UNIVERSITY UNDERGRADUATE STUDIES:

UNDERGRADUATE STUDIES of PHYSICS

March 2005

1) INTRODUCTION

a) Reasons for initiation of studies

- The basic reason is scientific study of physics as the basic science. It should be emphasized that more and more tumultuous development of new technologies on the bases of physics creates the need for as much flexibility as possible in education established on the basic knowledge which is slower in becoming obsolete. This makes possible the employment in all production segments and in public life in which the modern technologies and techniques are present. The studies are also a prerequisite to further GRADUATE studies of PHYSICS as a scientific discipline and basis for educational streamings in the spheres of physics.
- The connection with contemporary scientific perceptions is out of question since physics as the science is founded in all modern technologies and techniques, and is in permanent tumultuous development.
- The comparison with numerous equivalent and similar programmes in European Union is possible but, according to the instruction, we state only two: at the University of Uppsala and the university of Saarland.

b) Previous experiences of proposer in carrying out of equivalent or similar programmes

There is a significant scientific and educational experience of the staff in the organization of theoretical and experimental teaching of physics at the Department of Physics of the University J.J. Strossmayer in Osijek. The existence of two four-year studies of physics up to the present moment: Mathematics and Physics, Physics and Technical Culture with Informatics accomplished by the Department of Physics, University J.J.Strossmayer guarantee the above-mentioned experience.

c) Graduate Studies

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d) *Openness of studies towards mobility of students*

The coordination of undergraduate studies of physics with the undergraduate studies of physics or corresponding technical studies in Croatia and European Union makes possible a significant openness towards mobility of students. There will be the mobility towards graduate and doctoral studies of physics.

e) Other components

Three-year undergraduate studies of physics is a basis of all studies of physics (graduate, doctoral ones) in Croatia and European Union. It should be noted that there are adequate laboratories, cabinets for practical courses, space and the equipment for the studies programme realization at the Department of physics.

2) GENERAL PART

1) Title of studies

UNDERGRADUATE STUDIES OF PHYSICS

2) Implementation-bearer

UNIVERSITY J.J. STROSSMAYER, OSIJEK

Realization:

DEPARTMENT OF PHYSICS, UNIVERSITY J.J. STROSSMAYER, OSIJEK

3) Duration

Three years (6 semesters)

4) Admission requirements

Completed high school or adequate secondary school

5) Undergraduate Studies

After the students have finished undergraduate studies, they would acquire basic knowledge in physics, mathematics and informatics needed for the corresponding graduate studies as well as the concrete professions (laboratory technicians at the faculty, school or institute, programmer, jobs in informatics companies).

The students could follow all programmes of studies in the sphere of physics at the University J.J. Strossmayer in Osijek as well as at the other universities in Croatia.

6) Graduate studies

7) _

8) Professional or academic title acquired after completing studies

BACHELOR OF PHYSICS (B. Sc.)

3) DESCRIPTION OF PROGRAMME

3.1. Programme structure with credits

1. YEAR

1st Semester						
Course code	Course title	Course structure*				ECTS
		L	S	E	P	
F101	General Physics I	60	15	30	0	9
M101	Mathematics 1 (Differential calculus)	30	0	45	0	7
I101	Elementary Informatics	30	0	0	30	4
I102	E-Office	0	0	0	30	3
	Elective courses: student choose 7 credits					
Z105	General and Inorganic Chemistry 1	30	0	15	0	5
I103	Data Communications and Computer nets	30	0	0	30	5
M105	Geometry of Plane and Space	30	0	30	0	5
Z101	English 1 (optional)	0	30	0	0	2
	Total:					30
* L=Lectures, S=Seminars, E= exercises, , P=Practical (Laboratory)						

2nd Semester						
Course code	Course title	Course structure*				ECTS
		L	S	E	P	
F102	General Physics II	60	15	30	0	9
M102	Mathematics 2 (Integral calculus)	30	0	45	0	7
	Elective courses: student choose 14 credits					
M103	Linear Algebra 1	30	0	30	0	6
Z106	General and Inorganic Chemistry 2	30	0	15	0	6
I104	Algorithms and Data Structures	30	0	0	30	6
Z102	English 2 (optional)	0	30	0	0	2
	Total:					30
* L=Lectures, S=Seminars, E= exercises, , P=Practical (Laboratory)						

2. YEAR

3rd Semester						
Course code	Course title	Course structure*				ECTS
		L	S	E	P	
F103	General Physics III	60	15	30	0	9
M104	Matematics 3 (Functions of more variables)	30	0	30	0	6
F107	Fundamentals of Measurement in Physics and Statistical Analysys	30	0	15	0	4
F111	General Physics Laboratory A	0	0	0	60	5
	Elective courses: student choose 6 credits					
I106	Elementary Programming 1	15	0	0	30	4
Z103	English 3 (optional)	0	30	0	0	2
	Total:					30
* L=Lectures, S=Seminars, E= exercises, , P=Practical (Laboratory)						

4th Semester						
Course code	Course title	Course structure*				ECTS
		L	S	E	P	
F104	General Physics IV	60	15	30	0	9
M105	Diferencial Equations	30	0	30	0	6
F114	General Physics Laboratory B	0	0	0	60	5
F105	Classical Mechanics 1	30	0	15	0	4
	Elective courses: student choose 6 credits					
I107	Elementary Programming 2	15	15	0	30	4
Z104	English 4 (optional)	0	30	0	0	2
	Total:					30
* L=Lectures, S=Seminars, E= exercises, , P=Practical (Laboratory)						

3. YEAR

5th Semester						
Course code	Course title	Course structure*				ECTS
		L	S	E	P	
F108	Electrodynamics 1	30	0	15	0	5
F109	Introduction to Stastical Physics	30	15	0	0	5
F106	Classical Mechanics 2	30	0	15	0	5
	Elective courses: student choose 15 credits					
T106	Science of Strength	30	0	15	0	3
F110	Mathematical Methods of Physics	45	0	30	0	7
I108	Database and Process Analysis	30	0	0	30	5
I109	Usage of Computers in Lectures	30	0	0	30	5
	Total:					30
* L=Lectures, S=Seminars, E= exercises, , P=Practical (Laboratory)						

6th Semester						
Course code	Course title	Course structure*				ECTS
		L	S	E	P	
F112	Special and General Relativity	30	0	15	0	5
F113	Quantum Mechanics 1	45	0	30	0	7
F115	Fundamentals of the Condensed Mater Physics	30	0	15	0	5
I105	Multimedia Systems	30	15	0	15	5
	Elective courses: student choose 8 credits					
I110	Security of Information Systems	30	0	0	30	4
I111	Systems of Teaching at a Distance	15	15	0	30	4
F131	Electrodynamics 2	30	0	15	0	4
F123	Introduction to Astronomy and Astrophysics	30	0	15	0	4
	Total:					30
* L=Lectures, S=Seminars, E= exercises, , P=Practical (Laboratory)						

3.2. Description of every course of lectures:

Course title	**General Physics I**		
Course code	F101		
Type of course	Lectures (60 hours), Seminars (15 hours), Exercises (30 sati)		
Level of course	Fundamental course		
Year of study	1st	**Semester**	1st
ECTS (Number of credits allocated)	9 ECTS: • 60+15+30 (lectures + seminars + exercises) class units = 80 contact hours ~ 2.6 ECTS • about 190 h of independent student work with consultations ~ 6.4 ECTS		
Name of lecturer	Ph.D. Josip Planinić, Full Professor		
Learning outcomes and competences	Problem solving capacity in the field of mechanics. Theoretical understanding of important concepts from that field.		
Prerequisites	To be Undergraduate student.		
Course contents	Introduction to physics. Physical quantity units. Motion; velocity, acceleration, free-fall, slope, vertical projectile motion, slant projectile motion, circular motion. Dynamics; Newton's laws. Conservation of linear momentum. Gravitation. Dynamics law for two systems in relative motion. The Galilean transformations, circular motion, Coriolis force, elastic force. Friction force. Work and kinetic energy. Conservation of mechanical energy. Power. Collisions. Relativistic mechanics. The Lorentz transformations, length contraction, time dilation, relativistic conservation of momentum, relativistic energy. Statics; the center of mass, handle, rigid body rotating about a fixed axis, parallel axis theorem, conservation of angular momentum, rigid body rotating about a free axis. Fluids at rest; hydraulic pressure, buoyant force, atmospheric pressure, surface tension of liquids, capillarity. Fluids in motion; the equation of continuity, Bernoulli's equation, viscosity, flow of real fluids within tube, motion of body in fluids. Viscosity measurements, errors of measurements. Oscillations; mathematical pendulum, Lissajous figures, damped simple harmonic motion, forced harmonic oscillator, the physical pendulum.		
Recommended reading	1) Planinić, J., *Osnove fizike 1*, Školska knjiga, Zagreb, 2005. 2) Cindro, N., *Fizika 1*, Školska knjiga, Zagreb, 1988. 3) Kulišić, P., *Mehanika i toplina*, Školska knjiga, Zagreb, 1990.		
Supplementary reading	1) Paić, M., *Gibanje, Sile, Valovi*, Liber, Zagreb, 1997. 2) Kittel, C., Knight, W., Ruderman, M., *Mehanika*, Tehnička knjiga, Zagreb, 1986. 3) Young, H., Freedman, R., *University Physics*, Addison-Wesley Publ., New York, 1996 4) E. Babić, R. Krsnik i M. Očko. Zbirka riješenih zadataka iz fizike. Školska knjiga, Zagreb 2004. 5) P. Kulišić, L.Bistričić, D. Horvat, Z. Narančić, T. Petrović i D. Pevec. Riješeni zadaci iz mehanike i topline. Školska knjiga, Zagreb, 2002.		
Teaching methods	The course consists of lectures, classroom presentation of simple experiments connected with corresponding lecture and chosen so to illustrate theoretical concepts, classroom presentation of simple numerical models by using a computer, problem solving by students both during lectures and during exercises, and student		

	seminars about chosen topics. Student seminars are designed to induce students in the direction of independent problem solving work when both the problem and solution methods are chosen by students after some example problems suitable for seminars are offered to students. Discussion and questions are encouraged.
Assessment methods	Weekly tests. Exams each month (the total of three during semester). Final exam immediately after the end of course. The exam is simplified for those students that collect more than 50% credits from both tests and monthly exams.
Language of instruction	Croatian language except for invited foreign speaking lecturers that would be willing to lead chosen student seminar session.
Quality assurance methods	A questionnaire will be offered to students at the end of the semester with a goal of finding weak spots in the course conception and delivery.

Course title	**General Physics II**		
Course code	F102		
Type of course	Lectures (60 hours), Seminars (15 hours), Exercises (30 sati)		
Level of course	Fundamental course		
Year of study	1st	**Semester**	2nd
ECTS (Number of credits allocated)	9 ECTS: • 60+15+30 (lectures + seminars + exercises) class units = 80 contact hours ~ 2.6 ECTS • about 190 h of independent student work with consultations ~ 6.4 ECTS		
Name of lecturer	Ph.D. Josip Planinić, Full Professor		
Learning outcomes and competences	Problem solving capacity in the field of electricity and magnetism. Theoretical understanding of important concepts from that field.		
Prerequisites	To be Undergraduate student.		
Course contents	Electricity. Coulomb's law. Electric fields. Electric potential. Work in the electric field. Electric influence, induction. Gauss' law. Charge layout on the conductor. Capacitors and capacitance. Capacitor with a dielectric. Dielectric polarization. Electrostatic field energy. Source of electricity, electricity engines. Electromotor force. Electric current. Joule's and Ohm's law. Electric resistance. Potentiometer. Networks and Kirchhoff's rules. Shunting conductors. Electric current in electrolytes. Current in vacuum and gasses. Current in semicondutors. The magnetic field and magnetic force. Magnetic fields due to currents: Biot-Savart and Ampere's law. Electrodynamics force. Lorentz's force. Force between two parallel currents, ampere. Work due electrodynamics force. Magnetic flux. Conducting loop in a magnetic field. Galvanometer; ammeter, voltmeter. Faraday's law of induction. Lenz' rule. Induced EMF; dynamo generator, generator for alternating currents. Mutual induction. Self-induction. RL, RC, LC circuits. Energy stored in a magnetic field. Energy stored on a capacitor; LC, LRC circuits. Alternating current; resistance, Ohm's law, power. Transformer. Inductor. Triphase alternating current. Magnetism of matter: Permeability, diamagnetism, paramagnetism and ferromagnetism. Potential energy in magnetic field. Magnetization curves. Hysteresis. Electromagnets. Electrodynamics microphone. Magnetic tape.		
Recommended reading	1) Cindro, N., *Fizika 2*, Školska knjiga, Zagreb, 1988. 2) Kulišić, P., Lopac, V., *Elektromagnetske pojave i struktura tvari,*		

	Školska knjiga, Zagreb, 1991.
Supplementary reading	1) Paić, M., *Osnove fizike, III dio,* Liber, Zagreb, 1989.. 2) Purcell, M., *Berkeleyski tečaj fizike, II dio (Elektricitet i magnetizam),* Tehnička knjiga, Zagreb 1988. 3) E. Babić, R. Krsnik i M. Očko. Zbirka riješenih zadataka iz fizike. Školska knjiga, Zagreb 2004.
Teaching methods	Lectures with Power Point presentations, interactive simulations, demonstration experiments, discussions, solving of sample problems individually and in group, regular tests. Problem solving in exercise classes independently and under the guidance of the teaching assistant. Student seminars are designed to induce students in the direction of independent problem solving work when both the problem and solution methods are chosen by students after some example problems suitable for seminars are offered to students. Discussion and questions are encouraged.
Assessment methods	Exams each month (the total of three during semester). Final exam immediately after the end of course. The exam is simplified for those students that collect more than 50% credits from monthly exams.
Language of instruction	Croatian, English (possible)
Quality assurance methods	A questionnaire will be offered to students at the end of the semester with a goal of finding weak spots in the course conception and delivery.

Course title	**General Physics III**		
Course code	F103		
Type of course	Lectures (60 hours), Seminars (15 hours), Exercises (30 sati)		
Level of course	Fundamental course		
Year of study	2st	**Semester**	3rd
ECTS (Number of credits allocated)	9 ECTS: • 60+15+30 (lectures + seminars + exercises) class units = 80 contact hours ~ 2.6 ECTS • about 190 h of independent student work with consultations ~ 6.4 ECTS		
Name of lecturer	Ph.D. Josip Planinić, Full Professor		
Learning outcomes and competences	Understanding the basic physical concepts and relations connected with oscillations, waves and optics.		
Prerequisites	Competences acquired in General Physics I, General Physics II		
Course contents	Waves; longitudinal waves – equation, standing waves, transverse waves. Acoustics; standing waves in air, speed of sound, transmission of energy in progressive waves. Doppler effect. Sources of sound. Sensitivity of human ear. Shock waves. Optics; basic laws of geometrical optics. Plane mirror, spherical mirrors. Prism. Dispersion of light. Spherical diopter. Optical systems: eye, magnifier, microscope, binoculars. Photometry. Physical optics; interference of light. Fresnel's mirrors. Lloyd's mirror, interference at planparallel plate. Newton's rings. Michelson interferometer. Diffraction of light; Fraunhoffer diffraction, diffraction grating, Fresnel's diffraction. Polarized light. Malus' law. Optical activity. Atomic line spectra and energy levels. Structure of atom. Lasers.		
Recommended reading	1) Planinić, J., *Osnove fizike III.,* Valovi – akustika – optika - uvod u atomsku fiziku, Filozofski fakultet Osijek, 2005.		

	2) Henč-Bartolić, V., Kulišić, P., *Valovi i optika*, Školska knjiga, Zagreb, 1991. 3) Cindro, N., *Fizika 1*, Školska knjiga, Zagreb, 1988.
Supplementary reading	1) Paić, M., *Gibanje, Sile, Valovi*, Liber, Zagreb, 1997. 2) Paić, M., *Osnove fizike, IV dio*, Sveučilišna naklada Liber, Zagreb, 1983. 3) Young, H., Freedman, R., *University Physics*, Addison-Wesley Publ., New York, 1996. 4) E. Babić, R. Krsnik i M. Očko. Zbirka riješenih zadataka iz fizike. Školska knjiga, Zagreb 2004.
Teaching methods	Lectures with Power Point presentations, interactive simulations, demonstration experiments, discussions, solving of sample problems individually and in group, regular tests. Problem solving in exercise classes independently and under the guidance of the teaching assistant. Student seminars are designed to induce students in the direction of independent problem solving work when both the problem and solution methods are chosen by students after some example problems suitable for seminars are offered to students. Discussion and questions are encouraged.
Assessment methods	Exams each month (the total of three during semester). Final exam immediately after the end of course. The exam is simplified for those students that collect more than 50% credits from monthly exams.
Language of instruction	Croatian, English (possible)
Quality assurance methods	A questionnaire will be offered to students at the end of the semester with a goal of finding weak spots in the course conception and delivery.

Course title	**General Physics IV**		
Course code	F104		
Type of course	Lectures (60 hours), Seminars (15 hours), Exercises (30 sati)		
Level of course	Fundamental course		
Year of study	2st	**Semester**	4th
ECTS (Number of credits allocated)	9 ECTS: • 60+15+30 (lectures + seminars + exercises) class units = 80 contact hours ~ 2.6 ECTS • about 190 h of independent student work with consultations ~ 6.4 ECTS		
Name of lecturer	Ph.D. Josip Planinić, Full Professor		
Learning outcomes and competences	Basic assumptions of the statistical and thermo dynamical descriptions of the many body systems. Relationship between the law of the increasing entropy in the isolated systems and phenomenological formulations of the second law of the thermodynamics. Explanation of the principle of the work of heat engines using p-V diagram. Application of the thermodynamic laws on the problem of phase transitions. Solving the simple problems in transport phenomena. Outline of historical evolution of the atomic structure. Explanation of the necessity of the replacement of the deterministic description of the nature with probabilistic one. Solving Schrödinger's equation in the simple cases. Description of the structure of the atomic nucleus.		
Prerequisites	Competences acquired in General Physics II.		
Course contents	Structure of matter; amount of substance, mol, Brown's motion. Diffusion. Molecular forces. States of matters. Kinetic theory of gases. Ideal gas law. Maxwell-Boltzmann distribution. Temperature. Thermometrics. Changes between		

	states of matters. Humidity of air. Phase change graph, triple point of water. Calorimetrics; heat measurements, heat capacity. Calorimeters. Boling point, melting point, heat of transformation. Dalton's law. Real gases, Van der Waals equation. Thermodynamics; internal energy, work. First law of thermodynamics. Gay-Lussac-Joule experiment. Mayer's relation. Entalpy. Adiabatic process. Second law of thermodynamics, perpetuum mobile. Reversible and irreversible processes. Statistical theory of heat. Entropy. Carnot cycle. Efficiency of a Carnot engine. Clausius-Clapeyron equation. Engines. Thermodynamic temperature scale. Refrigerators. Heating pump. Heat transport. Spectrum of black body radiation. Kirchhoff's law of radiation. Planck law of black body radiation. Stefan law of radiation. Structure of atoms. Schrödinger wave equation. Heisenberg principle of uncertainty. Quantum numbers. The Pauli exclusion principle. Periodic table. Atomic nucleus. Radioactivity. Radioactive decay law. Nuclear reactions; nuclear fission, nuclear fusion. Accelerators, Roentgen's radiation. Interactions of radiation with matters. Radiation dosimetry. Radiation protection. Particle physics; quarks. The standard model of cosmology.
Recommended reading	1) Cindro, N., *Fizika 1*, Školska knjiga, Zagreb, 1988. 2) Kulišić, P., *Mehanika i toplina*, Školska knjiga, Zagreb, 1990 3) Kulišić, P., Lopac, V., *Elektromagnetske pojave i struktura tvari*, Školska knjiga, Zagreb, 1991.
Supplementary reading	1) Paić, M., Toplina, *Termodinamika, Energija*, Liber, Zagreb, 1993. 2) Young, H., Freedman, R., *University Physics*, Addison-Wesley Publ., New York, 1996. 3) E. Babić, R. Krsnik i M. Očko. Zbirka riješenih zadataka iz fizike. Školska knjiga, Zagreb 2004.
Teaching methods	Lectures accompanied with experiments. Home experiments. Solving problems instructed by assistant. Uninfluenced solving of problems. Check of the solved problems and discussion on tutorials. Home experiments.
Assessment methods	Exams each month (the total of three during semester). Final exam immediately after the end of course. The exam is simplified for those students that collect more than 50% credits from monthly exams.
Language of instruction	Croatian, English (possible)
Quality assurance Methods	A questionnaire will be offered to students at the end of the semester with a goal of finding weak spots in the course conception and delivery.

Course title	**Fundamentals of Measurement in Physics and Statistical Analysys**		
Course code	F107		
Type of course	Lectures (30 hours), Exercises (15 sati)		
Level of course	Fundamental course		
Year of study	2st	**Semester**	4th
ECTS (Number of credits allocated)	4 ECTS: • 20+0+15 (lectures + seminars + exercises) class units = 40 contact hours ~ 1.4 ECTS • about 80 h of independent student work with consultations ~ 2.6 ECTS		
Name of lecturer	Ph.D. Zvonko Glumac, Assistant Professor		
Learning outcomes and competences	Students become trained in initial independent and successful implementing scientific-research work as well as in independent applying scientific results to professional work.		

Prerequisites	
Course contents	Probability. Empirical distributions: Arithmetic and geometric mean. Variance, standard deviation. Binomial and Poisson distribution. Normal curve, log-normal distribution. Sampling theory, t-distribution. Errors of measurements. Estimation of parameters of population. Tests of hypoteses. Regression and correlation; sum of squares of the errors; fitting.
Recommended reading	1) Pavlić, I., *Statistička teorija i primjena*, Tehnička knjiga, Zagreb, 1980. 2) Šošić, I., Serdar, V., *Uvod u statistiku*, Školska knjiga, Zagreb, 1997.
Supplementary reading	1) Bevington, P., *Dana reduction and error analysis for the physical sciences*, Mc Graw-Hill Book Company, New York, 1980. 2) Caria, M., *Measurement analysis*, Imperial College Press, 2000.
Teaching methods	Lectures with discussions, solving of sample problems individually and in group, regular tests. Problem solving in exercise classes independently and under the guidance of the teaching assistant.
Assessment methods	Exams each month (the total of three during semester). Final exam immediately after the end of course. The exam is simplified for those students that collect more than 50% credits from monthly exams.
Language of instruction	Croatian, English (possible)
Quality assurance methods	A questionnaire will be offered to students at the end of the semester with a goal of finding weak spots in the course conception and delivery.

Course title	**Mathematics 1 (differential calculus)**		
Course Code	M101		
Type of course	Lectures (30 hours), Exercises (45 hours)		
Level of course	Elementary mathematical course		
Year of study	1st	Semester	1st
ECTS (Number of credits allocated)	7 ECTS Attending lectures and exercises, independent learning, homeworks, preliminary exams and final exams.		
Name of lecturer	Ph.D. Antoaneta Klobučar, Assistant Professor		
Learning outcomes and competences	At the introductory level the students should be taught main ideas and methods of mathematical analysis, which are the basis for many other courses of lectures. The main terms will be explained in an informal way, their usefullness and usage will be presented. During exercises the students should become familiar with certain technics and be able to solve concrete problems.		
Prerequisites	Knowledge from secondary school		
Course contents	1. Introduction. Field of real numbers, infimum and supremum, apsolute value, intervals. Field of complex numbers. 2. Functions. Definition of function and basic properties. Elementary functions. Compositon of functions. Biection and inversion function. 3. Real number series. Coception of series, basic properties and convergention. e number. 4. Limes and continuity of functions. Concept of a limes of function, Properties of		

	limes. One-band limes. Infinities and limes in infinity. Asymptotics. Continuity and properties of continous functions. 5. Differential calculus. Velocity and tangent problem. Concept of derivation. Derivation rules. Derivation of elementary functions. Derivation of implicite functions. Derivation of parametric functions. Derivation of high order. Taylors theorem. 6. Applications of differential calculus. Differential. Newton's tangent method. L'Hospital rule. Function investigation (monotony, extrems, convexity, asymptotics)
Recommended reading	1) W.Rudin, Principles of Mathematical Analysis, Mc Graw-Hill, Book Company, 1964. 2) D. Jukić, R. Scitovski, Matematika I, Odjel za matematiku, Osijek, 2000.
Supplementary reading	1) S. Kurepa, Matematička analiza 1 (diferenciranje i integriranje), Tehnička knjiga, Zagreb, 1989. 2) S. Kurepa, Matematička analiza 2 (funkcije jedne varijable), Tehnička knjiga, Zagreb, 1990. 3) 3. B.P. Demidovič, Zadaci i riješeni primjeri iz više matematike s primjenom na tehničke nauke, Tehnička knjiga, Zagreb, 1986
Teaching methods	Lectures and exercises are obligatory
Assessment methods	The exam consists of oral and written parts of exam. The students can go in for an exam after attending all lectures and after doing all exercises. During one semester there is a possibility for the students to go in for 2 preliminary exams; these exams can replace the written part of the exam.
Language of Instruction	Croatian
Quality assurance methods	An anonymous questionnaire

Course title	**Elementary Informatics**		
Course code	I101		
Type of course	30+0+0+30		
Level of Course	Elementary		
Year of study	1st	**Semester**	1st
ECTS (Number of credits allocated)	4		
Name of lecturer	Ph.D. Branimir Dukić, Full Professor		
Learning outcomes and competences	Elementary knowledge that is the basis for further studies, for both informatics and non-informatics subjects.		
Prerequisites	None		
Course contents	Basic definitions and classifications, binary and hexadecimal number system, parity check (parity bit), logical functions, memory, register, data transfer, microprocessor, computer model, CISC, RISC, operating system, basic input/output system units, file, directory, network, network protocols, Information		

	systems, types and elements of IS.
Recommended reading	1) Ribarić S., Arhitektura pete generacije računala, Školska knjiga, Zagreb, 1990. 2) Smiljanić G., Mikroračunala, Školska knjiga Zagreb, 1986. - 1996. 3) 3. Kvaternik R., Uvod u operativne sisteme, Informator, Zagreb, 1991.
Supplementary reading	1) L. Budin, Informatika za 1. razred gimnazije, Element, Zagreb 1996. 2) Williama K.B., Sawyer C.S., Hutchinson E.S., Using Information Technology, R.D. Irwin, Inc, USA, 1995. 3) 3. S. Ribarić, Arhitektura računala RISC i CISC, Školska knjiga, Zagreb 1996
Teaching methods	Lectures, laboratory exercises
Assessment methods	Written and oral exams, preliminary exams
Language of instruction	Croatian/ English
Quality assurance methods	The quality of teaching methods could be checked by exams, personal practical work in accordance with given tasks and by the ability of students to use their knowledge and skills learnt at this course at some other courses.

Course title	**E-office**		
Course code	I102		
Type of course	0+0+0+30		
Level of course	Elementary		
Year of study	1st	**Semester**	1st
ECTS (Number of credits allocated)	3		
Name of lecturer	Ph.D. Branimir Dukić, Full Professor		
Learning outcomes and competences	The main goal of this course of lectures: to develop general and specific knowledge dealing with the usage of programming tools, to become familiar with standards and norms of electronic business and with the principles of the modern business communication		
Prerequisites	None		
Course contents	Introduction to concept of E-office. Office equipment, Hardware, Software, Computer, Printer, Plotter, Scanner, Operating systems, Office tools, Automation tools, Database tools, Organizers, Communication tools, Internet, e-mail, hypertext, hypermedia, Data storage, Text processing. Data worksheet processing. Presentation tools, Netiquette		
Recommended reading	1) Srića, Velimir; Kliment, Antun i Knežević, Blaženka: Uredsko poslovanje: Strategija i koncepti automatizacije ureda, Zagreb, Sinergija, 2003. 2) 2. Mesarić, J., Zekić-Sušac, M., Dukić, B.: PC u uredskom poslovanju, EFO, Osijek 2001		
Supplementary reading	1) D.Chaffey: Groupware, Workflow and Intranets. Reengineering the Enterprise with Collaborative Software, Digital Press, Boston, MA, 1998.		

	2) Kliment, Antun: Digitalne poslovne komunikacije, Ekonomski fakultet Zagreb, Mikrorad, 2000.
Teaching methods	Exercises
Assessment methods	Written exam
Language of instruction	Croatian/ English
Quality assurance methods	The quality of teaching methods could be checked by exams, personal practical work in accordance with given tasks and by the ability of students to use their knowledge and skills learnt at this course at some other courses.

Course title	**General and Inorganic Chemistry 1**		
Course code	Z105		
Type of course	Lectures		
Level of course	Introductory		
Year of study	1st	**Semester**	1st
ECTS (Number of credits allocated)	5 ECTS credits *Description:* • lectures and excercises: 3,00 ECTS • examination: 2,00 ECTS		
Name of lecturer	Ph.D. Milan Čačić, Assistant Professor		
Learning outcomes and competences	Student preparation for science courses as well as specific on general and inorganic Cemistry.		
Prerequisites			
Course contents	Introduction to Chemistry.The matter,Elements,Compounds and mixtures. Structures of the Atom .Cemical bonding and structures of the molecules. Acids,bases and salts.Osmosis and osmotic pressure.Solutions of Electrolyts. Buffer, hydrolisis and ion-product constant.Solubility product.Oxidations and Reductions.Equilibria in Chemical reactions.Daniel's cell.Electrolysis. gasses.		
Recommended reading	1) I. Filipović, S. Lipanović: Opća i anorganska kemija, Školska knjiga, Zagreb, 1991. 2) M. Sikirica: Stehiometrija, Školska knjiga, Zagreb, 1991.		
Supplementary reading	1) F.A. Cotton,G. Wilkinson: Basic Inorganic Chemistry, A Wiley Interscience Publ. New York, 2000.		
Teaching methods	Lectures		
Assessment methods	There is both written and-or oral examination upon the completion of the lecture period: after 15 classes of lectures and after 5 classes of seminars.		
Language of instruction	Croatian		
Quality assurance			

Methods	

Course title	**General and Inorganic Chemistry 2**		
Course code	Z106		
Type of course	Lectures		
Level of course	Introductory		
Year of study	1st	**Semester**	2nd
ECTS (Number of credits allocated)	6 ECTS credits *Description:* • lectures and excercises: 4,00 ECTS • examination: 2,00 ECTS		
Name of lecturer	Ph.D. Milan Čačić, Assistant Professor		
Learning outcomes and competences	Student preparation for science courses as well as specific on general and inorganic Cemistry.		
Prerequisites			
Course contents	Corossion and protection from corossion.Ceramics of the matter. Glass. Metals. Woods. Synthetic and natural polymers. Polyurethanes. Polyetylenes. Polyesters. Vinylpolymers. Poly carbonates. Polyizoprens. Celulose. Starck.Cotton.Oil and gasses.		
Recommended reading	1) I. Filipović, S. Lipanović: Opća i anorganska kemija, Školska knjiga, Zagreb, 1991. 2) M. Sikirica: Stehiometrija, Školska knjiga, Zagreb, 1991.		
Supplementary reading	1) F.A. Cotton, G. Wilkinson: Basic Inorganic Chemistry, A Wiley Interscience Publ. New York, 2000.		
Teaching methods	Lectures		
Assessment methods	There is both written and-or oral examination upon the completion of the lecture period: after 15 classes of lectures and after 5 classes of seminars.		
Language of instruction	Croatian		
Quality assurance Methods			

Course title	**Data Communications and Computer nets**		
Course code	I103		
Type of course	30+0+0+30		
Level of course	Elementary		
Year of study	1st	**Semester**	1st
ECTS (Number of	5		

credits allocated)	
Name of lecturer	Ph.D. Mario Essert, Full Professor
Learning outcomes and competences	The main goals of this course of lectures are the following: to develop general and specific knowledge dealing with computer nets and communication protocols in modern information society. The student is becoming familiar with general trends, but also with standards and norms in modern communication. It can be achived through Internet services, which help student to use pragmatically chiptography in electronic change of dana.
Prerequisites	None
Course contents	Basic definitions and classifications, computer networks: ISO/OSI network model, layers, TCP/IP network model, encapsulation, application layer, transport layer (TCP, UDP, ICMP), IP layer, calcification of IP addressees, network layer, LAN, MAN, WAN, network topology, Internet services, cryptography, encryption, decryption, SSL, PGP, SSH, tunneling.
Recommended reading	1) A. S. Tanenbaum: Computer Networks, 3/e, Prentice-Hall, 1996. 2) U. Black: Advanced Internet Technologies, Prentice Hall, 1999. 3) B. O. Szuprowicz: Multimedia Networking, McGraw-Hill, 1995. 4) 4. Bruce Schneier, Applied Cryptography, Wiley, 1994
Supplementary reading	1) Whitfield Diffie and Martin E. Hellman, "New Directions in Cryptography," IEEE Transactions on Information Theory, v. IT-22, No. 6, Nov 1976, pp. 644-654 2) William M. Raike, "The RPK Public-Key Crptographic System-Tehnical Summary",1993-1996. 3) William M. Raike, "Detailed Supplemental Tehnical Description of the RPK Public-Key Cryptographic System",1993-1996.
Teaching methods	Lectures and laboratory exercises
Assessment methods	Written and oral exam, preliminary exams
Language of instruction	Croatian/ English
Quality assurance method	Evaluation done by students, lectures and experts, number of students, who passed the exams, international supervision

Course title	**Geometry of Plane and Space**		
Course code	M105		
Type of course	Lectures and auditory exercises		
Level of course	Elementary mathematical course of lectures		
Year of study	1st	Semester	1st
ECTS (Number of credits allocated)	5 ECTS Attending lectures and exercises, independent learning, homeworks, preliminary exams and final exams.		
Name of lecturer	Ph.D. Rudolf Scitovski, Full Professor		
Learning	The main goal of this course of lectures, at this introductory level, is to make		

outcomes and competences	students familiar with elementary linear algebra.
Prerequisites	None
Course contents	1) Vectors in plane and space. 2) Square matricies of second and third order. 3) Linear operators in a plane 4) Linear operators in space X(E). 5) Isometry group
Recommended reading	1) S. Kurepa, Uvod u linearnu algebru, Vektori – matrice – grupe, Školska knjiga, Zagreb, 1978.
Supplementary reading	1) D.M. Bloom, Linear algebra and geometry, Cambridge Univ. Press, Cambridge, 1988. 2) K.W. Gruenberg, A.J. Weir, Linear geometry, Springer Verlag, Berlin, 1977.
Teaching methods	Lectures and exercises are obligatory for all students.
Assessment methods	Lectures and exercises are obligatory for students. The exam consists of oral and written parts of exam. The students can go in for an exam after attending all lectures and after doing all exercises. During one semester there is a possibility for the students to go in for 2 or more preliminary exams; these exams can replace the written part of the exam.
Language of instruction	Croatian
Quality assurance method	An anonymous questionnaire

Course title	**English 1-4**		
Course code	Z101-Z104		
Type of course	Seminars		
Level of course	Advanced course of lectures		
Year of study	1st and 2nd	Semester	1st to 4th
ECTS (Number of credits allocated)	2 ECTS 60 hours = 22.5 hours (lectures) + 22.5 hours (preparation of seminars) + 15hours (preparation for exams)		
Name of lecturer	Lidija Kraljević, prof., Gordana Todorović, prof.		
Learning outcomes and competences	Acquiring basic terminology dealing with physics, technology and informatics. Using grammatical structures which characterize the language of profession correctly. Enabling students for reading specialized books and for having conversation about general subjects connected with the profession.		
Prerequisites	English taught in the secondary school		
Course contents	Introduction to computer science terminology. Computer applications: What can computers do? What is a computer? What's inside a microcomputer? About the keyboard. Point and click. Types of printers. Optical disks: pros and cons.		

	Grammar: Parts of speech. Word order. Tenses. Modals. Participles. Relative clauses. Passive voice. Conditional clauses. Irregular plural. Word building – prefixes, suffixes. Comparison of adjectives. Acronyms. Connectors and modifiers. Antonyms and synonyms.
Recommended reading	1) I.Ferčec, A Course in Scientific English: Mathematics, Physics, Computer Science, Odjel za matematiku/Elektrotehnički fakultet, Osijek, 2001. [2) R.Murphy, English Grammar in Use, CUP, Cambridge, 1995.
Supplementary methods	1) Hercezi-Skalicki, Marela: Reading Technical English for Academic Purposes, Školska knjiga, Zagreb, 1993. 2) Oxford Dictionary of Computing (ur. V. Illingworth), OUP, Oxford, 1996. 3) Allen, J. P. B i Widdowson, H. G.: English in Physical Science, Oxford University Press, 1978.
Teaching methods	Teaching is going to be through papers which are obligatory for all students. During educational process audio-visual aids (tape recorder, computer programmes which use LCD projector) and many specialized magazines and books will be available in the library of the Department of Physics. From time to time students will be given homework which is going to affect their final grade. Moreover, students have to write a paper and present it orally in front of their colleagues.
Assessment methods	At the end of the semestre there is an exam consisting of griten and oral part.
Language of instruction	English
Quality assurance methods	An anonymous questionnaire

Course title	**Mathematics 2 (integral calculus)**		
Course code	M102		
Type of course	Lectures and auditory exercises		
Level of course	Elementary mathematical course of lectures		
Year of study	1st	Semester	2nd
ECTS (Number of credits allocated)	7 ECTS Attending lectures and exercises (60 hours + 60 hours = 120 hours), independent learning, homeworks, preliminary exams and final exams.		
Name of lecturer	Ph.D. Antoaneta Klobučar, Assistant Professor		
Learning outcomes and competences	At the introductory level the students will become familiar with main ideas and methods of mathematical analysis, which are the basis for many other courses of lectures. The main terms will be explained in an informal way, their usefulness and usage will be presented. At the exercises the students should become familiar with certain tehcnics and be capable to solve concrete problems.		
Prerequisites	Differential calculus		
Course contents	1) Riemanns integral. Area problem. Definition and properties of Riemanns integral. Integrability of monotonous and continous functions. Average value theorem for integral of continous function. Newton-Leibniz formula. Primitive function. Methods of integration. Basic technics of integration.		

	Applications of integral calculus: Area of pseudotrapeze, volumes of axialy symmetric bodies, length of a curves, work, momentum of inertia, center of mass. Nummerical integration (trapeze and Simpsons formula). 2) Summation of series of real numbers. Concept of summation and convergence. Convergence criteria. 3) Function series. Uniform convergence. Power series. Taylor series of elementary functions. Exponential and logaritmic functions in a form of series.
Recommended reading	1) W.Rudin, Principles of Mathematical Analysis, Mc Graw-Hill, Book Company, 1964. 2) D. Jukić, R. Scitovski, Matematika I, Odjel za matematiku, Osijek, 2000.
Supplementary reading	1) S. Kurepa, Matematička analiza 1 (diferenciranje i integriranje), Tehnička knjiga, Zagreb, 1989. 2) S. Kurepa, Matematička analiza 2 (funkcije jedne varijable), Tehnička knjiga, Zagreb, 1990. 3) B.P. Demidovič, Zadaci i riješeni primjeri iz više matematike s primjenom na tehničke nauke, Tehnička knjiga, Zagreb, 1986
Teaching methods	Lectures and exercises are obligatory.
Assessment methods	The exam consists of oral and written parts of exam. The students can go in for an exam after attending all lectures and after doing all exercises. During one semester there is a possibility for the students to go in for 2 preliminary exams; these exams can replace the written part of the exam.
Language of instruction	Croatian
Quality assurance methods	An anonymous questionnaire

Course title	**Linear algebra 1**		
Course code	M103		
Type of course	Lectures and auditory exercises		
Level of course	Elementary mathematical course of lectures		
Year of study	1st	**Semester**	2nd
ECTS (Number of credits allocated)	6 ECTS Attending lectures and exercises, independent learning, homeworks, preliminary exams and final exams		
Name of lecturer	Ph.D. Davor Butković, Full Professor		
Learning outcomes and competences	Students are becoming familiar with basic concepts and problems of linear algebra		
Prerequisites	Knowledge from secondary school		
Course contents	Matrices. Systems of linear equations. Concept of matrices and operation with them – M(K) space. Diagonal, identity, transpose hermite-conugate matrices. Trace and determinante of matrices. Produce of matrices. Regular matrices. Inverse matrices.		

	Vector spaces. Definition. Examples. Subspaces. Linear combinations. Summs of subspaces. Linear dependence and independence. Basis vectors. Vector spaces of finite dimensionality. Linear dependence. Definition of finite dimensionality. Basis. Dimension. Direct summ and complement. Isomorfism. Linear operators. Definition. Theorem about rank and deffect. Opperations with operators. Correspondence matrices – operators. Characterisation of an isomorfism with a matrix regularity. Connection between matrices of same operator for different basis. Polynoms of lin. operator. Minimal polynoms. Eigenvalues and eigenvectors (spectra of operators).
Recommended reading	1) S. Kurepa, Konačno dimenzionalni vektorski prostori i primjene, Liber, Zagreb, 1992. 2) S. Kurepa, Uvod u linearnu algebru, Vektori – matrice – grupe, Školska knjiga, Zagreb, 1978.
Supplementary reading	1) D.M. Bloom, Linear algebra and geometry, Cambridge Univ. Press, Cambridge, 1988. 2) K.W. Gruenberg, A.J. Weir, Linear geometry, Springer Verlag, Berlin, 1977. 3) K. Horvatić, Linearna algebra I, II, III, PMF–Matematički odjel, Zagreb
Teaching methods	Lectures and exercises are obligatory for all students
Assessment methods	The exam consists of oral and written parts of exam. The students can go in for an exam after attending all lectures and after doing all exercises. During one semester there is a possibility for the students to go in for 2 or more preliminary exams; these exams can replace the written part of the exam.
Language of instruction	Croatian
Quality assurance methods	An anonymous questionnaire

Course title	**Algorithms and data structures**		
Course code	I104		
Type of course	30+0+0+30		
Level of course	Elementary		
Year of study	1st	**Semester**	2nd
ECTS (Number of credits allocated)	6		
Name of lecturer	Ph.D. Darko Fischer, Full Professor		
Learning outcomes and competences	Students should become familiar with the usage and implementation of simple and complex data structures. The influence of the data structure on the algoritam performace and speed will be shown.		
Prerequisites	None		
Course contents	Data types and structures. Operations over data. Errors and types of errors. Interpolation. Solving; a linear system of equations, a nonlinear system of		

	equations. Approximations. Gauss-Newton method. Linear programming. Nonlinear programming.
Recommended reading	1) D.Barković, Operacijska istraživanja, Ekonomski fakultet, Osijek, 2001. 2) 2. A.Björck, Numerical Methods for Least Squares Problems, SIAM, Philadelphia, 1996.
Supplementary reading	1) Scitovski, R.: Numerička matematika, Elektrotehnički fakultet, Osijek, 2000. 2) Scitovski, R.: Problemi najmanjih kvadrata. Financijska matematika, Ekonomski fakultet, Elektrotehnički fakultet, Osijek, 1993. 3) Wolfram, S.: The Mathematica Book, Wolfram Media, Champaign, 1999..
Teaching methods	Lectures and exercises
Assessment methods	Written and oral exam and the course of lectures (passed)
Language of instruction	Croatian / English
Quality assurance methods	The quality of teaching methods could be checked by exams, personal practical work in accordance with given tasks and by the ability of students to use their knowledge and skills learnt at this course at some other courses

Course title	**Mathematics 3 (functions of several variables)**		
Course code	M104		
Type of course	Lectures and auditory exercises		
Level of course	Elementary mathematical course of lectures		
Year of study	2nd	**Semester**	3rd
ECTS (Number of credits allocated)	6 ECTS Attending lectures and exercises, independent learning, homeworks, preliminary exams and final exams		
Name of lecturer	Ph.D. Ninoslav Truhar, Full Professor		
Learning outcomes and competences	Students should become familiar with basic concepts and problems of linear algebra		
Prerequisites	Knowledge from secondary school		
Course contents	Derivation of vector function of one variable. Rectification of curves. Functions of more variables. Partial derivation. Differentiability and gradient. Partial derivation of higher oreder. Tangent plane. Derivation in direction. Functions which depends only of radial distance. Extrems. Critical points. Boundary points. Lagranges multiplicators. Talors formula. Quadratic forms. Potential of vector field. Locality of potentials. Line integrals. Dependence of the trajectory of integration. Double integrals. Change of variables in multiple integrals. Polar coordinates.		

	Greens theorem. Divergence and rotation of vector field. Triple and volume integrals. Cylindric and spherical coordinates. Surface. Vector areas of surfaces. Surface integrals. Divergence and rotation of vector field. Gauss theorem about divergence. Stokes theorem. Jacobi's matrix and determinant. Differentiability. Theorems about inverse and implicite function. Change of variables in multiple integrals
Recommended reading	1) S. Kurepa, Konačno dimenzionalni vektorski prostori i primjene, Liber, Zagreb, 1992. 2) S. Kurepa, Uvod u linearnu algebru, Vektori – matrice – grupe, Školska knjiga, Zagreb, 1978.
Supplementary reading	1) D.M. Bloom, Linear algebra and geometry, Cambridge Univ. Press, Cambridge, 1988. 2) K.W. Gruenberg, A.J. Weir, Linear geometry, Springer Verlag, Berlin, 1977. 3) K. Horvatić, Linearna algebra I, II, III, PMF–Matematički odjel, Zagreb
Teaching methods	Lectures and exercises are obligatory for all students.
Assessment methods	The exam consists of oral and written parts of exam. The students can go in for an exam after attending all lectures and after doing all exercises. During one semester there is a possibility for the students to go in for 2 or more preliminary exams; these exams can replace the written part of the exam.
Language of instruction	Croatian
Quality assurance methods	An anonymous questionnaire

Course title	**Classical Mechanics 1**		
Course code	F105		
Type of course	undergraduate (obligated)		
Level of course	Intermediate		
Year of study	2nd	**Semester**	4st
ECTS (Number of credits allocated)	4 ECTS credits *Description:* • lectures and excercises: 2,00 ECTS • examination: 2,00 ECTS		
Name of lecturer	Ph.D. Zvonko Glumac, Assistant Professor		
Learning outcomes and competences	The students must acquire a knowledge about the concepts and mathematically formulated laws of mechanics, which enables them to understand mechanical phenomena in nature as well as to solve simple problems.		
Prerequisites	general physics, calculus, linear algebra		
Course contents	Vector algebra; derivatives and integrals of vectors; velocity; acceleration; circular motion; gradient; divergence; curl; Newton's laws; inertial frames of references;		

	work; power; kinetic energy; conservative force fields; potential energy; conservation of energy; impulse; torque and angular momentum; consrvation of momentum and angular momentum; stability of equilibrium; uniform force fields; the simple harmonic oscilator; the damped harmonic oscilator; forced vibrations; the simple pendulum; central forces; equations of motion for a particle in a central field; potential energy of a particle in a central field; conic sections; Kepler's laws; Newton's law of gravitation; rotating coordinate systems; derivative operators; Coriolis and centripetal force; the Foucault pendulum.
Recommended reading	1) Theory and Problems in Theoretical Mechanics - M. Spiegel 2) Teorijska mehanika - Z. Jankovic
Supplementary reading	1) Classical Mechanics - H. Goldstein; 2) Mehanika - L. D. Landau, E. M. Lifsic; 3) Teorijska fizika i struktura materije - I. Supek; 4) Mathematical Methods of Classical Mechanics - V. I. Arnold; 5) Uvod u analiticku mehaniku - I. Aganovic, K. Veselic; 6) Teorijska mehanika - S. M. Targ; 7) A Guided Tour of Mathematical Physics - R. Snieder, http://samizdat.mines.edu/snieder/
Teaching methods	Lectures (30 hours) and excercises (15 hours)
Assessment methods	Written (2 hours) and oral examination
Language of instruction	Croatian or English
Quality assurance Methods	permanent contact with students

Course title	**Multimedia systems**		
Course code	I105		
Type of course	30+15+0+15		
Level of course	Elementary		
Year of study	3nd	**Semester**	6rd
ECTS (Number of credits allocated)	5		
Name of lecturer	Ph.D. Goran Martinović, Assistant Professor		
Learning outcomes and competences	Students should become familiar with basic terms dealing with multimedia and components of multimedia systems. They will learn how to use computers and external devices, when creating multimedia contents. They will be taught elementary programming of multimedia contents in visual surrounding and web		
Prerequisites	None		
Course contents	Multimedia elements (text, graphic, audio, video, animation). Elements of multimedia systems. Hypermedia and Web. Multimedia authoring tools. VRML. Video and audio compression. Visualization. Copyright. Trademark. Patents.		

	Privacy.
Recommended reading	1) N. Chapman, J. Chapman. Digital Multimedia, John Wiley & Sons, New York, 2004. 2) C.Rey, B.Schneier. Macromedia Flash MX: Training from the Source, Peachpit Press, San Francisco, 2002.
Supplementary reading	1) Z-N Li, M.S. Drew. Fundamentals of Multimedia 2) R. Simon, M. Schmidt. Teach Yourself Visual C++.NET in 24 Hours, Sams, Indianapolis, 2002. 3) R.W. Sebesta, Programming the World Wide Web (2nd Ed.), Addison Wesley, Boston, 2003.
Teaching methods	Lectures, seminars and laboratory exercises
Assessment methods	Written and oral exam and course of lectures (passed)
Language of instruction	Croatian/ English
Quality assurance methods	Evaluation done by students, lectures and experts; number of students, who passed the exams; international supervision

Course title	**Elementary programming I**		
Course code	I106		
Type of course	15+0+0+30		
Level of course	Elementary		
Year of study	2nd	**Semester**	3 rd
ECTS	4		
Name of lecturer	Ph.D. Darko Fischer, Full Professor		
Learning outcomes and competences	Students should get elementary knowledge dealing with the development of program support and above all application of program support. The main goal can be achived by learning and teaching: basic terms on programming, on development of program support, on algoritam structures; the usage in one structural program language ; programming methods		
Prerequisites	None		
Course contents	Introduction to Programming. Programming languages. Interpreters. Compilers. Algorithms and Data Structures. Pseudo code. Data flow. Errors. Software developing. Documentation.		
Recommended reading	1) S. Stankov: *Programiranje I.*, Fakultet prirodoslovno-matematičkih znanosti i odgojnih područja Sveučilišta u Splitu, listopad, 2003.		
Supplementary reading	1) R. Simon, M. Schmidt. Teach Yourself Visual C++.NET in 24 Hours, Sams, Indianapolis, 2002.		
Teaching methods	Lectures and laboratory exercises		
Assessment methods	Written and oral course of lectures (passed)		
Language of	Croatian/ English		

instruction	
Quality assurance methods	The quality of teaching methods could be checked by exams, personal practical work in accordance with given tasks and by the ability of students to use their knowledge and skills learnt at this course at some other courses

Course title	**Differential equations**		
Course code	M105		
Type of course	Lectures and seminars		
Level of course	Elementary course of lectures		
Year of study	2nd	Semester	4th
ECTS (Number of credits allocated)	6 ECTS • lectures 3 ECTS • preparation for the exam and the exam 3 ECTS		
Name of lecturer	Ph.D. Domagoj Matijević, Assistant Professor		
Learning outcomes and competences	Students should become familiar with the term of simple differential equations. Elementary types and methods will be presented. Only the motivation shoud be stated.		
Prerequisites	Mathematics 1 i 2		
Course contents	Introduction Ordinary differential equations of first order Ordinary differential equations of second order Ordinary differential equations of higher order Systems of ordinary differential equations Series solutions of ordinary differential equations		
Recommended reading	1) M. Alić, Obične diferencijalne jednadžbe, PMF - Matematički odjel, Zagreb, 2001. 2) I. Ivanšić, Fourierovi redovi. Diferencijalne jednadžbe, Odjel za matematiku, Osijek, 2000.		
Supplementary reading	1) L.E. Eljsgoljc, Differencialjnie uravnenija, Gosudarstvenoe izdateljstvo tehniko-teoretičeskoj literaturi, Moskva, 1957. 2) G.F. Simmons, J.S.Robertson, Differential Equations with Applications and Historical Notes, 2^{nd Ed., McGraw-Hill, Inc., New York, 1991. 3) Schaum's outline series, McGRAW-HILL, New York, 1991. 4) S. Kurepa, Matematička analiza 2 (funkcije jedne varijable), Tehnička knjiga, Zagreb, 1990.		
Teaching methods	The exercises are partly auditory and partly laboratory, with the usage of computers and LCD projectors and with the help of programming system mathematica and Matlab		
Assessment methods	The exam consists of oral and written parts of exam. The students can go in for an exam after attending all lectures and after doing all exercises. During one semester there is a possibility for the students to go in for 2 to 4preliminary exams, that cover the complete topic; the students might go in for preliminary exam; the quality of the preliminary exam ha san influence on the final mark		

Language of instruction	Croatian
Quality assurance methods	An anonymous questionnaire

Course title	**Classical Mechanics 2**		
Course code	F106		
Type of course	undergraduate (obligated)		
Level of course	Intermediate		
Year of study	3rd	**Semester**	5th
ECTS (Number of credits allocated)	5 ECTS credits *Description:* • lectures and excercises: 2,00 ECTS • examination: 2,00 ECTS		
Name of lecturer	Ph.D. Zvonko Glumac, Assistant Professor		
Learning outcomes and competences	The students must acquire a knowledge about the concepts and mathematically formulated laws of mechanics, which enables them to understand mechanical phenomena in nature as well as to solve simple problems.		
Prerequisites	Classical Mechanics 1		
Course contents	Discrete and continuous systems of particles; mass density; degrees of freedom; center of mass; motion of the center of mass; momentum and angular momentum of system of particles; total external torque; conservation laws; kinetic energy, work and potential energy of a system of particles; virtual displacements; Lagrange's and D'Alembert's principles; rockets; the vibrating string; boundary-value problems; Fourier series; translations and rotations of rigid body; instantaneous axis of rotation; the compound pendulum; general motion of rigid body; moment of inertia; kinetic energy and angular momentum about the principal axes; Euler's equations of motion; rotation of Earth; the Euler angles; motion of a spinning top; generalized coordinates; conservative, scleronomic and holonomic systems; Lagrange's equations; Hemilton's equations; Liouville's theorem; the calculus of variations.		
Recommended reading	1) Theory and Problems in Theoretical Mechanics - M. Spiegel 2) Teorijska mehanika - Z. Jankovic		
Supplementary reading	1) Classical Mechanics - H. Goldstein; 2) Mehanika - L. D. Landau, E. M. Lifsic; 3) Teorijska fizika i struktura materije - I. Supek; 4) Mathematical Methods of Classical Mechanics - V. I. Arnold; 5) Uvod u analiticku mehaniku - I. Aganovic, K. Veselic; 6) Teorijska mehanika - S. M. Targ; 7) A Guided Tour of Mathematical Physics - R. Snieder,		

	http://samizdat.mines.edu/snieder/
Teaching methods	lectures (30 hours) and excercises (15 hours)
Assessment methods	written (2 hours) and oral examination
Language of instruction	Croatian or English
Quality assurance Methods	permanent contact with students

Course title	**Elementary programming II**		
Course code	I107		
Type of course	15+15+0+30		
Level of course	Elementary		
Year of study	2nd	**Semester**	4th
ECTS (Number of credits allocated)	4		
Name of lecturer	Ph.D. Darko Fischer, Full Professor		
Learning outcomes and competences	The main goal is to teach students programming in modern development surrounding and working in a programming teams. Furthermore, students should become familiar with the evaluation and with the methods used for testing program support. These goals could be achived by becoming familiar with basic methods and programming paradigmas at the lectures and exercises – students will be able to create program support in a group or individually		
Prerequisites	None		
Course contents	Classification and overview of programming languages. Developing methodology. Structural programming. Modular programming, Object oriented programming. GUI programming. Web programming. Network services programming. Building and Testing Application.		
Recommended reading	1) Robert W. Sebesta: Concepts of Programming Languages, Addison Wesley, 6 edition, 2003. 2) Paul Kimmel: Advanced C# Programming (McGraw-Hill/Osborne), ISBN: 953-7063-07-0 3) Luke Welling, Laura Thomson: razvoj aplikacija za Web, ISBN 86-7555-237-8 4) Blake Schwendiman: PHP4 Vodič za programere, ISBN: 86-7555-173-8 5) Greg Buczek: ASP Developer's Guide (The McGraw-Hill Companies, Inc., 2000), ISBN: 86-7555-171-1		
Supplementary reading	1) Hugh E. Williams, David Lane: Web Database Applications with PHP & MySQL (O'Reilly), ISBN 86-7555-225-4 2) Eric A. Smith: Active Server Pages 3 Weekend Crash Course, ISBN: 86-7555-176-2 3) Charles Wright: C# Tips & Techniques (McGraw-Hill/Osborne, 2002)		
Teaching methods	Lectures, seminars and laboratory exercises		

Assessment methods	Written and oral exams and course of lectures (passed)
Language of instruction	Croatian/ English
Quality assurance methods	Evaluation done by students, lectures and experts; number of students, who passed the exams; international supervision

Course title	**Introduction to stastical physics**		
Course code	F109		
Type of course	undergraduate (obligated)		
Level of course	Intermediate		
Year of study	3rd	**Semester**	5th
ECTS (Number of credits allocated)	5 ECTS • Teaching (lectures 30 hours, exercises 15 hours) ≈ 2 ECTS • Student studying, about 90 hours ≈ 3 ECTS		
Name of lecturer	Ph.D. Ramir Ristić, Assistant Professor		
Learning outcomes and competences	Microscopic explanation about fenomenological behaviour of many particle systems.		
Prerequisites	General Physics		
Course contents	Intermolecular scatering. Equation of state.Laws of thermodynamics. Thermodynamic potentials. Systems with changeable number of the particles. Maxwell-Boltzmann distribution. Phase space. Understanding of the second law of thermodynamics. Equipartition theorem. Barometric equation. Thermal properties of the ideal gas. Explanation of the third law of thermodynamics. Negative temperature. Black body radiation. Elastic vibrations in crystalline solids. Bose-Einstein and Fermi-Dirac functions of distribution. Limes of the classical statistical physics. Strongly degenerated fermi systems. Bose-Einstein condensation.		
Recommended reading	1) Šips, V. Uvod u statističku fiziku, Školska knjiga, Zagreb, 1990. 2) Lenac, Z., Šips, V. Zadaci iz statističke fizike I, Liber, Zagreb, 1980. 3) Lenac, Z., Šips, V. Zadaci iz statističke fizike II, Liber, Zagreb, 1981.		
Supplementary reading	1) Supek, Teorijska fizika i struktura materije, Školska knjiga, Zagreb, 1974 2) Mandl, F. Statistical Physics, John Wiley & Sons, 1988.		
Teaching methods	lectures (30 hours) and excercises (15 hours)		
Assessment methods	written (2 hours) and oral examination		
Language of instruction	Croatian or English		
Quality assurance methods	permanent contact with students		

Course title	**General Physics Laboratory A**		
Course code	F111		
Type of course	Laboratory exercises		
Level of course	Basic		
Year of study	2nd	**Semester**	3rd
ECTS (Number of credits allocated)	5 ECTS credits *Description:* - making experiments: 60 h ~ 2 credit - learning theoretical background for experiments: around 20 h ~ 1 of the credit - data analysis and writing the experiment reports: around 30 h ~ 1 credit - exam preparation and exam: around 7 hours ~ 1 of the credit		
Name of lecturer	Ph.D. Branko Vuković, Assistant Professor		
Learning outcomes and competences	Skill of the independent running up experiments from the field of geometrical and physical optics, thermodynamics, fluid mechanics and modern physics, data analysis and understanding of their physical background, as well as writing the experiment reports.		
Prerequisites	Competences acquired from the course “General Physics I - II”.		
Course contents	Errors of measurements and graphical analysis of data. Density of liquids, Mohr density balance, picnometer. Helical spring, verification of Hooke's law. Caliper gauges, micrometer and spherometer. Static and dynamical determination of the torsion modules of bars. Reversible pendulum. Surface tension of liquids. Determination of unknown resistances with Wheatstone Bridge. Current-voltage characteristic of lamps. Measurements with oscilloscope. Determination of the specific charge of the electron (e/m).Triode and transistor. Calibration of the galvanometer. Measurements of the temperature with thermocouples.		
Recommended reading	1) M. Požek, A. Dulčić; Fizički praktikum I i II, Sunnypress, Zagreb, 1999. 2) Paić, M. Fizička mjerenja I, II i III, Liber, Zagreb, 1988.		
Supplementary reading	1) B. Marković, D. Miler, A. Rubčić, Račun pogrešaka i statistika, Liber, Zagreb, 1987		
Teaching methods	Students within 4 hours perform experiments.		
Assessment methods	While performing the experiment, student will be examined on it. On each experiment done, student is obliged to write an experiment report which will be graded. The exam is consisted of performing one of experiments. The final mark is formed on the basis of the knowledge shown on the exam, during the semester and the average experimental reports mark.		
Language of instruction	Croatian, English (Optional)		
Quality assurance methods	During the semester the progression in performing experiments, data analysis and their physical understanding, as well as the quality of experiment reports will be recorded. Student questionnaires about the didactical and suitability level of experiments, and the quality of the script, teacher and assistant as well.		

Course title	**Science of Strength**		
Course code	T106		
Type of course	Theoretical with exercises		
Level of course	Intermediate level (for graduate study)		
Year of study	3rd	Semester	5th
ECTS (Number of credits allocated)	3 ECTS Teaching ≈ 1 ECTS Student studying ≈ 1 ECTS		
Name of lecturer	Ph.D. Tomislav Mrčela, Full Professor		
Learning outcomes and competences	During the course students acquire general knowledge's theory of solids element strength, until the special knowledge notions base for dimensioning technical produce.		
Prerequisites			
Course contents	Strain and deformations: Basic theory of interior forces and deformations, relations between Strain and deformations, Hooks act, Strain force, Strain in the leaning cutest(normal and tangential strain), Morhs circuits. Two axle and tree axle strain, security coefficient, Strain working range, Product Geometrical characteristic of diagonally cutest: surfaces moment of inertia and resistance, Normal strain: tension and pressure strain, bending, wrapping (Euler's force, Tetmajer's method and "W" procedures) Tangential strain: cut, twisting. Complex strain: tension and bending, bending and wrapping (hypotheses of maximum normal strain, hypotheses of maximum tangential strain and hypotheses of maximum deformation);		
Recommended reading	1) Alfirević, I. Nauka o čvrstoći, Tehnička knjiga, Zagreb 2) Bazijanac, D. Nauka o čvrstoći Tehnička knjiga Zagreb		
Supplementary reading	1) Tehnička enciklopedija 2) Kraut, B. Strojarski priručnik, Tehnička knjiga, Zagreb 3) Kruz. Tehnička mehanika, Školska knjiga, Zagreb 4) Kruz. Nauka o čvrstoći, Školska knjiga, Zagreb		
Teaching methods	lectures, labor, seminar		
Assessment methods	Course is successfully resolved trough two preliminary exams during presentations or in the end of presentation by written and oral exam.		
Language of instruction	Croatian		
Quality assurance methods	At the beginning and at the end of the teaching process: questionnaires about learning outcomes and competences, and about the course.		

Course title	**Mathematical Methods of Physics**
Course code	F110

Type of course	undergraduate (obligated)		
Level of course	Intermediate		
Year of study	3st	**Semester**	5th
ECTS (Number of credits allocated)	7 ECTS credits *Description:* • lectures and excercises: 4,00 ECTS • examination: 3,00 ECTS		
Name of lecturer	Ph.D. Zvonko Glumac, Assistant Professor		
Learning outcomes and competences	The laws of physics are often expressed through the relatively complex mathematical apparatus. This course is intended to give mathematical tools necessary for better understanding of the later courses in physics such as classical electrodynamics, quantum mechanics, solid state physics and statistical physics.		
Prerequisites	general physics, calculus, linear algebra		
Course contents	Review of complex variables; multi-valued functions; Riemann surfaces; calculus of functions of complex variables: Cauchy-Riemann conditions; properties of analytic functions; analytic continuation; residue theorem; contour integration; second order linear differential equations; Fourier series and transforms; Laplace transforms; partial differential equations; The Sturm-Liouville form: complete sets of eigenfunctions, eigenvalues; The special functions; Green functions for solving inhomogeneous differential equations; theory of distributions; dispersion relations and Kramers-Kronig elations; variational method.		
Recommended reading	1) Mathematical Physics - Eugene Butkov		
Supplementary reading	1) Mathematical Methods for Physicists, G. B. Arfken and H. J. Weber; 2) Methods of Theoretical Physics- P. M. Morse and H. Feshbach 3) A Guided Tour of Mathematical Physics - R. Snieder, http://samizdat.mines.edu/snieder/		
Teaching methods	lectures (30 hours) and excercises (15 hours)		
Assessment methods	written (2 hours) and oral examination		
Language of instruction	Croatian or English		
Quality assurance methods	permanent contact with students		

Course title	**Database and process analysis**
Course code	I108
Type of course	30+0+0+30
Level of course	Elementary

Year of study	3rd	**Semester**	5th
ECTS(Number of credits allocated)	5		
Name of lecturer	Ph.D. Branimir Dukić, Full Professor		
Learning outcomes and competences	The main goals of the course of lectures are the following: to develop specific knowledge dealing with the systematic analysis of business structure, events and processes with the function to create dana basis. Students should become familiar with the methods of conceptual, logical and physical modelling. Students should also be able to use pragmatically the system of dana base management		
Prerequisites	None		
Course contents	Data models and modeling. Process models and modeling. Business processes. Relation data model. SQL. Physical implementation of data modeling. Database security and integrity. Database usage. Multimedia databases. Mobile databases. Data storage.		
Recommended reading	1) Tkalac, S.: Relacijski model podataka, DRIP, Zagreb 1993. 2) Varga M.: Baze podataka – konceptualno, logičko i fizičko modeliranje podataka, DRIP, Zagreb 1994		
Supplementary reading	1) Mesarić, J., Zekić-Sušac, M., Dukić, B.: PC u uredskom poslovanju, EFO, Osijek 2001. 2) Strahonja, V., Varga, M., Pavlić, M.: Projektiranje informacijskih sustava, Zavod za informatičku djelatnost Hrvatske i INA-INFO, Zagreb 1992. 3) C. J. Shepherd, Database Management: Theory and Application, Boston: IRWIN, 1990. 4) http://www.mysql.com		
Teaching methods	Lectures and laboratory exercises		
Assessment methods	Written and oral exam and course of lectures (passed)		
Language of instruction	Croatian / English		
Quality assurance methods	The quality of teaching methods could be checked by exams, personal practical work in accordance with given tasks and by the ability of students to use their knowledge and skills learnt at this course at some other courses		

Course title	**Usage of computers in lectures**		
Course code	I109		
Type of course	30+0+0+30		
Level of course	Elementary		
Year of study	3rd	**Semester**	5th
ECTS (Number of credits allocated)	5		
Name of lecturer	Ph.D. Vanja Radolić, Assistant Professor		
Learning outcomes and	The main goal is to teach students the systems of e-learning and their usage in education. The main goal can be achived by learning and teaching: definitions,		

competences	functional models, configuration of systems of e-learning, pedagogical paradigmas of the system of e-learning, examples of systems of e-learning, learning through games
Prerequisites	None
Course contents	Introduction to e-learning systems. Model of e-learning systems. Architecture and configuration of e-learning systems. E-learning system methodology and pedagogy.
Recommended reading	1) S. Stankov: Suvremena informacijska tehnologija u nastavi, Fakultet prirodoslovno matematičkih znanosti i odgojnih područja Sveučilišta u Splitu, (Materijal priređen za: Poslijediplomski znanstveni studij iz Didaktike prirodnih znanosti usmjerenja: kemija, biologija, fizika), Split, siječanj, 2005. 2) B.S. Bloom „The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring“, Educational Researcher, 13, 1984, pp. 4-16.
Supplementary reading	1) Edupoint http://www.carnet.hr
Teaching methods	Lectures and laboratory exercises
Assessment methods	Written and oral exam and course of lectures (passed)
Language of instruction	Croatian/ English
Quality assurance methodssvakog predmeta i /ili modula	The quality of teaching methods could be checked by exams, personal practical work in accordance with given tasks and by the ability of students to use their knowledge and skills learnt at this course at some other courses

Course title	**General Physics Laboratory B**		
Course code	F114		
Type of course	Laboratory exercises		
Level of course	Basic		
Year of study	2nd	**Semester**	4th
ECTS (Number of credits allocated)	5 ECTS credits *Description:* • making experiments: 60 h ~ 2 credit • learning theoretical background for experiments: around 20 h ~ 1 of the credit • data analysis and writing the experiment reports: around 30 h ~ 1 credit • exam preparation and exam: around 7 hours ~ 1 of the credit		
Name of lecturer	Ph.D. Branko Vuković, Assistant Professor		
Learning outcomes and competences	Skill of the independent running up experiments from the field of geometrical and physical optics, thermodynamics, fluid mechanics and modern physics, data analysis and understanding of their physical background, as well as writing the		

	experiment reports.
Prerequisites	Competences acquired from the course “General Physics I - IV”.
Course contents	Determination of speed of sound with Kundt's Tube. Sound waves - properties. Laws of lenses and optical instruments. Linear and volume expansion in solids. Viscosity measurements with the falling ball viscometer. Electrolysys. Conductivity of the electrolyte solutions. Spectrophotometrics. Experiments in Physics with Electronics Workbench. Electron absorption in aluminium (beta decay). Solenoids in the AC circuit. Capacity in the AC circuit. Malus's law - linear polarized light. Polarimetry – the rotation of the plane of polarisation through a sugar solution. Heat of vaporization for water. Determination of ratio for specific heat at constant pressure and specific heat at constant volume. Determination of the specific heat for liquids. Earth's magnetic field.
Recommended reading	1) M. Požek, A. Dulčić; Fizički praktikum I i II, Sunnypress, Zagreb, 1999. 2) Paić, M. Fizička mjerenja I, II i III, Liber, Zagreb, 1988.
Supplementary reading	1) B. Marković, D. Miler, A. Rubčić, Račun pogrešaka i statistika, Liber, Zagreb, 198*7*
Teaching methods	Students within 4 hours perform experiments.
Assessment methods	While performing the experiment, student will be examined on it. On each experiment done, student is obliged to write an experiment report which will be graded. The exam is consisted of performing one of experiments. The final mark is formed on the basis of the knowledge shown on the exam, during the semester and the average experimental reports mark.
Language of instruction	Croatian. English (Optional)
Quality assurance methods	During the semester the progression in performing experiments, data analysis and their physical understanding, as well as the quality of experiment reports will be recorded. Student questionnaires about the didactical and suitability level of experiments, and the quality of the script, teacher and assistant as well.

Course title	**Fundamentals of the condensed mater physics**		
Course code	F115		
Type of course	undergraduate (obligated)		
Level of course	Intermediate		
Year of study	3rd	**Semester**	6th
ECTS (Number of credits allocated)	5 ECTS Teaching (lectures 30 hours, exercises 15 hours) ≈ 2 ECTS Student studying, about 90 hours ≈ 3 ECTS		
Name of lecturer	Ph.D. Ramir Ristić, Assistant Professor		
Learning outcomes and competences	With lectures, disscusion and excersises to introduce the students with some properties of metals, isolators and semiconductors.		
Prerequisites	General Physics		

Course contents	Crystal Structure. Defects in crystal structure. Cohesive energy. Chemical Bondings. Crystal dynamics. Infrared absorption. Neutron and X-ray diffraction. Thermal expansion. Free electron gas. Heat capacity of the free electron gas. Thermoelectronic emission. Electron in periodic potencial. Effective electron mass. Density of electron states. Conductors and isolators. Transport properties. Wiedemann-Franz law. Matthiessens rule. Resistivity of the ideal metal. Hall effect. Metal in oscilator field. Superconductivity. Extrinsic semiconductors. Mobility in semiconductors. Magnetic properties. Diamagnetism, paramagnetism and ferromagnetism.
Recommended reading	1) Šips, V. Uvod u fiziku čvrstog stanja, Školska knjiga, Zagreb, 1991. 2) Knapp, V., Colić, P. Uvod u električna i magnetska svojstva materijala, Školska knjiga, Zagreb, 1990.
Supplementary reading	1) Kittel, C. Introduction to Solid State Physics, J.Wiley, New York 1996. 2) J. R. Hook, Hall, H.E. Solid State Physics, J.Wiley, New York 1994. 3) I.Supek, Teorijska fizika i struktura materije, Školska knjiga, Zagreb, 1974
Teaching methods	lectures (30 hours) and excercises (15 hours)
Assessment methods	The exam is in writing and oral form.
Language of instruction	Croatian
Quality assurance methods	Student questionnaires

Course title	**Security of information systems**		
Course code	I110		
Type of course	30+0+0+30		
Level of course	Elementary		
Year of study	3rd	**Semester**	6th
ECTS (Number of credits allocated)	4		
Name of lecturer	Ph.D. Ninoslav Novak, Full Professor		
Learning outcomes and competences	Theoretical and practical knowledge needed for the management of the security of information systems – security of information systems policy, evaluation of the security system, tracking incidents together with the methodology of security		
Prerequisites	None		
Course contents	Types of communication-network treats; physical treat, while processing, while transferring data. Security policy. Privacy. ISO standards. System protection. System integrity. Security planning.		
Recommended reading	1) Anderson, J. R., Security Engenering: A Guide to Bilding Dependable Distributed Systems, John Wiley & Sons, Inc. New York, 2001. 2) Timpton, H., M. Krause, Information security Management, Auerbach, 1998. 3) Thorenson, J. D., J. H. Blankenship, Information Secrets, Valuable		

	Information, Ltd. Co., Richardson, Texas, 1996. 4) Fumy W., H. P. Riel, Kryptographie, R Oldenburg Verlag, München, Wien.
Supplementary reading	1) Jenkins, G. H., Information Systems Policies and Procedures Manual - 2nd ed., Prentice-Hall, Inc., 1994. 2) Krapac, D., Kompjutorski kriminalitet, Pravni fakultet Sveučilišta u Zagrebu, Zagreb, 1992. 3) ISO/BS 17799:2000
Teaching methods	Lectures and laboratory exercises
Assessment methods	Written and oral exam and course of lectures (passed)
Language of instruction	Croatian / English
Quality assurance methods	Evaluation done by students, lectures and experts; number of students, who passed the exams; international supervision

Course title	**Systems of teaching at a distance**		
Course code	I111		
Type of course	30+0+0+30		
Level of course	Elementary		
Year of study	3rd	**Semester**	6th
ECTS	4		
Name of lecturer	Ph.D. Branimir Dukić, Full Professor		
Learning outcomes and competences	The main goal is to present and to teach students the areas of learning and teaching at a distance. At the end of the course the student is able to evaluate the systems used for teaching at a distance in accordance with the requirements of chosen groups of potential users. The student can take the role of leading the system of teaching at a distance. He can also take an active part in a team that has a task to build such systems.		
Prerequisites	None		
Course contents	Basic definitions and classifications of e-learning systems. History overview. Web based e-learning systems. Developing e-learning system. Validating e-learning systems. E-learning methodology. Visualization.		
Recommended reading	1) W. Chan: "Artificial Agents in Distance Learning", International Journal of Educational Telecommunications, Vol. 1, No. 2-3, pp. 263-282, 1995. 2) Kassiml, K. Sabbir, S. Ranganath: "A Web-based intelligent approach to tutoring", Proceedings of Conference on Engineering Education ICEE 2001, Oslo, Norway, August 6-10, 2001. 3) J. Rickel, W. L. Johnson: "Intelligent Tutoring in Virtual Reality: A Preliminary Report", Proceedings of 8th World Conference on AI in Education, August, 1997. 4) M. Rosić: “Sustavi poučavanja na daljinu” – interni skript		
Supplementary	1) 1. Edupoint http://www.carnet.hr		

reading	
Teaching methods	Lectures and laboratory exercises
Assessment methods	Written and oral exam and course of lectures (passed)
Language of instruction	Croatian / English
Quality assurance methods	Evaluation done by students, lectures and experts; number of students, who passed the exams; international supervision

Course title	**Introduction to astronomy and astrophysics**		
Course code	F123		
Type of course	Theoretical and practical		
Level of course	Basic		
Year of study	3rd	**Semester**	6th
ECTS (Number of credits allocated)	4 ECTS Teaching ≈ 1 ECTS Preparation for seminars, ≈ 1 ECTS Student studying ≈ 2 ECTS		
Name of lecturer	Ph.D. Vladis Vujnović, Full Professor		
Learning outcomes and competences	Orientation on the celestial sphere. Knowledge about matter in cosmic dimensions. Ability to explain the structure and development of celestial bodies and universe as a whole.		
Prerequisites	Basic knowledge of physics.		
Course contents	History of astronomy. Earth motion and movements on the celestial sphere. Gravitation and celestial mechanics. Solar system. Telescopes. Stars, determining general properties. Spectral classification of stars. Hertzsprung- Russellov diagram. Formation and development of stars. Interstellar matter. Milky way. Methods for determining distances. Galaxies and cosmology.		
Recommended reading	1) V. Vujnović, Astronomija I, Školska knjiga Zagreb, 1993 2) V. Vujnović, Astronomija II, Školska knjiga Zagreb, 1994		
Supplementary reading	1) different www pages 2) M. Zeilik, Astronomy: The Evolving Universe, Cambridge University Press; 9 edition, 2002 3) Carl Sagan, Kozmos, Sveučilišna knjižara-Zagreb, 2004.		
Teaching methods	Lectures with Power Point presentations, interactive simulations, demonstration experiments, discussions, solving of sample problems individually and in group. Students get experience in observational astronomy during field work.		
Assessment methods	Oral examination.		
Language of instruction	Croatian, English (possible)		
Quality assurance	Student survey		

Methods	

Course title	**Quantum mechanics I**		
Course code	F113		
Type of course	Lectures (45), Exercises (30)		
Level of course	Basic course		
Year of study	III.	**Semestar**	VI.
ECTS (Number of credits allocated)	7 ECTS : - 75 class units ~ 56 h ~ 1.8 ECTS - about 155 h of independent student work with consultations ~ 5.2 ECTS		
Name of lecturer	Ph.D. Josip Brana, Assistant Professor		
Learning outcomes and competences	The understanding and knowledge of the physical phenomena of modern physics. Quantum mechanical problem solving skills, both analytical and computational.		
Prerequisites	General physics, mathematics, classical mechanics.		
Course contents	Hystorical rewiev and experimental foundations 1900-1928. Wave function and Schrödinger equation. Onedimensional problems. Uncertainity relations. Eigenvalues and eigenfunctions of physical operators. Central potential – bounded states. Motion ina n electromagnetic field. Operators, matrices and states vectors. Representation theory. Other pictures of QM. Spin and magnetic momentum. Pauli's equation. Angular momenta composition. Aproksimative methods for stationary states. Zeeman and Stark effects. Dirac's perturbation theory and absorption, emission and spontaneous emission. Scattering theory - Born approximation.		
Recommended reading	1) R. L. Liboff, Introductory Quantum Mechanics, Addison-Wesley, 2003., 2) F. Schwabl, Quantum mechanics, Springer-Verlag, Berlin, 2002. 3) L. I. Schiff, Quantum Mechanics, Mc-Graw Hill, New York 1968.		
Supplementary reading	1) F.S. Levin, An Introduction to Quantum Theory, Cambridge University Press, 2002. 2) R. Ročak, M. Vrtar, Zbirka zadataka iz kvantne mehanike, Zagreb 1969. 3) I. Supek, Teorijska fizika i struktura materije, Školska knjiga, Zagreb		
Teaching methods	The teaching of the course is carried out through lectures and exercises. Exercises are devoted to deeper explanation of mathematical and physical concepts and solving physical problems. Discussions and solving specific problems using computers are stimulated.		
Assessment methods	The exam is in writing and oral form.		
Language of instruction	Croatian/english		
Quality assurance methods	Trough the student polling and statistical analysis of exam results		

Course title	**Electrodynamics I**		
Course code	F108		
Type of course	Lectures (30), Exercises (15)		
Level of course	Basic course		
Year of study	III.	**Semestar**	V.
ECTS (Number of credits allocated)	5 ECTS : - 45 class units ~ 34 h ~ 1.1 ECTS - about 116 h of independent student work with consultations ~ 3.9 ECTS		
Name of lecturer	Ph.D. Josip Brana, Assistant Professor		
Learning outcomes and competences	Theoretical understanding of basic laws of electrostatic and magnetostatic, as well as electrodynamics in vacuum, and be possible to solve different problems in this field.		
Prerequisites	Three mathematics, three generall physics and classical mechanics 1.		
Course contents	**Electrostatics and Magnetostatics:** Foundamental conceptions and equations. **Electrodinamics in vacuum:** a) *Charge motions in determined electromagnetic fields*. Motions in a homogeneous and static fields and motions in periodical fields. b) *Electromagnetic field of defined charge and currents motion*: Maxwell equations in vacuum. Continuity equation. Maxwell equations far from currents and charges – electromagnetic waves, polarisation. Energy and momentum of emg.field. Electromagnetic potentials, their importance and gauge transformation and invariance. Retarded and advanced solutions. Lienard-Wichert potentials. c) *Radiation effects*: Larmors formula for dipol radiation. Quadrupol and magnetic dipol radiation. Radiative reaction force and radiation damping.		
Recommended reading	1) J. D. Jackson: Classical Electrodynamics, 3rd edition, John Wiley, New York, 1998 2) I. Supek: Teorijska fizika I struktura materije, Školska knjiga, Zagreb, 1977		
Supplementary reading	1) A.O. Barut: Electrodynamics and Classical Theory of Fields and Particles, MacMillan, New York, 1964 2) F. Rorlich: Classical charged particles. Addison-Wisley, Reading, Massachusetts, 1965		
Teaching methods	Na predavanjima teorija, a na vježbama rješavanje problema i seminarski radovi.		
Assessment methods	The exam is in writing and oral form		
Language of instruction	Croatian/english		
Quality assurance methods	Student's survey and statistical analysis of exam results		

Course title	**Special and General Relativity**		
Course code	F112		
Type of course	Lectures (30), Exercises (15)		
Level of course	Basic course		
Year of study	III.	**Semestar**	VI.
ECTS (Number of credits allocated)	5 ECTS : - 45 class units ~ 34 h ~ 1.1 ECTS - about 116 h of independent student work with consultations ~ 3.9 ECTS		
Name of lecturer	Ph.D. Josip Brana, Assistant Professor		
Learning outcomes and competences	Understanding basic concepts and principles of the special and general relativity. To be learned about consequences to measured length and time and well known three tests of OTR. About black holes in Universe, evolution of Universe and about gravitation waves.		
Prerequisites	Three mathematics, three generall physics and classical mechanics		
Course contents	**Special theory of relativity:** Michelson-Morley9s experiments. Postulates of STR, Lorentz transformations and its consequences. Minkowsky 4-space-time. Mechanics in STR. Mechanics and Electrodynamics in 4^{th} dim form. **General theory of relativity:** Postulates of OTR and programme of gravitation field description in a curved space-time. Riemann 4 – space-time. Tensor algebra and analysis in a Riemann space, generalization of derivation. Geodesics. Einstein's equations of gravitation field. Schwartzschield solution, black holes.Three classical tests of OTR. Linearised equations, gravitation waves. Friedman cosmological models and Hubble law. Accelerated Universa.		
Recommended reading	1) W. D. McGlinn: Introduction to Relativity, The John Hopkins University Press, Baltimore and London, 2003. 2) B. Schutz, Gravity from the ground up, Cambridge University Press, 2004.		
Supplementary reading	1) Adler, Bazin, Schiffer, Introduction to General Relativity, McGraw-Hill 1975. 2) J. D. Jackson: Classical Electrodynamics, 3rd edition, John Wiley, New York, 1998. 3) Supek: Teorijska fizika I struktura materije, Školska knjiga, Zagreb, 1977		
Teaching methods	Theory on lectures and trough exercises problems solving and exposition of seminars works		
Assessment methods	Oral exam and observation and verification trough seminars works		
Language of instruction	Croatian/english		
Quality assurance methods	Student's survey and statistical analysis of exam results		

Course title	**Electrodynamics II**		
Course code	F131		
Type of course	Lectures (30), Exercises (15)		
Level of course	intermediate elective course		
Year of study	III.	**Semestar**	V.
ECTS (Number of credits allocated)	4 ECTS : - 45 class units ~ 34 h ~ 1.1 ECTS - about 116 h of independent student work with consultations ~ 3.9 ECTS		
Name of lecturer	Ph.D. Josip Brana, Assistant Professor		
Learning outcomes and competences	Student must learned and correctly expressed basic laws of electrostatic, magnetostatic and electrodynamics of macroscopic media, and to be possible to solve different problems in this field as well.		
Prerequisites	mathematics, general physics, classical mechanics, electrodynamics 1		
Course contents	Electrostatics in macroscopics media and boundary conditions. Magnetostatics in macroscopics media and boundary conditions. Equations of macroscopics electrodynamics. Boundary conditions between two media. Emg waves in isolated media – polarization, reflexion and refraction of waves on a boundary of two media – wave optics. Emg. waves in dispersive media. Emg waves in conduction media. Wave guides, optical fibers and resonant cavities. Multipole expansion of emg field. Quadrupole and magnetic dipole radiation.Linear antena. Scattering and diffraction of emg waves. Relativistic generalisation of Larmore's formula. Dirac-Lorentz relativistic equation and radiation reaction.		
Recommended reading	1) J. D. Jackson: Classical Electrodynamics, 3rd edition, John Wiley, New York, 1998 2) I. Supek: Teorijska fizika I struktura materije, Školska knjiga, Zagreb, 1977		
Supplementary reading	1) A.O. Barut: Electrodynamics and Classical Theory of Fields and Particles, MacMillan, New York, 1964 2) F. Rorlich: Classical charged particles. Addison-Wisley, Reading, Massachusetts, 1965		
Teaching methods	Theory on lectures and trough exercises problems solving and exposition of seminars works		
Assessment methods	Oral exam and observation and verification trough seminars works		
Language of instruction	Croatian/englishS		
Quality assurance methods	Student's survey and statistical analysis of exam results		