.		
Oral presentation of a seminar.		

EXAMINATION METHODS:

Final written exam.

In the total grade the final exams contributes with 30%, discussions and written exams with 40% and oral presentation of a seminar with 30%.

COURSE(s) NEEDED FOR THIS COURSE: **General physics.**

COMPULSORY LITERATURE:

PowerPoint presentations of the lectures and selected review articles.

ADDITIONAL READING:

Cotterill R. "Biophysics: An Introduction" John Wiley & Sons, N.Y., 2002

Weiss, T.F. "Cellular Biophysics I" The MIT Press, Cambridge, USA, 1996

COURSE TITLE: Physics of the Earth and Atmosphere		
COURSE TEACHER/TEACHERS: Davorka Herak, Associate Professor; Zvezdana Bencetić-Klaić, Assistant professor, Mira Pasarić, Ph.D., Assistant		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4		
SEMESTER: 7		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	Teachers: Davorka Herak, Zvezdana Bencetić-Klaić
Exercises	1	Asistent: Mira Pasarić
Seminars		
Laboratory		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding of physical characteristics and processes in the atmosphere, the ocean and in the Earth's interior, knowledge of techniques for measurement and processing of parameters describing the physical state of the Earth, comprehension of relevance of this knowledge for the education related to some important environmental problems (greenhouse effect, climate change, global sea-level rise, protection from earthquakes).		
DESCRIPTION OF THE COURSE: Radiation on Earth. Hydrological cycle. Equation of state for air and seawater. Hydrostatic equilibrium. Adiabatic processes and static stability. Motion of geophysical fluids. Governing equations. Geostrophic and gradient flow. General, secondary and local circulation of the atmosphere. Waves in the sea and tidal oscillations. Structure of the Earth. Seismic waves. Fundamentals of wave theory. Seismicity. Earthquake quantification (magnitude scales, magnitude, intensity, seismic moment, earthquake energy). Earthquakes and plate tectonics. Gravity and the figure of the Earth. Theory of isostasy. Geomagnetism. Geomagnetic elements.		
STUDENT OBLIGATIONS DURING THE COURSE: Lectures, exercises and two colloquia during a semester. Each colloquium is written for 60 minutes and merits 10 points.		
METHODS TO EVALUATE STUDENT PERFORMANCE: The student must earn at least 12 points from the two colloquia in the course of semester.		
EXAMINATION METHODS: Exam consists of a written and an oral part.		
COURSE(s) NEEDED FOR THIS COURSE: Elementary Physics and Mathematics courses		

from the first 2 years.

COMPULSORY LITERATURE:

Shearer, P.M.: Introduction to Seismology, University Press, Cambridge, 1999

Garland, G.D.: Introduction to geophysics, W.B. Saunders Co., Toronto, 1979.

Moran, J. M., Morgan M. D.: Meteorology. McMillan Publ. Company, New York 1989.

Pond, S., Pickard G. L.: Introductory Dynamical Oceanography, Pergamon, Oxford, 1983.

ADDITIONAL READING:

Skoko, D., J. Mokrović: Mohorovičić, Školska knjiga, Zagreb, 1998.

Wells, N.: The Atmosphere and Ocean, Wiley, Chichester, 1997.

COURSE TITLE: Electrodynamics		
COURSE TEACHER/TEACHERS: Prof.dr. Slobodan Brant		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3		
SEMESTER: 6		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	4	teacher
Exercises	2	assistant
Seminars		
Laboratory		
ECTS credits: 8		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</p> <p>The course is designed for understanding the theoretical approach in classical fields of physics and for a better understanding of phenomena in electricity and magnetism.</p>		

DESCRIPTION OF THE COURSE:

1. Electric charge. Coulomb's law. Electric field. Gauss' law. Electric potential.
2. Electric dipol. Multipole expansion of electric potential.
3. Laplace's and Poisson's equations. Boundary conditions.
4. Green functions in electrostatics. Method of images.
5. Electrostatics inside dielectrics. Polarization. Electrostatic energy.
6. Steady currents. Continuity equation. The Lorentz force. Magnetic field. Ampere's law.
7. The vector potential. The Biot-Savart law. Magnetic moment. Magnetic moment vs. angular momentum.
8. Macroscopic magnetostatics. Induction.
9. Maxwell's equations. Systems of units. Wave equation.
10. Electromagnetic waves in nonconducting and conducting media. Polarization of plane waves. Poynting's theorem.
11. Introduction to radiation theory.
12. Special theory of relativity. Lorentz transformation.
13. Four-vectors. Covariance of electrodynamics.

STUDENT OBLIGATIONS DURING THE COURSE:

Course attendance is controled. During exercises students solve problems that illustrate the topics. Three colloquia are offered.

METHODS TO EVALUATE STUDENT PERFORMANCE:

Results of written colouquia and the result of the final examination.

EXAMINATION METHODS:

The final exam consists of the written part (students have to solve four problems) and oral examination. The results of the colouquia are added to the results of the written part.

COURSE(S) NEEDED FOR THIS COURSE:

Physics 1-4, Mathematical analysis, Mathematical methods in physics.

COMPULSORY LITERATURE:

M.H.Nayfeh and M.K.Brussel, Electricity and Magnetism, John Wiley and Sons, New York, 1985.

ADDITIONAL READING:

I.Supek, Teorijska fizika i struktura materije I, Skolska knjiga, Zagreb, 1988.

COURSE TITLE: Statistical Physics		
COURSE TEACHER/TEACHERS: Ivo Batistić		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3		
SEMESTER: 6		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	<i>teacher</i>
Exercises	1	<i>assistant</i>
Seminars		
Laboratory		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To provide a basic understanding of the global properties of many particle systems, (thermodynamics) and their relationship to the system microscopical structure.		
DESCRIPTION OF THE COURSE: <ol style="list-style-type: none"> 1. Introduction to probability theory, combinatorial analysis and distribution functions 2. Molecular collisions, ideal gas pressure 3. Introduction to thermodynamics, the equation of state 4. Laws of thermodynamics, Carnot's circle, engines 5. Basic relation of thermodynamics, systems with variable number of particles 6. Maxwell's distribution function 7. Configuration space, limits of the classical statistical physics 8. Stirling's approximation, Boltzmann's distribution function 9. Brown's particle motion, equipartition law, Dalton's law 10. Energy quantisation and the third law of thermodynamics, black body radiation 11. Specific heat of solid bodies, bosons and fermions, Bose-Einstein's distribution function 12. Fermi-Dirac's distribution function, fermionic systems 		
STUDENT OBLIGATIONS DURING THE COURSE: lecture and exercise attendance		

METHODS TO EVALUATE STUDENT PERFORMANCE:
EXAMINATION METHODS: written and oral examination
COURSE(s) NEEDED FOR THIS COURSE: theoretical mechanics and quantum mechanics
COMPULSORY LITERATURE: V. Sips: Uvod u statisticku fiziku (Introduction to statistical physics)
ADDITIONAL READING: Landau and Lifshitz. Statistical physics

COURSE TITLE: Energy and Ecology		
PROPOSED BY: Đuro Miljanić, senior scientist, Ruđer Bošković Institute, Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2		
SEMESTER: 4		
TYPES OF INSTRUCTION	CONTACT HRS PER WEEK	DELIVERED BY
Lectures	2	lecturer
Examples Classes		lecturer
Seminars	1	
ECTS CREDITS:		
COURSE AIMS AND OBJECTIVES: To acquire knowledge on: a) main characteristics of different energy sources; b) physical and technological aspects of their use; c) social, environmental and economical issues connected with meeting present and future energy needs.		
COURSE DESCRIPTION AND SYLLABUS: Work, energy, power. Primary energy sources: their main characteristics, reserves, production and consumption in Croatia and the world. Energy conversion: basics, processes, devices, engines, plants. Transmission, transport and storage of different forms of energy. Energy and society: impacts on human health and environment, economy, sustainable development.		
TEACHING AND ASSESSMENT METHODS:		
PREREQUISITES: Physics and mathematics courses – prerequisites for the third year of study.		
READING LIST: 1. B. Udovičić: Energetika, Školska knjiga, Zagreb, 1993 2. V. Knapp: Novi izvori energije I, Školska knjiga, Zagreb, 1993. 3. P. Kulišić: Novi izvori energije II., Školska knjiga, Zagreb, 1991.		
ADDITIONAL READING:		
<ol style="list-style-type: none"> 1. Obnovljivi izvori energije (ed. B. Labudović), Energetika Marketing, Zagreb, 2002. 2. Energy Systems and Sustainability: Power for a Sustainable Future (ed. G. Boyle, B. Everett and J. Ramage), Oxford University Press, Oxford, 2003. 3. Renewable Energy: Power for a Sustainable Future (ed. G. Boyle), Oxford University Press, Oxford, 2004. 		

COURSE TITLE: Physics and Philosophy		
COURSE TEACHER/TEACHERS: Tihomir Vukelja, Ph.D.		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3		
SEMESTER: 6		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	teacher
Exercises	0	
Seminars	1	assistant
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: <p>The objective of the course is to encourage students to ponder about physics, to help them in placing their own profession within a wider historical, philosophical, cultural and social context, and to teach them how to enrich teaching and make it more interesting by pointing to the philosophical problems that physics raises. The course presents physics, as a human activity, and the physical knowledge, as a product of that activity, as a philosophical problem, i.e. as a subject of a philosophical investigation. The accent is on the two points of this investigation: on the problem of the nature of physics and justification of the physical knowledge (philosophy of science: what physics and science in general are?) and on the problem of the worldview shaped on the basis of physical theories (philosophy of physics: what kind of a worldview physics offers?). The course offers an overview of the basic philosophical problems of physics and some of its solutions. Problems and solutions are intended to be presented in a form suitable for pupils, in order to use acquired knowledge in teaching.</p>		
DESCRIPTION OF THE COURSE: <p>Week 1: Introduction. Different aspects of the interconnectedness between physics and philosophy. Modern physics as a philosophical problem: the philosophy of science and the philosophy of physics.</p> <p>Part one: Philosophy of science</p> <p>Week 2: Rationalism and empiricism. Inductive account of physical knowledge. Logical positivism.</p> <p>Week 3: Popper and falsificationism. Duhem – Quine thesis.</p> <p>Week 4: Kuhn: paradigms and scientific revolutions. Social constructivism.</p> <p>Week 5: Lakatos: research programmes. Feyerabend and scientific method.</p>		

Week 6: The nature of laws and explanation in physics. The philosophy of experiment.

Week 7: Realism and instrumentalism.

Part two: Philosophy of physics

Week 8: Space and time. Space-time. Dynamical laws and symmetries.

Week 9: The ontology of classical physics: particles and fields. Determinism. The nature of classical physics. Modern physics and the ideal of divine knowledge.

Week 10: Probability, thermodynamics and statistical mechanics. Irreversibility. Introduction to the philosophy of quantum mechanics: the double slit thought experiment and real experiments (electrons, neutrons, atoms, the *welcher Weg* experiment).

Week 11: Dual nature of light: the existence of photons and the delayed-choice experiment. Stationary states and quantum beats. The discussion about experiments: experiential, theoretical, and interpretational level.

Week 12: Different interpretations of quantum mechanics: quantum realism, Copenhagen interpretation, epistemic interpretation, ontological interpretation (Bohm and hidden variables), statistical interpretation, quantum logic. Various interpretations of the uncertainty relations.

Week 13: Measurement problem and some solutions (modifications of quantum mechanical formalism, many worlds and many minds, decoherence by environment, decoherent histories...).

Week 14: EPR dilemma, Bell's inequality and experiments. Nonseparability of the quantum phenomenon. Quantum mechanics, classical physics and the antic natural philosophy: relationship, similarities and differences.

METHODS TO EVALUATE STUDENT PERFORMANCE:

Classes are organized in lectures (2 hours per week) and seminars (1 hour per week). The intention is to use lectures for the active debate and students' questions regarding the course topics in maximum degree. Students are therefore obliged to prepare beforehand readings for the lectures. In seminars students present their essays accompanying lectures, in which particular lecture topics are elaborated and commented in more details. Essays are prepared individually or in a group (depending on the number of students). After 7th and 14th week, an obliged written preliminary exam is expected, by which the knowledge of the first and the second part of the lectures (Philosophy of science and Philosophy of physics, respectively) should be evaluated.

STUDENT OBLIGATIONS DURING THE COURSE:

Student is obliged to complete an essay and to pass preliminary exams.

EXAMINATION METHODS:

The exam is oral, in the form of an individual conversation with a student. The accent of the exam is on checking student's abilities to apply the acquired knowledge in physics teaching. A student is evaluated on the basis of the knowledge demonstrated at the exam, grades of the preliminary exams and grade of the essay.

COURSE(S) NEEDED FOR THIS COURSE:

COMPULSORY LITERATURE:

S. Lelas i T. Vukelja, *Filozofija znanosti*, Školska knjiga, Zagreb, 1996.

L. Sklar, *Philosophy of Physics*, Westview Press, Boulder, 1992.

The main studying aid for preparing the preliminary and final exam(s) would be lecture notes, available at the URL pages of the Department.

ADDITIONAL READING:

A. F. Chalmers, *What is this thing called Science?*, third edition, Open University Press, Buckingham, 1999.

M. Curd i J. A. Cover, *Philosophy of Science: The Central Issues*, W. W. Norton & Comp., 1998.

J. Lelas, *Teorije razvoja znanosti*, ArTresor, Zagreb, 2000.

R. Torretti, *The Philosophy of Physics*, Cambridge University Press, Cambridge, 1999.

J. T. Cushing, *Philosophical Concepts in Physics: The Historical Relation between Philosophy and Scientific Theories*, Cambridge University Press, Cambridge, 1998.

G. Greenstein i A. G. Zajonc, *The Quantum Challenge*, Jones and Bartlett Publishers, Boston, 1997.

COURSE TITLE: Educational Psychology		
COURSE TEACHER/TEACHERS: Dr. sc. Nikola Pastuović, redoviti profesor Učiteljska akademija Sveučilišta u Zagrebu		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4		
SEMESTER:		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	4	teacher
Exercises	2	teacher and assistant
Seminars		
Laboratory		
ECTS credits: 8		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The understanding of scientific concepts about the structure of personality, about the individual differences regarding abilities and non-cognitive dimensions of the personality, understanding the role of heredity and the environment in the development of individual differences, understanding the consequences of individual differences regarding the education with a special emphasis on the educating of people with special needs (handicapped students and talented students).		
DESCRIPTION OF THE COURSE:		
<ul style="list-style-type: none"> • The subject-matter and the development of Educational Psychology • The Concept of Personality and ways of researching personality • The Humanistic approach in Personality Psychology • The Personality Structure • Individual differences and measuring standards • Heredity and the environment in the genesis of individual differences • The Educational consequences of individual differences in intellectual abilities • The Educational consequences of individual differences in conative characteristics • The Development of moral conscience and the theories of moral development • School and Moral development 		

STUDENT OBLIGATIONS DURING THE COURSE: Students need to successfully carry out all the tasks, regularly attend classes and actively participate during classes.	
METHODS TO EVALUATE STUDENT PERFORMANCE:	The course realization is conducted through lectures, discussions and independent reading. Assessment is checked during the semester by writing a term paper and solving objective tasks
EXAMINATION METHODS: The exam is oral	
COURSE(S) NEEDED FOR THIS COURSE: There are no special enrolment conditions.	
COMPULSORY LITERATURE: Pastuović, N. (1997). Osnove psihologije obrazovanja i odgoja. Zagreb: Znamen	
ADDITIONAL READING: Fulgosi, A. (1983). Psihologija ličnosti. Zagreb: Školska knjiga Grgin, T. (1997). Edukacijska psihologija. Jastrebarsko: Naklada Slap Pastuović, N. (1999). Edukologija. Zagreb: Znamen Raboteg-Šarić, Z. (1995). Psihologija altruizma. Zagreb: Alinea Žužul, M. (1989). Agresivno ponašanje. Zagreb: Radna zajednica Republičke konferencije saveza socijalističke omladine hrvatske.	

COURSE TITLE: Fundamentals of Solid State Physics		
COURSE TEACHER/TEACHERS: Ivo Batistić		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4		
SEMESTER: 7		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	<i>teacher</i>
Exercises	1	<i>assistant</i>
Seminars		
Laboratory		
ECTS credits: 6		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Basic concepts of the solid state physics: crystal structure, elasticity, magnetism, thermal and transport properties		
DESCRIPTION OF THE COURSE: <ol style="list-style-type: none"> 1. Crystal structure 2. Atomic bonding 3. Lattice dynamics – phonons 4. Lattice dynamics – thermal properties 5. Metals – Sommerfeld’s model 6. Metals – electron band structure 7. Transport properties – electrical and thermal conductivity, Hall’s effect 8. Transport properties – conductivity of metal and alloys 9. Semiconductors 10. Magnetic properties – paramagnetism and diamagnetism 11. Magnetic properties of metals and ferromagnetism 12. Superconductivity 		
STUDENT OBLIGATIONS DURING THE COURSE: lecture and exercise attendance		
METHODS TO EVALUATE STUDENT PERFORMANCE: problem solving		

EXAMINATION METHODS: written and oral examination

COURSE(s) NEEDED FOR THIS COURSE: Statistical physics and quantum mechanics

COMPULSORY LITERATURE: V. Sips: Uvod u fiziku cvrstog stanja
(Introduction to solid state physics)

ADDITIONAL READING: Charles Kittel: Introduction to Solid State Physics

COURSE TITLE: Laboratory in Physics Education 1 and 2		
COURSE TEACHER/TEACHERS: P.Pećina, M.Planinić, A. Sušac		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4		
SEMESTER: 7 and 8		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures		
Laboratory	4 4	<i>assistant</i>
Seminars		
ECTS credits: 6		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The main aim is to develop competence in preparing, performing, analyzing and discussing experiments in classroom. Students are trained to do experiments which keep pupils actively engaged in thinking and learning, while they are provided with enough guidance and feedback to ensure a sound basis for their subsequent work in school.</p>		
<p>DESCRIPTION OF THE COURSE:</p> <p>1.Introductory discussion about work in laboratory and role of experiment in physics teaching</p> <p>2. Concepts and models-initial test and discussion</p> <p>3.-7. Lab exercise in rotation</p> <p>1.1 The molecular kinetic theory</p> <p>1.2 Laws of motion</p> <p>1.3 Mechanics</p> <p>1.4 Simple electrical circuits</p> <p>1.5 Geometrical optics</p> <p>8. Conceptual test and discussion</p> <p>9-13 Lab exercise in rotation</p> <p>2.1 Waves</p> <p>2.2 Electromagnetic induction</p> <p>2.3 Pressure in fluids and gases</p> <p>2.4 Basic laws of D.C. current</p> <p>2.5 Physical optics</p> <p>14. Conceptual test and discussion</p> <p>15. Overview</p> <p>II semester</p> <p>1. Demonstration of some “nice” experiments</p> <p>2. Concepts and models-initial test and discussion</p>		

3.-7. Lab exercise in rotation

3.1 Law of conservation of energy

3.2 Heat

3.3 Radioactivity

3.4 Resistance in A.C. circuits

3.5 Atomic physics

8. Conceptual test and discussion

9-13 Lab exercise in rotation

4.1 Harmonic oscillations

4.2 Gas laws

4.3 Conservation of momentum

4.4 Experiments with computer

4.5 Waves and light

14 Conceptual test and discussion

15 Overview

STUDENT OBLIGATIONS DURING THE COURSE: Students are performing a set of experiments and discussing both physical concepts and ways of presenting that experiment in classroom.

METHODS TO EVALUATE STUDENT PERFORMANCE: During each session student is asked to solve some simple problems. There is an initial test, small colloquium for each session and two conceptual tests. Results of all these are discussed with each student separately.

EXAMINATION METHODS: Student prepares, does and interprets 3 experiments and the role of these experiments in teaching physics.

COURSE(S) NEEDED FOR THIS COURSE: General Physics 1,2,3,4 , Psychology and Pedagogy

COMPULSORY LITERATURE: Vernić-Mikuličić, Vježbe iz fizike, Školska knjiga, Zagreb, 1998.

<http://www.phy.hr/~ana/praktikum.htm>

ADDITIONAL READING: Textbooks for physics, primary, elementary and second school level.

COURSE TITLE: Didactics		
COURSE TEACHER/TEACHERS: assistant professor Vlatka Domović, Ph.D Učiteljska akademija Sveučilišta u Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	4	teacher
Exercises		
Seminars		
Laboratory		
ECTS credits: 4		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</p> <p>The course should qualify students for orientating themselves in the school/educational context, understanding the goals and tasks of modern education and making it possible to understand the theoretical/scientific notions in the area of the curriculum theory. During their work students will gain practical skills necessary for participating in the development, creation, implementation and evaluation of the curriculum.</p>		
<p>DESCRIPTION OF THE COURSE:</p> <ul style="list-style-type: none"> • The historical development of school and the didactic idea • The subject-matter and tasks of didactics and the relation between didactics and other educational sciences. • Fundamental didactic concepts • The organization and goals of « the traditional school» and the modern concept of the development of schools • The concept of life-long education/learning • The curriculum theory • The establishment of educational needs and defining the educational goals • The content of learning and educational system • The educational programme –the criteria of choice, organization, scope, depth, order. • Learning conditions • The inner and outer learning conditions. Teaching, organizational processes, 		

school and class environment, classroom management.

- **Evaluation of the curriculum**
- **The evaluation of teacher's work**
- **The evaluation and improvement of one's own work. Self-evaluation techniques.**

STUDENT OBLIGATIONS DURING THE COURSE: Students must attend lectures, prepare for each topic by reading the proposed literature.

METHODS TO EVALUATE STUDENT PERFORMANCE:

The course realization will be conducted through lectures and seminars. Students must attend classes, prepare for each topic by completing their independent reading. During the course realization students must also attend seminars and prepare for these seminars according to the course leader's instructions.

EXAMINATION METHODS:

The exam is oral.

COURSE(S) NEEDED FOR THIS COURSE: There are no special enrolment conditions

COMPULSORY LITERATURE:

1. **Erickson, H. L. (2002). Concept – Based Curriculum and Instruction. California, USA: Corwin Press, INC.**
2. **Ornstein, A. C. and Hunkins, F. P. (2004). Curriculum – Foundations, Principles, and Issues. USA: Allyn and Bacon.**
3. **Pastuović, N. (1999). Edukologija. Zagreb. Znamen**
4. **Terhart, E. (2001). Metode poučavanja i učenja. Zagreb. Educa.**

ADDITIONAL READING:

1. **Bežen, A. (ur). (2004). Temeljne edukacijske znanosti i metodike nastave. Zagreb: AOZH i Profil.**
2. **Bognar, L. i Matijević, M. (2002). Didaktika. Zagreb: Školska knjiga.**
3. **Domović, V. (2004). Školsko ozračje i učinkovitost škole. Jastrebarsko: Naklada Slap.**
4. **Jelavić, F. (1998). Didaktika. Jastrebarsko: Naklada Slap.**

COURSE TITLE: General Pedagogy		
COURSE TEACHER/TEACHERS: Dr. sc. Marija Bratanić, red. prof. Učiteljska akademija Sveučilišta u Zagrebu		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 1		
SEMESTER: 2		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	4	teacher
Exercises		
Seminars		
Laboratory		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The goal of the course is to introduce students to the development of educational activities and the pedagogical idea in the history of mankind as a referential framework for understanding contemporary educational problems. Starting from experiencing the educational proces and developing the scientific notion of education and their mutual connection and how they are conditioned. Raising awareness of the connection between society and the process of education and becoming aware of the role of education in the development of human society and every individual. Master the ideas that will develop abilities and skills for establishing of human relations and a more successful communication as a basis f competence. Master the basis of pedagogical methodology and statistics for the indepedent studying of educational activities with the intention of promoting them. Enabling the students to observe and solve contemporary problems in education so that students will, as future educators and teachers of various subjects, be able to face the the challenges.		
DESCRIPTION OF THE COURSE: <ul style="list-style-type: none"> • Education - fundamental notions. • Education - the goals, norms and values. • The division and tendencies in pedagogy as a science about education. • Education and society. • Education and the development of personality. 		

- **Education and interpersonal relations.**
- **Developmental educational activities in the history of mankind.**
- **The development of pedagogical ideas.**
- **The research of education.**
- **Modern demands of pedagogy as science and as a activity.**

STUDENT OBLIGATIONS DURING THE COURSE:

Students need to successfully carry out all the tasks, regularly attend classes and actively participate during classes.

METHODS TO EVALUATE STUDENT PERFORMANCE:

The course is organized in form of dialogue and lectures. Contemporary methods of work will be used during the seminars. These methods will activate and stimulate the development of their abilities and skills for educational activities. The students will also keep a diary (not compulsory), but they will have to create portfolio in order to follow the work in class and the efficiency of the independent study work. At the end of the semester the way in which the students will take the exam depend on the results of the students' efficiency during the semester. Working with students is based on the paradigm directed towards the students.

EXAMINATION METHODS:

The exam is oral.

COURSE(S) NEEDED FOR THIS COURSE: There are no special enrolment conditions.

COMPULSORY LITERATURE:

Bratanić, M. (1993). Mikropedagogija. Interakcijsko - komunikacijski aspekt odgoja. Zagreb: Školska knjiga.

Delors, J.(1998). Učenje - blago u nama. Zagreb: Educa, Zagreb.

Giesecke, H. (1993). Uvod u pedagogiju. Zagreb: Educa.

Gudjons H. (1994). Pedagogija - temeljna znanja. Zagreb: Educa.

Mijatović, A. (ur.) (1999). Osnove suvremene pedagogije. Zagreb, HPKZ.

Pastuović, N.(1999). Edukologija. Zagreb: Znamen.

ADDITIONAL READING:

Brajša, P. (1993). Pedagoška komunikologija. Zagreb: Školske novine.

Bratanić, M. (2002). Paradoks odgoja. Zagreb: Hrvatska sveučilišna naklada.

Legrand, L.(1995). Moralna izobrazba danas: ima li to smisla? Zagreb: Educa.

Lesourne, J.: Obrazovanje & društvo. Izazovi 2000 godine. Educa, Zagreb, 1993.

COURSE TITLE: Fundamentals of Electronics		
COURSE TEACHER/TEACHERS: Prof. Damir Veža		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4		
SEMESTER: 8		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	teacher
Exercises	1	assistant
Seminars		
Lab		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding basics of Electronics		
DESCRIPTION OF THE COURSE:		
Lectures: 1.Cathode ray tube. 2.Semiconductors. Semiconductor diode. 3.Transistors. 4.Methods of circuit analysis. 5.Single stage amplifier and follower. 6.Multistage and feedback amplifiers. 7.Differential amplifier. 8. Operational amplifier. 9. Basic logic gates. 10.Booleen algebra and logic circuits. 11.Fundamentals of optoelectronics. 12.Photodiode and light emitting diode. 13.Laser diode.		
Exercises: Supplementary material to lectures: solving problems in electronics.		
Demo-Lab: Supplementary material – practical examples: 1.CRT Osci. 2.Diode and transistor. 3.Application of PC s in physics demonstrations (using transducers and sensors). 4.Optoelectronic elements.		
STUDENT OBLIGATIONS DURING THE COURSE: Attendance to lectures, homeworks		
METHODS TO EVALUATE STUDENT PERFORMANCE: Homeworks and written exams		
EXAMINATION METHODS: evaluation of homeworks and an exam at the end of the semester		
COURSE(S) NEEDED FOR THIS COURSE: Electricity and magnetism course		
COMPULSORY LITERATURE:		
C.L.Hemenway, R.W.Henry, M.Caulton, <i>Physical Electronics</i>, John Wiley & Sons Inc. 1967. P. Biljanović, <i>Elektronički sklopovi</i>, Školska knjiga, Zagreb 1999.		

ADDITIONAL READING: J.Millman, A.Grabel, *Microelectronics*, McGraw-Hill, New York 1988.

COURSE TITLE: Fundamentals of Atomic and Molecular Physics		
COURSE TEACHER/TEACHERS: Prof. Damir Veža		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY:		
SEMESTER:		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	teacher
Exercises	1	assistant
Seminars		
Lab		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding basics of AMO Physics		
DESCRIPTION OF THE COURSE: 1.Atomic energy levels 2.Molecular energy levels 3.Spectra of alkali atoms and molecules 4.Emission and absorption of radiation 5. Ionized gases and plasma 6. Atomic collision processes in gases and plasmas 7.Classical spectroscopy (basic methods and devices) 8.Laser spectroscopy (basic methods and devices) 9. Spectra of ionized gases and plasmas and elementary plasma diagnostics 10.Selected examples of AMO applications in medicine, environmental science and communications 11.Contemporary developments in fundamental research in the AMOP Exercises: Complementary material to lectures. Solving problems in atomic and molecular physics.		
STUDENT OBLIGATIONS DURING THE COURSE: Attendance to lectures, homeworks		
METHODS TO EVALUATE STUDENT PERFORMANCE: Homeworks and written exams		
EXAMINATION METHODS: evaluation of homeworks and an exam at the end of the semester		
COURSE(S) NEEDED FOR THIS COURSE: Quantum physics		
COMPULSORY LITERATURE: A.P.Thorne, U. Litzen, S, Johansson, <i>Spectrophysics</i> , Springer Verlag, Berlin 1999.		
ADDITIONAL READING: C. W. Bradley,O. A. Dale, <i>An introduction to modern stellar astrophysics</i> , Addison-Wesley, 1996.		

F.F. Chen, *Introduction to Plasma Physics*, New York, 1974.

COURSE TITLE: Physics of Disordered Systems		
COURSE TEACHER/TEACHERS: Dr.sc. Krešo Zadro,		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4		
SEMESTER: 8		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	teacher
Exercises		
Seminars	1	teacher
Laboratory		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:		
DESCRIPTION OF THE COURSE: Order – disorder: ordering rules, order parameters Glasses: insulating, metallic and spin glasses, neural networks. Fractals: fractal dimension, fractal patterns in nature, random walk and fractals. Percolation: percolation threshold, correlation length, phenomena on percolation networks.		
STUDENT OBLIGATIONS DURING THE COURSE: lectures attendance		
METHODS TO EVALUATE STUDENT PERFORMANCE: student projects		
EXAMINATION METHODS: oral examination		
COURSE(s) NEEDED FOR THIS COURSE:		
COMPULSORY LITERATURE: 1. N.E. Cusak, The Physics of Structurally Disordered Matter, Adam Higler, Bristol, 1988. 2. A. Bunde, S.Havlin , Eds., Fractala and Disordered Systems, Springer, Berlin, 1996., 3. D. Stauffer, A. Aharony, Introduction to Percolation Theory, Taylor& Francis, London, 1992.		
ADDITIONAL READING:		

COURSE TITLE: Teaching Methods in Physics 1		
COURSE TEACHER/TEACHERS: Prof.dr.sc. Rudolf Krsnik, Mr. sc. Maja Planinić, PMF, Zagreb Dipl.inž. Planinka Pećina, PMF, Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4		
SEMESTER: 7		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	teacher
Exercises		
Seminars	2	teacher, assistant
Laboratory		
ECTS credits:		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Development of interactive teaching skills in prospective physics teachers. Deepening of conceptual understanding of basic physics concepts with emphasis on their didactical aspects. Acquainting students with results of physics education research and cognitive sciences, and their use in physics teaching.		
DESCRIPTION OF THE COURSE: <ol style="list-style-type: none"> 1. Status and content of physics education. The need for radical changes in the teaching of natural sciences. 2. Important breakthroughs in the recent development of physics teaching. Learning as development of mental structures. Assimilation and accommodation. Results of J. Piaget and physics teaching. 3. Stages of cognitive development. Development of formal thinking and procedural knowledge. Application to physics teaching.. 4. Concepts in physics and students' alternative conceptions. The importance of eliciting students' alternative conceptions. 5. Examples of students' alternative conceptions. 6. Constructivist approach to physics teaching (educational constructivism). 		

7. Problem - oriented teaching. Conceptual change. Cognitive conflict, concept substitution, bridging analogies.
8. Types of knowledge. Declarative and procedural knowledge. The ways of physics development and their consequences on teaching.
9. Observation, experiment, physics law.
10. Models and theories in physics teaching.
11. Historical overview of some larger projects in physics teaching in the world (PSSC, PPC, Nuffield, Project 2061, NSSE). Scientific literacy. World educational standards.
12. Organization of teaching on constructivist basis.
13. Methods and results of physics education research. Test design.
14. **Role of experiments in physics teaching. Use of computers in physics teaching.**
15. **Physics curriculum for elementary schools, secondary schools and gymnasia.**

The topics listed above are also discussed in seminar, where students give their talks.

STUDENT OBLIGATIONS DURING THE COURSE: Regular attendance (at least 70 %), active participation in discussions, giving at least one talk in seminar.

METHODS TO EVALUATE STUDENT PERFORMANCE: Students' talks in seminar, tests that probe students' alternative conceptions and procedural knowledge.

EXAMINATION METHODS: Oral exam. Student's final grade is influenced by the quality of their seminar talks and the level of their participation in discussions.

COURSE(S) NEEDED FOR THIS COURSE: General physics 1-4, Laboratory in physics education

COMPULSORY LITERATURE:

R. Krsnik, Ideje suvremene metodike fizike, in print

G. Šindler, Metodološke osnove oblikovanja početne nastave fizike, Školska knjiga, Zagreb, 1980

A. B. Arons, Teaching Introductory Physics, John Wiley & Sons, Inc., New York, 1996

ADDITIONAL READING:

Proceedings of Croatian symposia on physics teaching, HFD, (biannually since 1993)

L. C. McDermott & P. Shaffer, Tutorials in Introductory Physics, Prentice Hall, Inc., 2002

L. C. McDermott, Physics by Inquiry, John Wiley & Sons, Inc., New York, 1996

A. E. Lawson, Science Teaching and Development of Thinking, Thomson Learning, London, 2002

L. Viennot, Reasoning in Physics: The Part of Common Sense, Kluwer Academic Publishers, Dordrecht, 2001

R. A. Duschl & R. J. Hamilton (eds.), Philosophy of Science, Cognitive Psychology, and Educational Theory and Practice, State University of New York Press, Albany, 1992.

COURSE TITLE: Teaching Methods in Physics 2		
COURSE TEACHER/TEACHERS: <p style="text-align: center;">Prof.dr.sc. Rudolf Krsnik, PMF, Zagreb Mr. sc. Maja Planinić, PMF, Zagreb Dipl.inž. Planinka Pećina, PMF, Zagreb</p>		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4		
SEMESTER: 8		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	teacher
Exercises		
Seminars	2	teacher, assistant
Laboratory		
ECTS credits:		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Development of interactive teaching skills in prospective physics teachers. Deepening of conceptual understanding of basic physics concepts with emphasis on their didactical aspects. Acquainting students with results of physics education research and cognitive sciences, and their use in physics teaching.		
DESCRIPTION OF THE COURSE: In this semester selected physics topics are treated from educational point of view, through application of educational principles that were introduced in the previous semester and with emphasis on important role of experiments in teaching. <ol style="list-style-type: none"> 16. Newton's laws. Force. Comparison with Aristotelian views on force and motion. 17. Passive forces: elastic force, string tension, normal force, friction. 18. Circular motion. Centripetal force. Noninertial reference frames. Inertial forces. 19. Energy. Conservation laws. 20. Geocentric and heliocentric system: historical development of ideas. Kepler's laws. Newton's law of gravitation. 21. Ideal gas laws. Kinetic model of gas. Particulate nature of matter. 22. First and second law of thermodynamics. 23. Electric charge, electric force. Electric field. Potential. 24. Simple DC circuits. 		

25. Magnetic phenomena. Lorentz force. Electromagnetic induction.
26. Harmonic oscillations. Waves in elastic medium. Electromagnetic waves.
27. Laws of geometrical optics. Diffraction and interference of light.
28. Continuous and line spectra. Models of atom. Development of ideas about atomic nucleus.
29. Basic principles of quantum mechanics.
30. **Elementary particles. Big Bang theory.**

The topics listed above are also discussed in seminar, where students give their talks.

STUDENT OBLIGATIONS DURING THE COURSE: Regular attendance (at least 70 %), active participation in discussions, giving at least one talk in seminar.

METHODS TO EVALUATE STUDENT PERFORMANCE: Students' talks in seminar, tests that probe students' alternative conceptions and procedural knowledge.

EXAMINATION METHODS: Oral exam. Student's final grade is influenced by the quality of their seminar talks and the level of their participation in discussions.

COURSE(S) NEEDED FOR THIS COURSE: General physics 1-4, Laboratory in physics education

COMPULSORY LITERATURE:

R. Krsnik, Ideje suvremene metodike fizike, in print

G. Šindler, Metodološke osnove oblikovanja početne nastave fizike, Školska knjiga, Zagreb, 1980

A. B. Arons, Teaching Introductory Physics, John Wiley & Sons, Inc., New York, 1996

ADDITIONAL READING:

Proceedings of Croatian symposia on physics teaching, HFD, (biannually since 1993)

L. C. McDermott & P. Shaffer, Tutorials in Introductory Physics, Prentice Hall, Inc., 2002

L. C. McDermott, Physics by Inquiry, John Wiley & Sons, Inc., New York, 1996

A. E. Lawson, Science Teaching and Development of Thinking, Thomson Learning, London, 2002

L. Viennot, Reasoning in Physics: The Part of Common Sense, Kluwer Academic Publishers, Dordrecht, 2001

R. A. Duschl & R. J. Hamilton (eds.), Philosophy of Science, Cognitive Psychology, and Educational Theory and Practice, State University of New York Press, Albany, 1992.

COURSE TITLE: Teaching Practice in Physics		
COURSE TEACHER/TEACHERS: <p style="text-align: center;">Dr. Rudolf Krsnik, PMF, University of Zagreb Maja Planinić, PMF, University of Zagreb Planinka Pećina, PMF, University of Zagreb</p>		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 5		
SEMESTER: 10		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures		
Exercises		
Seminars	4	Teacher, assistant, teacher – mentor at school
Laboratory		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Development and evaluation of interactive teaching skills in prospective physics teachers.		
DESCRIPTION OF THE COURSE: Students attend at least 10 lessons of chosen teachers – mentors at elementary schools and/or gymnasia. Afterwards they prepare themselves for teaching and teach two trial lessons in class. If they are ready, according to mentor's opinion, to teach , they prepare and perform a public lesson. Teacher of physics education course and other students attend the public lesson, and later they all discuss it.		
STUDENT OBLIGATIONS DURING THE COURSE: Attending mentor's lessons at schools, performing trial and public lessons at schools, discussing public lessons of other students.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Assessment of student's public lesson.		
EXAMINATION METHODS: Assessment of student's public lesson.		
COURSE(S) NEEDED FOR THIS COURSE: Physics education, Psychology, Didactics, Pedagogy, Laboratory in physics education		

**COMPULSORY LITERATURE: Physics textbooks for elementary school and gymnasia
chosen by teacher - mentor**

ADDITIONAL READING:

COURSE TITLE: Low temperature physics and superconductivity		
COURSE TEACHER/TEACHERS: Prof. dr. Amir Hamzić		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 5		
SEMESTER: 9		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	teacher
Exercises	1	teacher
Seminars		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Introduction to the methods for the production of low temperatures, unique properties of helium (superfluidity) and basic characteristics and applications of superconductivity		
DESCRIPTION OF THE COURSE: Liquefying principles, helium and nitrogen liquefiers; Work with cryogenic liquids (cryostats, thermal losses); Low temperature thermometry, Properties of He⁴ and He³ (superfluidity); Temperatures below 1 K (He³ cryostat, He³- He⁴ dilution cryostat); Superconductivity (basic properties – ideal conductivity and Meissner effect); Characteristics of low- and high-temperature superconductors; London theory, thermodynamical properties; Main results of Ginzburg-Landau i Bardeen-Cooper-Schrieffer models; Large- and small-scale application of classic and high-temperature superconductivity (research, industry, medicine, power, transport).		
STUDENT OBLIGATIONS DURING THE COURSE: (written and exposed) reports on given subjects, active participation in the low-temperature laboratory		
METHODS TO EVALUATE STUDENT PERFORMANCE: submitted reports		
EXAMINATION METHODS: oral exam		
COURSE(s) NEEDED FOR THIS COURSE: solid state physics, statistical physics		
COMPULSORY LITERATURE: D. Tilley, J. Tilley, Superfluidity and Superconductivity, IOP Publishing Ltd., 1990. M. Cyrot, D. Pavuna: Introduction To Superconductivity and High Tc Materials, World Scientific Publishing Co., Singapore, 1992.		
ADDITIONAL READING:		

COURSE TITLE: Physics of Nanomaterials		
COURSE TEACHER/TEACHERS: professor dr. sc. Antun Tonejc		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 5		
SEMESTER: 9		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures	2	teacher
Exercises		
Seminars	1	teacher
Laboratory		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To provide a students with basic concepts of physics of nanomaterials, using experimental facts and theoretical models.		
<p>DESCRIPTION OF THE COURSE:</p> <ol style="list-style-type: none"> 1. Crystal structure of monocrystals, polycrystals, quasicrystals, nanocrystals and nanoglasses. 2. Point defects and dislocations 3. Diffusion in crystalline and i nanocrystalline materials 4. Physical methods for nanomaterials characterisation 5. Phase diagrams 6. Structure of metals, solid solutions, intermetallic compounds and glassy materials 7. Diffusive and nondiffusive phase transformations 8. Metastable state of materials 9. Metastable micro- and nanostructures 10. Mechanical properties of micro- and nanocrystals 12. Magnetic properties of micro- and nanocrystals 13. Nanotubes 13. Nanocrystals as new materials for applications 		
STUDENT OBLIGATIONS DURING THE COURSE: Students have to attend lectures and give one seminar of a selected topic (40 minutes long seminar). Students have to work out homeworks and colloquia.		

METHODS TO EVALUATE STUDENT PERFORMANCE: **Regular attendance of lectures and exercises. Reasonable good presentation of the seminar.**

EXAMINATION METHODS: **no exam**

COURSE(s) NEEDED FOR THIS COURSE: Solid State physics

COMPULSORY LITERATURE:

R. W. Cahn, P. Haasen, Physical Metallurgy, Vol. I-III, North-Holland, Amsterdam 1996.

J. I. Gersten, F. W. Smith, The Physics and Chemistry of Materials, Yohn Wiley&Sons, New York, 2001

ADDITIONAL READING:

W. D. Callister, Materials Science and Engineering, Yohn Wiley&Sons, New York, 2003

A. R. West, Basic Solid State Chemistry, Yohn Wiley&Sons, New York, 1999

COURSE TITLE: Laboratory in Fundamentals of Electronics		
COURSE TEACHER/TEACHERS: Prof. dr.sc. Amir Hamzić, Dr.sc. Mario Basletić		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 5		
SEMESTER: 9		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (<i>teacher or assistant</i>)
Lectures		
Exercises		
Seminars		
Laboratory exercises	3	<i>teacher and assistant</i>
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Assembling, measurements and analysis of basic electronic circuits and simple devices using discrete and integrated elements.		
DESCRIPTION OF THE COURSE: FET amplifiers, BJT amplifiers, feedback, circuits with passive elements, operational amplifier, basic logic circuits, digital voltmeter, time-base circuits, voltage stabilization, signal modulation and demodulation		
STUDENT OBLIGATIONS DURING THE COURSE: analysis of measurement, discussion of results, partial exams (colloquy) each week, computer programming of specific physical measurements in real time (on-line experiment)		
METHODS TO EVALUATE STUDENT PERFORMANCE: partial exams (colloquy), homework		
EXAMINATION METHODS: written exam; the final score consists of the results of final written exam, weeks' partial exams, and evaluation of student's skills		
COURSE(s) NEEDED FOR THIS COURSE: Basic electronics		
COMPULSORY LITERATURE: H.M.Jones, A Practical Introduction to Electronic Circuits, Cambridge Univer. Press, 1987. P. Biljanović, Elektronički sklopovi, Školska knjiga, Zagreb 1989. Notices and instruction manuals (for internal use only).		
ADDITIONAL READING:		

COURSE TITLE: General Chemistry		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 1 st		
SEMESTER: 1 st		
LECTURER: Branko Kaitner, Professor		
CAN THE COURSE BE TAUGHT IN ENGLISH? Yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	4	Lecturer
seminar / exercises	3	Assistant
laboratory work	0	-
ECTS credits: 8		
COURSE OBJECTIVES: The main scope of the course is the improvement of the knowledge acquired in the elementary and high school education. Some additional specific lectures, that are not thought during the high school education, will ensure the knowledge necessary in understanding the special – inorganic, organic, analytical and physical chemistry, and biochemistry courses.		
COURSE CONTENT: Composition of the matter. Important chemical observations, Dalton's atomic theory, the atomic structure, chemical calculus, the main types of chemical reactions. The gas laws, thermochemistry, quantum theory and electron configuration, chemical periodicity. Chemical bond, structure of the molecules, theory of covalent bonding, intermolecular attractive forces, liquids, solids, phase change, mixtures. Chemical kinetics and equilibrium, the reach of the chemical reaction, acid-base equilibrium, solubility. The elements of thermodynamics, electrochemistry, the chemical elements in the nature and industry.		
EXPECTED COMPETENCES TO BE ACQUIRED: See 'Course objectives', please.		
STUDENT OBLIGATIONS: Attending to the lectures and seminar (chemical calculus) regularly.		
TERMS FOR RECEIVING A SIGNATURE: See the 'Student obligations', please.		
MODES OF LECTURING: Oral lectures followed by animated LCD projection.		
STUDENT ASSESSMENT: The knowledge of chemical calculus and separately the knowledge of the general chemistry lectured during the semester.		
COURSE QUALITY ASSESSMENT: As a ground, elementary course General chemistry is necessary as an introduction for understanding and attending the specific courses of inorganic, analytical, organic and physical chemistry and biochemistry following in the higher years of education.		

PREREQUISITES FOR THE COURSE: Not necessary.

REQUIRED LITERATURE:

1. I. Filipović, S. Lipanović, Opća i anorganska kemija, 9. izd., Školska knjiga, Zagreb, 1995.
2. D. Grdenić, Molekule i kristali, IV. izd., Školska knjiga, Zagreb, 1989.
3. M. Sikirica, B. Korpar-Čolig, Praktikum iz opće kemije, Školska knjiga, Zagreb, 2001.
4. M. Sikirica, Stehiometrija, XVII. izd., Školska knjiga, Zagreb, 1994.

FURTHER READING:

M.S. Silberberg, Chemistry, McGraw-Hill, 3rd Ed., 2003. Every contemporary textbook of General Chemistry.

COURSE TITLE: GENERAL CHEMISTRY LABORATORY 1		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 1 st		
SEMESTER: 1 st		
LECTURER: Dr. sc. Antonija Hergold-Brundić, associate professor, Faculty of Science, University of Zagreb		
CAN THE COURSE BE TAUGHT IN ENGLISH? yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	0	
seminar / exercises	0	
laboratory work	4	LECTURER, ASSISTANT
ECTS: 3		
COURSE OBJECTIVES:		
Getting acquainted with basic laboratory equipment, apparatus, reagents and work techniques.		
COURSE CONTENT:		
Introduction to the basic laboratory equipment		
Mass measurement and determination of sample density		
Decantation and filtration		
Recrystallization, fractional crystallization		
Distillation, vacuum distillation, sublimation		
Melting and boiling point determination		
Measurement of molar enthalpy of solubilization of a salt		
Preparation of a solution of a given concentration		
Preparation of different gases, purification and drying		
Determination of the molar mass of carbon dioxide		
Determination of the molar mass by the Dumas method		
Reduction of copper(II) oxide by hydrogen		
Determination of the molar and equivalent mass of a metal		
Determination of the formula of silver oxide		

<p>EXPECTED COMPETENCES TO BE ACQUIRED:</p> <p>Knowledge of basic laboratory equipment, apparatus, reagents and techniques.</p>
<p>STUDENT OBLIGATIONS:</p> <p>Preliminary exams before the every exercise, successful realization of the laboratory exercises, the report writing.</p>
<p>TERMS FOR RECEIVING A SIGNATURE:</p> <p>Regular attendance to laboratory exercises and written reports.</p>
<p>MODES OF LECTURING:</p>
<p>STUDENT ASSESSMENT:</p> <p>Preliminary exams before every exercise. Evaluation of student's work in the laboratory is based on his/her practical skills, achievement in preliminary exams and report writing.</p>
<p>COURSE QUALITY ASSESSMENT: Anonymous student evaluation.</p>
<p>PREREQUISITES FOR THE COURSE: none</p>
<p>REQUIRED LITERATURE:</p> <p>M. Sikirica, B. Korpar-Čolig, <i>Praktikum iz opće kemije</i>, 2nd ed., Školska knjiga, Zagreb, Croatia, 2003.</p> <p>I. Filipović, S. Lipanović, <i>Opća i anorganska kemija</i>, 9th ed., Školska knjiga, Zagreb, Croatia, 1995.</p>
<p>FURTHER READING:</p> <p>1. M. Sikirica, <i>Stehiometrija</i>, 19th ed., Školska knjiga, Zagreb, Croatia, 2001.</p>

COURSE TITLE GENERAL CHEMISTRY LABORATORY 2		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY PHYSICS AND CHEMISTRY		
YEAR OF STUDY. 1 st		
SEMESTER 2 nd		
LECTURER Dr. sc. Antonija Hergold-Brundić, associate professor, Faculty of Science, University of Zagreb		
CAN THE COURSE BE TAUGHT IN ENGLISH? yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	0	
seminar / exercises	0	
laboratory work	4	LECTURER, ASSISTANT
ECTS: 3		
COURSE OBJECTIVES: Getting acquainted with the basic chemical reactions, preparation and isolation of reaction products, acquiring experimental skill.		
COURSE CONTENT: Kinetics of chemical reactions: dependence of the rate of chemical reaction on temperature, concentration and catalyst Ion exchange Halogen elements: preparation of chlorine, potassium chlorate, hydrogen chloride Halogen elements: preparation of oxygen and sulfur dioxide, properties of sulfur Compounds of the nitrogen group: preparation of ammonia, nitrogen(I) oxide, nitrogen(II) oxide and nitrogen(IV) oxide Equilibrium of chemical reactions and hydrolysis Electrolysis and galvanic cell Transition elements: preparation of chromic alumin, iron(II) sulfate heptahydrate, tetraamminecopper(II) sulfate monohydrate		
EXPECTED COMPETENCES TO BE ACQUIRED: Knowledge of basic laboratory equipment, apparatus, reagents and techniques.		
STUDENT OBLIGATIONS: Preliminary exams before every exercise, successful realization of laboratory exercises, report		

writing.
TERMS FOR RECEIVING A SIGNATURE: Regular attendance to laboratory exercises and written reports.
MODES OF LECTURING:
STUDENT ASSESSMENT: Preliminary exams before the every exercise. Evaluation of the student work in laboratory is based on his/her practical skills, achivement in preliminary exams and report writing.
COURSE QUALITY ASSESSMENT:
PREREQUISITES FOR THE COURSE: PRAKTIKUM OPĆE KEMIJE 1
REQUIRED LITERATURE: M. Sikirica, B. Korpar-Čolig, <i>Praktikum iz opće kemije</i> , 2 nd ed., Školska knjiga, Zagreb, Croatia, 2003. I. Filipović, S. Lipanović, <i>Opća i anorganska kemija</i>, 9th ed., Školska knjiga, Zagreb, Croatia, 1995.
FURTHER READING: 1. M. Sikirica, <i>Stehiometrija</i> , 19 th ed., Školska knjiga, Zagreb, Croatia, 2001.

COURSE TITLE: ANALYTICAL CHEMISTRY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 1		
SEMESTER: 2		
LECTURER: dr. sc. Astrid GOJMERAC IVŠIĆ, assistant professor; PMF		
CAN THE COURSE BE TAUGHT IN ENGLISH?		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	3	LECTURER
seminar / exercises	2	LECTURER, ASSISTANT
laboratory work	0	
ECTS: 8		
COURSE OBJECTIVES: Introduction with basic principles and application of fundamental and instrumental chemical analysis.		
COURSE CONTENT: Role of Analytical Chemistry in the Science; Chemicals, Apparatus, Basic Operations and Calculations Used in Analytical Chemistry; Chemical Equilibria in Solution Important for Analytical Chemistry (acid-base, complexation, solubility and redox equilibria in solution); Sampling, Decomposing and Dissolving the Sample, Titrimetric Analysis-(theory and application); Principles and Examples of Gravimetric Analysis; Separation Techniques (precipitation, extraction, chromatography, ion exchange); Spectrometric Analytical Methods - principles, instrumentation and applications (UV/VIS , IR , NMR, mass spectrometry);		
EXPECTED COMPETENCES TO BE ACQUIRED: Acquireing fundamental knowledge necessary for understanding and performance classical and instrumental methods of chemical analysis		
STUDENT OBLIGATIONS: Lectures, seminars, seminar work and home works. Two preliminary exams are compulsory during semester. Positive mark of preliminary exams contribute to final exam mark.		
TERMS FOR RECEIVING A SIGNATURE: Performing student's obligations		
MODES OF LECTURING: Lectures, seminars, seminar work and home works		
STUDENT ASSESSMENT: Written and oral exam		
COURSE QUALITY ASSESSMENT: Anonymous opinion poll, Interviews with students		
PREREQUISITES FOR THE COURSE: Analytical Chemistry		

REQUIRED LITERATURE: D.A.Skoog, D.M.West i F.J.Holler, *Osnove analitičke kemije*, Školska knjiga, Zagreb

D.A.Skoog, D.M.West, F.J.Holler, S.R.Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Thomson, Brooks/Cole, Belmont CA, 2004.

FURTHER READING: M. Kaštelan-Macan, *Kemijska analiza u sustavu kvalitete*, Školska knjiga, Zagreb, 2003.

Z.Soljić, *Kvalitativna kemijska analiza anorganskih tvari*, Fakultet kemijskog inženjerstva i tehnologije, Zagreb, 2003.

P.W.Atkins, *Physical Chemistry*, 6th Edition, Oxford University Press, 1998.

COURSE TITLE: INORGANIC CHEMISTRY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2.		
SEMESTER: 3.		
LECTURER NEVEN STRUKAN, assistant professor		
CAN THE COURSE BE TAUGHT IN ENGLISH? Yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	4	Lecturer
seminar / exercises	2	Assistant
laboratory work		
ECTS: 8		
COURSE OBJECTIVES: Introduction to the systematic chemistry of the elements with the emphasize on the structure, bonding, properties and reactivity of the various inorganic substances.		
<p>COURSE CONTENT:</p> <p>Introduction. Origin and stability of the elements and their isotopes. Periodic table. Electronic Structure of the atom. Periodic properties (1. week)</p> <p>Hydrogen. Properties and preparation. Water and hydrogen bonding. Clathrates. Hydrides, electron deficient hydrides.</p> <p>The noble gases, group trends. Ionization energies and electron affinity. Xenon fluorides and oxides. (2. week)</p> <p>The halogens, group trends. Halides, interhalogen compounds and polyhalide ions. VSEPR theory. Oxyacids and oxyanions. (3. week)</p> <p>The group 16 elements, group trends. Oxygen: properties, preparation, allotropes. Oxides. Sulphur: allotropes, catenation. Sulfur halides, oxides and acids. Selenium and tellurium halides.(4. week)</p> <p>The group 15 elements, group trends. Nitrogen: nitrides, nitrogen hydrides, oxides and acids. Phosphorus, allotropes, phosphides, oxides and acids. Phosphates. Halides of group 15 elements. (5. week)</p> <p>The group 14 elements, group trends. Carbon: allotropes, catenation, multiple bonding. Oxides. Silicon:silanes, comparison with carbon chemistry. Silicates, structure and properties. Halides of group 14 elements. (6. week)</p> <p>The group 13 elements, group trends. Boron, borides, boranes, halides. Aluminium, properties and production, halides.</p> <p>Ionic compounds, lattice energy, ionic radii, close packing, mixed oxides. (7. week)</p> <p>Chemistry of zinc, cadmium and mercury.</p>		

<p>The group 1 and 2 elements, group trends. Halides and oxygen compounds, hydroxides. Solutions of the metals in liquid ammonia. Complexation by crowns and cryptates. Organometallic compounds. (8. week)</p> <p>Transition metal complexes. Coordination compounds, coordination polyhedra and number. Nomenclature. Isomerism. Ligands. Crystal field theory, octahedral and tetrahedral complexes, tetragonally distorted octahedral complexes. (9. week)</p> <p>Electronic spectroscopy. Spectrochemical series of ligands. Magnetic properties of transition metal complexes. (10. week)</p> <p>Overview of the transition metals. Elements of the first transition series (Ti – Cu), binary and complex compounds. (11. week)</p> <p>Elements of the second and third transition series: Zr and Hf, Nb and Ta, Mo and W, Tc and Re, platinum metals, binary and complex compounds. (12. week)</p> <p>Scandium, yttrium, lanthanides and actinides. Comparison with transition metals, coordination compounds. Uranium: halides, oxides and hydrides. Extraction of uranium. (13. week)</p> <p>Organometallic compounds. Bioinorganic chemistry. (14. week)</p> <p>Inorganic solid state chemistry. Inorganic materials. (15. week)</p>
<p>EXPECTED COMPETENCES TO BE ACQUIRED: Basic knowledge of inorganic chemistry</p>
<p>STUDENT OBLIGATIONS: Two written examinations during the course, regular attendance of the course and seminar, elaboration of one selected subject during the course.</p>
<p>TERMS FOR RECEIVING A SIGNATURE Regular attendance of the seminar, elaboration of one selected subject during the course.</p>
<p>MODES OF LECTURING: Oral presentation with demonstration experiments.</p>
<p>STUDENT ASSESSMENT: Written and oral examination.</p>
<p>COURSE QUALITY ASSESSMENT:</p>
<p>PREREQUISITES FOR THE COURSE:</p> <p>General Chemistry</p>
<p>REQUIRED LITERATURE:</p> <ol style="list-style-type: none"> 1. I. Filipović, S. Lipanović, <i>Opća i anorganska kemija</i>, 9. Izd., Školska knjiga, Zagreb, 1995. 2. D. Grdenić, <i>Molekule i kristali</i>, 4. izd., Školska knjiga, Zagreb, 1989. 3. F. Albert Cotton, G. Wilkison, P. Gauss, <i>Basic Inorganic Chemistry</i>, 3. izd., John Willey & Sons, New York 1995.
<p>FURTHER READING:</p> <p>1. D. F. Shriver, P. W. Atkins, C. H. Langford, <i>Inorganic Chemistry</i>, 2. izd., Oxford University</p>

Press, Oxford 1998.

2. F. Albert Cotton, G. Wilkison, C. A. Murillo, M. Bochmann, *Advanced Inorganic Chemistry*, 6. izd., John Willey & Sons, New York 1999.

COURSE TITLE PHYSICAL CHEMISTRY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY. 2		
SEMESTER 4		
LECTURER Tomislav CVITAŠ, professor		
CAN THE COURSE BE TAUGHT IN ENGLISH? yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	4	lecturer
seminar / exercises	2	assistant
laboratory work	0	
ECTS: 8		
<p>COURSE OBJECTIVES:</p> <p>Detailed analysis of basic physical chemistry concepts in order to enable students to teach more elementary concepts at school level and to understand molecular structure, equilibria and rates of chemical processes.</p>		
<p>COURSE CONTENT:</p> <p>Introductory overview of physical chemistry. Hydrogen atom. Atomic orbitals. Spin and manyelectron atoms. Atomic spectra. Born-Oppenheimer approximation. Molecular orbitals. Diatomic molecules. Correlation diagram. Hybridization. Hückel molecular orbitals. Electronic structure of crystals. Ligand field theory. Quantum chemistry in schools.</p> <p>Molecular spectra. Absorption, emission and scattering. Molecular rotations. Molecular vibrations. IR spectra. Electronic spectra. Lasers. Photoelectron spectra. Magnetic resonance. NMR. Spectroscopy in schools. Properties of gases. Ideal gas and real gases. Kinetic theory of gases. Distribution of molecular velocities and speeds. Collisions. Statistical mechanics. Boltzmann's law. Thermodynamics and temperature. First law: heat and work. Enthalpy. Extent of reaction and stoichiometry. Reaction enthalpies. Thermochemistry. Calorimetry. Temperature dependence of enthalpy. Adiabatic and isothermal work. Irreversibility and entropy. Probability and entropy. Entropy of mixing. Thermodynamic potentials. Gibbs energy. Fundamental equations. Dependence $G(p)$ and $G(T)$. Phase equilibria. Phase diagrams $p(T)$. Partial molar quantities. Chemical potential. Colligative properties: krioscopy i ebulioscopy. Osmosis. Mixtures. Standard states. Relative activity. Chemical equilibrium. Coupled reactions. Solutions. Electrochemistry. Electrolyte solutions. Conductivity. Electrochemical cells. Nernst equation. Kinetics: definition of concepts. Rate laws. Mechanisms and rates. Temperature dependence of reaction rates. Theories of reaction rates. Catalysis.</p>		

<p>EXPECTED COMPETENCES TO BE ACQUIRED: A deeper understanding of fundamental concepts taught in primary and secondary schools.</p>
<p>STUDENT OBLIGATIONS: Active participation in lectures and seminars. Homework.</p>
<p>TERMS FOR RECEIVING A SIGNATURE: Regular participation in the course.</p>
<p>MODES OF LECTURING: Lectures for the whole audience in larger theatres with PowerPoint presentations and seminars and numerical exercises in smaller groups.</p>
<p>STUDENT ASSESSMENT: Tests and oral examination.</p>
<p>COURSE QUALITY ASSESSMENT: Preferably by an evaluation team from outside the Faculty of Science. Periodic assessment by students.</p>
<p>PREREQUISITES FOR THE COURSE: General Chemistry; Inorganic Chemistry</p>
<p>REQUIRED LITERATURE: P. W. Atkins: <i>Elements of Physical Chemistry</i>, 3. izd., Oxford University Press, Oxford 2001. T. Cvitaš, I. Planinić, N. Kallay: <i>Rješavanje računskih zadataka u kemiji</i>, parts I and II, manuscript in press.</p>
<p>FURTHER READING: P. W. Atkins, J. de Paula: <i>Atkins' Physical Chemistry</i>, 7. izd., Oxford University Press, Oxford, 2002. T. Cvitaš: <i>Fizikalna kemija</i>, manuscript in preparation</p>

COURSE TITLE: ANALYTICAL AND PHYSICAL CHEMISTRY LABORATORY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY. 2nd		
SEMESTER 4		
LECTURER NIKOLA KALLAY, professor dr. sc. Astrid GOJMERAC IVŠIĆ, assistant professor; PMF		
CAN THE COURSE BE TAUGHT IN ENGLISH? YES		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	0	
seminar / exercises	0	
laboratory work	4	ASSISTANT
ECTS:4		
<p>COURSE OBJECTIVES:</p> <p>Experimental confirmation of validity of fundamental physico-chemical rules; introduction to physico-chemical measurements, devices, experimental data analysis and interpretation, as well as writing scientific reports.</p> <p>To teach the students the fundamentals of qualitative and quantitative analyses and help them acquire experimental skilfulness.</p>		
<p>COURSE CONTENT:</p> <p>Conductometry; conductance of strong and weak electrolytes, Kohlrausch law, conductivity measurements</p> <p>Potentiometry; pH measurements, glass electrode potentiometric titration</p> <p>Spectrophotometry; UV-Vis spectrophotometers, Beer-Lambertov law</p> <p>Calorimetry; calorimeters, determination of enthalpy of neutralization</p> <p>Chemical kinetics; kinetics of decomposition of hydrogen peroxide</p> <p>Adsorption; adsorption of acetic acid on active carbon</p> <p>Qualitative analysis of cations, anions and solid materials; Selected methods of titrimetric, gravimetric and spectrometric analysis</p>		
<p>EXPECTED COMPETENCES TO BE ACQUIRED: Learning laboratory skills specific to physical chemistry</p> <p>Acquiring experimental skilfulness, and understanding some qualitative and quantitative mechanisms.</p>		

STUDENT OBLIGATIONS: Thorough preparation for all laboratory exercises, passing the introductory colloquiums, writing laboratory reports.
TERMS FOR RECEIVING A SIGNATURE completing laboratory course
MODES OF LECTURING: Practical laboratory work
STUDENT ASSESSMENT: on the basis of colloquia held before every laboratory exercise and on the basis of laboratory reports
COURSE QUALITY ASSESSMENT: students' questionnaire, direct interaction with students
PREREQUISITES FOR THE COURSE: Physical chemistry 1 and Physical chemistry 2, Analytical Chemistry
<p>REQUIRED LITERATURE:</p> <p>N. Kallay, S. Žalac, D. Kovačević, T. Preočanin, i A. Čop, <i>Osnovni praktikum fizikalne kemije, Fizikalno-kemijski praktikum I</i>, skripta, drugo obnovljeno i dopunjeno izdanje, Fizičko-kemijski zavod, Kemijski odsjek, Prirodoslovno-matematički fakultet, Zagreb, 2002.</p> <p>D.A. Skoog, D. M. West i F.J. Holler, <i>Osnove analitičke kemije</i>, Školska knjiga 1998.</p>
<p>FURTHER READING:</p> <p>P. W. Atkins i J. de Paula, <i>Atkins' Physical Chemistry</i>, 7. izdanje, Oxford Univ. Press, Oxford, 2002.</p> <p>R. J. Silbey i R. A. Alberty, <i>Physical Chemistry</i>, 3. izdanje, John Wiley & Sons, Inc., New York, 2001.</p> <p>P. W. Atkins i M. J. Clugston, <i>Načela fizikalne kemije</i>, Školska knjiga, Zagreb, 1989.</p> <p>T. Cvitaš i N. Kallay, <i>Fizičke veličine i jedinice međunarodnog sustava</i>, Školska knjiga, Zagreb, 1980.</p> <p>G. D. Christian, <i>Analytical Chemistry</i>, 5. izdanje, John Wiley & Sons, Inc., New York, 1994.</p>

COURSE TITLE: CHEMICAL SYNTHESIS LABORATORY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3.		
SEMESTER: 5.		
LECTURER: S. TOMIĆ-PISAROVIĆ, professor NEVEN STRUKAN, assistant professor		
CAN THE COURSE BE TAUGHT IN ENGLISH? YES		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures		
seminar / exercises		
laboratory work	4	ASSISTANT
ECTS: 4		
COURSE OBJECTIVES: Introduction to laboratory and instrumental techniques and their application in organic and inorganic synthesis		
<p>COURSE CONTENT:</p> <p>Caffeine Column chromatography Oxidation Reduction IR Spectroscopy Esterification Synthesis of metal (Fe, Cu, Al, Sn or Pb) halides. Synthesis of transition metal (Fe, Co, V, Mn or Cr) complexes with β-diketonate. Synthesis and identification of oxalato complexes. Metal complexes with nitrogen-containing ligands</p>		
EXPECTED COMPETENCES TO BE ACQUIRED: Basic techniques of organic and inorganic synthesis.		
<p>STUDENT OBLIGATIONS:</p> <p>Preliminary exam before every laboratory practice, final exam (not mandatory for the inorganic part), assays with results of every experiment</p>		
TERMS FOR RECEIVING A SIGNATURE: Completed experimental part of the course		
MODES OF LECTURING:		

STUDENT ASSESSMENT: Written or oral preliminary exams, final exam (not mandatory for the inorganic part)
COURSE QUALITY ASSESSMENT: Anonymous student evaluation
PREREQUISITES FOR THE COURSE: Introduction to Chemistry, 4+3 (1 st sem.), General chemistry laboratory 1 & 2, Analytical and physical chemistry laboratory, Inorganic chemistry
REQUIRED LITERATURE: Internal Textbook of Synthetic Practical Chemistry M. Cindrić, Z. Popović, V. Vrdoljak, Internal textbook of inorganic synthesis (in Croatian).
FURTHER READING: <ol style="list-style-type: none">1. L. F. Fieser, K. L. Williamson, <i>Organic Experiments</i>, D. C. Heat and Co., Lexington, 1975.2. J. A. Moore, D. L. Dalrymple, <i>Experimental Methods in Organic Chemistry</i>, W. B. Saunders, Philadelphia, 1976.3. C. F. Most Jr., <i>Experimental Organic Chemistry</i>, John Wiley & Sons, New York, 1988.4. R. M. Silverstein, G. C. Bassler, T. C. Morrill, <i>Spectrometric Identification of Organic Compounds</i>, 5th Ed., John Wiley & Sons, New York, 1991.5. S. H. Pine, <i>Organska kemija</i>, Školska knjiga, Zagreb, 1994.6. J. March, <i>Advanced Organic Chemistry</i>, John Wiley & Sons, New York, 2001.7. G. S. Girolami, T. B. Rauchfuss, R. J. Angelici, <i>Synthesis and Technique in Inorganic Chemistry</i>, 3rd Ed., University Science Books, Sausalito, 1999.8. W. L. Jolly, <i>The Synthesis and Characterization of Inorganic Compounds</i>, Waveland Press., 1991.

COURSE TITLE			Organic Chemistry 1
STUDY PROGRAMME:			UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY
YEAR OF STUDY.			3 rd year
SEMESTER			5 th
LECTURER			Dr.sc. Ante Deljac, professor
CAN THE COURSE BE TAUGHT IN ENGLISH?			
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT	
lectures	4	lecturer	
seminar / exercises	1	assistants	
laboratory work			
ECTS:7			
COURSE OBJECTIVES: Introduction to structure and reactivity of carbon compounds			
COURSE CONTENT:			
<ol style="list-style-type: none"> 1. Organic Chemistry; A Historical Perspective 2. Nomenclature of Organic Compounds 3. Bonding in Organic Molecules <ol style="list-style-type: none"> 3.1. Early Bond Theory Quantum Mechanics and Atomic Orbitals Molecular Orbitals Bond Angles, VSEPR-Theory Hybrid Orbitals Bond Energies and Distances 4. Acid and Bases 5. Characteristic Reactions of Organic Compounds <ol style="list-style-type: none"> 5.1. Reaction Mechanism 5.2. Reaction Energetics and Kinetics 6. Stereochemistry <ol style="list-style-type: none"> 6.1. Classes of Stereoisomers 6.2. Conformations of Acyclic and Cyclic Compounds 6.3. <i>Cis-trans</i> isomerisms 			

- 6.4. Chirality, Optical Activity, Stereoisomers Characteristics and Resolution
- 7. Structural Effects on Reactivity
 - 7.1. Inductive, Steric and Resonance Effects
 - 7.2. The Resonance Method
 - 7.3. Aromaticity
- 8. Nucleophilic Additions to the Carbonyl Group; Mechanism and Stereochemistry of Addition
- 9. Nucleophilic Substitutions on the Carbonyl Group; The Carboxylic Acid Family
- 10. Nucleophilic Substitutions at Saturated Carbon
 - 10.1. The Reaction Mechanism and Stereochemistry
 - 10.2. The Effects of Nucleophiles, Leaving Groups, Substrate Structures, Solvents, Cations and Neighbouring Groups on Reaction Course
- 11. Alpha-Carbanion; Alkylation of Enolate Anions
- 12. IR Spectroscopy (Examples of Organic Compounds Identifications)
- 13. NMR Spectroscopy (Structural Characterization of Simpler Organic Compounds)
- 14. Mass Spectroscopy
- 15. UV Spectroscopy

EXPECTED COMPETENCES TO BE ACQUIRED: Solution of the problems related to the reactions (including stereochemistry) mentioned in the previous paragraph

STUDENT OBLIGATIONS: Attendance to lectures and exercises is desirable

TERMS FOR RECEIVING A SIGNATURE: not specified

MODES OF LECTURING: verbal

STUDENT ASSESSMENT: final written and oral exam

COURSE QUALITY ASSESSMENT:

PREREQUISITES FOR THE COURSE: Introduction to Chemistry, 4+3 (1st sem.)

REQUIRED LITERATURE: Stanley H. Pine, *Organic Chemistry*, McGraw-Hill, 1988

FURTHER READING:

J. Clayden, N. Greeves, S. Warren & P. Wothers, *Organic Chemistry*, Oxford University Press, 2001

COURSE TITLE		Organic Chemistry 1 and 2
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY.		3 rd
SEMESTER		5 th and 6 th
LECTURER		Dr.sc. Ante Deljac, professor
CAN THE COURSE BE TAUGHT IN ENGLISH?		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	4	lecturer
seminar / exercises	1	assistants
laboratory work		
ECTS: 6		
COURSE OBJECTIVES: Introduction to structure and reactivity of carbon compounds		
<p>COURSE CONTENT:</p> <ol style="list-style-type: none"> 1. Elimination reactions <ol style="list-style-type: none"> 1.1. Mechanisms and stereochemistry of elimination reactions 1.2. Elimination versus substitution 2. Electrophilic additions to unsaturated carbon <ol style="list-style-type: none"> 2.1. Mechanisms and stereochemistry of addition reactions 2.2. Addition to conjugated dienes and conjugated carbonyl compounds 2.3. Homogenic and heterogenic catalysis 3. Pericyclic reactions <ol style="list-style-type: none"> 3.1. (4 + 2) cycloaddition and dipolar cycloaddition 3.2. Orbital symmetry control of pericyclic reactions (HOMO-LUMO and correlation diagram methods) 3.3. Electrocyclic reactions and sigmatropic rearrangements 4. Electrophilic aromatic substitution <ol style="list-style-type: none"> 4.1. Aromatic and antiaromatic compounds 4.2. Mechanism and orientation in electrophilic aromatic substitution 4.3. Substituent effects 5. Nucleophilic aromatic substitution 		

<p>6. Molecular rearrangements</p> <p>7. Free radical reactions</p> <p>8. Organic synthesis</p> <p>8.1. Design of a synthesis (starting materials, construction reactions, functional group interconversions and protecting groups)</p> <p>8.2. Retro-synthetic approach</p> <p>9. Natural organic compounds (carbohydrates, nucleosides, proteins, amino acids, lipids, alkaloids and pheromones)</p>
<p>EXPECTED COMPETENCES TO BE ACQUIRED: Solution of the problems related to the reactions (including stereochemistry) mentioned in the previous paragraph</p>
<p>STUDENT OBLIGATIONS: Attendance to lectures and exercises is desirable</p>
<p>TERMS FOR RECEIVING A SIGNATURE: not specified</p>
<p>MODES OF LECTURING: verbal</p>
<p>STUDENT ASSESSMENT: Written and oral final exam</p>
<p>COURSE QUALITY ASSESSMENT:</p>
<p>PREREQUISITES FOR THE COURSE: Introduction to Chemistry, 4+3 (1st sem.)</p>
<p>REQUIRED LITERATURE: Stanley H. Pine, <i>Organic Chemistry</i>, McGraw-Hill, 1988</p>
<p>FURTHER READING:</p> <p>J. Clayden, N. Greeves, S. Warren & P. Wothers, <i>Organic Chemistry</i>, Oxford University Press, 2001</p>

COURSE TITLE: BIOCHEMISTRY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3		
SEMESTER: 6		
LECTURER Đurđica Ugarković, senior scientist at Ruđer Bosković Institute (in the process of election for the professor at the Faculty of Natural Sciences)		
CAN THE COURSE BE TAUGHT IN ENGLISH? yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	5	lecturer
seminar / exercises	2	assistant
laboratory work	0	
ECTS: 8		
COURSE OBJECTIVES: structure and function of biological macromolecules and their metabolism; storing and transducing of chemical energy; DNA, RNA and the flow of genetic information		
COURSE CONTENT:		
<ol style="list-style-type: none"> 1. Introduction: basic macromolecules- DNA, RNA, proteins, covalent and non-covalent interactions, entropy and the laws of thermodynamics 2. Biochemical evolution: origin of key organic molecules, energy transformation in living systems, origin of organized biological systems (cells) and their interaction with environment 3. Proteins I; amino acid's structure and primary structure of proteins 4. Proteins II; secondary, tertiary and quaternary structure 5. Enzymes: basic concepts and kinetics, free energy change and equilibrium. Michaelis-Menten Model and allosteric enzymes kinetics. Influence of inhibitors on kinetic properties 6. Catalytic and regulatory strategies of enzymes. Proteases, hemoglobin, aspartate transcarbamoylase, isozymes, covalent modifications 7. Membranes: structural components – lipids and proteins. Transfer through membranes: pumps and ion channels 8. Metabolism. Coupled interconnecting reactions. ATP and structural basis of its high phosphoryl transfer potential. Electron carriers: NADH and FADH₂. Coenzyme A. Regulation of metabolism 9. Glycolysis and gluconeogenesis. Reactions of glucose degradation to pyruvate and energy yield. Glucose synthesis from noncarbohydrate precursors. 10. Cell respiration. Citric acid cycle (reactions, stoichiometry, control). Oxidative 		

phosphorylation (proton and electron carriers in respiratory chain, proton gradient formation)

11. Photosynthesis. Chlorophylls. Reactions of photosynthesis: photosystems I and II, cytochrome bf. Proton gradient and ATP synthesis
12. The Calvin cycle and the pentose phosphate pathway. Three steps in the Calvin cycle and two phases of the pentose phosphate pathway. The net reactions.
13. Glycogen metabolism. Breakdown and synthesis, regulation.
14. Fatty acid metabolism. Reactions of degradation and synthesis. Net reactions. Control of metabolism.
15. Protein turnover and amino acid catabolism. Degradations of proteins to amino acids and regulation. The urea cycle. Carbon atoms of degraded amino acids as major metabolic intermediates.
16. The biosynthesis of amino acids. Nitrogen fixation. amino acid synthesis from intermediates of citric acid cycle and other major pathways. Regulation of biosynthesis.
17. Nucleotide biosynthesis. Synthesis of pyrimidine ring from aspartate and carbamoyl phosphate. The purine ring assembled on ribose phosphate. Synthesis of deoxyribonucleotides.
18. DNA, RNA and the flow of genetic information. Structural elements of nucleic acids. The double helix and complementary chains. A, B, Z structure. Introduction into replication, transcription and translation.
19. Replication and recombination. Semiconservative replication. Cellular apparatus for DNA replication. Recombination. Recombinational repair.
20. Transcription and RNA processing. Bacterial transcription, postranscriptional modifications. Eukaryotic transcription: three types of RNA polymerases. Cellular apparatus for intron splicing.
21. Protein biosynthesis. Adaptor role of tRNA. Genetic code. Ribosome structure. Initiation, elongation and termination of polypeptide chain.
22. Control of gene expression. Operons: regulation by repressor. Eukaryotic regulation: transcriptional activation and repression. Posttranscriptional regulation.
23. Organization of eukaryotic genome. Genome size and gene content. Repetitive genes and noncoding DNA. Nucleosome structure.
24. Viruses. Structure, specificity in the transfer of genetic information. Relation to the host.

EXPECTED COMPETENCES TO BE ACQUIRED: understanding of basic metabolic reactions and processes

STUDENT OBLIGATIONS: obligatory attendance of the lectures, participation in the partial testing results of which could be added to the results of the exam or can even substitute the exam.

TERMS FOR RECEIVING A SIGNATURE performing of above mentioned obligations

MODES OF LECTURING: oral presentation

STUDENT ASSESSMENT: writing (if the results of testing are not adequate) and oral exams

COURSE QUALITY ASSESSMENT: acquired knowledge of students measured through results of exams

PREREQUISITES FOR THE COURSE: students should be regular attendants of the 3rd year

REQUIRED LITERATURE: J. M. Berg, J.L. Tymoczko and L. Stryer, BIOCHEMISTRY (Fifth Edition), W. H. Freeman & Co., New York 2002.

FURTHER READING: D. Voet & J. G. Voet, BIOCHEMISTRY (Third Edition), John Wiley and Sons, 2004.

COURSE TITLE: Biochemistry Laboratory		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 3 rd		
SEMESTER: 6.		
LECTURER: dr. sc. Irena Landeka Jurčević, Faculty of Science University of Zagreb		
CAN THE COURSE BE TAUGHT IN ENGLISH? Yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures		
seminar / exercises		
laboratory work	2	Irena Landeka Jurčević
ECTS: 2		
COURSE OBJECTIVES: The course should introduce students of chemistry with elementary biochemical laboratory methods. Students use experimental methods to solve biochemical problems.		
COURSE CONTENT: Potentiometric titration of amino acids. Determination of Alcohol-dehydrogenase kinetic parameters for ethanol. Specificity of Alcohol-dehydrogenase towards different alcohols. Inhibition of Alcohol-dehydrogenase activity. Size-exclusion chromatography of biological macromolecules. Size-exclusion chromatography of hemoglobin. Electrophoresis of hemoglobins on the agar gel. Polyacrylamide gel electrophoresis in the presence of SDS (SDS-PAGE). Electrophoresis of DNA on the agarose gel. Preparation of plasmid DNA from transformed bacterial cells.		
EXPECTED COMPETENCES TO BE ACQUIRED: After successful finishing Biochemistry Laboratory Course, students should be familiar with basic methods in biochemistry and develop biochemical way of thinking through solving laboratory problems.		
STUDENT OBLIGATIONS: Prior to the each practical exercise students's knoweldge and understanding would be tested by quiz. Students that did not pass the quiz would not be able to make that exercise. After successful finishing of the exercise students should write the report where they state the goal of the exercise, describe used methods and explain their results. Students would be encouraged to critically discuss obtained results.		
TERMS FOR RECEIVING A SIGNATURE: To receive the signature students should finish all exercises. For each exercise that includes quiz, experimetal part and written report positively evaluated by the assistant.		
MODES OF LECTURING: Lecturing would be performed through solving biochemical problems by experimental approach. Assistant would discuss with students about the problem, used methodology		

and obtained results. Students would be encouraged to expel their biochemical bacground knowledge.
STUDENT ASSESSMENT: Students would be evaluated through the written exam.
COURSE QUALITY ASSESSMENT: The course would be evaluated through the students polls and individual conversation with students.
PREREQUISITES FOR THE COURSE: Participants should be regular students of 3 rd year.
REQUIRED LITERATURE: Internal handbook for Biochemistry Laboratory, Department of Biochemistry, 2004, 10 th edition Relevant Chapters from Berg, J.M., Tymoczko, J.L., Stryer, L., 2002, <i>Biochemistry</i> , W.H.. Freeman&Co., New York, 5 th edition
FURTHER READING: Voet, D. and Voet, J.G., <i>Biochemistry</i> , John Wiley & Sons, 3 rd edition

COURSE TITLE: ADVANCED LABORATORY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4.		
SEMESTER: 8.		
LECTURER NEVEN STRUKAN, assistant professor Vlasta Vojković, assistant professor		
CAN THE COURSE BE TAUGHT IN ENGLISH? YES		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures		
seminar / exercises		
laboratory work	4	ASSISTANT
COURSE OBJECTIVES: Introduction to more complex techniques of chemical synthesis, identification and characterisation of reaction products with different methods.		
<p>COURSE CONTENT:</p> <p>Synthesis of organic compound Synthesis of transition metal complexes. Identification and analysis of complex compound Spectroscopic analyses of organic and complex compounds (IR, UV-VIS and mass spectroscopy, Raman), X-ray diffraction on single crystal and powder samples Thermal analysis Magnetic susceptibility measurement Solubility of organic and complex compounds in different solvent Characteristics of organic and complex compounds in solutions; factors which have influence on the UV-VIS and fluorescence characteristics Determination metal to ligand ratio with UV-VIS spectrometric method Determination of ligand dissociation constant Determination of complex stability constant. Determination of amount of metal ion with ICP-AES or flame emission spectrometry Statistical analytical data treatment and evaluation.</p>		
EXPECTED COMPETENCES TO BE ACQUIRED: Techniques of organic and inorganic synthesis. Instrumental techniques of analysis and characterisation.		
STUDENT OBLIGATIONS: Regular attendance at the laboratory, submission of written reports after the laboratory work.		
TERMS FOR RECEIVING A SIGNATURE: Regular attendance at the laboratory, submission of		

written reports after the laboratory work.
MODES OF LECTURING: Laboratory exercises
STUDENT ASSESSMENT: Written and oral examination before the laboratory work.
COURSE QUALITY ASSESSMENT: Anonymous student evaluation.
PREREQUISITES FOR THE COURSE: General chemistry laboratory I & II, Analytical and physical chemistry laboratory, Synthetic chemistry laboratory.
<p>REQUIRED LITERATURE</p> <ol style="list-style-type: none"> 1. G. S. Girolami, T. B. Rauchfuss, R. J. Angelici, <i>Synthesis and Technique in Inorganic Chemistry</i>, 3. izd., University Science Books Sausalito, 1999. 2. W. L. Jolly, <i>The Synthesis and Characterization of Inorganic Compounds</i>, Waveland Press., 1991. 3. D. A. Skoog, F. J. Holler, and T. A. Nieman, Principles of Instrumental Analysis, 5th Ed., Orlando, USA; 1998.
<p>FURTHER READING:</p> <ol style="list-style-type: none"> 1. G. S. Girolami, T. B. Rauchfuss, R. J. Angelici, <i>Synthesis and Technique in Inorganic Chemistry</i>, 3. izd., University Science Books Sausalito, 1999. 2. W. L. Jolly, <i>The Synthesis and Characterization of Inorganic Compounds</i>, Waveland Press., 1991. 3. D. L. Pavia, G. M. Lampman, and G. S. Kriz, Introduction to Spectroscopy, 3rd Ed. Harcourt, Inc., Orlando, USA, 2001. 4. <i>Infrared and Raman Spectroscopy, Methods and Applications</i>, Ed: B. Schrader, VCH Publishers, Inc., New York, 1995. 5. E. de Hoffmann and V. Stroobant, Mass Spectrometry, 2nd Ed., John Wiley & Sons, Chichester, UK, 2002.

COURSE TITLE TEACHING METHODS IN CHEMISTRY 1		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4.		
SEMESTER: 8.		
LECTURER Dr. sc. Draginja Mrvoš-Sermek, assistant professor, Faculty of Science, University of Zagreb		
CAN THE COURSE BE TAUGHT IN ENGLISH?		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	2	LECTURER
seminar / exercises	2	ASSISTANT
laboratory work	0	
ECTS: 6		
COURSE OBJECTIVES: Ability to create new teaching aids and experiments. Permanent education.		
COURSE CONTENT: 1. Introduction 2. Chemistry as a lecture course (Chemistry as science and as an education course, chemistry lecture room, laboratory equipment and chemicals, teaching aids, safety precautions) 3. Educational strategy and methods 1 (lecturing) 4. Educational strategy and methods 2 (strategy of learning: by discovery, in small groups, individual learning) 5. Educational plan and program. Analysis of actual educational chemistry programs in primary school, specificity of teaching in primary school, lecture books, educational program. 6. Analysis of actual education in chemistry, programs in secondary schools (specificity of teaching in secondary school, lecture books, educational program). 7. Social modes of work in the chemistry course (frontal, group, work in pairs, individual, creating an interdisciplinary course) 8. Lecturing 1 (strategy of working in the classroom, experiment as a main source of knowledge, purpose of the experiment (demonstration, group, individual experiment, preparation techniques, safety precautions). 9. Lecturing 2 (models, graphs, photographs, teacher's lecture, after school activities, competition, contest, talents). 10. Knowledge, abilities and skills evaluation and preparation of examination materials (work results		

<p>evaluation during the educational process, sociological effect of grades as an evaluating measure, internal evaluation, external evaluation - state graduation examination, creative tests preparation etc.)</p> <p>11. Preparing teachers for lectures 1 (terminology, preparations for s new school year, preparation for certain educational sections)</p> <p>12. Preparing teachers for lectures 2 (preparation for a certain educational unit, setting the object of the educational unit, written preparation for the single or double school lecture structure, blackboard plan, material, technical and psichological preparation, results and students' accomplishment evaluation)</p> <p>13. Invited lecture from the primary school teaching advisor (selected educational unit, double lecture)</p> <p>14. Invited lecture from the secondary school teaching advisor (selected educational unit, double lecture)</p> <p>15. Round table with inspectors from the Ministry of education (information about teachers' rights and duties, exams in the art, school supervision, terms of advancement, weekly obligations, material status of teachers, continuous education and seminaries for teachers, pedagogical standard, evaluation rules, lecture books approvement, students contests, help in working with students with special needs, after-school activities, talents, european integrations and education, addiction, violence, minimal standard of equipment in chemistry classrooms and other topics.)</p> <ul style="list-style-type: none"> • Topics of lectures and seminars are connected by subject and include taking an active part by students, assistants and teachers in the whole lecture plan.
<p>EXPECTED COMPETENCES TO BE ACQUIRED:</p> <p>Creative professor of Chemistry in secondary school and higher grades of primary school able to apply modern methods of teaching.</p>
<p>STUDENT OBLIGATIONS:</p> <p>Seminar from one of the following fields: chemistry programs in European and other countries, alternative schools, students with special needs, critical thinking in chemistry education, chemistry classroom, chemistry classroom equipment, teaching aids. Presentation also has to be appropriate for internet.</p>
<p>TERMS FOR RECEIVING A SIGNATURE</p> <p>Oral exam. Quality of the seminar work and active discussions add up to the final grade.</p>
<p>MODES OF LECTURING: lectures, seminar</p>
<p>STUDENT ASSESSMENT:</p> <p>Internal evaluation of student activity. The grade is part of the final grade given after the following semester.</p>
<p>COURSE QUALITY ASSESSMENT: Anonymous student evaluation.</p>
<p>PREREQUISITES FOR THE COURSE:</p> <p>General chemistry, Inorganic chemistry 1, 2, Analytical chemistry 1,2, General chemistry laboratory, Physical chemistry, Analytical and physical chemistry laboratory, Organic chemistry 1, 2, Synthesis in chemistry laboratory, Biochemistry, Biochemistry laboratory.</p>

REQUIRED LITERATURE:

1. M. Sikirica, *Metodika nastave kemije*, Školska knjiga, Zagreb, Croatia, 2003.
2. Textbooks, workbooks, teacher guides for primary and secondary schools (various authors, editors, publishers)
3. L. Bognar, M. Matijević, *Didaktika*, Školska knjiga, Zagreb, Croatia, 2002.
4. **M. Matijević, *Ocjenjivanje u osnovnoj školi*, TIPEX-Zagreb, Croatia, 2004.**

FURTHER READING:

1. ***Education in Chemistry*. Royal Society of Chemistry, UK.**
2. *Journal of Chemical Education*. Department of Chemistry and Biochemistry University of Northern Colorado, USA.
3. *Naturwissenschaften im Unterricht Chemie*. Erhard Friedrich Verlag GmbH & Co., Seelze.
4. Chemistry, *Students' book*, *Nuffield Advanced Science*, Addison Wesley Longman Limited, 1997.
5. Chemistry, *Teachers' guide*, *Nuffield Advanced Science*, Addison Wesley Longman Limited, 1998.

COURSE TITLE TEACHING METHODS IN CHEMISTRY 2		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY. 5.		
SEMESTER 9.		
LECTURER Dr. sc. Draginja Mrvoš-Sermek, assistant professor, Faculty of Science, University of Zagreb		
CAN THE COURSE BE TAUGHT IN ENGLISH?		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	2	LECTURER
seminar / exercises	2	ASSISTANT
laboratory work	0	
ECTS: 6		
COURSE OBJECTIVES: Educate a creative professor of Chemistry with ability to create new teaching aids and experiments. Permanent education.		
COURSE CONTENT: Each student gets a topic from different chemical educational journals. The student prepares the lecture at the level of the primary or the secondary school. For the lecture the student has to choose teaching strategies and methods, create a group or demonstrational experiment(s), give the written report, select or make suitable teaching aids etc. A mentor (teacher or assistant) helps each student in the lecture preparation. <u>The following items are emphasized:</u> <ol style="list-style-type: none"> 1. Matter, aggregation state, phase transitions 2. Physical and chemical change 3. Atom 4. Chemical bond and crystal structure of matter 5. Fundamental laws (physical chemistry) 6. Reactivity (thermodynamics) 7. Equilibrium systems 8. Solutions 9. Electrochemistry 		

10. Kinetics of chemical reactions
11. Properties of main groups, technological processes
12. Complex compounds
13. Main mechanisms of chemical reactions in organic chemistry
14. Structure of organic molecular compounds
15. Biologically important molecules (biochemistry)
16. Addiction (medication, smoking, alcoholism, drugs, ...)

EXPECTED COMPETENCES TO BE ACQUIRED:

Creative professor of Chemistry in secondary school and higher grades of primary school able to apply modern methods of teaching.

STUDENT OBLIGATIONS:

One lecture adapted to a secondary school or primary school level given to the other students. Active discussion after such a lecture. Written report of an analysis of another student's lecture.

TERMS FOR RECEIVING A SIGNATURE

Attendance to lectures and active discussion. Seminar work presenting a school lecture.

MODES OF LECTURING: lectures, seminar

STUDENT ASSESSMENT:

Oral exam. Quality of the seminar work and active discussions add up to the final grade.

COURSE QUALITY ASSESSMENT: Anonymous student evaluation.

PREREQUISITES FOR THE COURSE: TEACHING METHODS IN CHEMISTRY 1

REQUIRED LITERATURE:

1. M. Sikirica, *Metodika nastave kemije*, Školska knjiga, Zagreb, Croatia, 2003.
2. Textbooks, workbooks, students' books, teacher guides for primary and secondary schools (various authors, editors, publishers)
3. ***Education in Chemistry*. Royal Society of Chemistry, UK.**
4. *Journal of Chemical Education*. Department of Chemistry and Biochemistry University of Northern Colorado, USA.
5. *Naturwissenschaften im Unterricht Chemie*. Erhard Friedrich Verlag GmbH & Co., Seelze.

FURTHER READING:

1. Chemistry, *Students' book*, *Nuffield Advanced Science*, Addison Wesley Longman Limited, 1997.
2. Chemistry, *Teachers' guide*, *Nuffield Advanced Science*, Addison Wesley Longman Limited, 1998.

COURSE TITLE: LABORATORY TEACHING METHODS IN CHEMISTRY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY. 5.		
SEMESTER 9.		
LECTURER Dr.sc. Draginja Mrvoš-Sermek, assistant professor, Faculty of Sciences, University of Zagreb		
CAN THE COURSE BE TAUGHT IN ENGLISH?		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	0	
seminar / exercises	0	
laboratory work	8	LECTURER, ASSISTANT
ECTS: 9		
<p>COURSE OBJECTIVES:</p> <p>Qualifying a professor of Chemistry in the primary and the secondary school. Acquiring skills and adopting the up-to-date experimental techniques in chemistry teaching. Development of the critical opinion in the choice of experiment as basic knowledge resource.</p>		
<p>COURSE CONTENT:</p> <p><u>PART I</u></p> <ol style="list-style-type: none"> 1. Introduction in the laboratory work 2. Mixture separation 3. Principal chemical laws 4. Hydrogen and water 5. Oxygen and ozone 6. Preparation and properties of chlorine 7. Sulfur 8. Nitrogen, ammonia, nitric acid and nitrogen oxides 9. Electrochemistry 10. Air pollution 11. Water pollution 12. Selected experiment (Pupil's research mini project. Aim: independent creating of problem teaching, qualifying for the work with talented children as well as stimulating and preparing 		

pupils for competitions etc.)

13. Assigned experiment (where, when and how in the educational calendar of school programs)
14. Bases of computer software for drawing of chemical apparatuses and structural formulae, as well as work with selected educational and structural databases (completion of earlier accomplished knowledge and skills, getting acquainted with the newest programs and useful databases in order to acquire habits and knowledge for preparation of modern teaching materials and aids as well as writing reports with drawings of apparatuses, structural formulae etc.)

PART II

1. The introductory agreement and general instructions (Security measures for working with organic chemicals, organic chemicals in households and their creative use in teaching of Chemistry etc.)
2. Carbon and carbon compounds
3. Saturated and unsaturated hydrocarbons
4. Aromatic hydrocarbons
5. Alcohols, aldehydes and ketones
6. Carboxylic acids and their derivatives
7. Fats and oils
8. Soaps and detergents
9. Sugars
10. Proteins, aminoacids, enzymes
11. Organic compounds identification methods (adapted to the methodology in school conditions, renewing of knowledge and skills acquired in the previous practical courses)
12. Selected experiments (suggest and do as research mini project. Aim: independent creating of problem teaching, qualifying for the work with talented children as well as stimulating and preparing pupils for competitions etc.)
13. Assigned experiment (where, when and how in the educational calendar of school programs)
14. Photography (preparation of teaching aids and materials by using the basics of photography and picture taking; black-and-white, color and digital photography)

(Every exercise from 2nd to 11th in both parts consists of about ten experiments from the named teaching unit which are adopted to the work conditions and the teaching programs in the primary and secondary schools. Students do exercises cyclically and individually. Exercises 14 are done in groups.)

EXPECTED COMPETENCES TO BE ACQUIRED:

Creative professor of Chemistry in secondary school and higher grades of primary school able to apply modern methods of teaching.

STUDENT OBLIGATIONS:

Regular attendance, passing of preliminary exams, elaboration of the experimental data in the form of written report, completion of project assignments by doing the 12th and 13th exercises.

<p>TERMS FOR RECEIVING A SIGNATURE</p> <p>All exercises completed.</p>
<p>MODES OF LECTURING:</p>
<p>STUDENT ASSESSMENT:</p> <p>Verification of student knowledge during the semester (oral and written); the final exam (as required and judged by the assistant)</p>
<p>COURSE QUALITY ASSESSMENT: Anonymous student evaluation.</p>
<p>PREREQUISITES FOR THE COURSE:</p> <p>General chemistry, Inorganic chemistry 1, 2, Analytical chemistry 1,2, General chemistry laboratory, Physical chemistry, Analytical and physical chemistry laboratory, Organic chemistry 1, 2, Synthesis in chemistry laboratory, Biochemistry, Biochemistry laboratory.</p>
<p>REQUIRED LITERATURE:</p> <p>M. Sikirica, D. Mrvoš-Sermek, <i>Praktikum iz metodike nastave kemije</i> (course notes for the internal use)</p>
<p>FURTHER READING:</p> <ol style="list-style-type: none"> 1. Textbooks and handbooks for the primary and secondary schools (different publishers and editions) 2. M. Sikirica, B. Korpar-Čolig, <i>Praktikum iz opće kemije</i>, Školska knjiga, Zagreb, Croatia, 2001. 3. S. Borčić, O. Kronja, <i>Praktikum preparativne organske kemije</i>, Školska knjiga, Zagreb, Croatia, 1991. 4. Tom Ang, <i>Digitalna fotografija</i>, Znanje, Zagreb, Croatia, 2004. 5. Accessible educational journals (<i>Education in Chemistry.</i>, <i>Journal of Chemical Education</i>)

Elective course: CHEMISTRY 1 or 2

COURSE TITLE	ENVIRONMENTAL CHEMISTRY	
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY.	2 nd or 3 rd	
SEMESTER	winter	
LECTURER	Tomislav CVITAŠ, professor	
CAN THE COURSE BE TAUGHT IN ENGLISH? yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	2	lecturer
seminar / exercises	1	assistant
laboratory work	0	
COURSE OBJECTIVES: Inform the students about the dynamical nature of processes in the environment and their mutual interrelationships, on the effect of man on stationary states and the response of nature to such changes.		
COURSE CONTENT: Evolution of the Earth through the geological time-scales: the age of rocks, shifting of continents, consequences for life on the planet. Composition of air through history and the corresponding evidence. Isotopic composition and isotope fractionation. Stationary states, lifetimes and quantities in reservoirs. Conditions affecting the stationary states and comparison with dynamic equilibria. Global effects of man on the environment: greenhouse gases and stratospheric ozone. Regional effects: e.g. acid rain, forest decline, eutrofication of waters. Local effects: cities, tunnels, garages, odvodne vode, waste disposal. Feedback mechanisms. Hypothesis of Gaia as a living superorganism. Special problems and their solutions: water purification, hazardous waste. Strategies of sustainable development: industrial ecology and green chemistry.		
EXPECTED COMPETENCES TO BE ACQUIRED: Understanding some of the principles underlying the connected processes in the environment: relationships between cause, effect and feedback.		
STUDENT OBLIGATIONS: Active participation in lectures and seminars. Homework.		
TERMS FOR RECEIVING A SIGNATURE: Regular participation in the course.		
MODES OF LECTURING: Lectures for the whole audience in larger theatres with PowerPoint presentations and seminars in smaller groups.		
STUDENT ASSESSMENT: Tests and oral examination.		
COURSE QUALITY ASSESSMENT: Preferably by an evaluation team from outside the Faculty of Science. Periodic assessment by		

students.

PREREQUISITES FOR THE COURSE: General Chemistry; Inorganic Chemistry

REQUIRED LITERATURE:

J. Lovelock: *Taj živi planet Geja*, Izvori, Zagreb 1999.

S. E. Manahan: *Fundamentals of Environmental Chemistry*, 2. izd., Lewis Publishers, New York 2001

FURTHER READING:

R. P. Wayne: *The Chemistry of Atmospheres*, OUP, Oxford 2000.

COURSE TITLE: MINERALOGY I		
COURSE TEACHER/TEACHERS: Associate professor, DARKO TIBLJAŠ, Faculty of Science		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 2 nd or 3 rd		
SEMESTER: winter		
TEACHING METHODS	CONTACT HRS PER WEEK	LECTURER or ASSISTANT
Lectures	2	professor
Seminar/Exercises	1	assistant
Laboratory work		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Obtaining information about internal constitution of minerals and its correlation with mineral shape and properties, getting students acquainted with principles of symmetry		
<p>DESCRIPTION OF THE COURSE: 1. mineral definition, three-dimensional periodicity, crystal lattice, unit cell, crystal systems</p> <p>2. morphology, symmetry elements without translation, crystal form, habit, zone</p> <p>3. law of constancy of interfacial angles, spherical projection, stereographic projection, Wulff net</p> <p>4. theory of rational indices for crystal faces, notations for planes and lines,</p> <p>5. point groups (Herman-Mauguin symbols, names), general form</p> <p>6. cubic crystals forms (illustrated with three point groups)</p> <p>7. forms in other systems, tetragonal and hexagonal system</p> <p>8. holohedral classes of orthorhombic, monoclinic and triclinic systems, problems with symmetry determinations</p> <p>9. crystal structure definition, atomic coordinates, symmetry elements with translation</p> <p>10.-11. Bravais lattices, space groups, International tables for crystallography</p> <p>12. chemical bonds-crystal structure dependence, coordination number, coordination polyhedron, isomorphism, polymorphism</p> <p>13. solid solutions, exsolution, crystal defects</p> <p>14.-15. X-ray diffraction, Bragg law, Laue equations, principles of unit cell dimensions determination</p>		

STUDENT OBLIGATIONS DURING THE COURSE: attending classes, preliminary exams consisting of theoretical part and crystal models projections, homework assignments
METHODS TO EVALUATE STUDENT PERFORMANCE: fulfilled obligations
EXAMINATION METHODS: written exam based on crystal polyhedra symmetry determination, oral exam, final grade includes also results of prelim and homework assignments
COURSE(S) NEEDED FOR THIS COURSE:
COMPULSORY LITERATURE: Borchardt-Ott, W. (1995): Crystallography, Springer Verlag, Berlin, 307. Klein, C. (2002): Mineral Science. John Wiley & Sons, New York, 641 pp. Nesse, W.D. (2000): Introduction to Mineralogy. Oxford University Press, Oxford, 442 pp.
ADDITIONAL READING: Wenk, H.-R. & Bulakh, A. (2004): Minerals, their constitution and origin. Cambridge University Press, Cambridge, 656 pp.

Elective course: CHEMISTRY 3

COURSE TITLE: RADIOANALYTICAL METHODS		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4 th		
SEMESTER: Winter		
LECTURER: Vlasta Vojković, assistant professor		
CAN THE COURSE BE TAUGHT IN ENGLISH? Yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	2	Lecturer
seminar / exercises	1	Lecturer
laboratory work		
COURSE OBJECTIVES: To provide the students with a thorough look at the phenomenon of radioactivity and methods of protection. The course deals with practical application of radioactive isotopes and their quantitative analysis. The students will be given to read latest scientific literature in the field of radiochemistry.		
COURSE CONTENT: Fundamental concepts of the phenomenon of radioactivity. Interaction of radiation and matter. Sources of nuclear radiation, detection and measurement of ionising radiation. Application of radioactive isotopes in analytical chemistry. Activation methods, nuclear microanalysis, isotope dilution methods, radioimmunology, radioisotope mass spectrometry, automatic radiochemical separation, liquid scintillation methods in environmental analysis. Preparation techniques of samples for analysis. Statistical considerations in radioactivity measurements. Radiation-chemical processes and biological effects of radiation. Radiation protection in practice. ➔ The course content to be supplemented with new scientific achievements in the field.		
EXPECTED COMPETENCES TO BE ACQUIRED: The student should be able to understand phenomenon of radioactivity, radiation-chemical processes and biological effects of radiation.		
STUDENT OBLIGATIONS: The student is expected to take an active part in lectures, to complete all exercises and to prepare a paper on a given topic.		
TERMS FOR RECEIVING A SIGNATURE: Meeting the above obligations.		
MODES OF LECTURING: Lectures with power point presentation, seminars		
STUDENT ASSESSMENT: Acquired knowledge to be tested by submission of a paper and by exam.		
COURSE QUALITY ASSESSMENT: By a questionnaire to be completed by the students at the end of the course.		

PREREQUISITES FOR THE COURSE: General Chemistry

REQUIRED LITERATURE:

1. D. William, W. D. Ehmann, *Radiochemistry and Nuclear Methods of Analysis*, Chemical Analysis Monographs on Analytical and Its Applications, Larry Burchfield, 1993.
2. K.-H. Lieser, *Nuclear- and Radiochemistry (Fundamentals and Applications)* Wiley-VCH Verlag GmbH, 2001.
3. M. L'Annunziata, *HANDBOOK OF RADIOACTIVITY ANALYSIS* (Second Edition) Elsevier, Academic Press, New York, 2003.
4. Internal mimeographed notes.

FURTHER READING:

1. S. J. Parry, *Activation Spectrometry in Chemical Analysis*, John Wiley&Sons (1991?)
2. G. Choppin, J-O- Liljenzin, J. Rydberg, *Radiochemistry and Nuclear Chemistry*, 2nd, Butterwort-Heinemann, 2002
3. Latest scientific literature in the field.

COURSE TITLE CRYSTALLOCHEMISTRY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY. 4 th		
SEMESTER winter		
LECTURER Prof. dr. sc. Dubravka Matković-Čalogović, Faculty of Science, University of Zagreb		
CAN THE COURSE BE TAUGHT IN ENGLISH? yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures		LECTURER
seminar / exercises		ASSISTANT
laboratory work		
<p>COURSE OBJECTIVES:</p> <p>Understanding symmetry operations and general principles of crystal and molecular structures. This knowledge is useful for understanding other courses such as <i>Structure determination by diffraction methods</i>, <i>Solid state chemistry</i>, <i>Chemistry of materials</i>.</p> <p>Students are encouraged to choose a topic for their seminar work. They acquire skills for independent research and presentation.</p>		
<p>COURSE CONTENT:</p> <p>General principles of crystal and molecular structures. Macroscopic properties of crystals. Crystal symmetry (symmetry elements, Bravais lattice, crystal systems, point and space groups). Crystal structure of alloys, solid solutions, intermetallic compounds. Ionic bond (ionic radius, bond energy, lattice energy, Pauling's rules). Types of ionic structures. Molecular crystals (bond types, lattice energy). Experimental methods for structure determination. Structure-property relationship.</p>		
<p>EXPECTED COMPETENCES TO BE ACQUIRED:</p> <p>Knowledge of the main principles of crystallochemistry. Useful for diploma work in the field of structural chemistry. Students also acquire skills for independent research and presentation.</p>		
<p>STUDENT OBLIGATIONS:</p> <p>Attendance to the lectures and seminar work.</p>		
<p>TERMS FOR RECEIVING A SIGNATURE</p> <p>Written exam and seminar work. Oral exam is not mandatory.</p>		
<p>MODES OF LECTURING: lectures, seminar</p>		
<p>STUDENT ASSESSMENT: written exam and seminar</p>		
<p>COURSE QUALITY ASSESSMENT:</p>		

PREREQUISITES FOR THE COURSE:

REQUIRED LITERATURE:

A.R. West: *Solid State Chemistry and its Applications*, Wiley, NY 1998.

FURTHER READING:

C. Giacovazzo, H.L. Monaco, D. Viterbo et al.: *Fundamentals of Crystallography*, 2nd Ed, IUCr, Oxford Univ. Press, Oxford 2002.

D. Grdenić: *Molekule i kristali*, Školska knjiga, Zagreb 1987.

COURSE TITLE: COLLOID AND INTERFACIAL CHEMISTRY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY: 4 th		
SEMESTER: WINTER		
LECTURER: NIKOLA KALLAY, professor		
CAN THE COURSE BE TAUGHT IN ENGLISH? YES		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	2	LECTURER
seminar / exercises	1	ASSISTANT
laboratory work	0	
COURSE OBJECTIVES: Application of physical chemistry on colloidal systems.		
COURSE CONTENT: Solubility and evaporation of colloid particles Mobility and diffusion of colloid particles Charging of colloid particles Kinetics of aggregation and adhesion Surfactants.		
EXPECTED COMPETENCES TO BE ACQUIRED:		
STUDENT OBLIGATIONS: Attending lectures, being active during lectures		
TERMS FOR RECEIVING A SIGNATURE Attending lectures		
MODES OF LECTURING: Classical lectures and exercises		
STUDENT ASSESSMENT: Written examination and oral examination		
COURSE QUALITY ASSESSMENT: students' questionnaire, direct interaction with students		
PREREQUISITES FOR THE COURSE: Physical chemistry 1 and Physical chemistry 2		
REQUIRED LITERATURE: N. Kallay, <i>Koloidna i međupovršinska kemija</i> , interna skripta, Kemijski odsjek, PMF R. J. Hunter, <i>Introduction to Modern Colloid Science</i> , Oxford University Press, 2002.		
FURTHER READING: D. Evans and H. Wennerström, <i>The Colloidal Domain</i> , Wiley-VCH, 1999.		

Original and review scientific articles

COURSE TITLE: MOLECULAR SPECTROSCOPY		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND CHEMISTRY		
YEAR OF STUDY. 4 th		
SEMESTER: winter		
LECTURER: BRANKA KOVAČ		
CAN THE COURSE BE TAUGHT IN ENGLISH? yes		
COURSE CONTENT	HOURS PER WEEK	LECTURER or ASSISTANT
lectures	2	lecturer
seminar / exercises	1	assistant
laboratory work	0	
<p>COURSE OBJECTIVES: Introduction to the fundamental aspects of spectroscopy related to the absorption, emission and scattering of electromagnetic radiation by molecules; the importance of molecular symmetry arguments; determining molecular structure and modes of molecular motion from spectroscopic data.</p>		
<p>COURSE CONTENT:</p> <p>Basic principles:electromagnetic radiation and its interaction with matter: absorption, emission and Raman scattering;</p> <p>Rotational spectroscopy: rigid rotor/ linear molecules; transition frequencies; Raman scattering (Stokes, anti-Stokes); nuclear spin statistical weights/ spherical rotor molecules / symmetric rotor molecules (prolate, oblate)/ asymmetric rotor molecules / centrifugal distortion/ Stark effect in linear and symmetric rotor molecules/ structure determination from rotational spectra (structural, mechanic, electric and magnetic properties of molecules)</p> <p>Molecular vibrations and vibrational spectra of polyatomic molecules: harmonic oscillator, anharmonicity/ transition frequencies/ Birge-Sponner extrapolation/ vibrational selection rules/ vibrational Raman spectra / transition polarizability / method of combination differences/ normal modes of vibration/ valence force field/ vibrations and symmetry/ vibration-rotation spectroscopy (linear molecules, symmetric rotors, asymmetric rotors)/ informations from vibrational spectra analysis</p> <p>Electronic spectroscopy of polyatomic molecules : molecular orbitals and electronic states/ chromophores/ electronic and vibronic selection rules/ vibrational structure – Franck-Condon principle; sequences; progressions/ the fate of electronically excited states – fluorescence, phosphorescence;;) ionisation and photoelectron spectroscopy (UPS, XPS); lasers and laser spectroscopy (general features and properties; examples of lasers)/ nuclear magnetic resonance (nuclear spin; chemical shift; fine structure; two-dimensional nmr (cosy, hetero), NOESy; pulse nmr, FID; FourierFT spectroscopy, spin relaxation (longitudinal and transverse), MRI; electron spin resonance</p>		
<p>EXPECTED COMPETENCES TO BE ACQUIRED: Students will acquire competence in interpreting spectral data and determine molecular structure from them.</p>		
<p>STUDENT OBLIGATIONS: attending classes, doing homework assignments, attending preliminary exams</p>		
<p>TERMS FOR RECEIVING A SIGNATURE: attending classes, doing homework assignments, attending preliminary exams</p>		

MODES OF LECTURING lectures, discussions, seminars, performing suitable chemical demonstrations
STUDENT ASSESSMENT: written and oral exams
COURSE QUALITY ASSESSMENT: students opinion poll
PREREQUISITES FOR THE COURSE: Physical chemistry I, Mathematical methods in chemistry
<p>REQUIRED LITERATURE:</p> <p>T. Cvitaš: <i>Temelji kvantne kemije i spektroskopije</i>, Sveučilišna naklada Liber, Zagreb 1976.</p> <p>J.M. Hollas: <i>Modern Spectroscopy</i>, 4. ed., Wiley, Chichester 2004.</p>
<p>FURTHER READING:</p> <p>I. N. Levine: <i>Molecular Spectroscopy</i>, Wiley, N.York 1975.</p> <p>D.C. Harris, M.D. Bertolucci: <i>Symmetry and Spectroscopy: An Introduction to Vibrational and Electronic Spectroscopy</i>, Dover Publ., N.York 1989.</p> <p>P. Atkins, J de Paula: <i>Atkins' Physical Chemistry</i>, 7. ed., Oxford Univ. Press, Oxford 2002.</p> <p>F. A. Cotton: <i>Chemical Applications of Group Theory</i>, Wiley, N.York 1971.</p>