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

PROPOSAL

Of the university study of
EDUCATIONAL PHYSICS AND INFORMATICS
TEACHER OF PHYSICS AND INFORMATICS

Zagreb, January/February 2005.

The university study of
EDUCATIONAL PHYSICS AND INFORMATICS – TEACHER OF PHYSICS AND INFORMATICS

According to instructions of Croatian Rector's Conference, 14. January 2004.

1. INTRODUCTION

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

1.2. The former study of educational physics and informatics is a relatively new study and it is recognized by students as a very promising programme which offers fair opportunities for employment. Moreover, most students of this study find jobs even before graduation, by making use of acquired knowledge in informatics.

The combined knowledge and skills provided by this two-programme study are the basis of additional possibilities for employment, following international trends of a great need for interdisciplinary know-how.

1.3. The study of educational physics and informatics is open to students of related studies, if the differential exams are passed.

There is a possibility to conclude the study at the undergraduate level, as the need for experts competent in informatics is great in all branches of economy. We believe that some students will use that opportunity. It should be stressed that the undergraduate study does not provide the competence which is required for teaching in schools.

1.4. During the creation of the present programme, some thirty programmes in other countries have been reviewed, while the following universities have been referred to in formulation of the final version: Boston University, San Diego State University, University of Illinois Urbana Champaign, University of Utah, Brown University, Washington University in St. Louis, University of New Hampshire, Columbia State University, University of Liverpool, University of Windsor.

1.5. The most important task is a proper and adequate implementation of the proposed study; in order to ensure a high level of the study, an additional financial support will be necessary, as well as employing a number of junior researchers (assistants).

2. GENERAL

2.1. The term of study:	The University study of educational **PHYSICS AND 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, chemical vocational school, similar school with at least three-year programmes of mathematics, physics and chemistry; the priority enrolment list is defined by the classification procedure; the secondary school certificate in the future.
2.5. Undergraduate study:	There is a possibility to issue a diploma for the completion of the undergraduate study, due to a great need for experts in informatics. It is well known that the former students have found jobs before formal graduation, on the basis of the knowledge acquired during their study.
2.6. Graduate study:	—
2.7. The graduation degree achieved at the end of study:	Teacher of physics and informatics (Physicae et informaticae professor)

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University study of educational physics and informatics:
TEACHER OF PHYSICS AND INFORMATICS

3.1. Curriculum

YEAR 1

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

COURSE	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Fundamentals of Physics 1	**4+2+2+0**	**10**		
Mathematical Analysis 1	**3+2+0+0**	**7**		
Linear Algebra 1	**2+1+0+0**	4		
Introduction to Computer Science	**2+1+0+2**	6		
Word processing and spread sheets	**1+0+0+1**	3		
Fundamentals of Physics 2			**4+2+0+0**	8
Mathematical Analysis 2			**3+2+0+0**	7
Linear Algebra 2			2+1+0+0	5
Fundamentals of Programming			2+1+0+2	7
Fundamentals of Physics Measurements			**2+0+1+0**	3
	11+6+2+4		13+7+0+3	
Physical and Health Education	**0+2+0+0**		0+2+0+0	
TOTAL HOURS PER WEEK ANS TOTAL ECTS CREDITS:	**23**	**30**	**22**	**30**

YEAR 2

COURSE	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Fundamentals of Physics 3	**4+2+1+0**	**9**		
Classical Mechanics 1	**2+1+0+0**	4		
Mathematical Methods in Physics 1	**3+2+0+0**	**7**		
Computer Structure	**2+2+0+0**	5		
Data Structures and Algorithms	**2+0+0+2**	5		
Fundamentals of Physics 4			4+2+1+0	8
Classical Mechanics 2			1+1+0+0	3
Differential equations - dynamical systems			2+0+0+1	3
Mathematical Methods in Physics 2			**2+1+0+0**	4
Object Oriented Programming			2+0+0+2	5
Multimedia Presentations			1+1+0+2	4
Elective course 1			2+1+0+0	3
	15+8+1+2		**14+6+1+5**	
Physical and Health Education	**0+2+0+0**		0+2+0+0	
TOTAL HOURS PER WEEK ANS TOTAL ECTS CREDITS:	**23**	**30**	**26**	**30**

- **P =** broj sati predavanja tjedno, **V** = broj sati vježbi/seminara tjedno, **L** = broj sati laboratorijskih vježbi (praktikuma) tjedno

Elective course 1	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Symbolic Programming			1+0+0+2	3
Computer Networks (INTERNET)			1+0+0+0	3
Fundamentals of Geophysics			**1+1+0+0**	3
Energy and Ecology			**2+0+1+0**	3

YEAR 3

COURSE	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Quantum Physics	4+2+0+0	8		
Laboratory in Fundamental Physics A	0+0+0+4	3		
Operating Systems	2+2+0+0	6		
Advanced Programming	2+0+0+2	6		
Numerical Methods	1+0+0+3	4		
Computer networks	1+0+2+0	3	1+0+0+2	3
Electrodynamics			4+2+0+0	9
Statistical Physics			2+1+0+0	4
Laboratory in Fundamental Physics B			0+0+0+4	3
Databases			2+0+0+2	5
User interfaces			1+0+0+2	3
Elective course 2			2+1+0+0	3
TOTAL HOURS PER WEEK ANS TOTAL ECTS CREDITS:	**11+4+0+10 25**	**30**	**13+4+0+9 26**	**30**

Elective Course 2	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Fundamentals of Atomic and Molecular Physics			2+1+0+0	3
Physics of Disordered Systems			2+1+0+0	3
Energetics			2+0+1+0	3
General and inorganic chemistry			3+1+0+0	3
Object Oriented Programming (C++)			2+1+0+0	3
Medical Physics			2+1+0+0	3
Physics and Philosophy			2+0+1+0	3

YEAR 4

COURSE	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Laboratory in Physics Education1	**0+0+0+4**	**6**		
Educational Psychology	4+2+0+0	8		
Elective course 3	4+2+0+0	10		
Elective course 4	2+1+0+0	6		
Laboratory in Physics Education 2			**0+0+0+4**	6
Computers in Education			**1+0+1+2**	6
General Pedagogy			4+0+0+0	6
Didactics			4+0+0+0	6
Fundamentals of Electronics			2+2+0+0	6
TOTAL HOURS PER WEEK ANS TOTAL ECTS CREDITS:	**10+5+0+4 19**	**30**	**11+2+1+6 20**	**30**

Elective Course 3	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Selected Topics in Solid State Physice	**4+2+0+0**	10		
Selected Topics in Nuclear and Particle Physics	4+2+0+0	10		

Elective Course 4	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Selected Topics in General Physics	2+1+0+0	6		
Astronomy and Astrophysics	2+0+1+0	6		
Biophysics	2+0+1+0	6		
History of Physics	**2+0+1+0**	6		
Physics of the Earth and Atmosphere	2+1+0+0	6		
Fundamentals of Physics of Materials	**2+0+1+0**	6		

YEAR 5

COURSE	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Computer Science Education	**2+0+3+0**	8		
Laboratory in Fundamentals in Electronics	0+0+0+3	6		
Elective Course 5	2+1+0+0	5		
Physics Education	**2+0+0+2**	7	2+0+0+2	**7**
Teaching Practice in Physics 1	0+0+0+4	4		
Teaching Practice in Physics2			0+0+0+4	**4**
Teaching Practice in Computer Science			0+0+0+4	**4**
Thesis Research				15
TOTAL HOURS PER WEEK ANS TOTAL ECTS CREDITS:	**6+1+3+9 19**	**30**	**2+0+0+10 12**	**30**

Elective Course 5	WINTER SEMESTAR		SUMMER SEMESTAR	
	CONTACT HOURS (P +V+S+L)	ECTS CREDITS	CONTACT HOURS (P +V+S+L)	ECTS CREDITS
Seminar in Fundamentals of Atomic and Molecular Physics	0+0+0+3	5		
Seminar in Selected Topics in Solid State Physics	0+0+3+0	5		
Seminar in Selected Topics in Nuclear and Particle Physics	0+0+3+0	5		
Seminar in quantum physics and theory of relativity education	0+0+3+0	5		
Nanomaterial Physics	2+0+1+0	5		
Low Temperature Physics and Superconductivity	2+1+0+0	5		
Physics of Semiconductors	2+0+1+0	5		

University study of educational physics and informatics:
TEACHER OF PHYSICS AND 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 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	2	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: Mathematical analysis 1		
COURSE TEACHER/TEACHERS: Siniša Slijepčević, PhD		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 1		
SEMESTER: 1		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	3	Teacher
Exercises	2	Assistant
Seminars		
Laboratory		
ECTS credits: 7		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding and being able to use elementary techniques of Mathematical analysis		
DESCRIPTION OF THE COURSE: 1. Functions and graphs: Limit and continuity, understanding of limit, calculating limts of sequences and functions, asymptotic, limit of sin x / x when x $\rightarrow$ 0, continuous functions, properties of continuous functions, precise definition of limit in infinity and when x $\rightarrow$ a. 2. Derivation: the problem of tangents, the problem of speed, definition of derivation, definition of sums, difference between products and quotients, derivation of trigonometric functions, derivation of composition of functions 3. Lagrange theorem and applications: drawing of a graph of a function, derivation of higher order and binomial theorem, convexity and concavity, implicit function theorem, differential		
STUDENT OBLIGATIONS DURING THE COURSE: 6 homeworks, 2 tests		
METHODS TO EVALUATE STUDENT PERFORMANCE: Homeworks, tests		
EXAMINATION METHODS:Written and oral examination		
COURSE(s) NEEDED FOR THIS COURSE:None		
COMPULSORY LITERATURE: **S.K. Stein, Calculus and Analytic Geometry, McGraw-Hill,1987.**		

L. Krnić, Z. Šikić, Račun diferencijalni i integralni, I.dio, Školska knjiga, Zagreb,1992. **P. Javor, Matematička analiza I, Element, Zagreb, 1995.** **S. Kurepa, Matematička analiza I, Tehnička knjiga, Zagreb** **S. Kurepa, Matematička analiza II, Tehnička knjiga, Zagreb** B.P. Demidovič, Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb
ADDITIONAL READING:

COURSE TITLE: **Linear Algebra 1**		
COURSE TEACHER/TEACHERS: **Dr. Vjeran Hari, professor, Department of Mathematics, University of Zagreb.**		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: **First**		
SEMESTER: **First (fall semester)**		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	1	assistant
Seminars	0	Not obligatory
Laboratory		
ECTS credits: 4 **The student has to study more than 120 pages of theory and at least 60 pages of exercises and problems.**		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: **The students should acquire basic concepts and techniques of linear algebra which lead to clear understanding of the theory of a general system of linear equations and algorithms for solving it.**		
DESCRIPTION OF THE COURSE: **Introduction to linear systems. Vector space of real and complex n-tuples. Groups, rings, fields and general vector spaces. Scalar product and norm. Vector space V^3, analytical geometry in E^3. Matrices. Linear independent vectors, basis of a vector space, rank of a matrix. Homogeneous system of linear equations. Row-echelon form of a matrix. Nonhomogeneous system of linear equations and Gauss eliminations.** **The instructor will conduct classical teaching enhanced by computer driven projector. Interactive programs like Matlab and Mathematica will be at disposal to students.**		
STUDENT OBLIGATIONS DURING THE COURSE: To attend lectures and exercises regularly or to pass at least two colloquia exams.		
METHODS TO EVALUATE STUDENT PERFORMANCE: **Three colloquia exams during the semester, each one including few thoretical questions and several concrete problems to solve. The students with programming skills can get additional computational projects.**		
EXAMINATION METHODS: **In order to pass the exam, the student should collect sufficient points at each colloquium and the final mark will depend upon the sum of all collected points. Additionally, there will be only three terms for students to take exam. One in winter examination period, one in summer and one in fall examination period.**		

COURSE(s) NEEDED FOR THIS COURSE: None

COMPULSORY LITERATURE:

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

ADDITIONAL READING:

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

COURSE TITLE: Introduction to Computer Science		
COURSE TEACHER/TEACHERS: Doc.dr. Nenad Pavin		
STUDY PROGRAMME: University study of educational physics and 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: Text editing and table calculators

COURSE TEACHER/TEACHERS: dr.sc. Robert Pezer

STUDY PROGRAMME: University study of educational physics and informatics

YEAR OF STUDY: 1

SEMESTER: 1

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

ECTS credits: 3

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

Introduction to text editing using two complementary systems: WSWYG and LaTeX. Basics of good writing practise. Formatting, working with tables and graphics and automatisation. Selected examples of table calculator usage: database, physics, economy.

DESCRIPTION OF THE COURSE:

1. Intro to shell, GUI, computer system.
2. What WYSIWYG editors can do for us.
3. Text formatting (working in user interface, text manipulation, tables, graphics, data sharing).
4. Advanced elements: forms (working with fields) and form letters (automatic document generation)
5. Seminar and final project.
6. LaTeX intro. Comparing WYSIWYG editors (visual and logical design).
7. LaTeX and document elements.
8. Document structure and organisation. Working with math equations. Electronic data formats PS and PDF.
9. Document class "book". Working with graphics.
10. Intro to table calculators (TC). What can TC do for us.
11. Basic examples.
12. Advanced examples (including physics, economy, database).

STUDENT OBLIGATIONS DURING THE COURSE: Two written seminars.
METHODS TO EVALUATE STUDENT PERFORMANCE: Results of written **seminars**, final oral examination.
EXAMINATION METHODS: Oral examination. Seminars..
COURSE(s) NEEDED FOR THIS COURSE:
COMPULSORY LITERATURE: Ne tako kratki uvod u LaTeX, Tobias Oetiker. Dostupno preko weba i u prijevodu prof. Šime Ungara. S.L.Nelson and J. Kelly, Office XP: The Complete Reference, McGraw Hill 2001
ADDITIONAL READING:

COURSE TITLE: Fundamentals of Physics 2		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: University study of educational physics and 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: Mathematical analysis 2

COURSE TEACHER/TEACHERS: Siniša Slijepčević, PhD

STUDY PROGRAMME: University study of educational physics and informatics

YEAR OF STUDY: 1

SEMESTER: 2

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	3	Teacher
Exercises	2	Assistant
Seminars		
Laboratory		

ECTS credits: 7

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understanding and being able to use elementary techniques of Mathematical analysis

DESCRIPTION OF THE COURSE:

1. Integration: introduction, definite integral, fundamental theorems of calcucus, inverse integration and definite integral, proofs of fundamental theorems
2. Elementary functions: logarithmic and exponential function, inverse trigonometric functions, separable differential equation, hyperbolic functions, L´Hospital rule
3. Techniques of integration: substitution, partial integration, integrating rational functions, integrating trigonometric functions, applications of integral
4. Sequences: integral test, comparing sequences, absolute convergention, Taylors formula

STUDENT OBLIGATIONS DURING THE COURSE: 6 homeworks, 2 tests

METHODS TO EVALUATE STUDENT PERFORMANCE: Homeworks, tests

EXAMINATION METHODS:Written and oral examination

COURSE(s) NEEDED FOR THIS COURSE:None

COMPULSORY LITERATURE:

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

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

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

S. Kurepa, Matematička analiza I, Tehnička knjiga, Zagreb **S. Kurepa, Matematička analiza II, Tehnička knjiga, Zagreb** B.P. Demidovič, Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb
ADDITIONAL READING:

COURSE TITLE: **Linear Algebra 2**		
COURSE TEACHER/TEACHERS: **Dr. Vjeran Hari, professor, Department of Mathematics, University of Zagreb.**		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: **First**		
SEMESTER: **Second (spring semester)**		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	1	assistant
Seminars	0	Not obligatory
Laboratory		
ECTS credits: 5 **The student has to study more than 100 pages of the theory and at least 60 pages of exercises and problems. The contents of this course is harder than that of Linear Algebra 1.**		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: **The students should acquire basic concepts and techniques of linear algebra which lead to clear understanding of the theory of matrix equations, principal classes of matrices, determinants, linear operators and eigenvalue problems.**		
DESCRIPTION OF THE COURSE: **Linear matrix equations, regular matrices, elementary matrices. The main classes of matrices. Determinants and Cramer's rule. Linear operators, coordinatization. Matrix as operator representation in a pair of bases. Composition of linear operators with examples. Eigenvalues and eigenvectors. Diagonalization of a symmetric matrix and Jacobi method.**		
STUDENT OBLIGATIONS DURING THE COURSE: To attend lectures and exercises regularly or to pass at least two colloquia exams.		
METHODS TO EVALUATE STUDENT PERFORMANCE: **Three colloquia exams during the semester, each one including few thoretical questions and several concrete problems to solve. The students with programming skills can get additional computational projects.**		
EXAMINATION METHODS: **In order to pass the exam, the student should collect sufficient points at each colloquium and the final mark will depend upon the sum of all collected points. Additionally, there will be only three terms for students to take exam. One in summer examination period, one in fall and one in winter examination period.**		

COURSE(s) NEEDED FOR THIS COURSE: Linear Algebra 1

COMPULSORY LITERATURE:

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

ADDITIONAL READING:

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

COURSE TITLE: Fundamentals of Programming

COURSE TEACHER/TEACHERS: Doc.dr. Nenad Pavin

STUDY PROGRAMME: University study of educational physics and 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: 7

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: Statistics and basics of physical measurements

PROPOSED BY *(PhD Ime Prezime, zvanje, fakultet, sveučilište)*: **PhD Dinko Babić, assistant professor, Faculty of Scence, University of Zagreb**

PROGRAMME: Educational Physics - Teacher of Physics

YEAR OF STUDY: 1

SEMESTER: 2

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

ECTS CREDITS: 3

COURSE AIMS AND OBJECTIVES: Introduction into basic concepts of statistics and their application to analysis of experiment.

COURSE DESCRIPTION AND SYLLABUS: Combinatorics, elementary and conditional probability. Empirical data. Distribution of frequencies. General statistical parameters. One-dimensional discrete statistical distributions. Binoimnal and Poisson distribution. One-dimensional continuous statistical distributions. Gaussian distribution. Multidimensional statistical distributions. Theory of random errors, linear regression, analysis and presentation of experiment.

TEACHING AND ASSESSMENT METHODS: Lectures (theoretical background) and excercises (practical problems)

PREREQUISITES: Elementary mathematics, including basics of calculus.

READING LIST: Pavlić, Statistička teorija i primjena, Tehnička knjiga, Zagreb 1970.
Vranić, Vjerojatnost i statistika, Tehnička knjiga, III izdanje, Zagreb, 1970.

ADDITIONAL READING: none

COURSE TITLE: Fundamentals of Phyics 3		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: University study of educational physics and 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: Classical Mechanics 1		
COURSE TEACHER/TEACHERS: Vladimir Paar		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 2		
SEMESTER: 3		
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: Recapitulation and deeper understanding of basic concepts of classical mechanics. Theoretical treatment of illustrative examples from classical dynamics with particular emphasis for teaching classical mechanics in school**.**		
DESCRIPTION OF THE COURSE: **Conceptual framework of inertia and inertial forces.** **Dynamics of single-body problem under influence of force.** **Euler method for numerical solution of Newton equation and illustrative examples of one- and two-dimensional motion caused by given forces.** **Illustrative examples of nonlinear dynamics.** **Algebrac integration of Newton equation by quadrature and determination of constants of motion for illustrative cases of one-dimensional motion (harmonic oscillator, pendulum, etc.).**		
STUDENT OBLIGATIONS DURING THE COURSE: lecture and exercise attendance, obligatory colloquia		
METHODS TO EVALUATE STUDENT PERFORMANCE: written and oral examination		
EXAMINATION METHODS: written and oral examinations		
COURSE(s) NEEDED FOR THIS COURSE:general physics		
COMPULSORY LITERATURE: M. Tabor, Cxhaos and integrability in nonlinear dynamics – An introduction (Wiley, 1989) A. Beiser, Physics (Benjamin, 1982)		
ADDITIONAL READING:W.P. Crummett, A.B. Western, University Physics, Models and		

Applications (Mc Graw Hill, 1994)

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

COURSE TITLE: **Mathematical Methods in Physics 1**		
COURSE TEACHER/TEACHERS: **Prof. dr. Dražen Adamović**		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: second year		
SEMESTER: third semester		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	3	teacher
Exercises	2	assistant
Seminars		
Laboratory		
ECTS credits**: 7**		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

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

DESCRIPTION OF THE COURSE:

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

STUDENT OBLIGATIONS DURING THE COURSE:

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

METHODS TO EVALUATE STUDENT PERFORMANCE:

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

EXAMINATION METHODS:

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

COURSE(s) NEEDED FOR THIS COURSE:

Linear Algebra I, II; Mathematical Analysis I,II

COMPULSORY LITERATURE:

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

ADDITIONAL READING:

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

COURSE TITLE: Computer Organization

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

PROGRAMME: *(ostaviti odgovarajući ili odgovarajuće programe, ostale izbrisati)*

BSc in Mathematics

MSc in Computer Science and Mathematics

MSc in Mathematics and ICT Education

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: 5

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: Data Structures and Algorithms		
COURSE TEACHER/TEACHERS: Doc. dr. Mirko Planinić		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 2		
SEMESTER: 3		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises		
Seminars		
Laboratory	2	assistant
ECTS credits: 5		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

The course is designed for understanding of computing algorithms and for learning about different data structures.

DESCRIPTION OF THE COURSE:

1. Review of fundamental ideas and techniques for designing algorithms.
2. Data structures: queue, array, list, stack .
3. Recursive Algorithms, recursive functions
4. Greedy Algorithms
5. Trees, binary search
6. Time Complexity of Algorithms
7. Priority queues, heap
8. Sorting
9. Dinamic Algorithms: Fibonacci numbers, binomial coefficients
10. Divide and Conquer Algorithms
11. Graphics Algorithms
12. Games

STUDENT OBLIGATIONS DURING THE COURSE:

Course attendance is controled. During laboratory students solve problems that illustrate the topics.

METHODS TO EVALUATE STUDENT PERFORMANCE:

Students have to solve problems during laboratory.

EXAMINATION METHODS:

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

COURSE(s) NEEDED FOR THIS COURSE:

Introduction to computing , Fundamentals of Programming

COMPULSORY LITERATURE:

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

ADDITIONAL READING:

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

COURSE TITLE: Fundamentals of Physics 4		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: University study of educational physics and 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: 8		

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: Classical Mechanics 2		
COURSE TEACHER/TEACHERS: Vladimir Paar		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	1	teacher
Exercises	1	assistant
Seminars		
Laboratory		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Understandnis of basic concepts of nonlinear, Lagrangean and Hamiltonian classical mechanics.		
DESCRIPTION OF THE COURSE: Introduction into classical dynamics in phase space for many-body problems. Generalized coordinates. Introduction into nonlinear dynamics. Introduction into Lagrange and Hamilton formulations of classical mechanics. Conservation laws in classical mechanics.		
STUDENT OBLIGATIONS DURING THE COURSE: Deeper understanding of dynamical concepts of classical mechanics and illustrative examples.		
METHODS TO EVALUATE STUDENT PERFORMANCE: colloquia, written and oral examinations.		
EXAMINATION METHODS: written and oral examinations		
COURSE(s) NEEDED FOR THIS COURSE:general physics		
COMPULSORY LITERATURE: W.P. Crummett, A.B. Western, University Physics, Models and Applications (Mc Graw Hill, 1994) H.O. Peitgen (ed) Newtons method and dynamical systems (kluver, 1989)		
ADDITIONAL READING: M. Tabor, Cxhaos and integrability in nonlinear dynamics – An introduction (Wiley, 1989) A. Beiser, Physics (Benjamin, 1982)		

COURSE TITLE: Differential equations - dynamical systems		
COURSE TEACHER/TEACHERS: Doc. dr. Predrag Prester		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	0	
Seminars		
Laboratory	1	assistant
ECTS credits: 3		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

To teach basic knowledge of solving ordinary differential equations by using analitical, qualitative and numerical methods, and how to apply this to simple models of dynamical systems in different fields (physics, chemistry, biology, civil engineering etc).

DESCRIPTION OF THE COURSE:

1. Introduction: Modeling Via Differential Equations
2. Ordinary First-Order Differential Equations
   - 2.1. Analytic and Qualitative Methods
   - 2.2. Numerical Technique
   - 2.3 Autonomous Equations
   - 2.4. Bifurcations
   - 2.5. Linear Equations
3. First-Order Systems
   - 3.1. Modeling Via Systems
   - 3.2. Geometric and Analytic Methods
   - 3.3. Euler's Method for Systems
4. Autonomous Systems
   - 4.1. Systems with Real Eigenvalues
   - 4.2. Complex Eigenvalues
   - 4.3. Special Cases
   - 4.4. Homogenous Linear Systems
5. Forced Harmonic Oscillators
   - 5.1. General Solution. Sinusoidal Forcing
   - 5.2. The Tacoma Narrows Bridge

STUDENT OBLIGATIONS DURING THE COURSE: Homeworks every week. There are also 3 labs which include extensive use of computer and

should be reported in a form of essay

METHODS TO EVALUATE STUDENT PERFORMANCE: Two labs must be completely done to pass to exam.

EXAMINATION METHODS: Exam has written (only for students which obtained less than 70% for labs, in which case the total mark of written part is constituted 30% from labs and 70% from written examination) and oral part.

COURSE(s) NEEDED FOR THIS COURSE: Fundamentals of Physics 1 and 2, Mathematical analysis 1 and 2, Linear Algebra 1 and 2, Fundamentals of Programming

COMPULSORY LITERATURE:

Predrag Prester, Differential Equations and Dynamical Systems, script accesible from http://www.phy.hr/~pprester

ADDITIONAL READING:

P. Blanchard, R. L. Devaney and G. R. Hall, Differential Equations,

2nd edition (with CD-ROM), Brooks/Cole, 2002.

COURSE TITLE: **Mathematical Methods in Physics 2**		
COURSE TEACHER/TEACHERS: **Prof. dr. Dražen Adamović**		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY**: second year**		
SEMESTER: **fourth semester**		
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:

The goal of this course is to develop some methods from the theory of ordinary and partial differential equations and special functions which are important for students of physics. Particular emphasis will be put on the study of Legendre polynomials, Bessel functions, spherical functions and to the Laplace and wave partial differential equations.

DESCRIPTION OF THE COURSE:

1. Ordinary differential equations.
2. Linear differential equations. First order linear differential equations.
3. Theorem on existence and uniqueness of solutions of the Cauchy problem for linear differential equations .
4. Linear independence of functions. Wronsky's determinant.
5. Linear differential equations with constant coefficients.
6. Nonhomogeneous equations. The method of variations of parameters.
7. Solving differential equations using power series.
8. Second order linear differential equations with regular singularities.
9. The Legendre polynomials and Legendre's differential equation. The generating function of Legendre polynomials.
10. The associated Legendre functions. Spherical functions.
11. Laplace's differential equation. Separation of variables.
12. The wave equation.
13. The Bessel functions and Bessel's differential equation.
14. The Schroedinger differential equation. Laguerre's polynomials.

STUDENT OBLIGATIONS DURING THE COURSE:

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

METHODS TO EVALUATE STUDENT PERFORMANCE:

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

EXAMINATION METHODS:

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

COURSE(s) NEEDED FOR THIS COURSE:

Linear Algebra I, II; Mathematical Methods of Physics I

COMPULSORY LITERATURE:

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

ADDITIONAL READING:

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

COURSE TITLE: Object oriented programming		
COURSE TEACHER/TEACHERS: Doc.dr. Leo Marušić		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures		teacher
Exercises		assistant
Seminars		
Laboratory		
ECTS credits: 5		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

The course is designed to familiarize students with concepts of object oriented programming.

DESCRIPTION OF THE COURSE:

1. Introduction: why object oriented programming? Why Java? Other object oriented languages. Basic concepts of object oriented programming: objects, classes, messages, inheritance.
2. Basic Java syntax: variables, operators, expressions, control flow
3. Creating and using objects, commonly used object types: objects, characters, strings, arrays.
4. Classes: creating classes, constructors, accessing members of a class, inheritance, nested classes.
5. Definition of Java interface, implementing interface, creating and using packages
6. Essential classes in Java, error handling, using threads
7. Accessing system resources, using files
8. Using Swing components: using button, labels, event handling
9. Using menus, text formatting, displaying images
10. Applet writing

STUDENT OBLIGATIONS DURING THE COURSE:

Students have to attend lectures, exercises and do homework.

METHODS TO EVALUATE STUDENT PERFORMANCE: Lecture attendance and submitted homework
EXAMINATION METHODS: written and oral exam
COURSE(s) NEEDED FOR THIS COURSE: ***Uvod u računarstvo i Osnove programiranja – treba prevesti***
COMPULSORY LITERATURE: M. Campione, K. Walrath: Object-Oriented Programming for the Internet (2nd Edition), Addison Wesley Publishing Company, 1998.
ADDITIONAL READING:

COURSE TITLE: Multimedial presentations

COURSE TEACHER/TEACHERS: mr.sc. Dalibor Paar

STUDY PROGRAMME: University study of educational physics and 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: 4

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

The course is designed to introduce students to basics of HTML and multimedial elements for making the Web pages. That will be applied to a 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: Symbolic programming		
COURSE TEACHER/TEACHERS: doc. dr. sc. Krešimir Kumerički, PMF, Zagreb		
STUDY PROGRAMME: University study of educational physics and 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	0	
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Student solves standard problems in mathematics and physics on computer, acquiring skills in symbolic (and functional) programming. After the course he should be competent user of one of the standard Computer Algebra Systems.		
DESCRIPTION OF THE COURSE: 1. Basics of Computer Algebra System, basic algebraic manipulations, equation solving2. Mathematical Analysis and Linear Algebra on computer3. Plotting, data processing4. Example: Modeling a trajectory of particle in a force field5. Basics of symbolic prgramming: lists, functions, expressions6. Basics of symbolic prgramming: patterns, transformation rules7. Advanced programming: procedural programing8. Advanced programming: functional programming9. Advanced programming: programming via transformation rules10. Examples from classical mechanics11. Examples from classical electrodynamics and quantum physics12. Linking with other languages (such as C)		
STUDENT OBLIGATIONS DURING THE COURSE: Student must submit solutions to 50 percent of homework problems.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Homework problems and final project		
EXAMINATION METHODS: 60 percent of final grade comes from homeworks and another 40 percent from final project		
COURSE(s) NEEDED FOR THIS COURSE:Introduction to programming		
COMPULSORY LITERATURE:K. Kumericki, Symbolic programming for physicsists, course text available online at http://www.phy.hr/~kkumer		
ADDITIONAL READING:S. Wolfram, The Mathematica Book, available online with the Mathematica package		

COURSE TITLE: Introduction to computer networks and INTERNET		
COURSE TEACHER/TEACHERS: dr.sc. Robert Pezer		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 2		
SEMESTER: 4		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	1	teacher
Exercises	0	assistant
Seminars		
Laboratory		
ECTS credits: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Introduction to basic computer networks usage skills and working in such an enviroment. Principles and some history fact are also covered.		
DESCRIPTION OF THE COURSE: 1. 1Course overview. 2. E-mail. 3. Computer networks and INTERNET. 4. Traffic, packet, bandwidth, basic topology. 5. INTERNET. Protocols, services, size. 6. DNS, gateway, organisation, routing. 7. LAN, FTP, SSH, resources sharing. 8. Search the weba, engines, logic. 9. Intro to web and HTML. 10. Dynamic web pages. Content managment.		
STUDENT OBLIGATIONS DURING THE COURSE: One written seminar.		
METHODS TO EVALUATE STUDENT PERFORMANCE: Result of written **seminar**, final oral examination.		

EXAMINATION METHODS: Oral examination. Seminars..
COURSE(s) NEEDED FOR THIS COURSE:
COMPULSORY LITERATURE: S.E. Hutchinson and S.C.Sawyer, COMPUTERS, COMMUNICATIONS AND INFORMATIONS, McGraw Hill 2000
ADDITIONAL READING:

COURSE TITLE: Fundamentals of geophysics

COURSE TEACHER/TEACHERS: Dr. Snježana Markušić, assistant professor

STUDY PROGRAMME: University study of educational physics and informatics

YEAR OF STUDY: 2

SEMESTER: 4

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

ECTS credits: 3

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

Course introduce students to the broad spectrum of knowledge that can be obtained by the application of basic principles of physics and mathematics to the study of the Earth.

DESCRIPTION OF THE COURSE:

1. Introduction to the Earth (shape and size, mass and density, the Moon, the Earth's axis, the Earth's orbit, temperatures on Earth, atmosphere, origin of Earth, origin of water on Earth, Earth's interior – formerly and today)
2. Coordinates on the Earth's surface (sphere coordinates – axis and major circle, latitude and longitude, Earth as spheroid, geoid and geoid undulations, altitude and depths)
3. Gravity (Newton's law of gravitation and force of gravity, centripetal and centrifugal forces, gravitation, Clairaut's theorem, measurements of gravity accelerations, reduction of measured values of gravity accelerations – correction for altitude, Bouguer's correction, topographical correction, normal values of gravity accelerations, gravity field of the Earth, anomalies of gravity field, tides)
4. Isostasy (concept of isostasy, Pratt's and Airy's theory of isostasy)
5. Seismicity and the sources of earthquakes (concept of seismicity, spatial distribution and statistics of earthquakes, causes of earthquakes, sources and types of earthquakes, earthquake mechanism and Reid's elastic rebound theory, macroseismic method of earthquake investigation – earthquake intensity, macroseismic scales, isoseismal maps, microseismic method of earthquake investigation – earthquake magnitude, microseisms, tsunami)
6. Seismic waves and Earth's internal structure (constants of elasticity, oscillation and waves, wave equation, reflection, refraction, concept of seismograph, earthquake waves – body and surface, hodochrones and microseismical method of epicenter determination, earthquake magnitude, investigations of Earth's interior, Moho discontinuity)

7. Earth's magnetism (general terms, the Earth's magnetic field, geomagnetic elements, magnetosphere and main field, magnetic poles, polar light)
8. Earth's internal heat (heat as energy transfer, heat flow, heat conduction, heat convection – adiabatic temperature gradient, measurement of the Earth's surface heat flow)

STUDENT OBLIGATIONS DURING THE COURSE:

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

METHODS TO EVALUATE STUDENT PERFORMANCE:

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

EXAMINATION METHODS:

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

COURSE(s) NEEDED FOR THIS COURSE:

Principles of Physics 1 and 2, Introduction to mathematics

COMPULSORY LITERATURE:

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

ADDITIONAL READING:

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

• Turcotte D.L. and G. Schubert, 2002. *Geodynamics,* Cambridge University Press, Cambridge

COURSE TITLE: 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: 3

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: Quantum physics		
COURSE TEACHER/TEACHERS: Prof. dr. sc. Dubravko Klabučar		
STUDY PROGRAMME: University study of educational physics and 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: Mastering the fundamental concepts of quantum mechanics, understanding the basics of quantum physics and functioning of simple quantum systems. Qualitative and informative explanations of some more complex quantum systems.		

DESCRIPTION OF THE COURSE:

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

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

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

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

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

COMPULSORY LITERATURE:

- R. L. Liboff, Introductory Quantum Mechanics, Addison-Wesley, 2002.

- My own teaching materials which I hand out at some lectures and which are available in our library, and in part also available at my internet home page http://www.phy.hr/~klabucar/

ADDITIONAL READING:

- F. S. Levin, An introduction to Quantum Theory, Cambridge University Press, 2002.

- R. Eisberg and R. Resnick, Quantum Physicsof Atoms, Molecules and Solids, Nuclei and Particles, John Wiley and Sons, 1985.

COURSE TITLE: Laboratory in Fundamental Physics A		
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 informatics		
YEAR OF STUDY: 3		
SEMESTER: 5		
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: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The main goal is to provide the student with simple experiments in physics (Mechanics) which illustrates fundamental principles or the applications of these principles. Such exercises fulfil other purposes, such as: the realization of the importance of making precise measurements by making all measurements with as much care as possible; the choice of the best available technique; the care necessary in the design and completion of the experiment; the collection, tabulation and handling of data; and finally the final report writing (or its presentation.).		
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:

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).

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 planned measurements, skills and knowledge shown during performing measurements and quality of written final report, as well as the final written and oral exams will be combined together to estimate a student's final score.

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

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

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

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

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

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

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

COURSE TITLE: Advanced Programming		
COURSE TEACHER/TEACHERS: dr.sc. Robert Pezer		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	2	assistant
Seminars		
Laboratory		
ECTS credits: 6		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

This is your capstone sequence in the Computer Science Department and therefore this course will extend and deepen your understanding of topics previously covered. Specifically the objectives of this course are to gain an understanding of the theory and practice involved in designing, coding, and testing software. You will examine and implement advanced data structures, algorithms, and programming techniques. You will understand design tradeoffs, software testing, maintenance and documentation issues, and program execution and memory requirements.

DESCRIPTION OF THE COURSE:

1. Challenges of design, coding, and testing.
2. Introductory programming issues.
3. Implementation issues.
4. Compilation and linking issues.
5. Software design issues.
6. Software testing, maintenance and documentation issues.
7. Real-time systems, data compression, multithreading/signaling.
8. Preparing for a major project.

STUDENT OBLIGATIONS DURING THE COURSE:

Course attendance is controled. During exercises students solve problems that illustrate the topics. Major project.

METHODS TO EVALUATE STUDENT PERFORMANCE: Results of written **assignments**, projects.
EXAMINATION METHODS: Oral examination. Project and **assignments**..
COURSE(s) NEEDED FOR THIS COURSE: Physics 1-4, Mathematical analysis, Mathematical methods in physics.
COMPULSORY LITERATURE: Advanced C Programming by Example by John Perry, PWS Publishing Company.
ADDITIONAL READING: Code Complete, McConnell Software Project Management, Henry, Addison-Wesley (2003) Design Patterns Explained, Shalloway, Addison-Wesley

COURSE TITLE: Numerical Methods		
COURSE TEACHER/TEACHERS: Doc. dr. Mirko Planinić		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 3		
SEMESTER: 5		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	1	teacher
Exercises		
Seminars		
Laboratory	3	assistant
ECTS credits: 4		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

The course is designed for learning about Numerical Methods which are used for computing problems in physics.

DESCRIPTION OF THE COURSE:

1. Capabilities of todays computers .
2. Fortran 90.
3. NAG Numerical Libraries.
4. Solving Systems of Linear Equations.
5. Computing functions.
6. Solving nonlinear Equations.
7. Interpolations.
8. Aproximations, Chebishev Polynomials
9. Numerical Integration.
10. Runge-Kutta method for solving Differential Equations
11. Boundary condition for simple Differential Equations.
12. ROOT programming package.

STUDENT OBLIGATIONS DURING THE COURSE:

Course attendance is controled. During laboratory students solve problems that illustrate the topics.

METHODS TO EVALUATE STUDENT PERFORMANCE:

Students have to solve problems during laboratory..

EXAMINATION METHODS:

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

COURSE(s) NEEDED FOR THIS COURSE:

Introduction to computing , Fundamentals of Programming

COMPULSORY LITERATURE:

- **Fortran 90 Programming, T.M.R. Ellis, Ivor R. Philips, Thomas M. Lahey:Addison-Wesley, 1994,1995,1996., ISBN 0-201-54446-4**

ADDITIONAL READING:

- **A F90 Tutorial, 1993., On line version (Z. Dodson, Univ. of New Mexico),**
- **High performance Fortan programming, On line lectures (University of Liverpool, UK, 1997.)**

COURSE TITLE: Computer Networks		
COURSE LECTURER: Doc. dr. Darko Androić		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 3		
SEMESTER: 5 and 6		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*lecturer or assistant*)
Lectures	1/1	lecturer
Exercises	0	
Seminars	2/0	assistant
Laboratory	0/2	assistant
ECTS credits: 3 / 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: Electrodynamics		
COURSE TEACHER/TEACHERS: Prof.dr. Slobodan Brant		
STUDY PROGRAMME: University study of educational physics and 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: 9		

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:

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

STUDENT OBLIGATIONS DURING THE COURSE:

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

METHODS TO EVALUATE STUDENT PERFORMANCE:

Results of written 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 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: Laboratory in Fundamental Physics B		
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 informatics		
YEAR OF STUDY: 3		
SEMESTER: 6		
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: 3		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The course Laboratory Exercises in Physics 2 (abbr. LEP 2) is continuation of the course Laboratory Exercises in Physics 1(LEP 1). However, laboratory experience will teach student the limitations inherent in the applications of physical theories to real physical situations and the role that experimental uncertainty plays in physical measurements and introduce ways to minimize experimental uncertainty, as well. The main goal is similar like in LEP 1, i.e. the measurements of physical quantities and their statistical joint dependence. In this course student will carry-out experiments selected from the Fundamentals of Physics 2 (Electricity and Magnetism). Stress will be given to the fundamental principles and practical operations of AVO-meter and oscilloscope apparatus. Also, a number of experiments will involve a computer-assisted data acquisition and will allow sophistication of data manipulation and analysis. The use of this resource is simply inescapable; the computer-interfaced apparatus can teach student a lot about the capabilities of contemporary laboratory methods in the context of physics. Many problems in physics are analyzed with approximations or idealizations that make the mathematics of the analysis less complicated or that offer a more discernible physical picture, and thus, experimental data and analysis offer a validation or a rejection of the approximation.

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:

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

STUDENT OBLIGATIONS DURING THE COURSE: For each laboratory exercise student has to pre-prepare and study the theoretical background for given experiment. Before starting with the performing of experiments he must answer (orally or in written manner) to questions connected with experiment included in the exercise. Questions and description of experiments for each exercise will be displayed on Internet site of the Department of Physics. After finishing 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 planned measurements, skills and knowledge shown during performing measurements and quality of written final report, as well as the final written and oral exams will be combined together to estimate a student's final mark.

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

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

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

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

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

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

Grupa autora: Riješeni zadaci iz opće fizike-Mehanika, Elektricitet i magnetizam, u

redakciji prof. K. Ilakovca (Školska knjiga, Zagreb, 1989).

COURSE TITLE: Database Systems

COURSE TEACHER/TEACHERS: Ivo Batistić

STUDY PROGRAMME: University study of educational physics and informatics

YEAR OF STUDY: 3

SEMESTER: 6

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

ECTS credits: 5

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

To teach the basic concepts of the modern database management systems (DBMS), and to give a skill (SQL, programming) that may be used in real life application.

DESCRIPTION OF THE COURSE:

1. Introduction to databases
2. Entity relationship (ER) modelling and relational modelling
3. Normalization
4. Relational algebra and relational calculus
5. SQL language
6. SQL language – advances queries
7. Data storage – physical level
8. Data storage and implementation of relational operators
9. Security and integrity
10. Transactions and concurrency control
11. Application programming

STUDENT OBLIGATIONS DURING THE COURSE: lecture and exercise attendance, homework

METHODS TO EVALUATE STUDENT PERFORMANCE: regular test

EXAMINATION METHODS: written and oral examination
COURSE(s) NEEDED FOR THIS COURSE:
COMPULSORY LITERATURE: R. Mager: baze podataka (skripta)
ADDITIONAL READING: C.J. Date: An Introduction to Database Systems Jeffrey D. Ullman: Database Systems: The Complete Book Toby J. Teorey: Database Modeling and Design: the Fundamental Principles

COURSE TITLE: User interfaces		
COURSE TEACHER/TEACHERS: dr.sc. Robert Pezer		
STUDY PROGRAMME: University study of educational physics and 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: 3		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

Introduction to analisis, development and evaluation of the graphical user interface. Topics covered include: Human computer interface (HCI), Task-Centered User Interface Design (TCUID), intro to python language and wxPython toolkit.

DESCRIPTION OF THE COURSE:

1. Intro to HCI, TCUID
2. What is good UI. Psychology and HCI.
3. Scenarios and tasks. Context enquiry.
4. Vision: colour, visual perception. Modelling posibilities.
5. MVC (model vision controller). Design basics.
6. Drawing, "cliping", GUI programming models.
7. Intro to Python.
8. OOP in Pythonu and GUI programming.
9. Intro to wxWidgets and wxPython.
10. Elements and components of the GUI toolkit.
11. Components design and implementation.
12. Final project. Specification..

STUDENT OBLIGATIONS DURING THE COURSE:

Written seminar and final project..

METHODS TO EVALUATE STUDENT PERFORMANCE: Results of written **seminar**, final project.
EXAMINATION METHODS: Oral examination, seminar and final project..
COURSE(s) NEEDED FOR THIS COURSE: .
COMPULSORY LITERATURE: T. Mandel, THE ELEMENTS OF USER INTERFACE DESIGN, John Wiley & Sons 1997
ADDITIONAL READING: J. Johnson, GUI BLOOPERS., Morgan Kaufman 2000

COURSE TITLE: Fundamentals of Atomic and Molecular Physics

COURSE TEACHER/TEACHERS: Prof. Damir Veža

STUDY PROGRAMME: University study of educational physics and 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		
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 informatics		
YEAR OF STUDY: 3		
SEMESTER: 6		
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: General and inorganic chemistry		
COURSE TEACHER/TEACHERS:		

prof. Ivan Vicković, Ph.d., Faculty of Science, Univ. of Zagreb

STUDY PROGRAMME: Physics

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:

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: Object oriented programming (C++)		
COURSE TEACHER/TEACHERS: dr.sc. Robert Pezer		
STUDY PROGRAMME: University study of educational physics and 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: 3		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Introduction to Object-Oriented Programming (OOP) using C++ programming language. Covers standard library, class hierarchies, and single, repeated and multiple inheritance. Focuses on abstraction and information hiding. Covers polymorphism and dynamic binding. Use of high-level data structures from the start.		

DESCRIPTION OF THE COURSE:

1. Intro and basics of C++.
2. Strings.
3. Working with batches of data.
4. Organizing programs and data.
5. Sequence containers and strinngs.
6. Standard library algorithms.
7. Using associative containers.
8. Writing generic functions.
9. Defining new types and OOP.
10. Managing memory and low-level data structures.
11. Defining abstract data types.
12. Making class objects act like values.
13. Using inheritance and dynamic binding.
14. Managing memory (almost) automatically.
15. Revisiting character pictures (course techniques together).

STUDENT OBLIGATIONS DURING THE COURSE:

Course attendance is controled. During exercises students solve problems that illustrate the topics. Major project.

METHODS TO EVALUATE STUDENT PERFORMANCE:

Results of written **assignments**, projects.

EXAMINATION METHODS:

Oral examination. Project and **assignments**..

COURSE(s) NEEDED FOR THIS COURSE:

Introduction to computer science.

COMPULSORY LITERATURE:

Accelerated C++, Andrew Koenig and Barbara E. Moo; Addison-Wesley, 2000.

ADDITIONAL READING:

The C++ Programming Language Third Edition, Bjarne Stroustrup, 1997.

Julijan Šribar i Boris Motika, Demistificirani C++ (2. izdanje) , Element 2001

COURSE TITLE: **Medical Physics**		
COURSE TEACHER/TEACHERS: **Prof.dr.sc. Mladen Vrtar**		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 3		
SEMESTER: 6		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	**2**	**M.Vrtar (teacher)**
Exercises	**1**	**M. Vrtar (teacher)**
ECTS credits:: **3**		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS **The application of physical methods in modern medicine and the working area and responsibility of medical physicist in health care institutions. Additional help in choosing the direction of doctor or specialist study of medical physics.**		
DESCRIPTION OF THE COURSE: **Dosimetric methods of photon and electron beams and absorbed dose in water. Use of radioisotopes in nuclear medicine. Basic methods of tomographic reconstruction. Computerised tomography (CT). Positron emission tomography (PET). Single photon emission tomography (SPECT). Magnetic resonance (MR). Radiotherapy physics in clinical practice (roentgen, cobalt, linear accelerator). The special methods of radiotherapy (total body irradiation, stereo tactic radiosurgery-gamma knife). Influence of radiation to human tissue and radiation protection. Quality assurance in clinical use of radiation. Physical basis and application of ultrasound in medicine. Application of thermography in medicine.**		
STUDENT OBLIGATIONS DURING THE COURSE: **The students must be present on lectures and exercises. They explain one theme from medical physics in a semester and solve the numerical exercises from some chapters. The students are obliged to attend the organised visits at some medical institutions to see the practical demonstration of certain equipment and application of physics in medicine (the special attention should be directed to radiological diagnostic, radiotherapy and radiation protection).**		
METHODS TO EVALUATE STUDENT PERFORMANCE: **exams, obliged exercises**		
EXAMINATION METHODS: **oral exam**		
COURSE(s) NEEDED FOR THIS COURSE:		

The obliged courses needed to enter the 6. semester

COMPULSORY LITERATURE:

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

(available to photocopy)

ADDITIONAL READING:

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

COURSE TITLE: **Physics and Philosophy**

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

STUDY PROGRAMME: University study of educational physics and informatics

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: Laboratory in Physics Education 1 and 2		
COURSE TEACHER/TEACHERS: P.Pećina, M.Planinić, A. Sušac		
STUDY PROGRAMME: University study of educational physics and 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: 6, 6		

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The main aim is to develop competence in preparing, performing, analyzing and discussing experiments in classroom. Students are trained to do experiments which keep pupils actively engaged in thinking and learning, while they are provided with enough guidance and feedback to ensure a sound basis for their subsequent work in school.

DESCRIPTION OF THE COURSE:

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: Educational Psychology

COURSE TEACHER/TEACHERS:

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

STUDY PROGRAMME: University study of educational physics and informatics

YEAR OF STUDY: 4

SEMESTER: 7

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

ECTS credits: 8

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:
The understanding of scientific concepts about the structure of personality, about the individual differences regarding abilities and non-cognitive dimensions of the personality, understanding the role of heredity and the environment in the development of individual differences, understanding the consequences of individual differences regarding the education with a special emphasis on the educating of people with special needs (handicapped students and talented students).

DESCRIPTION OF THE COURSE:

- **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: COMPUTER ASSISTED LECTURING OF PHYSICS		
COURSE TEACHER/TEACHERS: dr. Petar Pervan		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 4		
SEMESTER: 8		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	1	teacher
Exercises		
Seminars	1	teacher
Laboratory	2	assistant
ECTS credits: 6		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: The course objectives are acquiring knowledge and skills in relation to the use of information communication technologies in different aspects of physics education in primary and secondary schools: information search, electronic publishing, on-line quiz an tests, computer assisted communication, work in virtual working space as a step in adopting e-learning. The course objectives are also adoption of different computer assisted learning strategies as well as use of the computer for on-line experiments, data acquisition and processing.		

DESCRIPTION OF THE COURSE:

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

Student activity: reading, discussion in forums

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

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

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

Student activity: work in WebCT and open source program Claroline

4. Electronic publishing: drawings

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

5. Electronic publishing: drawings

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

6. Electronic publishing: photo and video

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

7. Electronic publishing: audio formats

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

8. Work wit interactive animations and simulations

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

9. On-line quiz and self tests.

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

10. Computer assisted experiments

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

11. Computer assisted experiments

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

12. Computer assisted educational strategies: projects

Student activity: work on Internet project .

STUDENT OBLIGATIONS DURING THE COURSE:

Described above

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

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

METHODS TO EVALUATE STUDENT PERFORMANCE:

Continuous assessment

EXAMINATION METHODS:

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

COURSE(s) NEEDED FOR THIS COURSE:

Prerequisites for the course are general skills in using computer, Internet and certain knowledge of computer multimedia.
The program s closely related to the courses of General Physics (I, II, III and IV) as well as Physics Laboratories I, II, III and IV

COMPULSORY LITERATURE:

e-learning:
Tonny Bates, Upravljanje tehnološkim promjenama, CARNET, 2004.
O Courseware alatima na starnicama CARNetovog referalnog centra
http://www.carnet.hr/referalni/obrazovni/oca
Goran Bubaš, Metodika i komunikacija u obrazovanju na daljinu, Edupoint:
http://edupoint.carnet.hr/casopis/aktualni/clanak-02/index.htm

Project:
Fizika svemira, e-škola FIZIKA http://eskola.hfd.hr/fizika_svemira
e-škola ASTRONOMIJA, http://hpd.botanic.hr/ast/astronomija
WebQuest http://edweb.sdsu.edu/courses/edtec596/about_webquests.html

Information search
Definicije pretraživača i razlike između "Search engines", "Search directories" i "Metasearch engines" www.pandia.com/goalgetter/2.html
Popis web-resursa koji sadrže uputstva kako koristiti tražilice
searchenginewatch.com/resources/tutorials.html

Electronic publishing:
Nataša Hoić Božić: Grafika - Multimedijski sustavi, Filozofski fakultet u Rijeci,
http://top.pefri.hr/mms/grafika.htm
Nataša Hoić Božić: Animacija - Multimedijski sustavi, Filozofski fakultet u Rijeci
http://top.pefri.hr/mms/animacija.htm
Nataša Hoić-Božić: Video - Multimedijski sustavi, Filozofski fakultet u Rijeci

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

ADDITIONAL READING:

e-learning:
Čanak Zorana Lowa, direktora IT centra o e-učenju
http://www.itcenter.hr/kolumna_0307.asp
John Sloan: E-learning je potrebno analizirati, Edupoint:
http://edupoint.carnet.hr/casopis/aktualni/clanak-03/index.htm
On-line Pedagogija: http://people.uis.edu/rschr1/csu.htm
Bertijeve stranice fizike - anketa: http://www.prvagimnazija.hr/fizika/anketa.htm

Information search:
Korištenje logičkih funkcija u pretraživanju: searchenginewatch.com/facts/boolean.html
Popis najvažnijih općih pretraživača s opisima usluga
searchenginewatch.com/links/major.html
www.cro-web.com/internet/trazilica.php

Electronic publishing:
Interaktivne animacije: General Physics Java Applets
http://www.schulphysik.de/suren/Applets.html
NTNU Virtual Physics Laboratory http://www.phy.ntnu.edu.tw/java/index.html
Animation & Simulation Centre
http://www.pearsoned.ca/school/science11/physics11/simulat.htm
Provjera znanja: CARNet-ov referalni centar za provjeru znanja
http://www.carnet.hr/referalni/obrazovni/spzit

COURSE TITLE: General Pedagogy

COURSE TEACHER/TEACHERS: Dr. sc. Marija Bratanić, red. prof.
Učiteljska akademija Sveučilišta u Zagrebu

STUDY PROGRAMME: University study of educational physics and informatics

YEAR OF STUDY: 4

SEMESTER: 8

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

ECTS credits: 6

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: Didactics

COURSE TEACHER/TEACHERS:

assistant professor Vlatka Domović, Ph.D

Učiteljska akademija Sveučilišta u Zagrebu

STUDY PROGRAMME: University study of educational physics and informatics

YEAR OF STUDY: 4

SEMESTER: 8

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

ECTS credits: 6

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: Fundamentals of Electronics

COURSE TEACHER/TEACHERS: Prof. Damir Veža

STUDY PROGRAMME: University study of educational physics and 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: 6

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: **Selected topics in solid state physics**		
COURSE TEACHER/TEACHERS: **Prof.dr.Antun Tonejc**		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: **4**		
SEMESTER: **7**		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	**teacher**
Exercises	2	**assistant**
Seminars		
Laboratory		
ECTS credits: 10		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To provide a students with basic knowledge of solid state physics, using experimental facts and theoretical models.		
DESCRIPTION OF THE COURSE: 1. **Elements of crystal structure** 2. **Interatomic Forces** 3. **Defects** 4. **Diffusion** 5. **Mechanical properties of Materials** 6. **Crystal Dynamics** 7. **Free Electrons in Metals** 8. **The Effect of the Periodic Lattice** 9. **Electric Poperties of Materials** 10. **Superconductivity** 11. **Magnetic Properties of Materials** 12. **Nanocrystalline Materials**		
STUDENT OBLIGATIONS DURING THE COURSE: **Students have to attend lectures and exercises. Students have to work out homeworks and colloquia.**		
METHODS TO EVALUATE STUDENT PERFORMANCE: **Regulary attendence of lectures and exercises + 75% worked out homeworks and colloquia.**		

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

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

COMPULSORY LITERATURE:

V. Šips, Uvod u fiziku čvrstog stanja, Školska knjiga Zagreb, 1991.
G.I.Epifanov, Solid State Physics, MIR Publishers, Moskva 1979.

ADDITIONAL READING:

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

COURSE TITLE: **Selected topics in nuclear physics and particle physics**		
COURSE TEACHER/TEACHERS: **Prof.dr.Marijan Miletović**		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: **4**		
SEMESTER: **7**		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	4	**teacher**
Exercises	2	**assistant**
Seminars		
Laboratory		
ECTS credits: 10		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To provide a students with basic knowledge of nuclear and particle physics,using experimental facts and theoretical models.		
DESCRIPTION OF THE COURSE: **(a) Nuclear physics** **Historical perspectives.Thomson model of atom vs. Rutherford model.The Rutherford scattering and the differential cross-section.** **Static properties of atomic nuclei.The binding energy.Masses and radii of nuclei.The charge distribution and form-factors.The diffractive scattering.** **Nuclear moments.The electric quadrupole moments.Intermezzo:the spin and angular moments of nuclei.Magnetic dipole moments and Schmidt lines.** **The bound two nucleon system (deuteron).Basic properties and the theoretical model of deuteron.** **Forces between nucleons-basic properties.Mesonic theory of nuclear forces.Yukawa potential.** **Nuclear models.The liquid drop model.The Fermi gas model.The shell model.Rotational and vibrational models.** **The stability of nuclei,decays and radioactivity.The theory of alpha-decay.The radioactive decay law.** **(b) Particle physics** **Historical perspectives.The discovery of elementary particles and fundamental interactions.The classification of subnuclear particles**		

(hadrons,leptons,quarks and gauge bosons).

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

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

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

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

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

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

METHODS TO EVALUATE STUDENT PERFORMANCE: Regulary attendence of lectures and exercises + 50% points from homeworks and colloquia.

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

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

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

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

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

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

COURSE TITLE: Selected Topics in General Physics		
COURSE TEACHER/TEACHERS: Professor Antonije Dulčić, Professor Stanko Popović		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 4		
SEMESTER/TERM: 7		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	professor
Exercises	1	professor/asistant
Seminars		
ECTS credits: 6		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: An overall view on /integral approach to/ the physical laws, achieved through courses Fundamentals of Physics 1-4, by considering possible analogies. To clarify misconceptions or misunderstanding in connection with physical laws, noticed during lectures, exercises, seminars and exams of Fundamentals of Physics 1-4. To introduce new topics of physics which are important for continuation of the study as well as to discuss contemporary achievments in physics.		
DESCRIPTION OF THE COURSE: In order to achieve an integral view on physics, possible analogies among natural phenomena and processes are treated in detail, e.g. problems, related to different branches of physics, which can be solved by applying the same procedure. Also, contemporary problems and achievments in physics are discussed, especially those, which could be included in the programme of physics in the secondary schools.		
STUDENT OBLIGATIONS DURING THE COURSE: Students are supposed to attend lectures and exercises and to autonomously submit a given topic in physics to other students.		
METHODS TO EVALUATE STUDENT PERFORMANCE:		
EXAMINATION METHODS: The exam may include a written part and an oral part. The students, who successfully submit the proposed topic in physics, are to pass only the oral part of the exam.		
COURSE(s) NEEDED FOR THIS COURSE: Fundamentals of Physics 1, 2, 3, 4.		
COMPULSORY LITERATURE: R.A. Serway, Physics for Scientists and Engineers, Saunders Publ., London, 1996 D. Halliday, R. Resnik, J. Walker, Fundamentals of Physics, John Wiley, New York, 1997 (or new editions)		

ADDITIONAL READING: Scientific American, Physics Today...

COURSE TITLE: Astronomy and Astrophysics		
COURSE TEACHER/TEACHERS: Prof. Krešimir Pavlovski		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 4		
SEMESTER: 7		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises		
Seminars	1	assistant
ECTS credits: 6		
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: **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 informatics

YEAR OF STUDY: **4**

SEMESTER: 7

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

ECTS credits: **6**

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: **History of Physics**		
COURSE TEACHER/TEACHERS: **Tihomir Vukelja, Ph.D.**		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 4		
SEMESTER: 7		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises	0	
Seminars	1	assistant
ECTS credits: 6		

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 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 (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: 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 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: 6		
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: 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 informatics		
YEAR OF STUDY: 4		
SEMESTER: 7		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	2	teacher
Exercises		
Seminars	1	teacher
Laboratory		
ECTS credits: 6		

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: **Computer Science Education**

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

STUDY PROGRAMME: University study of educational physics and informatics

YEAR OF STUDY: **5**

SEMESTER: **9**

TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	**2**	**teacher**
Exercises		
Seminars	**3**	**teacher**

ECTS credits: 8

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

DESCRIPTION OF THE COURSE:

1. **Theoretical basis**
   - **the aim of computer science teaching**
   - **content,**
   - **organization and**
   - **methodology of teaching.**
2. **Knowledge and skills in computer science**
3. **Usage of a personal computer**
4. **Basics of computer technology**
5. **Solving problems**
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 2-3 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: **Computer science courses, Psychology of education, Didactics**
COMPULSORY LITERATURE: **Computer science courses for elementary schools and gymnasia**
ADDITIONAL READING: **Enter, Internet**

COURSE TITLE: Laboratory in Fundamental Electronics		
COURSE TEACHER/TEACHERS: Prof. dr.sc. Amir Hamzić, Dr.sc. Mario Basletić		
STUDY PROGRAMME: University study of educational physics and 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: **6**		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Assembling, measurements and analysis of basic electronic circuits and simple devices using discrete and integrated elements.		
DESCRIPTION OF THE COURSE: **FET amplifiers, BJT amplifiers,feedback,circuits with passive elements, operational amplifier, basic logic circuits, digital voltmeter, time-base circuits, voltage stabilization,** signal modulation and demodulation		
STUDENT OBLIGATIONS DURING THE COURSE: analysis of measurement, discussion of results, partial exams (colloquy) each week, computer programming of specific physical measurements in real time (on-line experiment)		
METHODS TO EVALUATE STUDENT PERFORMANCE: partial exams (colloquy), homework		
EXAMINATION METHODS: written exam; the final score consists of the results of final written exam, weeks' partial exams, and evaluation of student's skills		
COURSE(s) NEEDED FOR THIS COURSE: Basic electronics		
COMPULSORY LITERATURE: **H.M.Jones, A Practical Introduction to Electronic Circuits, Cambridge Univer. Press, 1987.** **P. Biljanović, Elektronički sklopovi, Školska knjiga, Zagreb 1989.** Notices and instruction manuals (for internal use only).		

ADDITIONAL READING:

COURSE TITLE: **Physics education 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 informatics**

YEAR OF STUDY: **5**

SEMESTER: **9**

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

ECTS credits: **7**

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS:

Development of interactive teaching skills in prospective physics teachers. Deepening of conceptual understanding of basic physics concepts with emphasis on their didactical aspects. Acquainting students with results of physics education research and cognitive sciences, and their use in physics teaching.

DESCRIPTION OF THE COURSE:

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: **Physics education 2**

COURSE TEACHER/TEACHERS:

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

Mr. sc. Maja Planinić, PMF, Zagreb

Dipl.inž. Planinka Pećina, PMF, Zagreb

STUDY PROGRAMME: **university study of educational physics and informatics**

YEAR OF STUDY: **5**

SEMESTER: **9, 10**

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

ECTS credits: **7, 7**

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Development of interactive teaching skills in prospective physics teachers. Deepening of conceptual understanding of basic physics concepts with emphasis on their didactical aspects. Acquainting students with results of physics education research and cognitive sciences, and their use in physics teaching.

DESCRIPTION OF THE COURSE:

In this semester selected physics topics are treated from educational point of view, through application of educational principles that were introduced in the previous semester and with emphasis on important role of experiments in teaching.

1. Newton's laws. Force. Comparison with Aristotelian views on force and motion.
2. Passive forces: elastic force, string tension, normal force, friction.
3. Circular motion. Centripetal force. Noninertial reference frames. Inertial forces.
4. Energy. Conservation laws.
5. Geocentric and heliocentric system: historical development of ideas. Kepler's laws. Newton's law of gravitation.
6. Ideal gas laws. Kinetic model of gas. Particulate nature of matter.

7. First and second law of thermodynamics.
8. Electric charge, electric force. Electric field. Potential.
9. Simple DC circuits.
10. Magnetic phenomena. Lorentz force. Electromagnetic induction.
11. Harmonic oscillations. Waves in elastic medium. Electromagnetic waves.
12. Laws of geometrical optics. Diffraction and interference of light.
13. Continous and line spectra. Models of atom. Development of ideas about atomic nucleus.
14. Basic principles of quantum mechanics.
15. **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: **Physics teaching practice 1, and 2**		
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 informatics		
YEAR OF STUDY: 5		
SEMESTER: **9,10**		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures		
Exercises		
Seminars	**4 4**	Teacher, assistant, teacher – mentor at school
Laboratory		
ECTS credits: **4, 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 10 lessons in gymnasia and/or secondary technical schools. Afterwards they prepare themselves for teaching and teach two trial lessons in class. If they are ready, according to mentor's opinion, to teach , they prepare and perform a public lesson. Teacher of physics education course and other students attend the public lesson, and later they all discuss it.**		
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 lessons.		
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 Practice in Computer Science		
COURSE TEACHER/TEACHERS: **dr.sc. Gorjana Jerbić-Zorc**		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 5		
SEMESTER: 10		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures	0	
Exercises		
Seminars	4	teacher, supervisor
Laboratory		
ECTS credits:		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: **Development and evaluation of interactive teaching skills in prospective computer science teachers.**		
DESCRIPTION OF THE COURSE: Students attend at least 10 lessons of chosen teachers – mentors at elementary schools and 10 lessons in gymnasia and/or secondary technical schools. Afterwards they prepare themselves for teaching and teach two trial lessons in class. If they are ready, according to mentor's opinion, to teach , they prepare and perform a public lesson. Teacher of computer science 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 lessons		
COURSE(s) NEEDED FOR THIS COURSE: Computer Science Education, Educational Psychology, General Pedagogy, Didactics		
COMPULSORY LITERATURE:		

Textbooks for elementary school and gymnasia chosen by teacher - mentor
ADDITIONAL READING: **Enter, Internet**

COURSE TITLE: Seminar in Fundamentals in Atomic and Molecular Physics

COURSE TEACHER/TEACHERS: Prof. Damir Veža

STUDY PROGRAMME: University study of educational physics and informatics

YEAR OF STUDY: 5

SEMESTER: 9

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

ECTS credits: 5

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Introducing students to new results in fundamental and applied atomic and molecular physics, plasma physics and spectroscopy.

DESCRIPTION OF THE COURSE:

Seminar topics:
New developments in fundamental research in AMO Physics.
New devices and methodes in contemporary classical spectroscopy.
New devices and methodes in laser spectroscopy.
Examples of devices and methods of AMO physics in medicine, environmental science and communications.

STUDENT OBLIGATIONS DURING THE COURSE: Attendance to seminars.

METHODS TO EVALUATE STUDENT PERFORMANCE: Oral and written seminary works

EXAMINATION METHODS: Active collaboration at seminars, evaluation of seminary works

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

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

ADDITIONAL READING: **Internet resources,like <http://xxx.lanl.gov>**

COURSE TITLE: Seminar in quantum physics and theory of relativity education		
COURSE TEACHER/TEACHERS: Vladimir Paar		
STUDY PROGRAMME: University study of educational physics and informatics		
YEAR OF STUDY: 5		
SEMESTER: 9		
TEACHING METHODS	CONTACT HRS PER WEEK	DELIVERED BY (*teacher or assistant*)
Lectures		
Exercises		
Seminars	3	
Laboratory		
ECTS credits: 5		
DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: Discussion and presentation of conceptual contents from quantum mechanics and relativity theory for the needs of school education.		
DESCRIPTION OF THE COURSE: Didactical approach to contents from quantum mechanics and relativity theory in high-school programs (conceptual aspects of electromagnetic waves vs. photons, energy quantization in quantum systems, atomic and nuclear spectroscopy, evolution of the Universe, semiconductors, relativity of space and time, relativistic dynamics)		
STUDENT OBLIGATIONS DURING THE COURSE: Attendance at seminars, individual projects		
METHODS TO EVALUATE STUDENT PERFORMANCE: oral and written presentation of individual projects		
EXAMINATION METHODS: oral and written presentation of individual projects		
COURSE(s) NEEDED FOR THIS COURSE:general physics, classical mechanics, classical electrodynamics		
COMPULSORY LITERATURE:		
ADDITIONAL READING: M. Russel Wehr, J. A. Richards, T. W. Adair, Physics of the atom, Addison-Wesley, 1978 S. Kuehnel, H. Schafbauer, H. Knauth, Physik 13, Oldenbourg, Muenchen, 1998 N. Bohr, Atomic theory and the description of nature, Cambridge University Press, 1961		

K. Krane, Modern Physics, Wiley, 1983

COURSE TITLE: Physics of Nanomaterials

COURSE TEACHER/TEACHERS: professor dr. sc. Antun Tonejc

STUDY PROGRAMME: University study of educational physics and 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: 5

DEVELOPMENT OF GENERAL AND SPECIFIC COMPETENCIES – KNOWLEDGE AND SKILLS: To provide a students with basic concepts of physics of nanomaterials, using experimental facts and theoretical models.

DESCRIPTION OF THE COURSE:

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 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: 5

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

DESCRIPTION OF THE COURSE:
Liquefying principles, helium and nitrogen liquefiers;
Work with cryogenic liquids (cryostats, thermal losses);
Low temperature thermometry,
Properties of He^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: PHYSICS OF SEMICONDUCTORS		
COURSE TEACHER/TEACHERS: Miroslav Požek		
STUDY PROGRAMME: university study of research physics		
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: 7		
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.		