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

PROPOSAL

Of the university study of

EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS – TEACHER OF PHYSICS AND TECHNIQUE WITH INFORMATICS

Zagreb, January/February 2005.

University study of
EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

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

1. INTRODUCTION

1.1. The students who complete their university study and graduate in educational Physics and technique with informatics are competent to teach the subject physics in the primary school (the final two years), in the secondary school (for four years), in various vocational schools (for two to four years), as well as to teach the subject Technical culture in the primary school (four years). Besides, the graduates have the competence to teach Informatics as an elective subject in the primary school.

1.2. The proposed study **is not a new one**; the existing study is 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 related studies in Europe. The Faculty of Science has a long and rich tradition in performing university research studies as well as the educational studies.

1.3. It is not expected to conclude the study after completing the undergraduate level. The study is open to students from related educational studies and vice versa, if the differential exams are passed (e.g. in relation to educational physics and informatics, educational physics, educational physics and chemistry…)

1.4. A mobility and exchange of students is anticipated among the universities in Croatia and Europe, having studies of educational physics and technique, on the basis of the ECTS credit system.

1.5. There is a great need for the teachers of educational physics and technique. Therefore we believe that the proposed study is really indispensable.

2. GENERAL

2.1. The term of study:	The University study of educational **PHYSICS AND TECHNIQUE WITH INFORMATICS**
2.2. The institution performing the study:	University of Zagreb, Faculty of Science, Department of Physics
2.3. The duration of study:	Five years
2.4. Conditions for enrolment:	Secondary school, vocational school, similar schools with at least three-year programmes of mathematics and physics. The priority enrolment list is based on the classification procedure; the secondary school certificate in the future.
2.5. Undergraduate study:	—
2.6. Graduate study:	The university study of the educational physics and technique with informatics is an integral five-year study. The study demands the competence in physics and technique and the basic knowledge of mathematics, pedagogy, psychology and didactics. Therefore, the undergraduate three-year study is not sufficient to achieve the required competence; a full expertise can be achieved in an integral five-year study.
2.7. The graduation degree achieved at the end of study:	Teacher of physics and technique with informatics (Physicae et informaticae professor)

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Ul. kralja Zvonimira 8
10000 Zagreb

University study of educational physics and technique with informatics
TEACHER OF PHYSICS AND TECHNIQUE WITH INFORMATICS

3.1 Curriculum

YEAR 1

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P+V+S+L)*	ECTS	CONTACT HOURS (P+V+S+L)*	ECTS
Mathematics 1	**4+3+0+0**	**9**		
Fundamentals of Physics 1	**4+2+2+0**	**10**		
Introduction to Computing	**2+1+0+2**	**6**		
Technical Documentation	**2+2+0+0**	**5**	**2+2+0+0**	5
Mathematics 2			**4+2+0+0**	**8**
Fundamentals of Physics 2			**4+2+0+0**	**8**
Fundamentals of Programming			**2+1+0+2**	6
General and Inorganic Chemistry			2+1+0+0	**3**
**** Physical and Health Education 1**	**0+0+0+2**		**0+0+0+2**	
**** English 1**	2+0+0+0		2+0+0+0	
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:	**24**	**30**	**25**	**30**

YEAR 2

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P+V+S+L)*	ECTS	CONTACT HOURS (P+V+S+L)*	ECTS
Mathematics 3	**3+2+0+0**	**7**		
Fundamentals of Physics 3	**4+2+1+0**	**9**		
Physics Laboratory A	1+0+0+4	5		
Computer Networks	**1+0+0+2**	**3**		
Fundamentals of Transport Technology	**2+0+1+0**	**3**		
Introduction to Civil Engineering	**2+0+1+0**	**3**		
Mathematics 4			**3+2+0+0**	**7**
Fundamentals of Physics 4			**4+2+1+0**	**9**
Physics Laboratory B			0+0+0+4	**4**
Fundamentals of Electrical Engineering			**3+1+0+0**	**4**
Fundamentals of telecommunication Technology			**2+0+1+0**	**3**
General Ecology			**2+0+1+0**	3
**** Physical and Health Education 2**	**0+0+0+2**		**0+0+0+2**	
***** English 2**	2+0+0+0		2+0+0+0	
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:	**13+4+3+6**	**30**	**14+5+3+4**	**30**
	26		**26**	

YEAR 3

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P+V+S+L)*	ECTS	CONTACT HOURS (P+V+S+L)*	ECTS
Quantum Physics	**4+2+0+0**	8		
Astronomy and Astrophysics	**2+0+1+0**	4		
Elective course – physics 1	**2+1+0+0**	3		
Fundamentals of Physics of Materials	**2+1+0+0**	**4**		
Fundamentals of Mechanical Engineering	**3+2+0+0**	**7**		
Elective Course – Technology and Informatics 1	**2+0+0+2**	**4**		
Electrodynamics			**4+2+0+0**	**8**
Statistical Physics			**2+1+0+0**	**4**
Elective Course – physics 2			**2+1+0+0**	**3**
Fundamentals of Chemical Engineering			**2+1+0+0**	**4**
Energy			**2+0+1+0**	**4**
Automatics			**2+1+0+0**	**4**
Elective Course – Technology and Informatics 2			**1+1+0+2**	**3**
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS	**15+6+1+2**	**30**	**15+7+1+2**	**30**
	24		**25**	

Elective Course – Physics 1 i 2

History of Physics	**2+0+1+0**			
Biophysics	**2+0+1+0**			
Physics of the Earth and Atmosphere	**2+1+0+0**			
Physics and Philosophy			**2+0+1+0**	
Medical Physics			**2+1+0+0**	
			2+1+0+0	

Elective Course – Technology and Informatics 1 i 2

Computer in Experiment	**2+0+0+2**			
Computer Structure	**2+2+0+0**			
Computors in Education			1+1+0+2	
Multimedia Presentations			1+1+0+2	

YEAR 4

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P+V+S+L)*	ECTS	CONTACT HOURS (P+V+S+L)*	ECTS
Educational Psychology	**4+2+0+0**	**6**		
Laboratory in Physics Education 1	0+0+0+4	**4**		
Fundamentals of Solid State Physics	**2+1+0+0**	**4**		
Computer Aided Construction	**2+0+0+2**	**4**		
History of Technology	**2+0+1+0**	**3**		
Laboratory in Physics Education 2			0+0+0+4	**4**
Didactics			**4+0+0+0**	**4**
General Pedagogy			**4+0+0+0**	**4**
Elective Course – physics 3			**2+1+0+0**	3
Fundamentals of Electronics			**2+2+0+0**	4
Undergraduate research project		9		11
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:	**10+4+0+6**	**30**	**12+3+0+4**	**30**
	20		**19**	

Elective Course – Physics 3

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

YEAR 5

COURSE	WINTER SEMESTER		SUMMER SEMESTER	
	CONTACT HOURS (P+V+S+L)*	ECTS		CONTACT HOURS (P+V+S+L)*
Elective Course – physics 4	2+1+0+0	3		
Teaching Methods in Physics	2+0+2+0	4		
Laboratory in Fundamentals of Electronics	**0+0+0+3**	**4**		
Teaching Methods in Technology and Informatics	**4+0+4+0**	**8**		
Teaching Methods in Physics			2+0+2+0	4
Practice in Teaching Physics			0+0+0+4	4
Teaching Methods in Technology and Informatics			**0+0+0+6**	**6**
Thesis Seminar			**0+0+2+0**	**2**
Thesis Research	**0+0+0+2**	**11**	**0+0+4+0**	**14**
TOTAL HOURS PER WEEK AND TOTAL ECTS CREDITS:	**8+1+8+3**		**2+0+8+10**	
	20		**20**	

Elective Course - physics 4

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

University study of educational physics and technique with informatics
TEACHER OF PHYSICS AND TECHNIQUE WITH INFORMATICS

3.2 Curriculum

COURSE TITLE: Fundamentals of Physics 1		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 1		
SEMESTER/TERM: 1		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	Professor
Exercises	2	Assistant
Seminars	1	Professor, Assistent
ECTS credits: 10		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

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.

DESCRIPTION OF THE COURSE:

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.

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, 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:
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: Introduction to Computer Science

COURSE TEACHER/TEACHERS: Doc.dr. Nenad Pavin

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 1

SEMESTER: 1

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	1	teacher
Seminars		
Laboratory	2	assistant

ECTS credits: 6

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

The course is designed for understanding the basics of Computer Scinece.

DESCRIPTION OF THE COURSE:

1. Bits, Storage of Bits, Gates, Flip-Flops, Other Storage Techniques, Hexadecimal Noatation
2. Maim Memory, Mass Storage, Coding Information for Storage, ASCII
3. Representing Numerical Values, The Binary System, Storing Integers, Excess Notation, Two's Complement Notation, Storing Fractions, Floating-Point Notation
4. Data Manupulation, The Central Processing Unit, Registers, CPU/Memory Interface, Machine Instructions, The Stored-Program Concept
5. A Typical Machine Language, Program execution, Other Architectures (CISC and RISC), Pipelining, Multiprocessor Machines
6. Algorthms, Algorithm Representation, Pseudocode, Algorithm Discovery
7. Iterative Structures, The Sequential Search Algorithm, The Insertion Sort Algorithm, Recursive Structures
8. Programming Languages
9. Program Units, Procedures, Parameters, Functions, I/O Statements
10. Data Structures, Arrays, Pointers
11. Lists, Contiguous Lists, Linked Lists, Stacks, Queues
12. Trees, Terminology, Tree Implementation, A Binary Tree

STUDENT OBLIGATIONS DURING THE COURSE: During laboratory students have to solve ten simple problems.
METHODS TO EVALUATE STUDENT PERFORMANCE: Students have to solve three more complicated problems, and two coloquia.
EXAMINATION METHODS: The final mark is consists of laboratory examination (40% of mark) and of two coloquia (2×30% of mark)
COURSE(s) NEEDED FOR THIS COURSE: none
COMPULSORY LITERATURE: **Brookshear, J.G., "Computer Science: An Overview", Addison-Wesley**
ADDITIONAL READING:

COURSE TITLE: Tehnical documentation		
COURSE TEACHER/TEACHERS: Ass.Prof. Zvonko Herold, Ph.D.M.E.		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 1st		
SEMESTER: 1st and 2th		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	Zvonko Herold
Exercises	2	Zvonko Herold
Seminars		
Laboratory		
ECTS credits: 5 + 5		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: **Introduction to technical standards, axonometric representation, orthogonal projecting, cross sections. Getting basic knowledge of dimensioning for manufacturing. Learning rules and presentation of standards for complete outfitting of technical documentation. Getting basic knowledge for engineering information exchange (communication) by mean of a technical drawing.**		
DESCRIPTION OF THE COURSE:		
STUDENT OBLIGATIONS DURING THE COURSE:		
METHODS TO EVALUATE STUDENT PERFORMANCE:		
EXAMINATION METHODS:		
COURSE(s) NEEDED FOR THIS COURSE: none		
COMPULSORY LITERATURE: Z. Herold: Inženjerska grafika, Inženjerski priručnik, Školska knjiga, Zagreb, 1994. M. Opalić, M. Kljajin, S. Sebastijanović: Tehničko crtanje, Zrinski d.d., Čakovec, 2003. Z. Herold, D. Žeželj: Inženjerska grafika - Metodička vježbenica, FSB, Zagreb, 2005.		
ADDITIONAL READING: Koludrović: Tehničko crtanje u slici s kompjuterskim aplikacijama, Autorska naknada KOLUDROVIĆ Ć. I. R., Rijeka, 1997. K. Horvatić- Baldasar, I. Babić: Nacrtna geometrija, Sand d.o.o., Zagreb 2001.		

COURSE TITLE: Fundamentals of Physics 2		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 1		
SEMESTER/ TERM: 2		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	Professor
Exercises	2	Assistant
Seminars		
ECTS credits: 8		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: 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.		
DESCRIPTION OF THE COURSE: Electric charge. Electric field, electric potential. Gauss' law. Dielectrics, electric capaticance. 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.		
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. Exersises 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: Fundamentals of Programming		
COURSE TEACHER/TEACHERS: Doc.dr. Nenad Pavin		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 1		
SEMESTER: 2		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	1	teacher
Seminars		
Laboratory	2	assistant
ECTS credits: 6		
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: 1. Memory Concept, Variable 2. Control Structures, The **`if`** Selection Structure, The **`if/else`** Selection Structure, The **`while`** Repetition Structure 3. Assignment Operators, The **`for`** Repetition Structure, The **`do/while`** Repetition Structure, The **`switch`** Multiple-Selection Structure 4. Functions 5. Arrays 6. Pointers 7. Characters and Strings 8. Structures, Unions, Bit Manipulations and Enumarations 9. File Processing 10. Data structures and Dynamic Memory Allocation 11. Preprocessor		

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 coloquia.
EXAMINATION METHODS: The final mark is consists of laboratory examination (40% of mark) and of two coloquia (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: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY:

undergraduate study 1st year

SEMESTER: winter

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	3	teacher
Exercises	1	assistant
Seminars	0	

ECTS credits:3

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 cinetics 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 assignements weekly, to have consultations, to pass 2 colloquia during semestar 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, assignemets and colloquia) except the examination.

EXAMINATION METHODS:

A grade structure: the asignements 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, Zagreb1989 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, Zagreb1994 I.Filipović i S.Lipanović, *Opća i anorganska kemija*, 9. izdanje, Školska knjiga, Zagreb 1995 D. Grdenić, *Molekule i kristali*, Školska knjiga, Zagreb1987

COURSE TITLE: Mathematics 3

COURSE TEACHER: Dijana Ilišević, PhD, Assistant Professor, Department of Mathematics, University of Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2

SEMESTER: 3

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY
Lectures	3	teacher
Exercises	2	assistant
Seminars	0	-
Laboratory	0	-

ECTS credits: 7

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Acquainting with classical vector algebra, analytic space geometry and bases of matricial calculus.

DESCRIPTION OF THE COURSE:

1. **Vectors in space.** Definition. Addition of vectors. Scalar multiplication. Colinear and complanar vectors. Linear dependence. Scalar, vector and mixed product. Concept of a group, a vector space, and an algebra. Coordinate system. Coordinate representation of vectors and operations.
2. **Analytic space geometry.** Cartesian coordinate system. Plane equation. Line equation. Mutual positions of a line and a plane.
3. **Matrices.** Definition. Addition of matrices. Product of a scalar and a matrix. Product of matrices. Regular matrices. Determinants.

STUDENT OBLIGATIONS DURING THE COURSE: Attending the lectures and exercises, solving the homework assignments and taking an active part in exercises. There will be preliminary exams during the semester for grading the achievements.

METHODS TO EVALUATE STUDENT PERFORMANCE: Homework assignments. Preliminary exams.

EXAMINATION METHODS: The final exam is written and/or oral. The final grade is formed on the basis of homework assignments, preliminary exams and the final exam.

COURSE(s) NEEDED FOR THIS COURSE: None
COMPULSORY LITERATURE: K. Horvatić, Linearna algebra 1 i 2, skripta, PMF-Matematički odjel, Zagreb, 1995.
ADDITIONAL READING: N. Bakić, A. Milas, Zbirka zadataka iz linearne algebre s rješenjima, skripta, PMF-Matematički odjel, Zagreb, 1995. L. Čaklović, Zbirka zadataka iz linearne algebre, Školska knjiga, Zagreb, 1985. V. Devide, Riješeni zadaci iz više matematike, Svezak I, Školska knjiga, Zagreb, 1989. N. Elezović, A. Aglić, Linearna algebra, zbirka zadataka, Element, Zagreb, 1995. S. Kurepa, Kvadratne matrice drugog i trećeg reda, Školska knjiga, Zagreb, 1979. S. Kurepa, Uvod u linearnu algebru, Školska knjiga, Zagreb, 1975. V.P. Minorski, Zbirka zadataka više matematike, Tehnička knjiga, Zagreb, 1972. I.V. Proskuryakov, Problems in Linear Algebra, Mir Publishers, Moscow, 1978.

COURSE TITLE: Fundamentals of Physics 3		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 2		
SEMESTER/TERM: 3		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	Professor
Exercises	2	Assistant
Seminars	1	Professor/Assistant
ECTS credits: 9		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: 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.		
DESCRIPTION OF THE COURSE: 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.		
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 demonstrared 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: Laboratory Exercises in Physics A

COURSE TEACHER/TEACHERS: Prof. Dr. Sc. Mirko Stubičar, Department of Physics, Faculty of Science, University of Zagreb

Dr. Sc. Gorjana Jerbić-Zorc, lecturer; Department of Physics, Faculty of Science, University of Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2

SEMESTER: 3

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	0	%
Exercises	0	%
Seminars	0	0
Laboratory	4	Assistant under supervision of teacher

ECTS credits: 5

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The main goal is to provide the student with simple experiments in physics (mainly in Mechanics) which illustrates fundamental principles or the applications of these principles. Such exercises fulfil other purposes, such as: the realization of the importance of making precise measurements by making all measurements with as much care as possible; the choice of the best available technique; the care necessary in the design and completion of the experiment; the collection, tabulation and handling of data; and finally the final report writing (or its presentation.).

DESCRIPTION OF THE COURSE: Physics is an experimental science and, as such, it is largely a science of measurements. The laboratory provides a unique opportunity to validate physical theories in a quantitative manner. So, in the course are included the standard experiments that have been used by many physics departments. Most of the equipments has been supplied by the PHYWE-The Manufacturer of University Laboratory Equipments. The use of rather sophisticated data analysis are major features of the course including the repeated use of the mean and standard deviation calculations, and the linear least squares fit analysis. At the beginning of the course four introductory themes are connected with the subjects such as:

1. The Nature of Measurements. Definitions and Related Concepts: Types of Measurement, Measurement as a Relation, Sources of Variability in Measurement, Scales of Measurement.
2. The Precision and Accuracy of Measurements. The Concepts of Precision and Accuracy; The Measurement of Accuracy; Statistical Measures of Precision.

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

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

(i)

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

(ii)

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

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

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

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

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

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

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: Computer Networks

COURSE LECTURER: Doc. dr. Darko Androić

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2

SEMESTER: 2

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*lecturer or assistant*)
Lectures	1	lecturer
Exercises		
Seminars		
Laboratory	0/2	assistant

ECTS credits: 3

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

General introduction in computer interconnections. Connection between computers and computer related peripherals. Crucial computer protocols and services will be studied.

DESCRIPTION OF THE COURSE:

1) Computer networks: small (home, office), local and global computer networks
2) The Physical layer; transmission media: cable, wireless and satellite networks
3) Network protocol scheme and standards: ISO OSI (Open System Interconnection)
4) Network protocol and standard: TCP/IP scheme
5) Internet and UDP (User Datagram Protocol)
6) Data communication: interfaces
7) Data communication: error corrections
8) Network services
9) Network applications
10) Multimedia network services
11) Network security
12) Data encryption
13) Network identification and digital signature

STUDENT OBLIGATIONS DURING THE COURSE: practical exercises, seminar

METHODS TO EVALUATE STUDENT PERFORMANCE: practical exercises, written description of selected exercise, multiple choice exams
EXAMINATION METHODS: final score is formed through weighted result of partial tasks during study period
COURSE(s) NEEDED FOR THIS COURSE:
COMPULSORY LITERATURE: selected chapters from: Andrew S. Tanenbaum: Computer Networks, Prentice Hall PTR, 4. izdanje, ISBN 0-13-038488-7
ADDITIONAL READING: Installation instructions for various Operating Systems, Internet

COURSE TITLE: Fundamentals of Transport Technology		
COURSE TEACHER/TEACHERS: Prof. Ivan Bošnjak, D.Sc., Faculty of Transport and Traffic Engineering, University of Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 2nd year of study		
SEMESTER:		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher: Ivan Bošnjak
Exercises		
Seminars	1	teacher: Ivan Bošnjak
Laboratory		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Acquiring knowledge about transport technology, transport vehicles and traffic facilities in all the transport branches. Training skills for systemic description and basic calculations regarding traffic flow volumes, delays and traffic safety risk. Understanding of the concept and application of the Intelligent Transport Systems (ITS). Understanding of transport logistics and logistic chains.		
DESCRIPTION OF THE COURSE: Conceptual definition of traffic, transport, communications and transport logistics. Physical and virtual mobility. Generalized traffic system model. Traffic network and transport vehicles. Determining and measuring of the main traffic flow values. Quality of service and traffic safety. Technique and technology of road transport of passengers and goods. Technology of railway transportation. Technology of air transport and traffic. Technology of water transport and traffic. Technology of addressed deliveries. Courier services and postal items transfer. Pipeline transport. Transport logistics and distribution. Development and implementation of Intelligent Transport Systems.		
STUDENT OBLIGATIONS DURING THE COURSE: Active attendance of lectures and work on a seminar paper in the field of traffic technology or Intelligent Transport Systems with a presentation and discussion on the given topic.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Proper and punctual realization of the given tasks at lectures, work on the seminar paper		

EXAMINATION METHODS: seminar paper, written and oral exam
COURSE(s) NEEDED FOR THIS COURSE:
COMPULSORY LITERATURE: I. Bošnjak, D. Badanjak: Osnove prometnog inženjerstva, Sveučilište u Zagrebu, 2005
ADDITIONAL READING: **I. Županović: Tehnologija cestovnog prometa, Fakultet prometnih znanosti, Zagreb, 2004.** **I. Bošnjak: Inteligentni transportni sustavi I, Fakultet prometnih znanosti, (in print)** **B. Ran, D. Boyce: Modelling Dynamic Transportation Networks, Springer-Verlag, Berlin, 1996.** **Journals: Transportation Science** **Traffic Technology**

COURSE TITLE: Mathematics 4

COURSE TEACHER: Dijana Ilišević, PhD, Assistant Professor, Department of Mathematics, University of Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2

SEMESTER: 4

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY
Lectures	3	teacher
Exercises	2	assistant
Seminars	0	-
Laboratory	0	-

ECTS credits: 7

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Acquainting with standard techniques of linear algebra and fundamentals of the structure of a vector space.

DESCRIPTION OF THE COURSE:

1. **Systems of linear equations.** Basic concepts. Rank of a matrix. Elementary transformations. Existence of a solution. Structure of a solution. Gauss elimination method.
2. **Vector spaces.** Definition, examples and basic properties. Linear combination. Linear dependence. Generators of a vector space. Basis and dimension. Subspaces. Transition matrix from one basis to another.
3. **Linear operators.** Definition, basic properties and examples. Eigenvalues of a linear operator. Isomorphism of vector spaces. Rank and defect. Vector space of linear operators. Characteristic and minimal polynomial. Invariant subspaces. Diagonalization.
4. **Curves and surfaces of the second order.**

STUDENT OBLIGATIONS DURING THE COURSE: Attending the lectures and exercises, solving the homework assignments and taking an active part in exercises. There will be preliminary exams during the semester for grading the achievements.

METHODS TO EVALUATE STUDENT PERFORMANCE: Homework assignments. Preliminary exams.

EXAMINATION METHODS: The final exam is written and/or oral. The final grade is

formed on the basis of homework assignments, preliminary exams and the final exam.

COURSE NEEDED FOR THIS COURSE: Mathematics 3

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

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

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

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

S. Kurepa, Konačnodimenzionalni vektorski prostori i primjene, SNL, Zagreb, 1986.

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

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

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

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

COURSE TITLE: Fundamentals of Physics 4		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	Professor
Exercises	2	Assistant
Seminars	1	Professor/Assistant
ECTS credits: 9		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

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.

DESCRIPTION OF THE COURSE:

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.

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: Laboratory Exercises in Physics B

COURSE TEACHER/TEACHERS: Prof. Dr. Sc. Mirko Stubičar, Department of Physics, Faculty of Science, University of Zagreb

Dr. Sc. Gorjana Jerbić-Zorc, Lecturer; Department of Physics, Faculty of Science, University of Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2

SEMESTER: 4

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	0	
Exercises	0	
Seminars	0	
Laboratory	4	Assistant under supervision of teacher

ECTS credits: 4

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The course Laboratory Exercises in Physics B (abbr. LEP B) is continuation of the course Laboratory Exercises in Physics A (LEP A). However, laboratory experience will teach student the limitations inherent in the applications of physical theories to real physical situations and the role that experimental uncertainty plays in physical measurements and introduce ways to minimize experimental uncertainty, as well. The main goal is similar like in LEP A, i.e. the measurements of physical quantities and their statistical joint dependence. In this course student will carry-out experiments selected mainly from the Fundamentals of Physics 2 (Electricity and Magnetism). Stress will be given to the fundamental principles and practical operations of AVO-meter and oscilloscope apparatus. Also, a number of experiments will involve a computer-assisted data acquisition and will allow sophistication of data manipulation and analysis. The use of this resource is simply inescapable; the computer-interfaced apparatus can teach student a lot about the capabilities of contemporary laboratory methods in the context of physics. Many problems in physics are analyzed with approximations or idealizations that make the mathematics of the analysis less complicated or that offer a more discernible physical picture, and thus, experimental data and analysis offer a validation or a rejection of the approximation.

DESCRIPTION OF THE COURSE:

At the beginning of the course two introductory themes will be connected with the subjects such as:

1. The fundamental principles and practical operation of: AVO-meter instrument and oscilloscope apparatus.

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

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

(i)

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

(ii)

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

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

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

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

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

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

Laboratory Exercises in Physics A

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

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

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

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

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

COURSE TITLE: Fundamentals of Telecommunications Technology

COURSE TEACHER/TEACHERS: Prof. Ivan Bošnjak, D.Sc.; Faculty of Transport and Traffic Engineering, University of Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2nd year

SEMESTER: 4

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher: Ivan Bošnjak
Exercises		
Seminars	1	teacher: Ivan Bošnjak
Laboratory		

ECTS credits: 3

The ECTS credits value is determined based on the student workload during lectures and the work on the seminar paper in the domain of telecommunication services, teletraffic and the application of new technologies. During the preparation and development of the seminar paper, the student has to actively search and use the available sources, combining knowledge acquired during lectures and the latest technical and technological advancements.

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

Understanding the function and technical design of telecommunication system and the method of functioning and performing services via the telecommunication network and the additional functions. Acquiring competence for formal specification of users' requests and basic teletraffic calculations. Acquiring knowledge about the development trends in telecommunication networks.

DESCRIPTION OF THE COURSE:

Conceptual definition of communications, telecommunications and teletraffic. General model of telecommunication network. Formalized specification of users' requests. Information transfer modes: channel, package, frame, ATM cell. Adaptation and transparency of transferring various forms of information. Electronic, optical and magnetic recording of information. Technology of telephone traffic using classical and integrated digital network. Monitoring and measuring traffic. Data traffic technology. Layered architectures and OSI model. Internet traffic and services. Mobile networks and services. Broadband Internet communications. Multimedia and intelmedia development.

STUDENT OBLIGATIONS DURING THE COURSE: Active attendance at lectures and work on a seminar paper in the domain of the technology of telecommunications, formal description of the users' requests and teletraffic calculations, with the presentation of the work.

METHODS TO EVALUATE STUDENT PERFORMANCE: Proper and punctual performance of tasks during lectures and work on the seminar paper.

EXAMINATION METHODS: work on the seminar paper, written and oral exam

COURSE(s) NEEDED FOR THIS COURSE:

COMPULSORY LITERATURE:

- I. Bošnjak, Telekomunikacijski promet I, Fakultet prometnih znanosti, Zagreb, 2001.
- I. Bošnjak: Tehnologija telekomunikacijskog prometa II, Fakultet prometnih znanosti, Zagreb, 2000.

ADDITIONAL READING:

- **A. Bažant et al.: Osnove arhitektura mreža, Element, Zagreb, 2003.**
- **Ericsson and Telia: Understanding telecommunications, 2000.**
- **Documents IETF, (Internet Engineering Task Force).**

14) Journals: Telecommunications
15) Communications
16)

COURSE TITLE: Introduction to electrical engineering.

COURSE TEACHER/TEACHERS: Dr. Ivica Kušević, Department of Physics, Faculty of Science, University of Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2

SEMESTER: IV

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	3	teacher
Exercises	1	assistant
Seminars		
Laboratory		

ECTS credits: 4

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Aim of this course is the understanding of principles of electrical machines, ways and places of their applications, and understanding of power systems.

DESCRIPTION OF THE COURSE:

Definition of the term “electro-engineering”. Electrical charges and materials as a base of electro-engineering, electrical properties of matter. Electrostatics: electrical force, field and potential, capacitance.

Direct current, Ohm’s law, electrical circuits and Kirchoff’s laws. Electrical sources, real electrical circuit, work and power of direct current.

Magnetism-origin and connection of electrical current and magnetism, magnetic field, Lorentz force. Magnetic fields in materials, materials regarding their magnetic properties. Magnetic circuit.

Electromagnetic induction, Faraday’s law. Self- and mutual inductance, transformer.

Transients in electrical elements (RC, RL, LC and RLC circuit). Alternating current. Methods of solutions of electrical circuits of alternating currents. Power of the alternating current, power factor triangle.

Poly-phase alternating current, coupled and uncoupled three-phase system, phase and line currents/voltages. Rotary magnetic field.

Standards and measurements in electrical engineering. Working principles of analogue and digital instruments, measurements of voltage, current and resistance.

Electrical machines: definition, division, common properties, working principles and design. Rotation electrical machines. Synchronous machines: working principle.

Asynchronous machines. Direct current machines. Small motors and machines for special purposes. Protection of electrical machines. Transformers: division and design, working conditions Fundamentals of electrical power systems: generation, transmission, distribution and consumption. Statistical data about generation and consumption of electrical power in Croatia and world. Safety issues in using electricity. Protection against electrical shocks. Electricity and electrical installations in home.
STUDENT OBLIGATIONS DURING THE COURSE: attendance to lectures and homeworks.
METHODS TO EVALUATE STUDENT PERFORMANCE: attendance to lectures and homeworks.
EXAMINATION METHODS: written and oral exam.
COURSE(s) NEEDED FOR THIS COURSE: General Physics II
COMPULSORY LITERATURE: M. Essert, Z. Valter: Osnove elektrotehnike, Sveučilišna naklada Liber, Zagreb (1989). V. Pinter, B. Skalicki: Elektrotehnika u strojarstvu, osnove elektroenergetike i električnih strojeva, FSB, Zagreb (1987).
ADDITIONAL READING: V. Pinter: Osnove elektrotehnike, Tehnička knjiga, Zagreb (1975). V. Bego: Mjerenja u elektrotehnici, Tehnička knjiga, Zagreb (1990). R. Wolf: Osnove električnih strojeva, Školska knjiga, Zagreb (1995).

COURSE TITLE: Quantum physics		
COURSE TEACHER/TEACHERS: Prof.dr. Slobodan Brant		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	teacher
Exercises	2	assistant
Seminars		
Laboratory		
ECTS credits: 8		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The course is designed for understanding the principles and essential ideas of quantum physics. The applications are limited to simple systems. The aim of the course is not to develop practical skills in solving problems beyond those illustrated in exercises. Therefore, the written exam is not required.		

DESCRIPTION OF THE COURSE:

1. Thermal radiation and Planck's postulate.
2. The photoelectric effect. The Compton effect.
3. Bohr's and Sommerfeld's model of the atom.
4. De Broglie's postulate. Wavelike properties of particles.
5. Schroedinger's equation.
6. Born's interpretation of wave functions. Required properties of eigenfunctions.
7. Expectation values.
8. One-dimensional problems:

   Well potentials.

   Barrier potentials.

   Simple harmonic oscilator potential.
9. Angular momentum and magnetic moment.
10. One-electron atom.
11. Multiparticle systems (general ideas only).
12. Approximate methods for solving the Schroedinger's equation (general ideas only).

STUDENT OBLIGATIONS DURING THE COURSE:

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

METHODS TO EVALUATE STUDENT PERFORMANCE:

Results of colloquia and the result of the final examination.

EXAMINATION METHODS:

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

COURSE(s) NEEDED FOR THIS COURSE:

Physics 1-4, mathematical courses.

COMPULSORY LITERATURE:

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

ADDITIONAL READING:

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

COURSE TITLE: Astronomy and Astrophysics

COURSE TEACHER/TEACHERS: Prof. Krešimir Pavlovski		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
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: **4**		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Introduction to the basic knowledge of astronomy and astrophysics (diurnal and annual movement, fundamental astrophysical quantities and stellar properties, formation and evolution of stars, structure of Milky Way galaxy, properties of galaxies, large-scale structure of the Universe, introduction to cosmology (origin and expansion of the Universe).		
DESCRIPTION OF THE COURSE: 1) Historical development of astronomy and astro-physics, 2) Celestial coordinate systems, 3) Solar and sideral 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: Fundamentals of Physics of Materials

COURSE TEACHER/TEACHERS: Prof. Dr. Sc. Mirko Stubičar, Department of Physics, Faculty of Science, University of Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY:

SEMESTER:

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	%	%
Seminars	1	teacher
Laboratory	%	%

ECTS credits: 4

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: ***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 supperalloys, 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.***

DESCRIPTION OF THE COURSE:

The Lecture Themes ***or the Core Titles in Contemporary Course*** *«Fundamentals of Physics of Materials»:*

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; *Structures of Metals and Ceramics;* ***Crystal Structures and Unit Cells; Metallic Crystal Structures; Ceramic Crystal Structures; Silicate Ceramics, Carbon; Polymorphism and Allotropy; Crystal Systems; Crystallographic Directions and Planes; Crystalline, Partialy Crystalline and Noncrystalline Materials; Single Crystals and Polycrystalline Materials.***

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

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

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

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

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

7) Phase Diagrams. Definitions and Basic Concepts: Solubility limit, Phase, Microstructure, Phase Equilibria; Types of the Equilibrium Binary Phase Diagrams: Isomorphous Alloy Systems, Eutectic, Peritectic, Monotectic, and with Intermediate Phases; The Metastable Phase Diagrams and Metastable States of Alloys; Methods of the Formation of Metastable Phases in Materials.

8) Phase Transformations. Definitions and Basic Concepts: Structural Phases, Their Formation and Transitions;The Mechanisms and Kinetics of Solid State Transformations; Diffusive and Non-difussive (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; Fautigue; 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 forTesting Materials Under Unusual Conditions (High and Low Temperatures, High and Low Pressures, High Electric and Magnetic Fields, etc.).

15) Modern Alloy and New Materials Developments.

16) Materials for the Advanced Technologies.

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

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

METHODS TO EVALUATE STUDENT PERFORMANCE:

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

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

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

Laboratory Exercises in Physics 1, 2, 3 and 4.

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

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

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

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

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

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

COURSE TITLE: **History of Physics**		
COURSE TEACHER/TEACHERS: **Tihomir Vukelja, Ph.D.**		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	0	
Seminars	1	assistant
ECTS credits: 3		

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.

DESCRIPTION OF THE COURSE:

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.

Part one: Natural philosophy

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 new world view and the beginnings of philosophy. The early cosmological theories, specific problems (magnetism, light, atmospheric phenomena), the new explanation of phenomena. The natural experience and mind. Motives for the investigation of nature.

The problem of change and the structure of matter: Parmenides and Zeno, Pythagoreans, Empedocles, Anaxagoras, the atomists. The sophists and Socrates.

Week 3: Plato's natural philosophy. The early Greek astronomy and the Pythagorean cosmology. Plato and the beginnings of theoretical astronomy. Eudoxus. Heraclides of Pontus.

Aristotle's natural philosophy, general characteristics: the definition of physics, metaphysics, methodology. The elements: definitions, properties, and transformations.

Week 4: Aristotle's natural philosophy: cosmology, natural and enforced movements, description and the laws of the change of place, the mover, optics. Aristotle's natural philosophy and the contemporary education in physics.

Hellenism: general historical circumstances, Alexandrian Museum and Library. Hellenistic natural philosophy: Lyceum after Aristotle, Epicureans, Stoics, Neoplatonists, John Philoponus.

Week 5: Hellenistic applications of mathematics in natural philosophy: statics (Archimedes), optics (Euclides, Ptolemy). Applied mechanics.

Hellenistic astronomy: heliocentric world model (Aristarchus), advancement of the observational astronomy (Hipparchus), development of the geocentric world model (Apollonius and Ptolemy). Achievements and the role of the ancient natural philosophy.

Week 6: Decline of the natural philosophy in the late-Hellenism. General characteristics of the Roman civilization and natural philosophy in Rome (popularizers, encyclopedists, translations). Early Middle Ages (from 5th to 10th century): general historical circumstances, social, intellectual, educational, material and economical foundations. Philosophy of nature and Christianity. Carolingian Renaissance. Natural philosophy in the Early Middle Ages: Isidore of Seville, Bede, John Scotus Erigena, Gerbert of Aurillac. Shaping of the medieval world view.

The Islamic civilization, general characteristics. The place of the Greek science in Islamic society. Islamic astronomy, statics, optics (Alhazen) and natural philosophy (Avicenna, Averroes).

Week 7: Christian Europe in 11th and 12th century: economic renewal and its consequences. The Medieval symbolic mentality and natural philosophy. The translation movement. Restoration of the cities and emergence of the universities, scholastics. Material life and the technology in the Middle Ages and consequences for the natural philosophy. Natural philosophy in 12th century urban schools: naturalism and deism.

Incursion of the Aristotelianism in 13th century and the problem of the relationship between faith and reason. Natural philosophy in the late Middle Ages (13th and 14th century): nature and methodology. Research areas: cosmology and astronomy, structure of the matter, kinematics (Mertonians and Oresme), dynamics (Buridan and the impetus theory), statics, optics (Roger Bacon, Vitello, explanation of the rainbow), magnetism (Peter the Pilgrim). Mathematics and experiment in medieval

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

Part two: Modern physics

Week 8: The Renaissance: general historical, social, intellectual, educational, material and economic circumstances. Renaissance science as a destructive phase of the scientific revolution. Interweaving of art, technology and natural philosophy, a new attitude toward experiment and science.
Restoration of Neoplatonic and Stoic ideas (Petrić and Bruno) and interest for Archimedes' approach to physics (Soto, Tartaglia, Benedetti, del Monte, Stevin, Cardano). Optics, magnetism and atomism in the Renaissance.

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

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

Week 11: Newton and the development of classical mechanics.
Thermodynamics: development of the experimental methods and concepts. Heat theory. Energy and entropy, laws of thermodynamics. Kinetic gas theory and statistical physics.

Week 12: Modern optics: completing the development in geometrical optics, velocity of light, theories of light (Newton, Huygens, Descartes). Development of the wave optics in 19th century.
Electrodynamics: Coulomb's law, electric currents, electromagnetic induction, Faraday's conception of the field.

Week 13: Maxwell's electrodynamics, electromagnetic waves. Theory of relativity.
Modern atomic theory of matter: mechanical, chemical and electric atom. New experimental devices: radioactivity, electron and atomic nucleus. First models of the complex atom.

Week 14: Planck's law of the black body radiation, Einstein's work on radiation, Bohr's model of atom. The old quantum mechanics.
Compton's effect, de Broglie's hypothesis. Correspondence principle, Heisenberg's matrix mechanics and Schrödinger's wave mechanics. Quantum mechanics and classical physics. Quantum mechanics and technology: nature of the experience with atomic objects.

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

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

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

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

COURSE(s) NEEDED FOR THIS COURSE:

COMPULSORY LITERATURE:

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

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

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

ADDITIONAL READING:

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

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

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

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

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

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

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

EXAMINATION METHODS:

Final written exam.

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

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

COMPULSORY LITERATURE:

PowerPoint presentations of the lectures and selected review articles.

ADDITIONAL READING:

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

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

COURSE TITLE: Physics of the Earth and Atmosphere		
COURSE TEACHER/TEACHERS: Davorka Herak, Associate Professor; Zvjezdana Bencetić-Klaić, Assistant professor, Mira Pasarić, Ph.D., Assistant		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 4		
SEMESTER: 7		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	Teachers: Davorka Herak, Zvjezdana Bencetić-Klaić
Exercises	1	Asistent: Mira Pasarić
Seminars		
Laboratory		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding of physical characteristics and processes in the atmosphere, the ocean and in the Earth's interior, knowledge of techniques for measurement and processing of parameters describing the physical state of the Earth, comprehension of relevance of this knowledge for the education related to some important environmental problems (greenhouse effect, climate change, global sea-level rise, protection from earthquakes).		
DESCRIPTION OF THE COURSE: Radiation on Earth. Hydrological cycle. Equation of state for air and seawater. Hydrostatic equlilibrium. 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: Computer in Experiment		
COURSE TEACHER/TEACHERS: Dr. Ivica Kušević, Department of Physics, Faculty of Science, University of Zagreb		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 3		
SEMESTER: V		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises		
Seminars	2	assistant
Laboratory		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The aim of this course is to adapt the use of computer in measuring physical quantities obtained during the experiment. Using sensors, these measured quantities are transformed into electrical signals, which are, using the acquisition cards or computer-controlled instruments, collected and analyzed in a way suitable to monitor the outcome of the experiment.		
DESCRIPTION OF THE COURSE: Definition of the term "experiment" and using the computer in experiment according to the aim of the course. Analysis of the chain experiment-measuring device-sensor-computer-man. Term "sensor" with emphasizing the conversion of non-electric to electric quantities. Transducer. Sensor classification and general properties of sensors (transfer function, accuracy, resolution, dynamic properties etc.). Physical principles of sensing. Physical effects underlying the work of some sensors: electrical resistance, piezoelectric, pyroelectric, Hall, Sebeck and Peltier effect. Measurement principles and selection of sensors according to the type of measurement: mechanical measurements and measurements of the thermal properties. Dynamic models of sensor elements and sensor's response functions on outer stimulus. Connection of electrical circuits, interface. Noise in sensors and electrical circuits, electrical shielding, magnetic coupling. Analysis of connection electrical circuit-sensor according to the signal frequency. Analog-to-digital (AD) converters: resolution and sampling speed. Techniques of AD conversion. Aliasing.		

Communication instrument-computer: acquisition cards and stand-alone acquisition systems. Specification of computer performance: processor, bus architecture, linking with the computer (serial/paralle port, USB, IEEE-488, IEEE-1394, Ethernet). Computer controlled experiments and software demands: operational systems and programming languages (textual- and graphical-based language). Efficiency of programming with emphasizing on the real-time experiments. An example of using the standard sound card as an affordable and available replacement of digital storage oscilloscope.
STUDENT OBLIGATIONS DURING THE COURSE: attending the lectures and work on an individual project.
METHODS TO EVALUATE STUDENT PERFORMANCE: course attendance.
EXAMINATION METHODS: Individual project.
COURSE(s) NEEDED FOR THIS COURSE:
COMPULSORY LITERATURE: J. Fraden, Handbook of modern sensors, Springer, New York (1996).
ADDITIONAL READING: Keithley Instruments, Inc: Data Acquisition and Control Handbook (2001), www.keithley.com

COURSE TITLE: Computer Structure

PROPOSED BY *(PhD Ime Prezime, zvanje, fakultet, sveučilište)***: PhD Slobodan Ribarić, Full Professor, Faculty of EE and Computing, University of Zagreb**

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2

SEMESTER: 3

TYPES OF INSTRUCTION	CONTACT HRS PER WEEK	DELIVERED BY
Lectures	2	lecturer
Examples Classes	2	assistant
Seminars	0	lecturer

ECTS CREDITS: 4

COURSE AIMS AND OBJECTIVES:

- get introduced to computer architecture and organization

- introduction to assembly programming

TEACHING AND ASSESSMENT METHODS:

Definition of the Computer Architecture. Computer Architecture Classification. Turing Machine. Von Neumann Computer Model. Simplified Models of CISC and RISC Processors. ISA Architecture. Control Unit: Hardware and Microprogramming Implementation. Arithmetic-Logic Unit. Data Path. Memory Unit. Hierarchical Organization of Memory System. Cache Memory. Virtual memory. Input/Output Subsystem. Programmed I/O. Interrupt. DMA. Exceptions. Speed-up techniques. Pipelining. Fine- and Coarse-Parallelism. Features of CISC and RISC. Examples of Advanced RISC and CISC Processors.

Exercises are organized as oral lectures as well as laboratory training. The students have to become familiar with assembly programming techniques by using simulators for 16- and 32-bit processors/computers.

PREREQUISITES: non

READING LIST:

1. S.Ribarić, Naprednije arhitekture mikroprocesora, Element, Zagreb 2002.

2. S.Ribarić, Arhitektura računala RISC i CISC, Školska knjiga, Zagreb 1996.

3. S. Ribarić, Arhitektura mikroprocesora, Tehnička knjiga, Zagreb 1990.

ADDITIONAL READING:

1. A.S. Tannenbaum, Structured Computer Organization, Prentice-Hall Int, 1990.

2. J.L.Hennessy, D.Patterson, Computer Architecture, A Quantitative Approach, Morgan Kaufmann Pub., 1996.

COURSE TITLE: Electrodynamics		
COURSE TEACHER/TEACHERS: Prof.dr. Slobodan Brant		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 3		
SEMESTER: 6		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	teacher
Exercises	2	assistant
Seminars		
Laboratory		
ECTS credits: 8		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: 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.		

DESCRIPTION OF THE COURSE:

13. Electric charge. Coulomb's law. Electric field. Gauss' law. Electric potential.
14. Electric dipol. Multipole expansion of electric potential.
15. Laplace's and Poisson's equations. Boundary conditions.
16. Green functions in electrostatics. Method of images.
17. Electrostatics inside dielectrics. Polarization. Electrostatic energy.
18. Steady currents. Continuity equation. The Lorentz force. Magnetic field. Ampere's law.
19. The vector potential. The Biot-Savart law. Magnetic moment. Magnetic moment vs. angular momentum.
20. Macroscopic magnetostatics. Induction.
21. Maxwell's equations. Systems of units. Wave equation.
22. Electromagnetic waves in nonconducting and conducting media. Polarization of plane waves. Poynting's theorem.
23. Introduction to radiation theory.
24. Special theory of relativity. Lorentz transformation.
25. Four-vectors. Covariance of electrodynamics.

STUDENT OBLIGATIONS DURING THE COURSE:

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

METHODS TO EVALUATE STUDENT PERFORMANCE:

Results of written coloquia 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 coloquia are added to the results of the written part.

COURSE(s) NEEDED FOR THIS COURSE:

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

COMPULSORY LITERATURE:

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

ADDITIONAL READING:

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

COURSE TITLE: Statistical Physics

COURSE TEACHER/TEACHERS: Ivo Batistić

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 3

SEMESTER: 6

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	*teacher*
Exercises	1	*assistant*
Seminars		
Laboratory		

ECTS credits: **4**

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:

1. Introduction to probability theory, combinatorial analysis and distribution functions
2. Molecular collisions, ideal gas pressure
3. Introduction to thermodynamics, the equation of state
4. Laws of thermodynamics, Carnot's circle, engines
5. Basic relation of thermodynamics, systems with variable number of particles
6. Maxwell's distribution function
7. Configuration space, limits of the classical statistical physics
8. Stirling's approximation, Boltzmann's distribution function
9. Brown's particle motion, equipatition law, Dalton's law
10. Energy quantisation and the third law of thermodynamics, black body radiation
11. Specific heat of solid bodies, bosons and fermions, Bose-Einstein's distribution function
12. Fermi-Dirac's distribution function, fermionic systems

STUDENT OBLIGATIONS DURING THE COURSE: lecture and exercise attendance

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

COURSE TITLE: **Fundamentals of Chemical Engineering**		
COURSE TEACHER/TEACHERS: **Hrvoje Ivanković**		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: **3rd**		
SEMESTER: **8th**		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	**2**	**teacher**
Exercises	**1**	**assistant**
Seminars		
Laboratory		
ECTS credits: 4		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: **Familiarizing with specific features of chemical engineering. Development of understanding the interaction between the unit operations, the equipment, the processing path and the state of product. Familiarizing with chemical processes of mineral fertilizers production and building materials.**		
DESCRIPTION OF THE COURSE: **Definition and elementary features of chemical engineering. Mass and energy balance equations. Mechanical and thermal separation processes and equipment. Reaction engineering and catalysis. Measurement and automatic process control. Process economy. Environmntal chemical engineering. Chemical processes of mineral fertilizers production. Ceramic processing.**		
STUDENT OBLIGATIONS DURING THE COURSE: **Individual project**		
METHODS TO EVALUATE STUDENT PERFORMANCE: **Essays associated with the project**		
EXAMINATION METHODS: **Oral**		
COURSE(s) NEEDED FOR THIS COURSE: **General and inorganic chemistry**		

COMPULSORY LITERATURE:

1. **M. Peters: Elementary Chemical Engineering, ed. II, McGraw Hill, New York, 1984**
2. **Z. Gomzi, Kemijski reaktori, HINUS, Zagreb, 1998.**
3. **W. L. Luyben, L. A. Wenzel, Chemical process Analysis: Mass and Energy Balances, Prentice Hall, New Jersey, 1988**

ADDITIONAL READING:

1. **A. Đureković, Cement, cementni kompoziti i dodaci za beton, IGH i Školska knjiga, Zagreb, 1996.**
2. **O. Henning, D. Knoefel, Baustoffchemie, Verlag Bauwesen, Wiesbaden und Berlin, 2002**

COURSE TITLE: Energy and Ecology

PROPOSED BY: Đuro Miljanić, senior scientist, Ruđer Bošković Institute, Zagreb

PROGRAMME: Educational Physics - Teacher of Physics

YEAR OF STUDY: 2

SEMESTER: 4

TYPES OF INSTRUCTION	CONTACT HRS PER WEEK	DELIVERED BY
Lectures	2	lecturer
Examples Classes		lecturer
Seminars	1	

ECTS CREDITS: 4

COURSE AIMS AND OBJECTIVES: To acquire knowledge on: a) main characteristics of different energy sources; b) physical and technological aspects of their use; c) social, environmental and economical issues connected with meeting present and future energy needs.

COURSE DESCRIPTION AND SYLLABUS: Work, energy, power. Primary energy sources: their main characteristics, reserves, production and consumption in Croatia and the world. Energy conversion: basics, processes, devices, engines, plants. Transmission, transport and storage of different forms of energy. Energy and society: impacts on human health and environment, economy, sustainable development.

TEACHING AND ASSESSMENT METHODS:

PREREQUISITES: Physics and mathematics courses – prerequisites for the third year of study.

READING LIST: 1. B. Udovičić: Energetika, Školska knjiga, Zagreb, 1993
2. V. Knapp: Novi izvori energije I, Školska knjiga, Zagreb, 1993.
3. P. Kulišić: Novi izvori energije II., Školska knjiga, Zagreb, 1991.

ADDITIONAL READING:

1. **Obnovljivi izvori energije (ed. B. Labudović), Energetika Marketing, Zagreb, 2002.**
2. **Energy Systems and Sustainability: Power for a Sustainable Future (ed. G. Boyle, B. Everett and J. Ramage), Oxford University Press, Oxford, 2003.**
3. **Renewable Energy: Power for a Sustainable Future (ed. G. Boyle), Oxford University Press, Oxford, 2004.**

COURSE TITLE: **Physics and Philosophy**

COURSE TEACHER/TEACHERS: **Tihomir Vukelja, Ph.D.**

STUDY PROGRAMME:

YEAR OF STUDY: 3

SEMESTER: 6

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	0	
Seminars	1	assistant

ECTS credits: **3**

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

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.

DESCRIPTION OF THE COURSE:

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.

Part one: Philosophy of science

Week 2: Rationalism and empiricism. Inductive account of physical knowledge. Logical positivism.

Week 3: Popper and falsificationism. Duhem – Quine thesis.

Week 4: Kuhn: paradigms and scientific revolutions. Social constructivism.

Week 5: Lakatos: research programmes. Feyerabend and scientific method.

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 beforehanded 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^{th} and 14^{th} 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 complet 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 Universitiy Press, Cambridge, 1999.

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

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

COURSE TITLE: Multimedia presentations

COURSE TEACHER/TEACHERS: mr.sc. Dalibor Paar

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2

SEMESTER: 4

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	1	teacher
Exercises	2	assistant
Seminars	1	teacher
Laboratory		

ECTS credits: 3

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 multimedal 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: Educational Psychology

COURSE TEACHER/TEACHERS:

Dr. sc. Nikola Pastuović, redoviti profesor
Učiteljska akademija Sveučilišta u Zagrebu

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 1

SEMESTER: 1

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	teacher
Exercises	2	teacher and assistant
Seminars		
Laboratory		

ECTS credits: 6

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:

- **The subject-matter and the development of Educational Psychology**
- **The Concept of Personality and ways of researching personality**
- **The Humanistic approach in Personality Psychology**
- **The Personality Structure**
- **Individual differences and measuring standards**
- **Heredity and the environment in the genesis of individual differences**
- **The Educational consequences of individual differences in intelectual abilities**
- **The Educational consequences of individual differences in conative characteristics**
- **The Development of moral conscience and the theories of moral development**
- **School and Moral development**

STUDENT OBLIGATIONS DURING THE COURSE:
Students need to successfully carry out all the tasks, regularly attend classes and actively participate during classes.

METHODS TO EVALUATE STUDENT PERFORMANCE: The course realization is conducted through lectures, dicussions and independent reading. Assessment is checked during the semester by writing a term paper and solving objective tasks

EXAMINATION METHODS:
The exam is oral

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

COMPULSORY LITERATURE:
Pastuović, N. (1997). Osnove psihologije obrazovanja i odgoja. Zagreb: Znamen

ADDITIONAL READING:
Fulgosi, A. (1983). Psihologija ličnosti. Zagreb: Školska knjiga
Grgin, T. (1997). Edukacijska psihologija. Jastrebarsko: Naklada Slap
Pastuović, N. (1999). Edukologija. Zagreb: Znamen
Raboteg-Šarić, Z. (1995). Psihologija altruizma. Zagreb: Alinea
Žužul, M. (1989). Agresivno ponašanje. Zagreb: Radna zajednica Republičke konferencije saveza socijalističke omladine hrvatske.

COURSE TITLE: Fundamentals of Solid State Physics

COURSE TEACHER/TEACHERS: Ivo Batistić

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 4

SEMESTER: 7

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	*teacher*
Exercises	1	*assistant*
Seminars		
Laboratory		

ECTS credits: 4

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

Basic concepts of the solid state physics: crystal structure, elasticity, magnetism, thermal and transport properties

DESCRIPTION OF THE COURSE:

1. Crystal structure
2. Atomic bonding
3. Lattice dynamics – phonons
4. Lattice dynamics – thermal properties
5. Metals – Sommerfeld's model
6. Metals – electron band structure
7. Transport properties – electrical and thermal conductivity, Hall's effect
8. Transport properties – conductivity of metal and alloys
9. Semiconductors
10. Magnetic properties – paramagnetism and diamagentism
11. Magnetic properties of metals and ferromagnetism
12. Superconductivity

STUDENT OBLIGATIONS DURING THE COURSE: lecture and exercise attendance

METHODS TO EVALUATE STUDENT PERFORMANCE: problem solving

EXAMINATION METHODS: written and oral examination
COURSE(s) NEEDED FOR THIS COURSE: Statistical physics and quantum mechanics
COMPULSORY LITERATURE: V. Sips: Uvod u fiziku cvrstog stanja (Introduction to solid state physics)
ADDITIONAL READING: Charles Kittel: Introduction to Solid State Physics

COURSE TITLE: Laboratory in Physics Education 1 and 2		
COURSE TEACHER/TEACHERS: P.Pećina, M.Planinić, A. Sušac		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 4		
SEMESTER: 7 and 8		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures		
Laboratory	4 4	*assistant*
Seminars		
ECTS credits: 4		

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:

1.Introductory discussion about work in laboratory and role of experiment in physics teaching

2. Concepts and models-initial test and discussion

3.-7. Lab exercise in rotation

1.1 The molecular kinetic theory
1.2 Laws of motion
1.3 Mechanics
1.4 Simple electrical circuits
1.5 Geometrical optics

8. Conceptual test and discussion

9-13 Lab exercise in rotation

2.1 Waves
2.2 Electromagnetic induction
2.3 Pressure in fluids and gases
2.4 Basic laws of D.C. current
2.5 Physical optics

14. Conceptual test and discussion

15. Overview

II semester

1. Demonstration of some “nice” experiments

2. Concepts and models-initial test and discussion

3.-7. Lab exercise in rotation

3.1 Law of conservation of energy

3.2 Heat
3.3 Radioactivity
3.4 Resistance in A.C. circuits
3.5 Atomic physics

8. Conceptual test and discussion

9-13 Lab exercise in rotation
4.1 Harmonic oscillations
4.2 Gas laws
4.3 Conservation of momentum
4.4 Experiments with computer
4.5 Waves and light

14 Conceptual test and discussion

15 Overview

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

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

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

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

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

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

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

COURSE TITLE: Didactics

COURSE TEACHER/TEACHERS:

assistant professor Vlatka Domović, Ph.D

Učiteljska akademija Sveučilišta u Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 2

SEMESTER: 4

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
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:

- **The historical development of school and the didactic idea**
- **The subject-matter and tasks of didactics and the relation between didactics and other educational sciences.**
- **Fundamental didactic concepts**
- **The organization and goals of « the traditional school» and the modern concept of the development of schools**
- **The concept of life-long education/learning**
- **The curriculum theory**
- **The establishment of educaional needs and defining the educational goals**
- **The content of learning and educational system**
- **The educational programme –the criteria of choice, organization, scope, depth, order.**
- **Learning conditions**
- **The inner and outer learning conditions. Teaching, organizational processes, school and class environment, classroom management.**
- **Evaluation of the curriculum**
- **The evaluation of teacher's work**
- **The evaluation and improvement of one's own work. Self-evaluation techniques.**

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

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

EXAMINATION METHODS:
The exam is oral.

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

COMPULSORY LITERATURE:

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

ADDITIONAL READING:

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

COURSE TITLE: General Pedagogy

COURSE TEACHER/TEACHERS:

Dr. sc. Marija Bratanić, red. prof.
Učiteljska akademija Sveučilišta u Zagrebu

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 1

SEMESTER: 2

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	teacher
Exercises		
Seminars		
Laboratory		

ECTS credits: 4

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

The goal of the course is to introduce students to the development of educational activities and the pedagogical idea in the history of mankind as a referential framework for understanding contemporary educational problems. Starting from experiencing the educational proces and developing the scientific notion of education and their mutual connection and how they are conditioned. Raising awareness of the connection between society and the process of education and becoming aware of the role of education in the development of human society and every individual. Master the ideas that will develop abilities and skills for establishing of human relations and a more successful communication as a basis f competence. Master the basis of pedagogical methodology and statistics for the indepedent studying of educational activities with the intention of promoting them. Enabling the students to observe and solve contemporary problems in education so that students will, as future educators and teachers of various subjects, be able to face the the challenges.

DESCRIPTION OF THE COURSE:

- **Education - fundamental notions.**
- **Education - the goals, norms and values.**
- **The division and tendencies in pedagogy as a science about education.**
- **Education and society.**
- **Education and the development of personality.**

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

STUDENT OBLIGATIONS DURING THE COURSE:
Students need to successfully carry out all the tasks, regularly attend classes and actively participate during classes.

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

EXAMINATION METHODS:
The exam is oral.

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

COMPULSORY LITERATURE:
Bratanić, M. (1993). Mikropedagogija. Interakcijsko - komunikacijski aspekt odgoja. Zagreb: Školska knjiga.
Delors, J.(1998). Učenje - blago u nama. Zagreb: Educa, Zagreb.
Giesecke, H. (1993). Uvod u pedagogiju. Zagreb: Educa.
Gudjons H. (1994). Pedagogija - temeljna znanja. Zagreb: Educa.
Mijatović, A. (ur.) (1999). Osnove suvremene pedagogije. Zagreb, HPKZ.
Pastuović, N.(1999). Edukologija. Zagreb: Znamen.

ADDITIONAL READING:
Brajša, P. (1993). Pedagoška komunikologija. Zagreb: Školske novine.
Bratanić, M. (2002). Paradoks odgoja. Zagreb: Hrvatska sveučilišna naklada.
Legrand, L.(1995). Moralna izobrazba danas: ima li to smisla? Zagreb: Educa.
Lesourne, J.: Obrazovanje & društvo. Izazovi 2000 godine. Educa, Zagreb, 1993.

COURSE TITLE: Fundamentals of Electronics

COURSE TEACHER/TEACHERS: Prof. Damir Veža

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 4

SEMESTER: 8

TEACHING METHODS	**CONTACT HRS PER WEEK**	**DELIVERED BY** (*teacher or assistant*)
Lectures	2	teacher
Exercises	1	assistant
Seminars		
Lab		

ECTS credits: 4

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding basics of Electronics

DESCRIPTION OF THE COURSE:

Lectures:
1.Cathode ray tube. 2.Semiconductors. Semiconductor diode. 3.Transistors. 4.Methods of circuit analysis. 5.Single stage amplifier and follower. 6.Multistage and feedback amplifiers. 7.Differential amplifier. 8. Operational amplifier. 9. Basic logic gates. 10.Boolean algebra and logic circuits. 11.Fundamentals of optoelectronics. 12.Photodiode and light emitting diode. 13.Laser diode.
Exercises:
Suplementary material to lectures: solving problems in electronics.
Demo-Lab:
Suplementary material – practical examples: 1.CRT Osci. 2.Diode and transistor. 3.Application of PC s in physics demonstrations (using transducers and sensors). 4.Optoelectronic elements.

STUDENT OBLIGATIONS DURING THE COURSE: Attendance to lectures, homeworks

METHODS TO EVALUATE STUDENT PERFORMANCE: Homeworks and written exams

EXAMINATION METHODS: evaluation of homeworks and an exam at the end of the semester

COURSE(s) NEEDED FOR THIS COURSE: Electricity and magnetism course

COMPULSORY LITERATURE:

C.L.Hemenway, R.W.Henry, M.Caulton, *Physical Electronics*, John Wiley & Sons Inc. 1967.
P. Biljanović, *Elektronički sklopovi*, Školska knjiga, Zagreb 1999.

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

COURSE TITLE: Fundamentals of Atomic and Molecular Physics

COURSE TEACHER/TEACHERS: Prof. Damir Veža

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 4

SEMESTER: 8

TEACHING METHODS	**CONTACT HRS PER WEEK**	**DELIVERED BY** (*teacher or assistant*)
Lectures	2	teacher
Exercises	1	assistant
Seminars		
Lab		

ECTS credits: 3

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding basics of AMO Physics

DESCRIPTION OF THE COURSE:

1.Atomic energy levels 2.Molecular energy levels 3.Spectra of alkali atoms and molecules 4.Emission and absorption of radiation 5. Ionized gases and plasma 6. Atomic collision processes in gases and plasmas 7.Classical spectroscopy (basic methods and devices) 8.Laser spectroscopy (basic methods and devices) 9. Spectra of ionized gases and plasmas and elementary plasma diagnostics 10.Selected examples of AMO applications in medicine, environmental science and communications 11.Contemporary developments in fundamental research in the AMOP
Exercises:
Complementary material to lectures. Solving problems in atomic and molecular physics.

STUDENT OBLIGATIONS DURING THE COURSE: Attendance to lectures, homeworks

METHODS TO EVALUATE STUDENT PERFORMANCE: Homeworks and written exams

EXAMINATION METHODS: evaluation of homeworks and an exam at the end of the semester

COURSE(s) NEEDED FOR THIS COURSE: Quantum physics

COMPULSORY LITERATURE:

A.P.Thorne, U. Litzen, S, Johansson, *Spectrophysics*, Springer Verlag, Berlin 1999.

ADDITIONAL READING:

C. W. Bradley,O. A. Dale, *An introduction to modern stellar astrophysics*, Addison-Wesley, 1996.

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

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

COURSE TITLE: PHYSICS OF SEMICONDUCTORS		
COURSE TEACHER/TEACHERS: Miroslav Požek		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: fifth		
SEMESTER: ninth		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	0	
Seminars	1	teacher
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Fundamentals of semiconductors physics and insight into current research on semiconductor physics in Croatia		
DESCRIPTION OF THE COURSE: Lectures: Elementary definition of semiconductors, historical overview, chemical approach. Zone theory of semiconductors. Intrinsic an extrinsic semiconductors. Origin and classification of defects. Controlled introduction of defects. Concentration of carriers in thermal equilibrium. Types of semiconductors and compensation. Scattering and transport properties. Electrical conductivity, thermoelectromotive force and Hall effect. Recombination. Optical properties. Absorption of radiationa and photoconductivity. Experimental determination of semiconducting parameters. Electrical and optical methods. Elemental semiconductors and semiconducting compounds. Crystal, amorphous and glassy semiconductors. Superlattices. Seminar: Student visits one of the research groups and makes a seminar about actual research. The seminar is to be presented to other students.		
STUDENT OBLIGATIONS DURING THE COURSE: Attendance of lectures and seminars.		
METHODS TO EVALUATE STUDENT PERFORMANCE: seminar		
EXAMINATION METHODS: Oral exam.		
COURSE(s) NEEDED FOR THIS COURSE: Quantum physics, statistical physics		
COMPULSORY LITERATURE: B. Sapoval and C. Hermann, Physics of Semiconductors, Springer Verlag, New York, 1995.		
ADDITIONAL READING: R.A. Smith, Semiconductors, 2nd Edition, Cambridge University Press, London, 1978.		

COURSE TITLE: Physics of Nanomaterials		
COURSE TEACHER/TEACHERS: professor dr. sc. Antun Tonejc		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: 5		
SEMESTER: 9		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises		
Seminars	1	teacher
Laboratory		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To provide a students with basic concepts of physics of nanomaterials, using experimental facts and theoretical models.		
DESCRIPTION OF THE COURSE: 1. Crystal structure of monocrystalls, polycrystalls, quasicrystalls, nanocrystalls and nanoglasses. 2. Point defects and dislocations 3. Diffusion in crystalline and i nanocrystalline materials 4. Physical methods for nanomaterials characterisation 5. Phase diagrams 6. Structure of metals, solid solutions, intermetallic compounds and glassy materials 7. Diffusive and nondiffusive phase transformations 8. Metastable state of materials 9. Metastable micro- and nanostructures 10. Mechanical properties of micro- and nanocrystalls 12. Magnetic properties of micro- and nanocrystalls 13. Nanotubes 13. Nanocrystalls 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: **Regulary attendence 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: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 5

SEMESTER: 9

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	1	teacher
Seminars		

ECTS credits: 3

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Introduction to the methods for the production of low temperatures, unique properties of helium (superfluidity) and basic characteristics and applications of superconductivity

DESCRIPTION OF THE COURSE:
Liquefying principles, helium and nitrogen liquefiers;
Work with cryogenic liquids (cryostats, thermal losses);
Low temperature thermometry,
Properties of He^4 and He^3 (superfluidity);
Temperatures below 1 K (He^3 cryostat, He^3- He^4 dilution cryostat);
Superconductivity (basic properties – ideal conductivity and Meissner effect);
Characteristics of low- and high-temperature superconductors;
London theory, thermodynamical properties;
Main results of Ginzburg-Landau i Bardeen-Cooper-Schrieffer models;
Large- and small-scale application of classic and high-temperature superconductivity (research, industry, medicine, power, transport).

STUDENT OBLIGATIONS DURING THE COURSE: (written and exposed) reports on given subjects, active participation in the low-temperature laboratory

METHODS TO EVALUATE STUDENT PERFORMANCE: submitted reports

EXAMINATION METHODS: oral exam

COURSE(s) NEEDED FOR THIS COURSE: solid state physics, statistical physics

COMPULSORY LITERATURE:
D. Tilley, J. Tilley, Superfluidity and Superconductivity, IOP Publishing Ltd., 1990.
M. Cyrot, D. Pavuna: Introduction To Superconductivity and High Tc Materials, World Scientific Publishing Co., Singapore, 1992.

ADDITIONAL READING:

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

COURSE TEACHER/TEACHERS:

Prof.dr.sc. Rudolf Krsnik,

Mr. sc. Maja Planinić, PMF, Zagreb

Dipl.inž. Planinka Pećina, PMF, Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: **4**

SEMESTER: **7**

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	**2**	teacher
Exercises		
Seminars	**2**	teacher, assistant
Laboratory		

ECTS credits: **4**

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:

1. Status and content of physics education. The need for radical changes in the teaching of natural sciences.
2. Important breakthroughs in the recent development of physics teaching. Learning as development of mental structures. Assimilation and accommodation. Results of J. Piaget and physics teaching.
3. Stages of cognitive development. Development of formal thinking and procedural knowledge. Application to physics teaching..
4. Concepts in physics and students' alternative conceptions. The importance of eliciting students' alternative conceptions.
5. Examples of students' alternative conceptions.
6. Constructivist approach to physics teaching (educational constructivism).

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

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

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

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

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

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

COMPULSORY LITERATURE:

R. Krsnik, Ideje suvremene metodike fizike, in print

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

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

ADDITIONAL READING:

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

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

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

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

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

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

COURSE TITLE: **Teaching methods in technology and informatics**

COURSE TEACHER/TEACHERS: **dr.sc. Gorjana Jerbić-Zorc**

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: **5**

SEMESTER: **9**

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	**4**	**teacher**
Exercises		
Seminars	**4**	**teacher**

ECTS credits: 8

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: **Development of teaching skills in prospective technique and computing teachers. Acquainting students with results of technique and computer science education research and their use in teaching.**

DESCRIPTION OF THE COURSE:

1. **Theoretical basis**
   - **the aim of technique and computing teaching**
   - **content,**
   - **organization and**
   - **methodology of teaching.**
2. **Technique curriculum for elementary schools**
3. **New methods in technique teaching**
4. **Development of technique - historical overview**
5. **Knowledge and skills in computer science**
6. **Role of programming**
7. **The topics listed above are also discussed in seminar, where students give their talks.**

STUDENT OBLIGATIONS DURING THE COURSE: **Regular attendance, active participation in discussions, giving at least 4 seminar talks.**

METHODS TO EVALUATE STUDENT PERFORMANCE: **Students' seminar talks and discussions.**

EXAMINATION METHODS: **Oral exam. The quality of their seminar talks and the level of**

their participation in discussions contribute to student's final grade.
COURSE(s) NEEDED FOR THIS COURSE: **Pedagogy, Psychology of education, Didactics**
COMPULSORY LITERATURE: **Technique courses for elementary schools**
ADDITIONAL READING: **Children's Encyclopedia, Internet**

COURSE TITLE: Laboratory in Fundamentals of Electronics

COURSE TEACHER/TEACHERS: Prof. dr.sc. Amir Hamzić,
Dr.sc. Mario Basletić

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 5

SEMESTER: 9

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures		
Exercises		
Seminars		
Laboratory exercises	3	*teacher and assistant*

ECTS credits: **4**

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: **Teaching Methods in Physics 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: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: **4**

SEMESTER: **8**

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	**2**	teacher
Exercises		
Seminars	**2**	teacher, assistant
Laboratory		

ECTS credits: **4**

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. Continous and line spectra. Models of atom. Development of ideas about atomic nucleus.

29. Basic principles of quantum mechanics.

30. Elementary particles. Big Bang theory.

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

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

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

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

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

COMPULSORY LITERATURE:

R. Krsnik, Ideje suvremene metodike fizike, in print

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

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

ADDITIONAL READING:

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

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

L. C. McDermott, Physics by Inqury, 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: **Practice in Teaching Physics**

COURSE TEACHER/TEACHERS:

Dr. Rudolf Krsnik, PMF, University of Zagreb

Maja Planinić, PMF, University of Zagreb

Planinka Pećina, PMF, University of Zagreb

STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS

YEAR OF STUDY: 5

SEMESTER: **10**

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures		
Exercises		
Seminars	**4**	Teacher, assistant, teacher – mentor at school
Laboratory		

ECTS credits: **4**

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: **Development and evaluation of interactive teaching skills in prospective physics teachers.**

DESCRIPTION OF THE COURSE: **Students attend at least 10 lessons of chosen teachers – mentors at elementary schools and/or gymnasia. Afterwards they prepare themselves for teaching and teach two trial lessons in class. If they are ready, according to mentor's opinion, to teach , they prepare and perform a public lesson. Teacher of physics education course and other students attend the public lesson, and later they all discuss it.**

STUDENT OBLIGATIONS DURING THE COURSE: **Attending mentor's lessons at schools, performing trial and public lessons at schools, discussing public lessons of other students.**

METHODS TO EVALUATE STUDENT PERFORMANCE: Assessment of student's public lesson.

EXAMINATION METHODS: Assessment of student's public lesson.

COURSE(s) NEEDED FOR THIS COURSE: **Physics education, Psychology, Didactics, Pedagogy, Laboratory in physics education**

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

COURSE TITLE: **Teaching methods in technology and informatics**		
COURSE TEACHER/TEACHERS: **dr.sc. Gorjana Jerbić-Zorc**		
STUDY PROGRAMME: UNIVERSITY STUDY OF EDUCATIONAL PHYSICS AND TECHNIQUE WITH INFORMATICS		
YEAR OF STUDY: **5**		
SEMESTER: **10**		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures		
Exercises		
Seminars		
Practice	**6**	**Teacher, teacher – mentor at school**
ECTS credits: 6		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: **Development and evaluation of teaching skills in prospective computer science teachers.**		
DESCRIPTION OF THE COURSE: **Students attend at least 10 lessons of chosen teachers of technique at elementary schools and 10 lessons of chosen teachers of computer science at elementary 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 technique and computing education course and other students attend the public lesson, and later they all discuss it.**		
STUDENT OBLIGATIONS DURING THE COURSE: **Attending mentor's lessons at schools, performing trial and public lessons at schools, discussing public lessons of other students.**		
METHODS TO EVALUATE STUDENT PERFORMANCE: **Assessment of student's public lesson.**		
EXAMINATION METHODS: **Assessment of student's public lesson.**		
COURSE(s) NEEDED FOR THIS COURSE: **Technique and computing education, Pedagogy, Psychology of education, Didactics**		
COMPULSORY LITERATURE: **Technique and computer science courses for elementary schools**		
ADDITIONAL READING: **Children's Encyclopedia, Internet**		