

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

**PROPOSAL OF THE INTEGRAL FIVE-YEAR  
UNIVERSITY STUDY PROGRAMMES  
OF EDUCATIONAL PHYSICS  
OF THE DEPARTMENT OF PHYSICS  
FACULTY OF SCIENCE  
UNIVERSITY OF ZAGREB**

## EXPLANATION OF THE PROPOSAL

Physics is a fundamental natural science and is the basic for understanding other natural sciences (chemistry, biology, geology, geophysics). Physics is incorporated in contemporary medicine and engineering. Scientific achievements in physics greatly influence advancements in technology, microelectronics, informatics...

The physicists, graduated at the Department of Physics, Faculty of Science, in Zagreb, have not been unemployed for years. Our graduated students in Croatia find positions with faculties (universities), in primary and secondary schools, research institutes in the education system, in medical institutions, in geophysical and meteorological institutions, in governmental offices, in banks and other financial institutions, with domestic and international enterprises, as well as in small firms. Some of the graduated physicists enrol postgraduate studies abroad or find jobs in international firms comprising research in physics. Our graduated students are members of the staff of prominent universities, e.g. Caltech, MIT, Stanford and others in the United States, as well as the Universities in Hamburg, Lousanne, Munich, Darmstadt, Stuttgart, Paris and others in Europe. Some of our former students hold positions as full professors and many of them the positions of research associates. In Croatia, the Department of Physics, thanks to its exceptional reputation, offers the best students a challenge to continue with postgraduate studies; these students prove to be as successful as their colleagues, who have chosen to study abroad. The proposed study aimed to graduation in **educational physics (Teacher of Physics)** is harmonized with the demands of the "Bologna process" and modernized in the teaching system as to achieve a better efficiency of study and compatibility with corresponding studies in Europe.

The university education of physicists (engineers of physics, i.e. research physicist, and teachers of physics) in the Republic of Croatia has been concentrated for decades in the Department of Physics, Faculty of Science, University of Zagreb. However, due to various circumstances, the Department of Physics moved, as late as in 1991, to a new building, which has modern lecture halls and up to date laboratories that cover a wide spectrum of scientific research in physics. Since the end of the War for Independence, the Department of Physics has worked in peacetime conditions, which have been reflected in an increased and internationally recognized scientific production and a rich education programme. The organization and performance of the Department of Physics is based on the unity of scientific and educational tasks, fully in line with the tendencies in the European Union and the United States.

The Department of Physics has played for decades a very important role in planning, programming, organization and performing the scientific investigations in physics, as well as education in physics, and in related fields in Croatia. The Department has opposed inadequate initiatives, especially the limitation of intellectual freedom, disadvantageous laws and other political measures harmful to the state. The Department of Physics has been educating excellent research physicists and excellent teachers of physics. We dare say that all active physicists in the Republic of Croatia have been educated within the frames of the Department of Physics, Faculty of Science, Zagreb. Several professors, the members of the staff of the Department of Physics, have been holding advisory positions in the governmental institutions of the Republic of Croatia.

Full professors in the Department of Physics are first-rate scientists and highly internationally recognized physicists. All of them have spent years abroad performing research and teaching in prominent universities and laboratories, and now continue their high-level international collaboration with the best universities in Europe and in the United States. Their international experience is connected with many countries, e-g. Italy, France, Germany, Great Britain, Sweden, Switzerland, Denmark, Austria, Hungary, the United States, Australia... Our professors are able to competently create models of higher education and to recognize scientific investigation in most western countries.

The Department of Physics has been applying the ECTS grading scale since 1998, as the Faculty of Science was chosen as an experimentally institution for the implementation of higher education in line with the Bologna scheme. In the past, the students also used to enrol the Department of Physics, as well as to leave the Department of Physics, by individual applications/ requests and on the basis of the exam marks and/or the ECTS points. There have been our students who have successfully applied for fellowship, with duration of 3 to 6 months and enroled research laboratories in, e.g. Austria, Switzerland, the United States, Australia. There they have performed experiments necessary for their diploma theses, defended afterwards in the Department of Physics. There have been students who have completed their postgraduate studies, ended with the PhD thesis, in international laboratories.

## 1. INTRODUCTION

- 1.1. The students who complete their university study and are graduated in educational physics are competent to teach the subject Physics in the primary school (two final years), in the secondary school (four years) and in various vocational schools (two to four years). Besides, the subject Science, taught in the primary school, includes the topics related to physics.

The university study, proposed here, **is not a new one**, but only harmonized with 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 corresponding studies of physics in Europe.

- 1.2. Physics is a fundamental natural science and 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.

Therefore, the universities all around the world include programmes for education of teachers of physics.

The beginning of higher education of college-level physics in Zagreb dates back to the 17<sup>th</sup> century. Within the frames of the Faculty of Arts, the programme of physics was introduced in 1874. The Faculty of Science was founded in 1946, consisting of some departments which were separated from the Faculty of Arts. Therefore, the university programmes of Physics have a long and worthwhile tradition.

- 1.3. The university study of educational physics is an integral five-year study because it demands a trough knowledge of physics as one of the natural sciences, and the indispensable knowledge of mathematics, informatics, pedagogy, psychology, didactics and physical educations, as well as the basic knowledge of other branches of natural sciences on the basis of numerous elective courses. In consequence of this, a full expertise can be achieved only in the integral five-year study (in harmony with the recommendation of the **National Board for Higher Education, dated March 17<sup>th</sup>, 2005**).

- 1.4. All prominent universities in Europe and in the world include the programmes of educational physics.

- 1.5. We thing that the most important justification of this program should be that the students at primary and secondary school need nowadays a modern education oriented and more training in science including physics and computer science. This part of the general education will play an increasing importance in the modern world and by that reason one needs in the schools an increasing number of well trained teachers in these topics.

## 2. GENERAL

2.1. The term of study:	The University study of educational physics
2.2. The institution performing the study:	University of Zagreb, Faculty of Science, Department of Physics
2.3. The duration of study:	<b>An integral five-year study</b> (in harmony with the recommendation of the <b>National Board for Higher Education, dated March 17<sup>th</sup>, 2005</b> ). In order to complete successfully the programme it is necessary to pass all exams during the five years of study and to collect 300 ECTS points (60 ECTS points/year). According to the Bologna declaration the students may continue to study the programme in the next year if he/she passes all exams in the previous year.
2.4. Conditions for enrolment:	Secondary school, chemical vocational school, similar school with at least three-year programmes of mathematics, physics and chemistry. The conditions of the classification procedure could be find at <a href="http://www.phy.hr/">http://www.phy.hr/</a>
2.5. and 2.6. An integral five-year Undergraduate study and Graduate study	No diploma will be issued for the undergraduate study, because the students are not competent to teach physics after undergraduate three-year study; so there is no need for such personnel. There is always a possibility of the transfer to similar studies, after completion of any year of study, either in the frame of the Faculty of Science, or in other universities, with a condition of passing differential exams.
2.7. The graduation degree achieved at the end of study:	Teacher of physics (Physicae professor) (in harmony with the recommendation of the <b>National Board for Higher Education, dated March 17<sup>th</sup>, 2005</b> ).

### 3.1. Curriculum

#### YEAR 1

P = Lectures, V = Tutorial, S = Seminar, L = Lab

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Fundamentals of Physics 1	4+2+2+0	9		
Mathematical Analysis 1	3+2+0+0	7		
Linear Algebra 1	2+1+0+0	6		
Educational Psychology	4+2+0+0	5		
Fundamentals of Physics 2			4+2+0+0	8
Mathematical Analysis 2			3+2+0+0	7
Computers and Operating Systems			2+1+0+0	4
Statistics and Basic Physics Measurements			2+0+1+0	4
Linear Algebra 2			2+1+0+0	6
General Pedagogy			4+0+0+0	4
	<b>13+7+2+0</b>		<b>17+6+1+0</b>	
<b>TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:</b>	<b>22</b>	<b>27</b>	<b>24</b>	<b>33</b>

## YEAR 2

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Fundamentals of Physics 3	4+2+1+0	9		
Physics Lab 1	0+0+0+4	5		
Computing Lab 1	1+0+0+2	3		
Classical Mechanics 1	2+1+0+0	4		
Mathematical Methods in Physics 1	3+2+0+0	7		
Fundamentals of Physics 4			4+2+1+0	9
Physics Lab 2			0+0+0+4	5
Computing Lab 2			0+0+0+2	3
Classical Mechanics 2			1+1+0+0	4
Mathematical Methods in Physics 2			3+2+0+0	7
Elective courses: One of			2+1+0+0	4
General Ecology			2+1+0+0	
Fundamentals of programming			2+1+0+2	
General and Inorganic Chemistry			2+1+0+0	
	<b>10+5+1+6</b>		<b>10+6+1+6</b>	
<b>TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:</b>	<b>22</b>	<b>28</b>	<b>23</b>	<b>32</b>

### YEAR 3

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Selected Topics in General Physics	2+1+0+0	5		
Physics Lab 3	0+0+0+4	4		
Astronomy and Astrophysics	2+0+1+0	5		
Quantum Physics	4+2+0+0	8		
Elective courses: Two of the following	2+1+0+0	4		
	2+1+0+0	4		
Word processing and spread sheets	1+1+0+0			
Fundamentals of Physics of Materials	2+0+1+0			
Fundamentals of Biophysics	2+0+1+0			
Physics of the Earth and Atmosphere	2+1+0+0			
Data Structures and Algorithms	2+0+0+2			
Physics Lab 4			0+0+0+4	5
Electrodynamics			4+2+0+0	8
Statistical Physics			2+1+0+0	6
Didactics			4+0+0+0	4
Elective courses: Two of			2+1+0+0	4
			2+1+0+0	4
Physics and Philosophy			2+0+1+0	
Energy			2+0+1+0	
Differential equations - dynamical systems			2+0+0+1	
Multimedia Presentations			1+1+0+2	
Fundamentals of Geophysics			2+1+0+0	
	<b>12+5+1+4</b>		<b>15+5+0+4</b>	
<b>TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:</b>	<b>22</b>	<b>30</b>	<b>23</b>	<b>30</b>

## YEAR 4

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Laboratory in Physics Education 1	0+0+0+4	6		
Selected Topics in Solid State Physics	4+2+0+0	8		
Selected Topics in Nuclear and Particle Physics	4+2+0+0	8		
Physics Education 1	2+0+2+0	6		
Laboratory in Physics Education 2			0+0+0+4	6
Physics Education 2			2+0+4+0	7
Fundamentals of Atomic and Molecular Physics			2+1+0+0	7
Fundamentals of Electronics			2+2+0+0	7
Elective courses: One of			2+1+0+0	5
Medical Physics			2+1+0+0	
Physics of Disordered Systems			2+0+1+0	
Computers in Education			1+1+0+2	
	<b>10+4+2+4</b>		<b>8+4+4+4</b>	
<b>TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:</b>	<b>20</b>	<b>28</b>	<b>20</b>	<b>32</b>

## YEAR 5

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Laboratory in Physics Education 3	0+0+0+4	5		
Teaching practice 1	0+0+4+0	5		
Laboratory in Fundamentals of Electronics	0+0+0+3	6		
History of Physics	2+0+1+0	4		
Elective courses: two of	2+1+0+0	5		
	2+1+0+0	5		
Seminar in Fundamentals in Atomic and Molecular Physics	0+0+3+0			
Seminar in Selected Topics in Solid State Physics	0+0+3+0			
Seminar in Selected Topics in Nuclear and Particle Physics	0+0+3+0			
Seminar in Quantum Physics and Theory of Relativity Education	0+0+3+0			
Physics of Nanomaterials	2+0+1+0			
Low Temperature Physics and Superconductivity	2+1+0+0			
Teaching Practice 2			0+0+4+0	5
Seminar in Thesis Research			0+0+2+0	3
Thesis Research			0+14+0+0	22
	<b>6+2+5+7</b>		<b>0+14+6+0</b>	
<b>TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:</b>	<b>20</b>	<b>30</b>	<b>20</b>	<b>30</b>

### 3.2. Curriculum (Details)

COURSE TITLE: Fundamentals of Physics 1		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
UNIVERSITY STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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	2	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>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</p>		

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.

**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:**

**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: Mathematical analysis 1		
COURSE TEACHER/TEACHERS: Siniša Slijepčević, PhD		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 1		
SEMESTER: 1		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	3	Teacher
Exercises	2	Assistant
Seminars		
Laboratory		
ECTS credits: 7 ETCS		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding and being able to use elementary techniques of Mathematical analysis		
DESCRIPTION OF THE COURSE:		
<ol style="list-style-type: none"> <li>1. Functions and graphs: Limit and continuity, understanding of limit, calculating limits of sequences and functions, asymptotic, limit of <math>\sin x / x</math> when <math>x \rightarrow 0</math>, continuous functions, properties of continuous functions, precise definition of limit in infinity and when <math>x \rightarrow a</math>.</li> <li>2. Derivation: the problem of tangents, the problem of speed, definition of derivation, definition of sums, difference between products and quotients, derivation of trigonometric functions, derivation of composition of functions</li> <li>3. Lagrange theorem and applications: drawing of a graph of a function, derivation of higher order and binomial theorem, convexity and concavity, implicit function theorem, differential</li> </ol>		
STUDENT OBLIGATIONS DURING THE COURSE: 6 homeworks, 2 tests		
METHODS TO EVALUATE STUDENT PERFORMANCE: Homeworks, tests		
EXAMINATION METHODS: Written and oral examination		
COURSE(S) NEEDED FOR THIS COURSE: None		
COMPULSORY LITERATURE:		

S.K. Stein, Calculus and Analytic Geometry, McGraw-Hill,1987.

L. Krnić, Z. Šikić, Račun diferencijalni i integralni, I.dio, Školska knjiga, Zagreb,1992.

P. Javor, Matematička analiza I, Element, Zagreb, 1995.

S. Kurepa, Matematička analiza I, Tehnička knjiga, Zagreb

S. Kurepa, Matematička analiza II, Tehnička knjiga, Zagreb

B.P. Demidovič, Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb

ADDITIONAL READING:

COURSE TITLE: <b>Linear Algebra 1</b>		
COURSE TEACHER/TEACHERS: <b>Dr. Vjeran Hari, professor, Department of Mathematics, University of Zagreb.</b>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: <b>First</b>		
SEMESTER: <b>First (fall semester)</b>		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	2	teacher
Exercises	1	assistant
Seminars	0	Not obligatory
Laboratory		
ECTS credits: 6		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: <b>The students should acquire basic concepts and techniques of linear algebra which lead to clear understanding of the theory of a general system of linear equations and algorithms for solving it.</b>		
DESCRIPTION OF THE COURSE: <b>Introduction to linear systems. Vector space of real and complex n-tuples. Groups, rings, fields and general vector spaces. Scalar product and norm. Vector space <math>V^3</math>, analytical geometry in <math>E^3</math>. Matrices. Linear independent vectors, basis of a vector space, rank of a matrix. Homogeneous system of linear equations. Row-echelon form of a matrix. Nonhomogeneous system of linear equations and Gauss eliminations.</b> <b>The instructor will conduct classical teaching enhanced by computer driven projector. Interactive programs like Matlab and Mathematica will be at disposal to students.</b>		
STUDENT OBLIGATIONS DURING THE COURSE: To attend lectures and exercises regularly or to pass at least two colloquia exams.		
METHODS TO EVALUATE STUDENT PERFORMANCE: <b>Three colloquia exams during the semester, each one including few thoretical questions and several concrete problems to solve. The students with programming skills can get additional computational projects.</b>		
EXAMINATION METHODS: <b>In order to pass the exam, the student should collect sufficient points at each colloquium and the final mark will depend upon the sum of all collected points. Additionally, there will be only three terms for students to take exam. One in winter</b>		

**examination period, one in summer and one in fall examination period.**

COURSE(S) NEEDED FOR THIS COURSE: None

**COMPULSORY LITERATURE:**

- V. Hari: Linearna algebra. Manuscript freely available on the web from 1998 (see [www.math.hr/~hari](http://www.math.hr/~hari))
- K. Nipp, D. Stoffer: Lineare Algebra, ETH, Zürich 1994.
- N. Bakić, A. Milas: Zbirka zadataka iz linearne algebre. Matematički odjel PMFa.

**ADDITIONAL READING:**

- S. Lipschutz , M. Lipson: Schaum's Outline of Linear Algebra, McGraw-Hill, 3rd ed. 2001.
- N. Elezović: Linearna algebra, Element, Zagreb 1995.
- S. Lang: Linear Algebra, Springer Verlag, 3rd ed. 1987.

COURSE TITLE: Educational Psychology		
COURSE TEACHER/TEACHERS: <u>Dr. sc. Nikola Pastuović, redoviti profesor</u> <u>Učiteljska akademija Sveučilišta u Zagrebu</u>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 1		
SEMESTER: 1		
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: 5		
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"> <li>• The subject-matter and the development of Educational Psychology</li> <li>• The Concept of Personality and ways of researching personality</li> <li>• The Humanistic approach in Personality Psychology</li> <li>• The Personality Structure</li> <li>• Individual differences and measuring standards</li> <li>• Heredity and the environment in the genesis of individual differences</li> <li>• The Educational consequences of individual differences in intellectual abilities</li> <li>• The Educational consequences of individual differences in conative characteristics</li> <li>• The Development of moral conscience and the theories of moral development</li> <li>• School and Moral development</li> </ul>		

<b>STUDENT OBLIGATIONS DURING THE COURSE:</b> Students need to successfully carry out all the tasks, regularly attend classes and actively participate during classes.	
<b>METHODS TO EVALUATE STUDENT PERFORMANCE:</b>	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
<b>EXAMINATION METHODS:</b> The exam is oral	
<b>COURSE(s) NEEDED FOR THIS COURSE:</b> There are no special enrolment conditions.	
<b>COMPULSORY LITERATURE:</b> Pastuović, N. (1997). Osnove psihologije obrazovanja i odgoja. Zagreb: Znamen	
<b>ADDITIONAL READING:</b> 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 Physics 2		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
UNIVERSITY STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: <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>		
DESCRIPTION OF THE COURSE: <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>		
STUDENT OBLIGATIONS DURING THE COURSE: Students are supposed to attend lectures and exercises, and to perform obligatory oral and written tests during the term.		
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.		

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:

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: Mathematical analysis 2		
COURSE TEACHER/TEACHERS: Siniša Slijepčević, PhD		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 1		
SEMESTER: 2		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	3	Teacher
Exercises	2	Assistant
Seminars		
Laboratory		
ECTS credits: 7 ETCS		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding and being able to use elementary techniques of Mathematical analysis		
DESCRIPTION OF THE COURSE:		
<ol style="list-style-type: none"> <li>4. Integration: introduction, definite integral, fundamental theorems of calculus, inverse integration and definite integral, proofs of fundamental theorems</li> <li>5. Elementary functions: logarithmic and exponential function, inverse trigonometric functions, separable differential equation, hyperbolic functions, L'Hospital rule</li> <li>6. Techniques of integration: substitution, partial integration, integrating rational functions, integrating trigonometric functions, applications of integral</li> <li>7. Sequences: integral test, comparing sequences, absolute convergence, Taylor's formula</li> </ol>		
STUDENT OBLIGATIONS DURING THE COURSE: 6 homeworks, 2 tests		
METHODS TO EVALUATE STUDENT PERFORMANCE: Homeworks, tests		
EXAMINATION METHODS: Written and oral examination		
COURSE(S) NEEDED FOR THIS COURSE: None		
COMPULSORY LITERATURE:		
S.K. Stein, Calculus and Analytic Geometry, McGraw-Hill, 1987.		

L. Krnić, Z. Šikić, Račun diferencijalni i integralni, I.dio, Školska knjiga, Zagreb, 1992.

P. Javor, Matematička analiza I, Element, Zagreb, 1995.

B.P. Demidovič, Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb

ADDITIONAL READING:

S. Kurepa, Matematička analiza I, Tehnička knjiga, Zagreb

S. Kurepa, Matematička analiza II, Tehnička knjiga, Zagreb

COURSE TITLE: Computers and Operating Systems		
COURSE TEACHER/TEACHERS: Prof. dr. sc. Damir Bosnar		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 1		
SEMESTER: 2		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	2	
Exercises	1	
Seminars		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Basics of computer and operating system		
DESCRIPTION OF THE COURSE: Main computer components and their properties: processor, main memory, secondary memory storages, other input-output components. General properties of modern operating systems and process scheduling, memory management, file systems, management of input/output units. Specific operating systems: Windows, Unix/Linux. Computer networks and usage of the web.		
STUDENT OBLIGATIONS DURING THE COURSE: Execution of assignments using computers.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Attending the lectures and individual work on computers.		
EXAMINATION METHODS: Practical work on computers. Oral exam.		
COURSE(S) NEEDED FOR THIS COURSE:		
COMPULSORY LITERATURE: A. Tanenbaum: Modern Operating systems, Prentice Hall, 2001.		
ADDITIONAL READING: Materials on the web.		

<b>COURSE TITLE: Statistics and basics of physical measurements</b>		
<b>PROPOSED BY</b> ( <i>PhD Ime Prezime, zvanje, fakultet, sveučilište</i> ): <b>PhD Dinko Babić, assistant professor, Faculty of Science, University of Zagreb</b>		
<b>PROGRAMME: Educational Physics - Teacher of Physics</b>		
<b>YEAR OF STUDY: 1</b>		
<b>SEMESTER: 2</b>		
<b>TYPES OF INSTRUCTION</b>	<b>CONTACT HRS PER WEEK</b>	<b>DELIVERED BY</b>
Lectures	2	lecturer
Examples Classes	1	assistant
Seminars		
<b>ECTS CREDITS: 4</b>		
<b>COURSE AIMS AND OBJECTIVES: Introduction into basic concepts of statistics and their application to analysis of experiment.</b>		
<b>COURSE DESCRIPTION AND SYLLABUS:</b> Combinatorics, elementary and conditional probability. Empirical data. Distribution of frequencies. General statistical parameters. One-dimensional discrete statistical distributions. Binomial and Poisson distribution. One-dimensional continuous statistical distributions. Gaussian distribution. Multidimensional statistical distributions. Theory of random errors, linear regression, analysis and presentation of experiment.		
<b>TEACHING AND ASSESSMENT METHODS: Lectures (theoretical background) and exercises (practical problems)</b>		
<b>PREREQUISITES: Elementary mathematics, including basics of calculus.</b>		
<b>READING LIST: Pavlič, Statistička teorija i primjena, Tehnička knjiga, Zagreb 1970. Vranić, Vjerojatnost i statistika, Tehnička knjiga, III izdanje, Zagreb, 1970.</b>		
<b>ADDITIONAL READING: none</b>		

COURSE TITLE: <b>Linear Algebra 2</b>		
COURSE TEACHER/TEACHERS: <b>Dr. Vjeran Hari, professor, Department of Mathematics, University of Zagreb.</b>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: <b>First</b>		
SEMESTER: <b>Second (spring semester)</b>		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	2	teacher
Exercises	1	assistant
Seminars	0	Not obligatory
Laboratory		
ECTS credits: 6		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: <b>The students should acquire basic concepts and techniques of linear algebra which lead to clear understanding of the theory of matrix equations, principal classes of matrices, determinants, linear operators and eigenvalue problems.</b>		
DESCRIPTION OF THE COURSE: <b>Linear matrix equations, regular matrices, elementary matrices. The main classes of matrices. Determinants and Cramer's rule. Linear operators, coordinatization. Matrix as operator representation in a pair of bases. Composition of linear operators with examples. Eigenvalues and eigenvectors. Diagonalization of a symmetric matrix and Jacobi method.</b>		
STUDENT OBLIGATIONS DURING THE COURSE: <b>To attend lectures and exercises regularly or to pass at least two colloquia exams.</b>		
METHODS TO EVALUATE STUDENT PERFORMANCE: <b>Three colloquia exams during the semester, each one including few theoretical questions and several concrete problems to solve. The students with programming skills can get additional computational projects.</b>		
EXAMINATION METHODS: <b>In order to pass the exam, the student should collect sufficient points at each colloquium and the final mark will depend upon the sum of all collected points. Additionally, there will be only three terms for students to take exam. One in summer examination period, one in fall and one in winter examination period.</b>		
COURSE(S) NEEDED FOR THIS COURSE: <b>Linear Algebra 1</b>		

#### COMPULSORY LITERATURE:

- V. Hari: Linearna algebra. Manuscript freely available on the web from 1998 (see [www.math.hr/~hari](http://www.math.hr/~hari))
- K. Nipp, D. Stoffer: Lineare Algebra, ETH, Zürich 1994.
- N. Bakić, A. Milas: Zbirka zadataka iz linearne algebre. Matematički odjel PMFa.

#### ADDITIONAL READING:

- S. Lipschutz , M. Lipson: Schaum's Outline of Linear Algebra, McGraw-Hill, 3rd ed. 2001.
- N. Elezović: Linearna algebra, Element, Zagreb 1995.
- S. Lang: Linear Algebra, Springer Verlag, 3rd ed. 1987.

COURSE TITLE: General Pedagogy		
COURSE TEACHER/TEACHERS: Dr. sc. Marija Bratanić, red. prof. Učiteljska akademija Sveučilišta u Zagrebu		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</p> <p>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.</p>		
<p>DESCRIPTION OF THE COURSE:</p> <ul style="list-style-type: none"> <li>• Education - fundamental notions.</li> <li>• Education - the goals, norms and values.</li> <li>• The division and tendencies in pedagogy as a science about education.</li> </ul>		

- 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 Physics 3		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
UNIVERSITY STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:		
<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>		
DESCRIPTION OF THE COURSE:		
<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>		
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.		
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.

**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 Lab 1		
COURSE TEACHER/TEACHERS: Prof. Dr. Sc. Mirko Stubičar, Department of Physics, Faculty of Science, University of Zagreb		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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: 5		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The main goal is to provide the student with simple experiments in physics (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.).</p>		
<p>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:</p> <ol style="list-style-type: none"> <li>1. The Nature of Measurements. Definitions and Related Concepts: Types of Measurement, Measurement as a Relation, Sources of Variability in Measurement, Scales of Measurement.</li> <li>2. The Precision and Accuracy of Measurements. The Concepts of Precision and Accuracy; The Measurement of Accuracy; Statistical Measures of Precision.</li> <li>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.</li> </ol>		

#### 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:

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 cotton 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).

**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 for each exercise will write the final report.

**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

**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: Computing Lab 1 and 2		
COURSE TEACHER/TEACHERS: Prof. dr. sc. Damir Bosnar		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 2		
SEMESTER: 3 , 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	1 0	teacher
Exercises	2 2	teacher
Seminars		
ECTS credits: 3 , 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Usage of computers in evaluation of specific problems in mathematics and physics.		
DESCRIPTION OF THE COURSE: Practical work with the most used modern computer operating systems: Windows, Linux, Unix. Usage of computer programs written in higher languages. Usage of specific applications: text processing, graphics, applications for solving problems in mathematics and physics, user libraries. Work on the web. Computers in teaching of physics: computer simulations of physical processes.		
STUDENT OBLIGATIONS DURING THE COURSE: Execution of assignments using computers.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Attending the lectures and individual work on computers.		
EXAMINATION METHODS: Practical work on computers.		
COURSE(S) NEEDED FOR THIS COURSE: Computers and operating systems.		
COMPULSORY LITERATURE: Lurnix: Unix Made Easy; Basics and Beyond, Osborne McGraw-Hill,1990 Documentation of specific applications: Mathematics, Microsoft-office, Gnuplot.		
ADDITIONAL READING: Materials on the web.		

COURSE TITLE: Classical Mechanics 1		
COURSE TEACHER/TEACHERS: Vladimir Paar		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 2		
SEMESTER: 3		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	2	teacher
Exercises	1	assistant
Seminars		
Laboratory		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Recapitulation and deeper understanding of basic concepts of classical mechanics. Theoretical treatment of illustrative examples from classical dynamics with particular emphasis for teaching classical mechanics in school.		
DESCRIPTION OF THE COURSE: Conceptual framework of inertia and inertial forces. Dynamics of single-body problem under influence of force. Euler method for numerical solution of Newton equation and illustrative examples of one- and two-dimensional motion caused by given forces. Illustrative examples of nonlinear dynamics. Algebraic integration of Newton equation by quadrature and determination of constants of motion for illustrative cases of one-dimensional motion (harmonic oscillator, pendulum, etc.).		
STUDENT OBLIGATIONS DURING THE COURSE: lecture and exercise attendance, obligatory colloquia		
METHODS TO EVALUATE STUDENT PERFORMANCE: written and oral examination		
EXAMINATION METHODS: written and oral examinations		
COURSE(S) NEEDED FOR THIS COURSE: general physics		
COMPULSORY LITERATURE: M. Tabor, <i>Chaos and integrability in nonlinear dynamics – An introduction</i> (Wiley, 1989)		

A. Beiser, Physics (Benjamin, 1982)

ADDITIONAL READING: W.P. Crummett, A.B. Western, University Physics, Models and Applications (Mc Graw Hill, 1994)

H.O. Peitgen (ed) Newtons method and dynamical systems (kluver, 1989)

COURSE TITLE: **Mathematical Methods in Physics 1**

COURSE TEACHER/TEACHERS: **Prof. dr. Dražen Adamović**

STUDY PROGRAMME:

**Educational Physics - Teacher of Physics**

YEAR OF STUDY: second year

SEMESTER: third semester

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	3	teacher
Exercises	2	assistant
Seminars		
Laboratory		

ECTS credits: 7

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

**The goal of this course is to develop some methods from mathematical analysis, theory of analytic functions, differential equations and special functions which have applications in physics.**

DESCRIPTION OF THE COURSE:

- 1. Complex numbers. The complex plane. Sequences of complex numbers.**
- 2. Complex functions. Continuity and limes of a function.**
- 3. Functions of many variables. Differentiating functions of many variables. Partial derivations.**
- 4. The derivation of a complex function. Analytic functions.**
- 5. The Cauchy-Riemann equations. Examples of analytic functions.**
- 6. Series of functions. Convergence of series of functions. Power series.**
- 7. The integral of a complex function.**
- 8. Cauchy's theorem and Cauchy's integral formula**
- 9. The Taylor expansion of an analytic function.**
- 10. The Laurent expansion of an analytic function.**
- 11. Isolated singularities. Classification of isolated singularities.**

- 12. The residue theorem. Applications of the residue theory on real integrals.**
- 13. The Gamma and beta functions.**

**STUDENT OBLIGATIONS DURING THE COURSE:**

**Attendance on lectures and exercises is required. Each student must write homework assignments and attend two colloquiums during the course.**

**METHODS TO EVALUATE STUDENT PERFORMANCE:**

**During the semester teacher will evaluate student homework assignments. Students will have two colloquiums and the final exam.**

**EXAMINATION METHODS:**

**The final exam will be written or oral. Colloquiums will have the form of a written exam. The final evaluation is based on the result of the final exam and evaluations of homework and colloquiums.**

**COURSE(S) NEEDED FOR THIS COURSE:**

**Linear Algebra I, II; Mathematical Analysis I,II**

**COMPULSORY LITERATURE:**

- 1. H. Kraljević, Matematičke metode fizike 1, Skripta-PMF 1976**

**ADDITIONAL READING:**

- 1. Š. Ungar, Matematička analiza III, Matematički odjel PMF, Zagreb 1994.**
- 2. Š. Ungar, Matematička analiza IV, Matematički odjel PMF, Zagreb 2001**
- 3. H. Kraljević, S. Kurepa, Matematička analiza 4, Tehnička knjiga, Zagreb, 1986**

COURSE TITLE: Fundamentals of Physics 4		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
UNIVERSITY STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:		
<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>		
DESCRIPTION OF THE COURSE:		
<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>		
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.		
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.

**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 Lab 2		
COURSE TEACHER/TEACHERS: Prof. Dr. Sc. Mirko Stubičar, Department of Physics, Faculty of Science, University of Zagreb		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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: 5		
<p>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The course Laboratory Exercises in Physics 2 (abbr. LEP 2) is continuation of the course Laboratory Exercises in Physics 1(LEP 1). 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 1, i.e. the measurements of physical quantities and their statistical joint dependence. In this course student will carry-out experiments selected 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"> <li>1. The fundamental principles and practical operation of: AVO-meter instrument and oscilloscope apparatus.</li> </ol>		

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:

- 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.

**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 for each exercise will write the final report.

**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 mark.

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

**COURSE(S) NEEDED FOR THIS COURSE:** Fundamentals of Physics 1

**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: Classical Mechanics 2		
COURSE TEACHER/TEACHERS: Vladimir Paar		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	1	teacher
Exercises	1	assistant
Seminars		
Laboratory		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understandnis of basic concepts of nonlinear, Lagrangean and Hamiltonian classical mechanics.		
DESCRIPTION OF THE COURSE: Introduction into classical dynamics in phase space for many-body problems. Generalized coordinates. Introduction into nonlinear dynamics. Introduction into Lagrange and Hamilton formulations of classical mechanics. Conservation laws in classical mechanics.		
STUDENT OBLIGATIONS DURING THE COURSE: Deeper understanding of dynamical concepts of classical mechanics and illustrative examples.		
METHODS TO EVALUATE STUDENT PERFORMANCE: colloquia, written and oral examinations.		
EXAMINATION METHODS: written and oral examinations		
COURSE(S) NEEDED FOR THIS COURSE: general physics		
COMPULSORY LITERATURE: W.P. Crummett, A.B. Western, University Physics, Models and Applications (Mc Graw Hill, 1994) H.O. Peitgen (ed) Newtons method and dynamical systems (kluver, 1989)		

ADDITIONAL READING: M. Tabor, *Chaos and integrability in nonlinear dynamics – An introduction* (Wiley, 1989)

A. Beiser, *Physics* (Benjamin, 1982)

COURSE TITLE: <b>Mathematical Methods in Physics 2</b>		
COURSE TEACHER/TEACHERS: <b>Prof. dr. Dražen Adamović</b>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: <b>second year</b>		
SEMESTER: <b>fourth semester</b>		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	3	teacher
Exercises	2	assistant
Seminars		
Laboratory		
ECTS credits: 7		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:  <b>The goal of this course is to develop some methods from the theory of ordinary and partial differential equations and special functions which are important for students of physics. Particular emphasis will be put on the study of Legendre polynomials, Bessel functions, spherical functions and to the Laplace and wave partial differential equations.</b>		
DESCRIPTION OF THE COURSE:  <b>1. Ordinary differential equations. 2. Linear differential equations. First order linear differential equations. 3. Theorem on existence and uniqueness of solutions of the Cauchy problem for linear differential equations . 4. Linear independence of functions. Wronsky's determinant. 5. Linear differential equations with constant coefficients. 6. Nonhomogeneous equations. The method of variations of parameters. 7. Solving differential equations using power series. 8. Fourier analysis. Fourier transform. Application. 9. Second order linear differential equations with regular singularities. 10. The Legendre polynomials and Legendre's differential equation. The</b>		

- generating function of Legendre polynomials.
11. The associated Legendre functions. Spherical functions.
  12. Laplace's differential equation. Separation of variables.
  13. The wave equation.
  14. The Bessel functions and Bessel's differential equation.
  15. The Schroedinger differential equation. Laguerre's polynomials.

STUDENT OBLIGATIONS DURING THE COURSE:

Attendance on lectures and exercises is required. Each student must write homework assignments and attend two colloquiums during the course.

METHODS TO EVALUATE STUDENT PERFORMANCE:

During the semester teacher will evaluate student homework assignments. Students will have two colloquiums and the final exam.

EXAMINATION METHODS:

The final exam will be written or oral. Colloquiums will have the form of a written exam. The final evaluation is based on the result of the final exam and evaluations of homework and colloquiums.

COURSE(S) NEEDED FOR THIS COURSE:

Linear Algebra I, II; Mathematical Methods of Physics I

COMPULSORY LITERATURE:

1. H. Kraljević, Matematičke metode fizike 2, Skripta PMF, 1976.

ADDITIONAL READING:

1. M. Alić, Diferencijalne jednađbe, skripta, PMF-Matematički odjel, 1994.
2. I. Aganović, K. Veselić, Jednađbe matematičke fizike, 1. svezak, Školska knjiga Zagreb, 1985.
3. G. Arfken, Mathematical methods for physicists, 3rd ed., Academic Press, New York, 1985

COURSE TITLE: <b>General Ecology</b>		
COURSE TEACHER/TEACHERS: <b>Dr Zlatko Mihaljević, Assistant Professor</b>		
STUDY PROGRAMME: <b>University study of educational physics</b>		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	2	teacher
Exercises	1	assistant
Seminars		
Laboratory		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: <b>The student will be able to examine interactions between groups of organisms, with the environment, and the effect that has on their distribution and abundance. Also the students will have the opportunity to become familiar with the breath of Ecology and to begin to develop an understanding of basic facts, principles, and concepts.</b>		
DESCRIPTION OF THE COURSE: <b>Definitions of ecology, objects and aims. Subdisciplines in ecology. Ecology as an interdisciplinary science. The abiotic factors and conditions for life. Properties of populations. Population growth and life history patterns. Interspecific relationships. The concept of the niche. Community structure and dynamics. Production in ecosystems, energy flow and trophic structure. Biogeochemical and nutrient cycles. Global environmental change (global warming, the ozone hole, and acid rains). Biomes and the major terrestrial ecosystems. Freshwater and marine ecosystems.</b>		
STUDENT OBLIGATIONS DURING THE COURSE: <b>Lectures, exercises and colloquia during a semester.</b>		
METHODS TO EVALUATE STUDENT PERFORMANCE: <b>exercises and colloquia</b>		

**during a semester.**

EXAMINATION METHODS: Exam consists of a written and an oral part.

COURSE(S) NEEDED FOR THIS COURSE:

COMPULSORY LITERATURE:

**Smith R.L., Smith T.M., 2000: Elements of Ecology. Benjamin/Cummings Science Publishing.**

ADDITIONAL READING:

**Glavač, V., 1999: Uvod u globalnu ekologiju. Državna uprava za zaštitu prirode i okoliša/Hrvatske šume, javno poduzeće za gospodarenje šumama i šumskim zemljištima u Republici Hrvatskoj, Zagreb**

**Scott, M., 1994.: Ekologija. Oxford University Press.**

COURSE TITLE: Fundamentals of Programming		
COURSE TEACHER/TEACHERS: Doc.dr. Nenad Pavin		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	2	teacher
Exercises	1	teacher
Seminars		
Laboratory	2	assistant
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The course is designed that a student accomplish skills necessary for programming in imperative (procedural) programming language (C)		
DESCRIPTION OF THE COURSE: <ol style="list-style-type: none"> <li>1. Memory Concept, Variable</li> <li>2. Control Structures, The <b>if</b> Selection Structure, The <b>if/else</b> Selection Structure, The <b>while</b> Repetition Structure</li> <li>3. Assignment Operators, The <b>for</b> Repetition Structure, The <b>do/while</b> Repetition Structure, The <b>switch</b> Multiple-Selection Structure</li> <li>4. Functions</li> <li>5. Arrays</li> <li>6. Pointers</li> <li>7. Characters and Strings</li> <li>8. Structures, Unions, Bit Manipulations and Enumarations</li> <li>9. File Processing</li> <li>10. Data structures and Dynamic Memory Allocation</li> <li>11. Preprocessor</li> </ol>		

STUDENT OBLIGATIONS DURING THE COURSE:

During laboratory student has to solve ten simple problems.

METHODS TO EVALUATE STUDENT PERFORMANCE:

The student has to write two more complicated programs, and two colloquia.

EXAMINATION METHODS:

The final mark is consists of laboratory examination (40% of mark) and of two colloquia (2×30% of mark). The final exam is optional.

COURSE(S) NEEDED FOR THIS COURSE:            Introduction to Computer Science

COMPULSORY LITERATURE:

**Deitel H.M. & Deitel P.J., C – How to Program, PRENTICE HALL**

ADDITIONAL READING:

COURSE TITLE: General and inorganic chemistry		
COURSE TEACHER/TEACHERS: prof. Ivan Vicković, Ph.d., Faculty of Science, Univ. of Zagreb		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	2	teacher
Exercises	1	assistant
Seminars	0	
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To learn the fundamentals of chemical reactions and basic properties of elements and compounds, conformed to the study programme in physics		
DESCRIPTION OF THE COURSE: Lectures: Thermochemistry, Physical properties of solutions and gases, Solid state chemistry, Structure of atoms and molecules, Chemical kinetics and equilibrium, Electrochemistry, Inorganic compounds, Instrumental analytical methods in chemistry Exercises: Stoichiometry according to the lectures		
STUDENT OBLIGATIONS DURING THE COURSE: To follow the lectures, to solve the assignments weekly, to have consultations, to pass 2 colloquia during semester or the written examination (who failed the colloquia) at the end of the lectures and to pass the oral examination		
METHODS TO EVALUATE STUDENT PERFORMANCE: The first teacher's signature confirmed the student's registration to the course, the second one confirmed that student met his/her commitments (lectures, assignments and colloquia) except the examination.		
EXAMINATION METHODS: A grade structure: the assignments 10 %, the colloquia 2 x 25%, oral examination 40%, or the		

asignements 10 %, written examination 40 %, and oral examination 50%

COURSE(S) NEEDED FOR THIS COURSE: none prerequisite requested

COMPULSORY LITERATURE:

P.W. Atkins i M.J.Clugstone, *Načela fizikalne kemije*, Školska knjiga, Zagreb 1989

M. Sikirica i B. Korpar-Čolig, *Kemija s vježbama 1*, Školska knjiga, Zagreb 1993

M. Sikirica i B. Korpar-Čolig, *Kemija s vježbama 2*, Školska knjiga, Zagreb 1994.

M.Sikirica, *Stehiometrija*, Školska knjiga 1989

ADDITIONAL READING:

S.H. Pine, *Organska kemija*, Dodatak A1-A6, Školska knjiga, Zagreb 1994

I.Filipović i S.Lipanović, *Opća i anorganska kemija*, 9. izdanje, Školska knjiga, Zagreb 1995

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

COURSE TITLE: Selected Topics in Physics		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
UNIVERSITY STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 3		
SEMESTER/TERM: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	2	professor
Exercises	1	professor/assistant
Seminars		
ECTS credits: 5		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: An overall view on /integral approach to/ the physical laws, achieved through courses Fundamentals of Physics 1-4, by considering possible analogies. To clarify misconceptions or misunderstanding in connection with physical laws, noticed during lectures, exercises, seminars and exams of Fundamentals of Physics 1-4. To introduce new topics of physics which are important for continuation of the study as well as to discuss contemporary achievements in physics.		
DESCRIPTION OF THE COURSE: In order to achieve an integral view on physics, possible analogies among natural phenomena and processes are treated in detail, e.g. problems, related to different branches of physics, which can be solved by applying the same procedure: motion of a particle along a path - rotation of a particle/rigid body around a given axis; gravitational field - electric field - magnetic field; mechanical oscillations - electromagnetic oscillations, etc. Also, contemporary problems and achievements in physics are discussed, especially those, which could be included in the programme of physics in the secondary schools: general and special theory of relativity, contemporary astrophysics, structure of matter at the atomic level, etc.		
STUDENT OBLIGATIONS DURING THE COURSE: Students are supposed to attend lectures and exercises and to autonomously submit a given topic in physics to other students.		
METHODS TO EVALUATE STUDENT PERFORMANCE:		
EXAMINATION METHODS: The exam may include a written part and an oral part. The students, who successfully submit the proposed topic in physics, are to pass only the oral part of the exam.		

COURSE(s) NEEDED FOR THIS COURSE: Fundamentals of Physics 1, 2, 3, 4.

COMPULSORY LITERATURE:

R.A. Serway, Physics for Scientists and Engineers, Saunders Publ., London, 1996

D. Halliday, R. Resnik, J. Walker, Fundamentals of Physics, John Wiley, New York, 1997

( or new editions)

ADDITIONAL READING: Scientific American, Physics Today...

COURSE TITLE: <b>PHYSICS LAB 3</b>		
COURSE TEACHER/TEACHERS: <b>dr.sc. Gorjana Jerbić-Zorc</b>		
UNIVERSITY STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: <b>3</b>		
SEMESTER: <b>5</b>		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures		
Exercises		
Seminars		
Laboratory	<b>4</b>	<b>Teacher/assistant</b>
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: <b>Understanding of physical foundations of the exercise to be done. Be able to explain measurements and results.</b>		
DESCRIPTION OF THE COURSE: <ol style="list-style-type: none"> <li><b>1. Lenses and optical instruments</b></li> <li><b>2. Interference of light</b></li> <li><b>3. Newton's rings</b></li> <li><b>4. Diffraction of light at a slit and an edge</b></li> <li><b>5. Polarisation by quarterwave plates</b></li> <li><b>6. The microscope</b></li> <li><b>7. Two-electron spectra with the prism spectrometer</b></li> <li><b>8. Atomic spectra of two-electron systems with the diffraction grating</b></li> <li><b>9. Measuring the velocity of light</b></li> </ol>		
STUDENT OBLIGATIONS DURING THE COURSE: <b>Preparation and execution of all exercises. Report on the measurements and results after each exercise</b>		
METHODS TO EVALUATE STUDENT PERFORMANCE: <b>All exercises and reports have to be done. Each exercise is given a mark.</b>		
EXAMINATION METHODS: <b>No final exam unless student is not satisfied with the given final mark.</b>		
COURSE(S) NEEDED FOR THIS COURSE: <b>General Physics 3</b>		

COMPULSORY LITERATURE: : **script on the web with setup for each exercise**

ADDITIONAL READING: **any General Physics Course**

COURSE TITLE: Astronomy and Astrophysics

COURSE TEACHER/TEACHERS: Prof. Krešimir Pavlovski

STUDY PROGRAMME: University study of educational physics - **Teacher of Physics**

YEAR OF STUDY: 3

SEMESTER: 5

TEACHING  
METHODS

CONTACT HRS  
PER WEEK

DELIVERED BY  
(*teacher or assistant*)

Lectures

2

teacher

Exercises

Seminars

1

assistant

ECTS credits: 5

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, aberation 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, *Astronomija I and II*, Školska knjiga, Zagreb 1990

ADDITIONAL READING:

M. Zeilik, Astronomy – the evolving universe, John Wiley & Sons, New York, 1997

COURSE TITLE: Quantum physics		
COURSE TEACHER/TEACHERS: Prof. dr. sc. Dubravko Klabučar		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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: 8		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Mastering the fundamental concepts of quantum mechanics, understanding the basics of quantum physics and functioning of simple quantum systems. Qualitative and informative explanations of some more complex quantum systems.		

**DESCRIPTION OF THE COURSE:**

- Introduction: conceptual and historical.
- Quanta of energy, and photons, the quanta of light: blackbody radiation, photoelectric effect, Compton effect, the dual particle-wave nature of photons.
- The dual particle-wave nature of matter and the waves of probability: Bohr model of the hydrogen atom, De Broglie hypothesis about the wave nature of micro-particles and its confirmation by Davisson-Germer experiment. The particle-wave duality of micro-particles and the necessity of their description through wave functions – probability amplitudes. Probabilistic nature of quantum physics in contrast to classical determinism. Heisenberg uncertainty relations.
- Some elements of the wave formalism and some motivation for the postulates of quantum mechanics.
- The postulates of quantum mechanics. Operators, eigenfunctions and eigenvalues. Illustrations on simple examples.
- The simplest bound state. Elements of the mathematical formalism. Schrödinger equation for the particle in the infinitely deep square potential well.
- The principle of superposition in quantum mechanics.
- Commutation properties of operators. Compatible and complementary observables.
- Time evolution, conservation theorems and symmetries, including parity.
- More involved one-dimensional problems for bound and unbound states. Harmonic oscillator. Some one-dimensional scattering problems. Tunneling through a rectangular barrier. The square potential well of finite depth: bound states and their energies.
- Extension to multi-particle and multi-dimensional systems. Symmetrical and antisymmetrical wave functions for two (and more) identical particles.
- Extension to three space dimensions. Introduction of angular momentum. Introduction of spin in an intuitive way. Fermions and bosons, remark on the spin-statistics connection for quantum objects.
- Hydrogen atom and similar systems.
- Pauli principle and a qualitative description of more complex atomic and molecular systems.

**STUDENT OBLIGATIONS DURING THE COURSE:** Handing in at least a minimal number of homeworks

**METHODS TO EVALUATE STUDENT PERFORMANCE:** Grading homeworks, colloquia-tests, final examinations.

**EXAMINATION METHODS:** Written (which can be accomplished also by accumulating sufficient number of points from homeworks and colloquia-tests) and oral

**COURSE(S) NEEDED FOR THIS COURSE:** General physics courses, mathematical courses

COMPULSORY LITERATURE:

- R. L. Liboff, Introductory Quantum Mechanics, Addison-Wesley, 2002.
- My own teaching materials which I hand out at some lectures and which are available in our library, and in part also available at my internet home page <http://www.phy.hr/~klabucar/>

ADDITIONAL READING:

- F. S. Levin, An introduction to Quantum Theory, Cambridge University Press, 2002.
- ∞ R. Eisberg and R. Resnick, Quantum Physics of Atoms, Molecules and Solids, Nuclei and Particles, John Wiley and Sons, 1985.

COURSE TITLE: Word processing and spread sheets		
COURSE TEACHER/TEACHERS: dr.sc. Robert Pezer		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	1	teacher
Exercises	1	assistant
Seminars		
Laboratory		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:		
Introduction to text editing using two complementary systems: WSWYG and LaTeX. Basics of good writing practise. Formatting, working with tables and graphics and automatisation. Selected examples of table calculator usage: database, physics, economy.		
DESCRIPTION OF THE COURSE:		
12. Intro to shell, GUI, computer system.		
13. What WYSIWYG editors can do for us.		
14. Text formatting (working in user interface, text manipulation, tables, graphics, data sharing).		
15. Advanced elements: forms (working with fields) and form letters (automatic document generation)		
16. Seminar and final project.		
17. LaTeX intro. Comparing WYSIWYG editors (visual and logical design).		
18. LaTeX and document elements.		
19. Document structure and organisation. Working with math equations. Electronic data formats PS and PDF.		
20. Document class "book". Working with graphics.		
21. Intro to table calculators (TC). What can TC do for us.		
22. Basic examples.		
23. Advanced examples (including physics, economy, database).		
STUDENT OBLIGATIONS DURING THE COURSE:		
Two written seminars.		

METHODS TO EVALUATE STUDENT PERFORMANCE:

Results of written **seminars**, final oral examination.

EXAMINATION METHODS:

Oral examination. Seminars..

COURSE(S) NEEDED FOR THIS COURSE:

COMPULSORY LITERATURE:

Ne tako kratki uvod u LaTeX, Tobias Oetiker. Dostupno preko weba i u prijevodu prof. Šime Ungara.

S.L.Nelson and J. Kelly, Office XP: The Complete Reference, McGraw Hill 2001

ADDITIONAL READING:

COURSE TITLE: Fundamentals of Physics of Materials		
COURSE TEACHER/TEACHERS: Prof. Dr. Sc. Mirko Stubičar, Department of Physics, Faculty of Science, University of Zagreb		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (teacher or assistant)
Lectures	2	teacher
Exercises		
Seminars	1	teacher
Laboratory		
ECTS credits: 4		
<b>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES –</b> <b>KNOWLEDGE AND SKILLS:</b> <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>		
<b>DESCRIPTION OF THE COURSE:</b> <b>The Lecture Themes or the Core Titles in Contemporary Course «Fundamentals of Physics of Materials»:</b> 1) Introduction to the Realm of Materials; Historical Perspective; Why to Study Course «Fundamentals of Physics of Materials»; Natural and Scientific Classification of Materials. 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. 3) Atomic Arrangements in Materials. The Real and Reciprocal Crystal Lattice and Information on the Structure of Crystals Contained (Hidden!?) in the Diffraction Patterns; <b>Structures of Metals and Ceramics</b> ; Crystal Structures and Unit Cells; Metallic Crystal Structures; Ceramic Crystal Structures; Silicate Ceramics, Carbon; Polymorphism and Allotropy; Crystal Systems; Crystallographic Directions and Planes; Crystalline, Partially Crystalline and Noncrystalline Materials; Single Crystals and Polycrystalline Materials. <b>Polymer Structures.</b> Introduction; Hydrocarbon Molecules; Polymer Molecules; The Chemistry of Polymer Molecules; The Thermoplastic and Thermosetting Polymers; Elastomers (Rubbers); Copolymers; Polymer Single Crystals. <b>Composite Materials;</b> 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: <b>Fundamentals of Biophysics</b>		
COURSE TEACHER/TEACHERS: <b>Dr. sc. Selma Supek, Assistant Professor, Department of Physics, Faculty of Science, University of Zagreb</b>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: <b>3</b>		
SEMESTER: <b>5</b>		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	<b>2</b>	<b>teacher</b>
Exercises		
Seminars	<b>1</b>	<b>teacher</b>
ECTS credits: <b>4 ECTS: Lectures (22,5 hours), preparation for written tests and discussions (50 hours), participation at seminars and seminar paper (30 hours) – total 102, 5 hours.</b>		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: <b>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.</b>		
DESCRIPTION OF THE COURSE:  <b>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. Bio-sensors. Neuroimplants.</b>		
STUDENT OBLIGATIONS DURING THE COURSE: <b>Lectures, discussions, written exams, seminars.</b>		
METHODS TO EVALUATE STUDENT PERFORMANCE: <b>Participation at lectures and seminars.</b> <b>Oral presentation of a seminar.</b>		
EXAMINATION METHODS: <b>Final written exam.</b> <b>In the total grade the final exams contributes with 30%, discussions and written exams with</b>		

**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: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 3		
SEMESTER: 5		
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: 4		
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: Data Structures and Algorithms		
COURSE TEACHER/TEACHERS: Doc. dr. Mirko Planinić		
STUDY PROGRAMME:		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (teacher or assistant)
Lectures	2	teacher
Exercises		
Seminars		
Laboratory	2	assistant
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:  The course is designed for understanding of computing algorithms and for learning about different data structures.		
DESCRIPTION OF THE COURSE:  <ol style="list-style-type: none"> <li>1. Review of fundamental ideas and techniques for designing algorithms.</li> <li>2. Data structures: queue, array, list, stack .</li> <li>3. Recursive Algorithms, recursive functions</li> <li>4. Greedy Algorithms</li> <li>5. Trees, binary search</li> <li>6. Time Complexity of Algorithms</li> <li>7. Priority queues, heap</li> <li>8. Sorting</li> <li>9. Dinamic Algorithms: Fibonacci numbers, binomial coefficients</li> <li>10. Divide and Conquer Algorithms</li> <li>11. Graphics Algorithms</li> <li>12. Games</li> </ol>		
STUDENT OBLIGATIONS DURING THE COURSE:  Course attendance is controled. During laboratory students solve problems that illustrate the topics.		
METHODS TO EVALUATE STUDENT PERFORMANCE:  Students have to solve problems during laboratory..		

**EXAMINATION METHODS:**

The final exam consists of oral examination . Student have to solve homeworks during semester.

**COURSE(S) NEEDED FOR THIS COURSE:**

Introduction to computing , Fundamentals of Programming

**COMPULSORY LITERATURE:**

Strukture podataka i algoritmi, skripta sveučilišta u Zagrebu – matematički odsjek, (Robert Manger, Miljenko Marušić

**ADDITIONAL READING:**

Introduction to Algorithms, The MIT Press, Cambridge, Massachusetts, (Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein)

COURSE TITLE: Physics Lab 4		
COURSE TEACHER/TEACHERS: Selim Pašić		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 3		
SEMESTER: 6		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (teacher or assistant)
Lectures		
Seminars		
Laboratory	4	
ECTS credits: 5		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Students individually perform the laboratory exercises developing their skills in handling with experimental apparatus. Also, they check laws of physics right on the place, where the physical phenomena occur. In the manner, students increase their confidence in the validity of the physical laws learned in the courses of General physics.		
DESCRIPTION OF THE COURSE: Laboratory exercises: Coupled pendulums, The equation of ideal gas, Heat capacity of metals, Heat capacity of gases, Planck constant, Electrical conductions of the electrolytes, Heisenberg uncertainty relations		
STUDENT OBLIGATIONS DURING THE COURSE: They should perform the laboratory exercise and make the processing of the data, at home, which is presented in the form of a report.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Evaluation of the student's knowledge of physics related to the subject of each exercises and corresponding laboratory reports. The student's knowledge has been checked continuously during the semester.		
EXAMINATION METHODS: In direct contact during, and evaluation of the laboratory report after an exercise.		
COURSE(S) NEEDED FOR THIS COURSE: Course of General physics 4.		
COMPULSORY LITERATURE: User manuals of the laboratory exercises written by their manufacture, Phywe. The internet site <a href="http://rigel.phy.hr">http://rigel.phy.hr</a> for the exercise Heisenberg uncertainty relations.		
ADDITIONAL READING: M.Paić, <i>Fizička mjerenja I, II</i> , Sveučilišna naklada Liber, Zagreb 1985. M.Paić, Z.Ogorelec, <i>Fizička mjerenja III</i> , Sveučilišna naklada Liber, Zagreb 1973. E. H. Wichmann, <i>Quantum physics, Berkeley physics course-volume 4</i> (Education Development Center, Inc., Newton, 1971), Vol. 4.		

COURSE TITLE: Electrodynamics		
COURSE TEACHER/TEACHERS: Prof.dr. Slobodan Brant		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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>		
<p>DESCRIPTION OF THE COURSE:</p> <ol style="list-style-type: none"> <li>24. Electric charge. Coulomb's law. Electric field. Gauss' law. Electric potential.</li> <li>25. Electric dipol. Multipole expansion of electric potential.</li> <li>26. Laplace's and Poisson's equations. Boundary conditions.</li> <li>27. Green functions in electrostatics. Method of images.</li> <li>28. Electrostatics inside dielectrics. Polarization. Electrostatic energy.</li> <li>29. Steady currents. Continuity equation. The Lorentz force. Magnetic field. Ampere's law.</li> <li>30. The vector potential. The Biot-Savart law. Magnetic moment. Magnetic moment vs. angular momentum.</li> <li>31. Macroscopic magnetostatics. Induction.</li> <li>32. Maxwell's equations. Systems of units. Wave equation.</li> <li>33. Electromagnetic waves in nonconducting and conducting media. Polarization of plane waves. Poynting's theorem.</li> <li>34. Introduction to radiation theory.</li> <li>35. Special theory of relativity. Lorentz transformation.</li> <li>36. Four-vectors. Covariance of electrodynamics.</li> </ol>		

**STUDENT OBLIGATIONS DURING THE COURSE:**

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

**METHODS TO EVALUATE STUDENT PERFORMANCE:**

Results of written colloquia 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 colloquia 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: <b>Educational Physics - Teacher of Physics</b>		
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: 6		
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"> <li>1. Introduction to probability theory, combinatorial analysis and distribution functions</li> <li>2. Molecular collisions, ideal gas pressure</li> <li>3. Introduction to thermodynamics, the equation of state</li> <li>4. Laws of thermodynamics, Carnot's circle, engines</li> <li>5. Basic relation of thermodynamics, systems with variable number of particles</li> <li>6. Maxwell's distribution function</li> <li>7. Configuration space, limits of the classical statistical physics</li> <li>8. Stirling's approximation, Boltzmann's distribution function</li> <li>9. Brown's particle motion, equipartition law, Dalton's law</li> <li>10. Energy quantisation and the third law of thermodynamics, black body radiation</li> <li>11. Specific heat of solid bodies, bosons and fermions, Bose-Einstein's distribution function</li> <li>12. Fermi-Dirac's distribution function, fermionic systems</li> </ol>		
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: Didactics		
COURSE TEACHER/TEACHERS: assistant professor Vlatka Domović, Ph.D Učiteljska akademija Sveučilišta u Zagrebu		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 3		
SEMESTER: 6		
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 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.		
DESCRIPTION OF THE COURSE:		
<ul style="list-style-type: none"> <li>• The historical development of school and the didactic idea</li> <li>• The subject-matter and tasks of didactics and the relation between didactics and other educational sciences.</li> <li>• Fundamental didactic concepts</li> <li>• The organization and goals of « the traditional school» and the modern concept of the development of schools</li> <li>• The concept of life-long education/learning</li> <li>• The curriculum theory</li> <li>• The establishment of educational needs and defining the educational goals</li> <li>• The content of learning and educational system</li> <li>• The educational programme –the criteria of choice, organization, scope, depth, order.</li> <li>• Learning conditions</li> <li>• The inner and outer learning conditions. Teaching, organizational processes, school and class environment, classroom management.</li> <li>• Evaluation of the curriculum</li> </ul>		

- 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: <b>Physics and Philosophy</b>		
COURSE TEACHER/TEACHERS: <b>Tihomir Vukelja, Ph.D.</b>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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: <b>4</b>		
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 7<sup>th</sup> and 14<sup>th</sup> 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.

<b>COURSE TITLE: Energy</b>		
<b>PROPOSED BY: Đuro Miljanić, senior scientist, Ruđer Bošković Institute, Zagreb</b>		
<b>PROGRAMME: Educational Physics - Teacher of Physics</b>		
<b>YEAR OF STUDY: 3</b>		
<b>SEMESTER: 6</b>		
<b>TYPES OF INSTRUCTION</b>	<b>CONTACT HRS PER WEEK</b>	<b>DELIVERED BY</b>
Lectures	2	lecturer
Examples Classes		lecturer
Seminars	1	
<b>ECTS CREDITS: 4</b>		
<b>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.</b>		
<b>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.</b>		
<b>TEACHING AND ASSESSMENT METHODS:</b>		
<b>PREREQUISITES: Physics and mathematics courses – prerequisites for the third year of study.</b>		
<b>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.</b>		
<b>ADDITIONAL READING:</b>		
<ol style="list-style-type: none"> <li>1. Obnovljivi izvori energije (ed. B. Labudović), Energetika Marketing, Zagreb, 2002.</li> <li>2. Energy Systems and Sustainability: Power for a Sustainable Future (ed. G. Boyle, B. Everett and J. Ramage), Oxford University Press, Oxford, 2003.</li> <li>3. Renewable Energy: Power for a Sustainable Future (ed. G. Boyle), Oxford University Press, Oxford, 2004.</li> </ol>		

COURSE TITLE: Differential equations - dynamical systems		
COURSE TEACHER/TEACHERS: Doc. dr. Predrag Prester		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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		
Laboratory	1	assistant
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:		
<p>To teach basic knowledge of solving ordinary differential equations by using analytical, qualitative and numerical methods, and how to apply this to simple models of dynamical systems in different fields (physics, chemistry, biology, civil engineering etc).</p>		
DESCRIPTION OF THE COURSE:		
<ul style="list-style-type: none"> <li>☞ Introduction: Modeling Via Differential Equations</li> <li>☞ Ordinary First-Order Differential Equations <ul style="list-style-type: none"> <li>1. Analytic and Qualitative Methods</li> <li>2. Numerical Technique</li> <li>3. Autonomous Equations</li> <li>4. Bifurcations</li> <li>5. Linear Equations</li> </ul> </li> <li>3. First-Order Systems <ul style="list-style-type: none"> <li>3.1. Modeling Via Systems</li> <li>3.2. Geometric and Analytic Methods</li> <li>3.3. Euler's Method for Systems</li> </ul> </li> <li>4. Autonomous Systems <ul style="list-style-type: none"> <li>4.1. Systems with Real Eigenvalues</li> <li>4.2. Complex Eigenvalues</li> <li>4.3. Special Cases</li> <li>4.4. Homogenous Linear Systems</li> </ul> </li> <li>5. Forced Harmonic Oscillators <ul style="list-style-type: none"> <li>5.1. General Solution. Sinusoidal Forcing</li> <li>5.2. The Tacoma Narrows Bridge</li> </ul> </li> </ul>		

<p><b>STUDENT OBLIGATIONS DURING THE COURSE:</b> Homeworks every week. There are also 3 labs which include extensive use of computer and should be reported in a form of essay.</p>
<p><b>METHODS TO EVALUATE STUDENT PERFORMANCE:</b> Two labs must be completely done to pass to exam.</p>
<p><b>EXAMINATION METHODS:</b> Exam has written (only for students which obtained less than 70% for labs, in which case the total mark of written part is constituted 30% from labs and 70% from written examination) and oral part.</p>
<p><b>COURSE(S) NEEDED FOR THIS COURSE:</b> Physics 1-2, Mathematical analysis, Linear Algebra, Basics of Programming</p>
<p><b>COMPULSORY LITERATURE:</b> Predrag Prester, Differential Equations and Dynamical Systems, script accesible from <a href="http://www.phy.hr/~pprester">http://www.phy.hr/~pprester</a></p>
<p><b>ADDITIONAL READING:</b> P. Blanchard, R. L. Devaney and G. R. Hall, Differential Equations, 2nd edition (with CD-ROM), Brooks/Cole, 2002.</p>

COURSE TITLE: Multimedial presentations		
COURSE TEACHER/TEACHERS: mr.sc. Dalibor Paar		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 3		
SEMESTER: 6		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	1	teacher
Exercises	1	assistant
Seminars		
Laboratory	2	teacher
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:  The course is designed to introduce students to basics of HTML and multimedial elements for making the Web pages. That will be applied to a multimedial presentation of physical experiment and to the analysis and presentation of experimental and other data.		
DESCRIPTION OF THE COURSE:  1. Methods of making a Web page 2. HTML basics (Hyper Text Markup Language). 3. Tables, links and anchors in Web pages. 4. Advanced options of HTML. 5. Pictures and graphs in Web document. 6. Graphical presentation of numerical data. 7. Statistical data analysis and multimedial presentation. 8. Introduction to the program for multimedial presentation (MS PowerPoint). 9. Digital photography. Using digital camera. 10. Sound digitalization. Preparation of multimedial content for Web pages and presentations. 11. Digital video. Using Internet for video transmission. 12. Multimedial elements in presentation of physical experiment.		
STUDENT OBLIGATIONS DURING THE COURSE  Course attendance to the lectures, practical exercises on computers and final seminar works.		
METHODS TO EVALUATE STUDENT PERFORMANCE  Solving problems and seminars		

**EXAMINATION METHODS:**

Seminar works and final exam

**COURSE(S) NEEDED FOR THIS COURSE:**

Introduction to computer science

**COMPULSORY LITERATURE:**

lecture script

**ADDITIONAL READING:**

D. Petrić, Naučite HTML i oblikujte sami efektne WWW stranice, Znak, Zagreb, 1997.

COURSE TITLE: Fundamentals of geophysics		
COURSE TEACHER/TEACHERS: Dr. Snježana Markušić, assistant professor		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 3		
SEMESTER: 8		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	2	Dr. Snježana Markušić
Exercises	1	Dr. Snježana Markušić
Seminars		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Course introduce students to the broad spectrum of knowledge that can be obtained by the application of basic principles of physics and mathematics to the study of the Earth.		
DESCRIPTION OF THE COURSE: <ol style="list-style-type: none"> <li>1. Introduction to the Earth (shape and size, mass and density, the Moon, the Earth's axis, the Earth's orbit, temperatures on Earth, atmosphere, origin of Earth, origin of water on Earth, Earth's interior – formerly and today)</li> <li>2. Coordinates on the Earth's surface (sphere coordinates – axis and major circle, latitude and longitude, Earth as spheroid, geoid and geoid undulations, altitude and depths)</li> <li>3. Gravity (Newton's law of gravitation and force of gravity, centripetal and centrifugal forces, gravitation, Clairaut's theorem, measurements of gravity accelerations, reduction of measured values of gravity accelerations – correction for altitude, Bouguer's correction, topographical correction, normal values of gravity accelerations, gravity field of the Earth, anomalies of gravity field, tides)</li> <li>4. Isostasy (concept of isostasy, Pratt's and Airy's theory of isostasy)</li> <li>5. Seismicity and the sources of earthquakes (concept of seismicity, spatial distribution and statistics of earthquakes, causes of earthquakes, sources and types of earthquakes, earthquake mechanism and Reid's elastic rebound theory, macroseismic method of earthquake investigation – earthquake intensity, macroseismic scales, isoseismal maps, microseismic method of earthquake investigation – earthquake magnitude, microseisms, tsunami)</li> <li>6. Seismic waves and Earth's internal structure (constants of elasticity, oscillation and waves, wave equation, reflection, refraction, concept of seismograph, earthquake waves – body and surface, hodochrones and microseismical method of epicenter determination, earthquake magnitude, investigations of Earth's interior, Moho discontinuity)</li> <li>7. Earth's magnetism (general terms, the Earth's magnetic field, geomagnetic elements,</li> </ol>		

magnetosphere and main field, magnetic poles, polar light)

8. Earth's internal heat (heat as energy transfer, heat flow, heat conduction, heat convection – adiabatic temperature gradient, measurement of the Earth's surface heat flow)

**STUDENT OBLIGATIONS DURING THE COURSE:**

After each lecture students have to do homework that will be discussed at next exercises. Many seminar themes are offered, as well as various numerical problems, with intention to get free from written part of exam.

**METHODS TO EVALUATE STUDENT PERFORMANCE:**

Students have to participate the practical exercises and to perform a set task.

**EXAMINATION METHODS:**

Students have a written exam that consists of 4 numerical and 2 theoretical tasks. Those who collect enough points from theoretical tasks (at least 6 from possible 11) and are satisfied with an obtained mark from written exam do not have to take of an oral exam. Final mark is an average of marks obtained in written and oral exams.

**COURSE(S) NEEDED FOR THIS COURSE:**

Principles of Physics 1 and 2, Introduction to mathematics

**COMPULSORY LITERATURE:**

- Bullen, K.E. and B.A. Bolt, 1985. *Introduction to the theory of geophysics*, Cambridge
- Kasumović M., 1971. *Opća i primijenjena geofizika s osnovama sferne astronomije (I dio – Opća geofizika)*, Sveučilište u Zagrebu, Zagreb
- Lay, T. and T.C. Wallace, 1995. *Modern global seismology*, Academic Press, Toronto

**ADDITIONAL READING:**

- Garland, G.D., 1979. *Introduction to geophysics*, W.B. Saunders Co., Toronto
- Turcotte D.L. and G. Schubert, 2002. *Geodynamics*, Cambridge University Press, Cambridge

COURSE TITLE: Laboratory in Physics Education 1 and 2		
COURSE TEACHER/TEACHERS: P.Pećina, M.Planinić, A. Sušac		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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 , 6		
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.		
DESCRIPTION OF THE COURSE:		
<ol style="list-style-type: none"> <li>1.Introductory discussion about work in laboratory and role of experiment in physics teaching</li> <li>2. Concepts and models-initial test and discussion</li> <li>3.-7. Lab exercise in rotation <ol style="list-style-type: none"> <li>1.1 The molecular kinetic theory</li> <li>1.2 Laws of motion</li> <li>1.3 Mechanics</li> <li>1.4 Simple electrical circuits</li> <li>1.5 Geometrical optics</li> </ol> </li> <li>8. Conceptual test and discussion</li> <li>9-13 Lab exercise in rotation <ol style="list-style-type: none"> <li>2.1 Waves</li> <li>2.2 Electromagnetic induction</li> <li>2.3 Pressure in fluids and gases</li> <li>2.4 Basic laws of D.C. current</li> <li>2.5 Physical optics</li> </ol> </li> <li>14. Conceptual test and discussion</li> <li>15. Overview</li> </ol> <p>II semester</p> <ol style="list-style-type: none"> <li>1. Demonstration of some “nice” experiments</li> <li>2. Concepts and models-initial test and discussion</li> <li>3.-7. Lab exercise in rotation <ol style="list-style-type: none"> <li>3.1 Law of conservation of energy</li> <li>3.2 Heat</li> <li>3.3 Radioactivity</li> </ol> </li> </ol>		

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: <b>Selected topics in solid state physics</b>		
COURSE TEACHER/TEACHERS: <b>Prof.dr.Antun Tonejc</b>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: <b>4</b>		
SEMESTER: <b>7</b>		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	4	<b>teacher</b>
Exercises	2	<b>assistant</b>
Seminars		
Laboratory		
ECTS credits: 8		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To provide a students with basic knowledge of solid state physics, using experimental facts and theoretical models.		
DESCRIPTION OF THE COURSE:		
<ol style="list-style-type: none"> <li>1. <b>Elements of crystal structure</b></li> <li>2. <b>Interatomic Forces</b></li> <li>3. <b>Defects</b></li> <li>4. <b>Diffusion</b></li> <li>5. <b>Mechanical properties of Materials</b></li> <li>6. <b>Crystal Dynamics</b></li> <li>7. <b>Free Electrons in Metals</b></li> <li>8. <b>The Effect of the Periodic Lattice</b></li> <li>9. <b>Electric Properties of Materials</b></li> <li>10. <b>Superconductivity</b></li> <li>11. <b>Magnetic Properties of Materials</b></li> <li>12. <b>Nanocrystalline Materials</b></li> </ol>		
STUDENT OBLIGATIONS DURING THE COURSE: <b>Students have to attend lectures and exercises. Students have to work out homeworks and colloquia.</b>		
METHODS TO EVALUATE STUDENT PERFORMANCE: <b>Regularly attendance of lectures and exercises + 75% worked out homeworks and colloquia.</b>		

EXAMINATION METHODS: Written and oral exams. Students which collect more than 50% points from homeworks and 50% points from colloquia are subjected to oral exam only.

COURSE(S) NEEDED FOR THIS COURSE: Quantum physics 1 and 2. Electrodynamics, and Fundamentals of Physics 1 to 4.

COMPULSORY LITERATURE:

V. Šips, Uvod u fiziku čvrstog stanja, Školska knjiga Zagreb, 1991.

G.I.Epifanov, Solid State Physics, MIR Publishers, Moskva 1979.

ADDITIONAL READING:

J. R. Hook and H. E. Hall, Solid State Physics, John Wiley&Sons, 1991

COURSE TITLE: <b>Selected topics in nuclear physics and particle physics</b>		
COURSE TEACHER/TEACHERS: <b>Prof.dr.Marijan Mileković</b>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: <b>4</b>		
SEMESTER: <b>8</b>		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	4	<b>teacher</b>
Exercises	2	<b>assistant</b>
Seminars		
Laboratory		
ECTS credits: <b>9</b>		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To provide a students with basic knowledge of nuclear and particle physics,using experimental facts and theoretical models.		
DESCRIPTION OF THE COURSE:		
<b>(a) Nuclear physics</b>		
Historical perspectives.Thomson model of atom vs. Rutherford model.The Rutherford scattering and the differential cross-section.		
Static properties of atomic nuclei.The binding energy.Masses and radii of nuclei.The charge distribution and form-factors.The diffractive scattering.		
Nuclear moments.The electric quadrupole moments.Intermezzo:the spin and angular moments of nuclei.Magnetic dipole moments and Schmidt lines.		
The bound two nucleon system (deuteron).Basic properties and the theoretical model of deuteron.		
Forces between nucleons-basic properties.Mesonic theory of nuclear forces.Yukawa potential.		
Nuclear models.The liquid drop model.The Fermi gas model.The shell		

model. Rotational and vibrational models.

The stability of nuclei, decays and radioactivity. The theory of alpha-decay. The radioactive decay law.

(b) Particle physics

Historical perspectives. The discovery of elementary particles and fundamental interactions. The classification of subnuclear particles (hadrons, leptons, quarks and gauge bosons).

Conservation laws and symmetries. New quantum numbers (the strangeness, the beauty, ...). Some examples.

Hadrons and the quark-parton model. Experimental facts. The notion of 'flavor' and 'colour'.

Strong interactions. Quarks, gluons and QCD as the theory of strong interactions (basic facts).

Leptons and their interactions. The Fermi theory of the beta-decay. The weak interaction. W and Z bosons. Weak decays. The Cabibbo mixing and the Cabibbo angle.

Perspectives. Neutrino oscillations, oscillations of the strangeness and CP violation. The proton decay and grand unified theories.

**STUDENT OBLIGATIONS DURING THE COURSE:** Students have to attend lectures and exercises. Students have to work out homeworks (3 in a semester) and colloquia (3 in a semester).

**METHODS TO EVALUATE STUDENT PERFORMANCE:** Regularly attendance of lectures and exercises + 50% points from homeworks and colloquia.

**EXAMINATION METHODS:** Written and oral exams. Students which collect 50% points from homeworks and 50% points from colloquia are subjected to oral exam only.

**COURSE(S) NEEDED FOR THIS COURSE:** Quantum physics 1 and 2. Electrodynamics.

**COMPULSORY LITERATURE:** W.S.C. Williams: 'Nuclear and Particle Physics' (Clarendon Press, Oxford, edition 2001).

W.S.C. Williams: 'Solution Manual for Nuclear and Particle Physics' (Clarendon Press, Oxford, edition 1997).

**ADDITIONAL READING:** R. Eisberg and B. Resnick: 'Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles' (J. Willey, 1985).

B. Povh et al. : 'Particles and Nuclei' (Springer Verlag, 1999).

COURSE TITLE: <b>Physics education 1</b>		
COURSE TEACHER/TEACHERS: Prof.dr.sc. Rudolf Krsnik, Mr. sc. Maja Planinić, PMF, Zagreb Dipl.inž. Planinka Pećina, PMF, Zagreb		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: <b>4</b>		
SEMESTER: <b>7</b>		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	<b>2</b>	teacher
Exercises		
Seminars	<b>2</b>	teacher, assistant
Laboratory		
ECTS credits: <b>6</b>		
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:  <b>1.</b> 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. In addition, the following topics are also covered in seminar:

- Basics of psychometric measurements.
- Stochastic Rasch model
- Planning and conduction of research in physics education
- Design and evaluation of tests and analysis of test results.
- Discussion of international research projects on physics learning (TIMSS)

**STUDENT OBLIGATIONS DURING THE COURSE:** Regular attendance (at least 70 %), active participation in discussions, giving at least 2 talks 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: Physics education 2**

**COURSE TEACHER/TEACHERS:**

Prof.dr.sc. Rudolf Krsnik, PMF, Zagreb

Mr. sc. Maja Planinić, PMF, Zagreb

Dipl.inž. Planinka Pećina, PMF, Zagreb

**STUDY PROGRAMME Educational Physics - Teacher of Physics**

**YEAR OF STUDY: 4**

**SEMESTER: 8**

**TEACHING METHODS**

**CONTACT HRS PER WEEK**

**DELIVERED BY**  
*(teacher or assistant)*

Lectures

2

teacher

Exercises

Seminars

4

teacher, assistant

Laboratory

**ECTS credits: 7**

**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.

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. In addition, the following topics are also covered in seminar:

- New teaching strategies that result from physics education research.
- Peer instruction.
- Socratic dialog inducing labs.
- Software packages for physics teaching.
- Introduction to journals in the field of physics education: reading and discussion of selected articles.

**STUDENT OBLIGATIONS DURING THE COURSE:** Regular attendance (at least 70 %), active participation in discussions, giving at least 2 talks 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.

<b>COURSE TITLE:</b> Fundamentals of Atomic and Molecular Physics		
<b>COURSE TEACHER/TEACHERS:</b> Prof. Damir Veža		
<b>STUDY PROGRAMME:</b> Educational Physics - Teacher of Physics		
<b>YEAR OF STUDY:</b> 4		
<b>SEMESTER:</b> 7		
<b>TEACHING METHODS</b>	<b>CONTACT HRS PER WEEK</b>	<b>DELIVERED BY</b> <i>(teacher or assistant)</i>
Lectures	2	teacher
Exercises	1	assistant
Seminars		
Lab		
<b>ECTS credits:</b> 7		
<b>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</b> Understanding basics of AMO Physics		
<b>DESCRIPTION OF THE COURSE:</b>		
<p>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</p> <p>Exercises:          Complementary material to lectures. Solving problems in atomic and molecular physics.</p>		

<b>STUDENT OBLIGATIONS DURING THE COURSE:</b> Attendance to lectures, homeworks
<b>METHODS TO EVALUATE STUDENT PERFORMANCE:</b> Homeworks and written exams
<b>EXAMINATION METHODS:</b> evaluation of homeworks and an exam at the end of the semester
<b>COURSE(S) NEEDED FOR THIS COURSE:</b> Quantum physics
<b>COMPULSORY LITERATURE:</b> A.P.Thorne, U. Litzen, S. Johansson, <i>Spectrophysics</i> , Springer Verlag, Berlin 1999.
<b>ADDITIONAL READING:</b> C. W. Bradley, O. A. Dale, <i>An introduction to modern stellar astrophysics</i> , Addison-Wesley, 1996. F.F. Chen, <i>Introduction to Plasma Physics</i> , New York, 1974.

<b>COURSE TITLE:</b> Fundamentals of Electronics		
<b>COURSE TEACHER/TEACHERS:</b> Prof. Damir Veža		
<b>STUDY PROGRAMME:</b> Educational Physics - Teacher of Physics		
<b>YEAR OF STUDY:</b> 4		
<b>SEMESTER:</b> 8		
<b>TEACHING METHODS</b>	<b>CONTACT HRS PER WEEK</b>	<b>DELIVERED BY</b> <i>(teacher or assistant)</i>
Lectures	2	teacher
Exercises	1	assistant
Seminars		
Lab		
<b>ECTS credits:</b> 7		
<b>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</b> Understanding basics of Electronics		
<b>DESCRIPTION OF THE COURSE:</b> <b>Lectures:</b> 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.Boolean algebra and logic circuits. 11.Fundamentals of optoelectronics. 12.Photodiode and light emitting diode. 13.Laser diode.		

<p><b>Exercises:</b> Supplementary material to lectures: solving problems in electronics.</p> <p><b>Demo-Lab:</b> 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.</p>
<p><b>STUDENT OBLIGATIONS DURING THE COURSE:</b> Attendance to lectures, homeworks</p>
<p><b>METHODS TO EVALUATE STUDENT PERFORMANCE:</b> Homeworks and written exams</p>
<p><b>EXAMINATION METHODS:</b> evaluation of homeworks and an exam at the end of the semester</p>
<p><b>COURSE(s) NEEDED FOR THIS COURSE:</b> Electricity and magnetism course</p>
<p><b>COMPULSORY LITERATURE:</b> C.L.Hemenway, R.W.Henry, M.Caulton, <i>Physical Electronics</i>, John Wiley &amp; Sons Inc. 1967. P. Biljanović, <i>Elektronički sklopovi</i>, Školska knjiga, Zagreb 1999.</p>
<p><b>ADDITIONAL READING:</b> J.Millman, A.Grabel, <i>Microelectronics</i>, McGraw-Hill, New York 1988.</p>

COURSE TITLE: <b>Medical Physics</b>		
COURSE TEACHER/TEACHERS: <b>Prof.dr.sc. Mladen Vrtar</b>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: <b>4</b>		
SEMESTER: <b>8</b>		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (teacher or assistant)
Lectures	<b>2</b>	<b>M.Vrtar (teacher)</b>
Exercises	<b>1</b>	<b>M. Vrtar (teacher)</b>
ECTS credits.: <b>5</b>		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS		
<p><b>The application of physical methods in modern medicine and the working area and responsibility of medical physicist in health care institutions. Additional help in choosing the direction of doctor or specialist study of medical physics.</b></p>		
DESCRIPTION OF THE COURSE:		
<p><b>Dosimetric methods of photon and electron beams and absorbed dose in water. Use of radioisotopes in nuclear medicine. Basic methods of tomographic reconstruction. Computerised tomography (CT). Positron emission tomography (PET). Single photon emission tomography (SPECT). Magnetic resonance (MR). Radiotherapy physics in clinical practice (roentgen, cobalt, linear accelerator). The special methods of</b></p>		

**radiotherapy (total body irradiation, stereo tactic radiosurgery-gamma knife). Influence of radiation to human tissue and radiation protection. Quality assurance in clinical use of radiation. Physical basis and application of ultrasound in medicine. Application of thermography in medicine.**

**STUDENT OBLIGATIONS DURING THE COURSE:**

**The students must be present on lectures and exercises. They explain one theme from medical physics in a semester and solve the numerical exercises from some chapters. The students are obliged to attend the organised visits at some medical institutions to see the practical demonstration of certain equipment and application of physics in medicine (the special attention should be directed to radiological diagnostic, radiotherapy and radiation protection).**

**METHODS TO EVALUATE STUDENT PERFORMANCE: exams, obliged exercises**

**EXAMINATION METHODS: oral exam**

**COURSE(S) NEEDED FOR THIS COURSE:**

**The obliged courses needed to enter the 6. semester**

**COMPULSORY LITERATURE:**

**Vrtar M. Medical physics (in Croatian). Internal script of Physics dept. Zagreb 2004)  
(available to photocopy )**

**ADDITIONAL READING:**

- 1. Podgorsak E.B. Review of radiation oncology physics, IAEA, Vienna, Austria 2003.  
(dostupno i preko interneta)**
- 2. Cherry S.R., Sorenson J.A., Phelps M.E. Physics in nuclear medicine, 3rd ed.  
Saunders, An Imprint of Elsevier Science, USA 2003.**
- 3. Bushberg J.T., Seibert J.A., Leidholdt E.M., Boone J.M. The essential physics of  
medical  
imaging. Williams & Wilkins, Baltimore 1995.**

COURSE TITLE: Physics of Disordered Systems		
COURSE TEACHER/TEACHERS: Dr.sc. Krešo Zadro,		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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: 5		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:		
DESCRIPTION OF THE COURSE: <b>Order – disorder: ordering rules, order parameters</b> <b>Glasses: insulating, metallic and spin glasses, neural networks.</b> <b>Fractals: fractal dimension, fractal patterns in nature, random walk and fractals.</b> <b>Percolation: percolation threshold, correlation length, phenomena on percolation networks.</b>		
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: COMPUTER IN EDUCATION		
COURSE TEACHER/TEACHERS: dr. Dalibor Paar		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 4		
SEMESTER: 8		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures	1	teacher
Exercises	1	assistant
Seminars		
Laboratory	2	teacher
ECTS credits: 5		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:  The course objectives are acquiring knowledge and skills in relation to the use of information communication technologies in different aspects of physics education in primary and secondary schools: information search, electronic publishing, on-line quiz an tests, computer assisted communication, work in virtual working space as a step in adopting e-learning. The course objectives are also adoption of different computer assisted learning strategies as well as use of the computer for on-line experiments, data acquisition and processing.		

## DESCRIPTION OF THE COURSE:

1. General elements of e-learning, organizational structure, instructional design.

Student activity: reading, discussion in forums

2. Information search. Search engines, repositories of learning objects, Standards - Learning Object Metadata

Student activity: search for a particular information using specialized search engines or repository (MERLOT)

3. Programs for supporting course – courseware programs. LMS-Learning Management System

Student activity: work in WebCT and open source program Claroline

4. Electronic publishing: drawings

Student activity: students should produce several drawings and incorporate them into a appropriate text.

5. Electronic publishing: drawings

Student activity: students should produce several drawings and incorporate them into a appropriate text.

6. Electronic publishing: photo and video

Student activity: students should produce several photos and one video clip and incorporate them into an appropriate text.

7. Electronic publishing: audio formats

Student activity: work with sound generator, analysis of sound files.

8. Work wit interactive animations and simulations

Student activity: work with selected interactive simulations. Students should produce a learning object using interactive simulation.

9. On-line quiz and self tests.

Student activity: work with different on-line quizzes and self tests. Students should produce one self test.

10. Computer assisted experiments

Student activity: measurements of time dependent electrical signals using USB oscilloscope. Analysis of beating.

11. Computer assisted experiments

Student activity: measurements of time dependent light signals using USB spectroscope.

12. Computer assisted educational strategies: projects

Student activity: work on Internet project .

13. Computer assisted experiments

Student activity: measurements of time dependent light signals using USB spectroscope.

14. Computer assisted educational strategies: projects

Student activity: work on Internet project .

## STUDENT OBLIGATIONS DURING THE COURSE:

Described above

Students should continuously and, on time, solve exercises and project activities.

Student should publish the results of their exercises on their personal web pages

## METHODS TO EVALUATE STUDENT PERFORMANCE:

### **Continuous assessment**

## EXAMINATION METHODS:

Continuous assessment , Project work, Seminar paper, Practical work, Oral exam

## COURSE(S) NEEDED FOR THIS COURSE:

Prerequisites for the course are general skills in using computer, Internet and certain knowledge of computer multimedia.

The program s closely related to the courses of General Physics (I, II, III and IV) as well as Physics Laboratories I, II, III and IV

## COMPULSORY LITERATURE:

### e-learning:

Tonny Bates, Upravljanje tehnološkim promjenama, CARNET, 2004.

O Courseware alatima na starnicama CARNetovog referalnog centra

<http://www.carnet.hr/referalni/obrazovni/oca>

Goran Bubaš, Metodika i komunikacija u obrazovanju na daljinu, Edupoint:

<http://edupoint.carnet.hr/casopis/aktualni/clanak-02/index.htm>

### Project:

Fizika svemira, e-škola FIZIKA [http://eskola.hfd.hr/fizika\\_svemira](http://eskola.hfd.hr/fizika_svemira)

e-škola ASTRONOMIJA, <http://hpd.botanic.hr/ast/astronomija>

WebQuest [http://edweb.sdsu.edu/courses/edtec596/about\\_webquests.html](http://edweb.sdsu.edu/courses/edtec596/about_webquests.html)

### Information search

Definicije pretraživača i razlike između "Search engines", "Search directories" i "Metasearch engines" [www.pandia.com/goalgetter/2.html](http://www.pandia.com/goalgetter/2.html)

Popis web-resursa koji sadrže uputstva kako koristiti tražilice

[searchenginewatch.com/resources/tutorials.html](http://searchenginewatch.com/resources/tutorials.html)

### Electronic publishing:

Nataša Hoić Božić: Grafika - Multimedijски sustavi, Filozofski fakultet u Rijeci,

<http://top.pefri.hr/mms/grafika.htm>

Nataša Hoić Božić: Animacija - Multimedijски sustavi, Filozofski fakultet u Rijeci

<http://top.pefri.hr/mms/animacija.htm>

Nataša Hoić-Božić: Video - Multimedijски sustavi, Filozofski fakultet u Rijeci

<http://top.pefri.hr/mms/video.htm>

## ADDITIONAL READING:

### e-learning:

Čanak Zorana Lova, direktora IT centra o e-učenju [http://www.itcenter.hr/kolumna\\_0307.asp](http://www.itcenter.hr/kolumna_0307.asp)

John Sloan: E-learning je potrebno analizirati, Edupoint:

<http://edupoint.carnet.hr/casopis/aktualni/clanak-03/index.htm>

On-line Pedagogija: <http://people.uis.edu/rschr1/csu.htm>

Bertijeve stranice fizike - anketa: <http://www.prvagimnazija.hr/fizika/anketa.htm>

### Information search:

Korištenje logičkih funkcija u pretraživanju: [searchenginewatch.com/facts/boolean.html](http://searchenginewatch.com/facts/boolean.html)

Popis najvažnijih općih pretraživača s opisima usluga

[searchenginewatch.com/links/major.html](http://searchenginewatch.com/links/major.html)

[www.cro-web.com/internet/trazilica.php](http://www.cro-web.com/internet/trazilica.php)

### Electronic publishing:

Interaktivne animacije: General Physics Java Applets

<http://www.schulphysik.de/suren/Applets.html>

NTNU Virtual Physics Laboratory <http://www.phy.ntnu.edu.tw/java/index.html>

Animation & Simulation Centre

<http://www.pearsoned.ca/school/science11/physics11/simulat.htm>

Provjera znanja: CARNet-ov referalni centar za provjeru znanja

<http://www.carnet.hr/referalni/obrazovni/spzit>

COURSE TITLE: <b>Laboratory in Physics Education 3</b>		
COURSE TEACHER/TEACHERS: P.Pećina, M.Planinić, A. Sušac		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 5		
SEMESTER: 9		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures		
Exercises		
Seminars		
Laboratory	4	<i>assistant</i>
ECTS credits: 5		
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. How to do experiment and its role in process of developing concepts and models and a structure of closely interwoven facts and ideas.		
DESCRIPTION OF THE COURSE: 3. Introductory discussion about work in laboratory and role of experiment in physics teaching 2. Magnetic induction 3. Internet in classroom 4. Computers and teaching physics 5. Distance learning 6. Black boxes 7. Millikans experiment 8. Electron diffraction 9. Electrons in magnetic and electric field 10. Ultrasound 11. Rotation 12. Stroboscopic measurements 13. Electromagnetic waves 14. Test and discussion 15. Team work		
STUDENT OBLIGATIONS DURING THE COURSE: Students are performing a set of experiments in each exercise and discussing both physical concepts and ways of presenting that experiment in classroom. Preparation and execution of all exercises. Report on the measurements		

and results after each exercise.
METHODS TO EVALUATE STUDENT PERFORMANCE: During each session student is asked to solve some simple problems, and to evaluate his/hers knowledge and understanding of that part of physics. Marks for each exercise are given.
EXAMINATION METHODS: No final exam unless student is not satisfied with the given final mark.
COURSE(S) NEEDED FOR THIS COURSE: <b>General Physics 1,2,3,4 , Laboratory-School experiments 1,2</b>
COMPULSORY LITERATURE: <b>Vernić-Mikuličić, Vježbe iz fizike, Školska knjiga, Zagreb, 1998.</b>
ADDITIONAL READING: Textbooks for physics, primary, elementary and second school level.

COURSE TITLE: <b>Teaching practice 1 and 2</b>		
COURSE TEACHER/TEACHERS: Dr. Rudolf Krsnik, PMF, University of Zagreb Maja Planinić, PMF, University of Zagreb Planinka Pećina, PMF, University of Zagreb		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 5		
SEMESTER: 9 , 10		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures		
Exercises		
Seminars	4 4	Teacher, assistant, teacher – mentor at school
Laboratory		
ECTS credits: 5 , 5		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: <b>Development and evaluation of interactive teaching skills in prospective physics teachers.</b>		
DESCRIPTION OF THE COURSE: <b>Students attend at least 10 lessons of chosen teachers – mentors at elementary schools and 10 lessons in gymnasias and/or secondary technical schools. 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.</b>		
STUDENT OBLIGATIONS DURING THE COURSE: <b>Attending mentor's lessons at schools, performing trial and public lessons at schools, discussing public lessons of other students.</b>		
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: <b>Physics education, Psychology, Didactics, Pedagogy, Laboratory in physics education</b>		
COMPULSORY LITERATURE: <b>Physics textbooks for elementary school and gymnasias chosen by teacher - mentor</b>		
ADDITIONAL READING:		

COURSE TITLE: Laboratory in Fundamental Electronics		
COURSE TEACHER/TEACHERS: Prof. dr.sc. Amir Hamzić, Dr.sc. Mario Basletić		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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: 6		
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: <b>History of Physics</b>		
COURSE TEACHER/TEACHERS: <b>Tihomir Vukelja, Ph.D.</b>		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 5		
SEMESTER: 9		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY <i>(teacher or assistant)</i>
Lectures	2	teacher
Exercises	0	
Seminars	1	assistant
ECTS credits: 4		
<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>		
<b>DESCRIPTION OF THE COURSE:</b>		
<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> <p>Week 2: Ancient Greek: general historical, social, intellectual, educational, material and economic circumstances in the Greek civilization. The Miletians and the concept of nature: the</p>		

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 5<sup>th</sup> to 10<sup>th</sup> 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 11<sup>th</sup> and 12<sup>th</sup> 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 12<sup>th</sup> century urban schools: naturalism and deism. Incursion of the Aristotelianism in 13<sup>th</sup> century and the problem of the relationship between faith and reason. Natural philosophy in the late Middle Ages (13<sup>th</sup> and 14<sup>th</sup> 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 17<sup>th</sup> 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 19<sup>th</sup> 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 7<sup>th</sup> and 14<sup>th</sup> 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, Osijek, 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.

<b>COURSE TITLE:</b> Seminar in Fundamentals in Atomic and Molecular Physics		
<b>COURSE TEACHER/TEACHERS:</b> Prof. Damir Veža		
<b>STUDY PROGRAMME:</b> Educational Physics - Teacher of Physics		
<b>YEAR OF STUDY:</b> 5		
<b>SEMESTER:</b> 9		
<b>TEACHING METHODS</b>	<b>CONTACT HRS PER WEEK</b>	<b>DELIVERED BY</b> <i>(teacher or assistant)</i>
Lectures		
Exercises		
Seminars	3	teacher
Lab		
<b>ECTS credits:</b> 5		
<b>DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:</b> Introducing students to new results in fundamental and applied atomic and molecular physics, plasma physics and spectroscopy.		
<b>DESCRIPTION OF THE COURSE:</b> Seminar topics: New developments in fundamental research in AMO Physics. New devices and methods in contemporary classical spectroscopy. New devices and methods in laser spectroscopy. Examples of devices and methods of AMO physics in medicine, environmental science and communications.		
<b>STUDENT OBLIGATIONS DURING THE COURSE:</b> Attendance to seminars.		
<b>METHODS TO EVALUATE STUDENT PERFORMANCE:</b> Oral and written seminary works		
<b>EXAMINATION METHODS:</b> Active collaboration at seminars, evaluation of seminary works		
<b>COURSE(S) NEEDED FOR THIS COURSE:</b> Intro to Atomic and Molecular Physics		
<b>COMPULSORY LITERATURE:</b> A.P.Thorne, U. Litzen, S. Johansson, <i>Spectrophysics</i> , Springer Verlag, Berlin 1999.		
<b>ADDITIONAL READING:</b> C. W. Bradley, O. A. Dale, <i>An introduction to modern stellar astrophysics</i> , Addison-Wesley, 1996.		

COURSE TITLE: Seminar in Selected topics in solid state physics		
COURSE TEACHER/TEACHERS: Prof.dr. sc. Antun Tonejc		
STUDY PROGRAMME: Educational Physics - Teacher of Physics		
YEAR OF STUDY: 5		
SEMESTER: 9		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (teacher or assistant)
Lectures	0	
Exercises	0	
Seminars	3	Teacher and assistant
Laboratory		
ECTS credits: 5		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The students should be able to prepare and give a short talk about selected topic. Use of Internet resources and new methods of presentation (e.g. PowerPoint) are strongly encouraged.		
DESCRIPTION OF THE COURSE: Illustrations and applications of various concepts already known from the accompanying course 'Selected topics in solid state physics'.		
STUDENT OBLIGATIONS DURING THE COURSE: Seminar work.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Reasonable good presentation		
EXAMINATION METHODS: No exam		
COURSE(S) NEEDED FOR THIS COURSE: 'Selected topics in solid state physics'		
COMPULSORY LITERATURE: Relevant articles from: 'Physics Today', 'Scientific American', and, 'American Journal of Physics'.		

ADDITIONAL READING: **Internet resources**

COURSE TITLE: **Seminar Selected topics in nuclear physics and particle physics**

COURSE TEACHER/TEACHERS: **Prof.dr.Marijan Mileković**

STUDY PROGRAMME: **Educational Physics - Teacher of Physics**

YEAR OF STUDY: **5**

SEMESTER: **9**

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures		
Exercises		
Seminars	<b>3</b>	
Laboratory		

ECTS credits: **5**

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The students should be able to prepare and give a short talk about selected topic. Use of Internet resources and new methods of presentation (e.g. PowerPoint) are strongly encouraged.

DESCRIPTION OF THE COURSE: **Illustrations and applications of various concepts already known from the accompanying course 'Selected topics in nuclear physics and particle physics'.**

STUDENT OBLIGATIONS DURING THE COURSE: **Seminar work.**

METHODS TO EVALUATE STUDENT PERFORMANCE: **Reasonable good talk.**

EXAMINATION METHODS:	No exam.
COURSE(S) NEEDED FOR THIS COURSE:	'Selected topics in nuclear and particle physics'
COMPULSORY LITERATURE:	Relevant articles from: 'Physics Today', 'Scientific American', 'Contemporary physics', 'American Journal of Physics'.
ADDITIONAL READING:	Internet resources, like < <a href="http://xxx.lanl.gov">http://xxx.lanl.gov</a> >

COURSE TITLE: Seminar in quantum physics and theory of relativity education		
COURSE TEACHER/TEACHERS: Vladimir Paar		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
YEAR OF STUDY: 5		
SEMESTER: 9		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY ( <i>teacher or assistant</i> )
Lectures		
Exercises		
Seminars	3	
Laboratory		
ECTS credits: 5		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Discussion and presentation of conceptual contents from quantum mechanics and relativity theory for the needs of school education.		
DESCRIPTION OF THE COURSE: Didactical approach to contents from quantum mechanics and relativity theory in high-school programs (conceptual aspects of electromagnetic waves vs. photons, energy quantization in quantum systems, atomic and nuclear spectroscopy, evolution of the Universe, semiconductors, relativity of space and time, relativistic dynamics)		
STUDENT OBLIGATIONS DURING THE COURSE: Attendance at seminars, individual projects		

METHODS TO EVALUATE STUDENT PERFORMANCE: oral and written presentation of individual projects
EXAMINATION METHODS: oral and written presentation of individual projects
COURSE(S) NEEDED FOR THIS COURSE: general physics, classical mechanics, classical electrodynamics
COMPULSORY LITERATURE:
ADDITIONAL READING: M. Russel Wehr, J. A. Richards, T. W. Adair, Physics of the atom, Addison-Wesley, 1978 S. Kuehnel, H. Schafbauer, H. Knauth, Physik 13, Oldenbourg, Muenchen, 1998 N. Bohr, Atomic theory and the description of nature, Cambridge University Press, 1961 K. Krane, Modern Physics, Wiley, 1983

COURSE TITLE: Physics of Nanomaterials		
COURSE TEACHER/TEACHERS: professor dr. sc. Antun Tonejc		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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: 5		
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.		
DESCRIPTION OF THE COURSE: <b>1. Crystal structure of monocrystals, polycrystals, quasicrystals, nanocrystals and nanoglasses.</b> <b>2. Point defects and dislocations</b> <b>3. Diffusion in crystalline and i nanocrystalline materials</b>		

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: Low temperature physics and superconductivity		
COURSE TEACHER/TEACHERS: Prof. dr. Amir Hamzić		
STUDY PROGRAMME: <b>Educational Physics - Teacher of Physics</b>		
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: 5		
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 He <sup>4</sup> and He <sup>3</sup> (superfluidity); Temperatures below 1 K (He <sup>3</sup> cryostat, He <sup>3</sup> - He <sup>4</sup> dilution cryostat); Superconductivity (basic properties – ideal conductivity and Meissner effect); Characteristics of low- and high-temperature superconductors;		

<p>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).</p>
<p>STUDENT OBLIGATIONS DURING THE COURSE: (written and exposed) reports on given subjects, active participation in the low-temperature laboratory</p>
<p>METHODS TO EVALUATE STUDENT PERFORMANCE: submitted reports</p>
<p>EXAMINATION METHODS: oral exam</p>
<p>COURSE(S) NEEDED FOR THIS COURSE: solid state physics, statistical physics</p>
<p>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.</p>
<p>ADDITIONAL READING:</p>