UNIVERSITY OF RIJEKA
FACULTY OF PHILOSOPHY

DEPARTMENT OF PHYSICS

UNDERGRADUATE CURRICULA

March, 2005

Syllabus

of the University Undergraduate Course in

PHYSICS

Rijeka, March 2005

1. INTRODUCTION

1.a) Reasons and grounds for introducing an independent course of physics, and an evaluation of its purpose regarding the needs of the labour market in the public and private sectors.

Presented below is the three-year course programme:

Undergraduate course in Physics

And the two-year postgraduate courses:

Physics and Mathematics
Physics and Computer Science
Physics and Polytechnics
Physics and Environmental Studies
Physics and Materials

1.a) i. Feasibility assessment regarding market needs

Exponential growth of scientific achievements in the area of natural sciences and technology, require a long-term and qualitative education for the experts in a wide range of competencies in the areas concerned. Due to these reasons, we propose programmes with a basic concept, which is a three-year programme of physics that can then continued by any of five proposed postgraduate programmes. The undergraduate course represents a firm common basis of fundamental knowledge of physics with mathematics basics necessary for their successful mastering. Numerous optional groups of modules are carefully integrated into the course, the choice of which enables a student, after gaining the title of Bachelor of Science, a choice of five possible continuations of a two-year postgraduate course without taking additional qualification exams. Concerning increasingly noticeable developments and needs of contemporary society for experts of natural science and technical areas, as well as concrete needs of industrial development, we strongly feel that in the region of the University of Rijeka there is an explicit necessity for the existence of an independent undergraduate course of physics and more postgraduate courses which represent its natural and imperative continuation. Through the proposed postgraduate courses, the student has the possibility to acquire a range of specialised knowledge, directed at the development of modern technologies, with a wide range of employment options available in society today.

Fundamental knowledge of physics and basic mathematics are obtained on the undergraduate course throughout the compulsory modules such as essential physics, applied physics, theoretical physics, mathematical analysis, linear algebra and mathematical methods of physics, as well as applied computer science and computer science physics.

The proposed programmes of postgraduate educational courses in Physics and Mathematics, Physics and Computer Science Physics and Polytechnics are established on the forty-year-old tradition of teaching courses of natural science and mathematics at the University of Rijeka. They represent a source of assurance of a sufficient number of physics teachers and other compatible subjects in primary and secondary schools of the County of Primorje-Gorski Kotar and neighbouring counties, which indicate a shortage of qualified personnel for these professions. In addition, it is estimated that this shortage will become more noticeable in the technologically developed future.

In the aforementioned *educational postgraduate courses*, fundamental knowledge is acquired from methodological teaching of individual teaching areas, as well as school teaching practice, starting from the Pedagogical and Psychological group of modules to a range of optional modules closely related to the profession itself. This will enable the future teachers' qualitative integration into the teaching profession and a lifelong education. The Pedagogical and Psychological group of modules integrated into the postgraduate educational courses is in accordance to the teaching proposal in the syllabus for gaining teaching competencies, and a teaching certificate proposed by the committee from the Faculty of Philosophy, University of Rijeka. This is founded on the current reform attempt to strengthen the professionalism of teaching.

The proposed programme for the *Physics and Environmental Studies* represents a continuum of the basic knowledge of environmental studies acquired from the undergraduate three-year course of Physics. The entire region surrounding the University of Rijeka has expressed the necessity for such personnel. Nowadays, the University is taking part in various projects regarding the environmental studies, which are directly financed by the County of Primorje-Gorski Kotar and the city of Rijeka.

The proposed programme for the *Physics and Materials* has arisen as a joint course that would be handled by the Department of Physics at the Faculty of Philosophy and Faculty of Engineering, University of Rijeka. The intention of this course is to combine the fundamental knowledge of physics into one unit with the newest achievements in analysis and treatment of materials, in order for the students who complete this course to actively develop new technologies and their application. The courses of such kind are arising in all European countries as a strong encouragement for economic development based on new scientific perceptions.

Courses in *Physics and Environmental Studies* and *Physics and Materials* are typical inter-disciplinary courses, and they represent a combination of existent personnel and knowledge at the University of Rijeka. Similar courses are just emerging at the other universities; therefore the need for all-rounded educated personnel, which these courses will produce, exists in the whole of Croatia.

1.a) ii. Connection of the Course with Contemporary Scientific Perceptions and/or their Skills Deriving from these Perceptions

The undergraduate course of physics represents the firm common grounds for the continuation and attendance at all postgraduate specialised courses of physics. In all the proposed course programmes, a wide choice of modules enables in the future the necessary programme modernisations by integrating new modules, rich of contemporary scientific contents.

1.a) iii. Comparison of the course with the programmes of the prestigious higher education establishments abroad (universities, four-year colleges, polytechnics and so on), especially those from the countries of the European Union. It is desirable, with an explanation, to mention the most two of such programmes, which are equivalent to the programme that is being proposed.

The basic course of physics is found in the programmes in most of the European universities under the same or compatible titles, and with a similar content. Common grounds on which all of them are based is a mathematics basis necessary for following physics contents, modules of fundamental physics, applied fundamental physics, theoretical physics,

advanced practical workshops as well as the usage of computers in physics. The compulsory modules proposed in the three-year undergraduate programme of Physics are equivalent to teaching programmes of physics courses at the universities in Zagreb, Split and Osijek.

In writing up the programme, we used the syllabi of a few European universities, especially of those in Germany.

The proposed programmes of the following postgraduate courses of *Physics and Mathematics, Physics and Computer Science, Physics and Polytechnics* as a possible continuations of the three-year undergraduate course of physics, can be compared to the system of gaining a teaching licence in the majority of the European Union countries (for example, Italy).

In Great Britain, upon completing the course for the individual profession, applicants are integrated into the programme of PGCE (Professional Graduate Certificate in Education).

The programmes of the following postgraduate courses of *Physics and Environmental Studies* and *Physics and Materials* are equivalent to the programmes that exist in a few other European universities, such as the University of Trieste (Italy). The equivalent programmes are developed even at the University of Split.

1.b) Past Experiences of the Propounder in the Implementation of Similar or Equivalent Programmes.

Natural science courses at the Faculty of Philosophy in Rijeka, have their roots in several higher-education establishments which started in 1953 to prepare young people for the teaching profession (the two-year Pedagogical College, the four-year Industrial Pedagogical College, the Faculty of Industrial Pedagogy, the Pedagogical Academy in Rijeka, Pula and Gospić, the Faculty of Pedagogy). Since the academic year 1964-1965, the four-year course in Mathematics and Physics has been running. In addition, since 1971-1972 the course in Physics and Technical Education and since the 2004-2005 the teaching course in Physics and Computer Science has been running. From the academic year 1979-1980 to 1984-1985, a teaching course in Physics and Chemistry existed in the Faculty of Pedagogy in Rijeka.

The Department of physics, as the propounder of this programme, is the holder of a four-year course in Mathematics and Physics, as well as Physics and Computer Science. The programmes are realised in the form of lectures, seminars, practical work and teaching practice, while the courses result in the qualification of teachers of Mathematics and Physics, as well as teachers of Physics and Computer Science. The lecturers of the Department of Physics participate in executing programmes of the teaching courses in Physics and Polytechnics, as well as Mathematics and Computer Science (whose holder is the Department of Polytechnics, i.e., the Department of Mathematics of the Faculty of Philosophy). The Ministry of science, education and sport has given the Licence for all the studies in which participate the Department of physics.

In the students' education, special attention is devoted to demonstrational experiments and laboratory training, which is in accordance to contemporary methods of constructivist physics studying. This enables better understanding of teaching contents and increases the level of knowledge, as well as preparing students for this kind of work in their future teaching profession. Students who show special inclinations and quality are introduced to scientific and research work. Hence, some of them after completing the postgraduate course and further improving their skills find their place at the universities and scientific research institutes in the country and abroad.

1.c) Possible Partners for the Postgraduate Course outside the higher education system (economy, public sectors and so on), which expressed interest or could be interested in its implementation.

Necessity and interest for implementing the postgraduate educational courses of *Physics and Mathematics, Physics and Computer Science, Physics and Polytechnics* have all the primary and secondary schools in the Republic of Croatia in which the subjects of Physics, Mathematics, Computer Science, Technical Education are taught.

For the postgraduate course of *Physics and Environmental Studies* as well as for the postgraduate course of *Physics and Materials*, there is an explicit necessity in industry, as well as in the structures of society in the region of the University of Rijeka and more. The development of ecologically clean tourism is a vital feature for the entire area covered by the University of Rijeka, and the development of new technologies in accordance to sustainable development is the fundamental target of every contemporary society. Up till now, the professional personnel from the aforementioned areas have been inappropriately educated. By opening these courses, such problems could be solved to a certain extent. By doing so, we should take into account constant improvement of knowledge, with permanent personnel of education and their scientific advancements in the appropriate institutions in Rijeka (for example, the Natural Science Museum and its ecological orientation, the Institute for Public Health observing environment pollution from chemicals, Technological-Innovation Centre with its application of new technologies, and so on).

1.d) Accessibility of the Course towards Student Mobility

The proposed syllabus has been coordinated with provisions of the law regarding activities in the field of science and higher education (N.n. No. 123/03), in accordance with the ECTS criteria (European Credit Transfer System) published in the university journal, vol. XLVI, 2000, as well as the Statute of the University of Rijeka.

All modules on the three-year undergraduate course and the two-year postgraduate courses are planned as one-semester subjects, which enable dynamic exchange of contents. In addition, it enables students in each phase of their studies upon completing all the taken subjects, to integrate into the mobility and student exchange scheme with other universities in Croatia and countries of the European Union. Particular possibilities of exchange are opened by optional groups of modules proposed in a three-year undergraduate programme as well as in postgraduate courses. The possibilities of programme transition from undergraduate to postgraduate are anticipated by the course of the studies.

1.e) Other Elements and Necessary Data According to the Propounder's Opinion

The importance of the collaboration among the Departments of Mathematics, Computer Science and Polytechnics at the Faculty of Philosophy in Rijeka, which the Department of Physics has been running combined courses with, as well as the Department of Philosophy is imperative for the compilation and implementation of the proposed undergraduate and postgraduate courses. Postgraduate educational courses are being implemented in collaboration with the departments of Pedagogy, Psychology, Croatian Studies and Philosophy at the Faculty of Philosophy in Rijeka.

This collaboration is to be continued especially in the first three years of the course, and later on in the educational courses. In the programmes of the postgraduate courses, modules related to *environmental studies* would be partially taught by lecturers from other faculties of the University of Rijeka, as well as acknowledged experts outside the University.

The assistance of highest quality personnel from the Ruđer Bošković Institute, with which the University of Rijeka has a contract of collaboration, is also expected. Modules related to *materials* would be mainly taught by lectures from the Faculty of engineering, University of Rijeka. Additionally, on the basis of an agreement between the Institute for Physics and the University of Rijeka, prominent scientists from the Institute would teach some modules related to the latest achievements in the analysis of material. Related to all postgraduate courses we plan collaboration with other similar faculties in Croatia, particularly with Faculty of science in Zagreb and Split.

The insurance of the inter-disciplinary and multi-disciplinary proposed postgraduate programmes supposes a blending of already existing personnel and knowledge under the wings of the University of Rijeka, with the collaboration of the most prestigious universities and scientific institutions in the Republic of Croatia. With it we contribute to a harmonic and fast development of the University of Rijeka, as well as the economic and social development of Rijeka and its wider surroundings.

2. GENERAL PART

2.1 Course Title

Undergraduate course in Physics
Postgraduate Course in *Physics and Mathematics*
Postgraduate Course in *Physics and Computer Science*
Postgraduate Course in *Physics and Polytechnics*
Postgraduate Course in *Physics and Environmental Studies*
Postgraduate Course in *Physics and Materials*

2.2 Holder of the Course (establishment – propounder) and Course Coordinator (component that runs or manages course running)

Department of Physics
Faculty of Philosophy in Rijeka
Omladinska 14
51 000 Rijeka

2.3. Course Duration

According to the proposal of law regarding science activities and high education, the proposed programme is to be run as a three-year undergraduate course in physics (6 semesters), and five separate two-year postgraduate courses. Each of the proposed postgraduate courses when combined with the undergraduate course has a total of five years (10 semesters) as its duration.

2.4 Requirements of Enrolment

To enrol in the three-year undergraduate course in physics, any may who have completed a four-year secondary school and passed the university entrance exam, or even if they meet all the requirements, without an entrance exam.

The requirements to enrol into the two-year postgraduate courses are a Bachelor of Science in physics, and to have passed the appropriate exams from the optional modules of Mathematics, Polytechnics, Computer Science, Ecology or Materials.

All the aforementioned postgraduate courses are designed in such a way that students, with their optional choice of modules (starting from the second year), may enrol after completing the undergraduate course without taking any additional exams. Naturally, if a student has not been choosing his or her modules adequately, to enrol in the desired postgraduate course, they must first take the appropriate modules and exams.

The manner of taking exams is in both oral and written forms, and the manner of acquiring the required credits (attending lessons, taking exams, carrying out a research task, seminars and so on), may vary from module to module. Within the syllabus of each individual module, specific options are available, such as segmented examinations or even taking the exam in a form of preliminary examinations.

2.5 Undergraduate Course: If the programme for the undergraduate course is being proposed, it should state the competencies the students gain upon completing the course, for which jobs it is enabled, as well as what post-graduate course

programmes could students follow at the establishment – propounder and/or other establishments within the Republic of Croatia if the students choose to continue academic education.

After the three-year *undergraduate course in Physics* (6 semesters), the student is capable of taking on a position as a *higher laboratory technician* at institutes, all education establishments, in the educational system in the republic of Croatia, and in industry.

After completing the three-year undergraduate course in Physics, a student is able to pursue any of the following course programmes at the University of Rijeka:

- Postgraduate Course in *Physics and Mathematics*
- Postgraduate Course in P*hysics and Computer Science*
- Postgraduate Course in *Physics and Polytechnics*
- Postgraduate Course in *Physics and Environmental Studies*
- Postgraduate Course in *Physics and Materials*

and compatible two-year postgraduate courses at the universities of Zagreb, Split and Osijek.

2.6 Postgraduate Course: If the programme for the postgraduate course is being proposed, it should state the competencies the students will have gained upon completing the course, and for which jobs hey are capable. Moreover, it should be stated that undergraduate courses programmes at the establishment – propounder and/or other establishments within the Republic of Croatia, which are sufficient (or partly-sufficient) for its attendance.

After the two-year postgraduate courses in *Physics and Mathematics, Physics and Computer Science, Physics and Polytechnics* the student is qualified for the position of a teacher of the appropriate subjects in all primary and secondary schools in the Republic of Croatia.

After the two-year postgraduate course in *Physics and Environmental Studies* and *Physics and Materials*, the acquired competencies will enable the graduates employment in the industry, specialised firms and incubation centres, which deal with the activities related to scientific approaches to biology and sustainable development, i.e. related to development of new technologies and the application of contemporary materials in industry. In solving the aforementioned problems, these graduate students will, with their activities, help in business, financial and social organisations, which deal with these. The proposed undergraduate and postgraduate programmes will offer content-related and formal fundamentals for the continuation of scientific work and schooling in the area of natural sciences and technical sciences.

The undergraduate course of Physics at the Faculty of Philosophy at the University of Rijeka, having passed the appropriate optional modules which are available as part of the three-year course, is sufficient for enrolling into the aforementioned postgraduate courses. Furthermore, compatible three-year courses of Physics at the universities of Zagreb, Split and Osijek, and having passed the appropriate differentiating modules, are sufficient for attending these postgraduate courses.

2.7 If introducing course programmes in which parts of the undergraduate courses are combined into one unit; the reasons for its combined implementation should be stated.

2.8. Professional and Academic Title or Level Gained upon Course Completion

After fulfilling the obligations of undergraduate course of Physics (three years), students gain the academic title of *Bachelor of Science in Physics*, while upon completing any of the five proposed postgraduate courses (five years), students gain the appropriate academic title of

Master of Science in Mathematics and Physics Education,
Master of Science in Physics and Computer Science Education,
Master of Science in Physics and Polytechnics Education,
Master of Science in Physics and Environmental Studies or
Master of Science in Physics and Materials.

UNDERGRADUATE STUDY IN PHYSICS CURRICULUM

0 semester: Mathematics precourse

I. YEAR								
	I. semester hours/week			**II. semester hours/week**			**Total hours**	**ECTS credits**
COURSE	**L**	**S**	**E**	**L**	**S**	**E**		
Gymnastics and health culture	-	-	-	-	-	-	60	1 + 1
Elementary Mathematics	3	0	2	-	-	-	75	5
Physics I	4	0	2	-	-	-	90	7
Computer Laboratory I	1	0	2	-	-	-	45	3
Analysis I	3	0	3	-	-	-	90	7
Linear algebra I	3	0	3	-	-	-	90	7
Physics II	-	-	-	4	0	2	90	7
Physics laboratory I	-	-	-	0	3	0	45	4
Computer Laboratory II	-	-	-	1	0	2	45	4
Analysis II	-	-	-	3	0	3	90	7
Linear algebra II	-	-	-	3	0	3	90	7
Hours per week	**14**	**0**	**12**	**11**	**3**	**10**		
TOTAL	**26**			**24**			**750**	**30 + 30**

(L=Lectures, S=Seminars, E= exercises)

II. YEAR

	III. semester hours/week			IV. semester hours/week			Total hours	ECTS credits
COURSE	**L**	**S**	**E**	**L**	**S**	**E**		
Gymnastics and health culture	-	-	-	-	-	-	60	1 + 1
Physics III	4	0	2	-	-	-	90	7
Physics laboratory II	0	3	0	-	-	-	45	4
Theoretical physics I	4	0	2	-	-	-	90	8
Elective course M1	3	0	3	-	-	-	90	6
Elective course F1	-	4	-	-	-	-	60	4
Physics IV	-	-	-	4	0	2	90	7
Physics laboratory III	-	-	-	0	3	0	45	4
Theoretical physics II	-	-	-	4	0	2	90	8
Mathematical methods in physics II	-	-	-	3	0	2	75	6
Elective course F2	-	-	-	-	4	-	60	4
Hours per week	**11**	**7**	**7**	**11**	**7**	**6**		
TOTAL	**25**			**24**			**735**	**30 + 30**

(L=Lectures, S=Seminars, E= Exercises)

ELECTIVE COURSES M1
Student chooses 6 ECTS credits.

Course	**Hours**	**ECTS**	**Recommendation for a graduate study programme**
Analysis III	3+0+3	6	Physics and mathematics
Mathematical methods in physics I	3+0+3	6	Other programmes

ELECTIVE COURSES F1
Student chooses 4 ECTS credits.

Course	Hours	ECTS	Recommendation for a graduate study programme
Combinatorics	2+0+2	4	Physics and mathematics
Programming	2+0+2	4	Physics and informatics
Introduction to polytechnics	2+0+0	4	Physics and polytechnics
Introduction into philosophy	2+2+0	4	Physics and philosophy

ELECTIVE COURSES F2
Student chooses 4 ECTS credits.

Course	Hours	ECTS	Recommendation for a graduate study programme
Mathematical logic	2+0+2	4	Physics and mathematics
Algorithms and data structures	2+0+2	4	Physics and informatics
Thermodynamics	2+0+2	4	Physics and polytechnics

III. YEAR

	V. semester hours/week			VI. semester hours/week			Total hours	ECTS credits
COURSE	**L**	**S**	**E**	**L**	**S**	**E**		
Theoretical physics III	4	0	2	-	-	-	90	8
Basic practicum IV	0	3	0	-	-	-	45	4
Advanced practicum	0	3	0	-	-	-	45	4
Elective course F3	-	4	-	-	-	-	60	4
Elective courses F4	-	8(9)	-	-	-	-	120 (135)	10
Theoretical physics IV	-	-	-	4	0	2	90	8
Bachelor thesis seminar	-	-	-	0	2	0	30	2
Elective courses F5	-	-	-	-	8	-	120	10
Elective courses F6	-	-	-	-	8(9)	-	120 (135)	10
Hours per week	**4**	**18 (19)**	**2**	**4**	**18 (19)**	**2**		
TOTAL	**24(25)**			**24(25)**			**720 (750)**	**30 + 30**

(L=Lectures, S=Seminars, E= Exercises)

ELECTIVE COURSES F3
Student chooses 4 ECTS credits.

Course	**Hours**	**ECTS**	**Recommendation for a graduate study programme**
Measurements in physics	2+2+0	4	All programmes
Computational physics	2+2+0	4	All programmes

ELECTIVE COURSES F4
Student chooses 10 ECTS credits.

Course	Hours	ECTS	Recommendation for a graduate study programme
Introduction to digital systems	2+0+2	5	Physics and informatics
	2+0+2	5	Physics and informatics
Euclidean spaces	2+0+2	5	Physics and mathematics
Introduction to differential geometry	3+0+2	5	Physics and mathematics
Graphical communication 1	2+0+1	3	Physics and polytechnics
Strength of material	2+0+1	4	Physics and polytechnics
Machine elements and mechanisms 1	2+0+1	3	Physics and polytechnics

ELECTIVE COURSES F5
Student chooses 10 ECTS credits.

Course	Hours	ECTS	Recommendation for a graduate study programme
Electronics	2+0+2	5	All programmes
Astrophysics and astronomy	2+0+2	5	All programmes
Atomic and molecular physics	2+0+2	5	All programmes
Condensed matter physics	2+0+2	5	All programmes
Nuclear physics	2+0+2	5	All programmes
Elementary particles and their interactions	3+0+1	5	All programmes
Experimental methods in physics	2+2+0	5	All programmes
Biophysics	2+0+2	5	All programmes

ELECTIVE COURSES F6
Student chooses 10 ECTS credits.

Course	Hours	ECTS	Recommendation for a graduate study programme

Computer organization and architecture	2+0+2	5	Physics and informatics
Digital signal processing	2+0+2	5	Physics and informatics
Algebraic structures	2+0+2	5	Physics and mathematics
Metric spaces	3+0+2	5	Physics and mathematics
Graphical communication 2	2+0+1	4	Physics and polytechnics
Materials science and engineering	2+0+1	3	Physics and polytechnics
Machine elements and mechanisms 2	2+0+1	3	Physics and polytechnics

The programme for the first and second year course “Gymnastics and Health Culture” will be presented to students at the beginning of each academic year.

Course code	
Course title	MATHEMATICS PRECOURSE

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	0	-
Hours/semester	0+0+30 (*)	-

Course objectives

Introduction to the undergraduate mathematics courses and mathematics topics in the physics courses.

Correspondence and correlation with the program

The course is important for the first year mathematics and physics courses.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

It is expected that students will repeat the mathematics from high-school courses.

Course content

Trigonometry. Functions. Exponential, logarithmic and trigonometric functions. Graphs of trigonometric functions. Equations and inequalities. Cartesian and polar coordinates. Analytic geometry. Vectors. Introduction to differential calculus. Integration.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	**Multimedia and the Internet**
Distance learning	Consultations	Laboratory work	Tutorials	Field work

Comments:
(*) Precoruse is organized in the month before the first winter semester.

Student requirements

Class attendance, final test.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	Seminar paper	Experiment
Written exam	Oral exam	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Required literature

1. Maths online: http://www.univie.ac.at/future.media/moe/galerie.html
2. Maths online interactive tests: http://www.univie.ac.at/future.media/moe/tests.html

Recommended literature

High-school mathematics textbooks

Quality assurance of course and/or module

Discussions with the students.

Course code	
Course title	ELEMENTARY MATHEMATICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	5	
Hours/semester	45 + 0 + 30	

Course objectives

- learning basic concepts about sets, relations and functions
- learning basic properties of polynomials, rational, exponential and logarithmic functions and solving equations and inequations
- learning basic concepts about arithmetic and geometric sequences
- learning basic properties of trigonometric functions and solving trigonometric equations and inequations

Correspondence and correlation with the program

Course program is in correlation with other mathematical courses, specially with Elementary mathematics II, Analysis I and Set theory.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will learn basic concepts and properties of sets, relations and functions and also arithmetic and geometric sequences. Students will learn basic properties of polynomials, rational, exponential, logarithmic and trigonometric functions and be able to solve equations and inequations in which these functions appear.

Course content

Sets, relations and functions. Polynomials. Graphs of polynomials. Rational functions. Equations and inequations. Exponential and logarithmic functions. Exponential and logarithmic equations and inequations. Arithmetic and geometric sequences.
Trigonometric functions. Graphs of trigonometric functions. Properties of trigonometric functions. Arcus functions. Trigonometric equations and inequations.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Every student is obliged to satisfy conditions for obtaining the signature for the course Elementary Mathematics I and pass the exam.
Conditions for obtaining the signature:
Attendance at all forms of classes and active participation in all forms of work required for this course is expected.
Exam: written and oral.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance Ø	Class participation Ø	Seminar paper Ø	Experiment Ø
Written exam **2**	**Oral exam** **3**	Essay Ø	Research work Ø
Project work Ø	Continuous assessment Ø	Presentation Ø	Practical work Ø

Comments:

Required literature

1. B.Pavković, D.Veljan: Elementarna matematika I, Tehnička knjiga, Zagreb, 1992.
2. S.Kurepa: Uvod u matematiku, Tehnička knjiga, Zagreb, 1975.

Recommended literature

1. H.Kruglak, J.T.Moore: Schaum's outline series, Theory and Problems of Basic Mathematics, McGraw-Hill, New York, 1973.
2. B. Rich: Schaum's outline series, Theory and Problems of Review of Elementary Mathematics, McGraw-Hill, New York, 1977.
3. D. Palman: Trokut i kružnica, Element, Zagreb, 1994.
4. D. Palman: Geometrijske konstrukcije, Element, Zagreb
5. Corresponding textbooks and collections of problems for high school mathematics are recommended

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	PHYSICS I: CLASSICAL MECHANICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	7	
Hours/semester	60+0+30	

Course objectives

Basic knowledge of classical mechanics as a cornerstone of physics

Correspondence and correlation with the program

The course program Physics I-IV acquaints the students with a large number of physical phenomena and, for the first (and possibly the last) time, can give them a complete overview over the entire field of physics. Part I will introduce the students to the concepts of classical mechanics.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

. In addition, this course program not only provides the basic knowledge required for the physics practicum, but also a grasp of more general aspects, e.g. among others
- the significance of "physical understanding",
- the role of experimental physics,
- the relationship between experimental and theoretical physics,
- basic vs. applied research.

Course content

- Introduction: intuition and measurement; basic physical quantities; vectors.
- Coordinate systems: pseudoforces; Galilei and Lorentz transformation; Michelson-Morley experiment; special relativity.
- Basic laws of classical mechanics: Newton axioms; discussion of special examples (gravitational forces; planetary motion and Kepler laws; elastic, impulsive and friction forces).
- Energy, work, power, potential, action; energy conservation and perpetuum mobile; momentum conservation.
- Extended systems: center of mass; mass-energy equivalence.
- Mechanics of rigid bodies: statics and equilibrium; rotation (angular momentum, torque, analogies between linear and rotational motion, parallel axis theorem, spinning top, inertial tensor, tides).
- Mechanics of deformable bodies (liquids, gases): statics, pressure, surface tension; dynamics (ideal and real currents, Bernoulli, laminar and turbulent flow).
- Oscillations and waves: harmonic oscillator (interference, polarization, Fourier analysis, two coupled oscillators); anharmonic oscillator; damping; forced oscillator, resonance; many coupled oscillators and waves (wave equation, sound, Doppler effect, resonator in one and

more dimensions, phase and group velocity, uncertainty relation).
● Dynamics of many-body systems and statistical mechanics: state equations (Boyle-Mariotte, Gay-Lussac, ideal and real gas); phases; kinetic gas theory (Brownian motion, pressure,specific heat, barometric pressure formula, Boltzmann distribution); laws of thermodynamics and examples(.Carnot, Stirling, heat pump, Otto and Diesel engine); probabilistic interpretation of entropy, reversibility and irreversibility.
● Heat transfer: heat conduction, convection, radiation.

Modes of instruction (mark in bold)

●Lectures	Seminars and workshops	**●Exercises**	Independent work	Multimedia and the Internet
Distance learning	• **Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Gymnasium mathematics (incl. differentiation, basic knowledge of integration)

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	Seminar paper	Experiment
• **Written exam 3**	• **Oral exam 4**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Required literature

1. Udžbenik fizike Sveučilišta u Berkeley, 1., Tehnička knjiga, Zagreb, 1982.
2. Paul A. Tippler: «Physics for Scientists and Engineers», Worth Publishers, NY, USA

Recommended literature

1. The Feynman Lectures on Physics, 1., California Institute of Technology, 1975.
2. H. Vogel: «Gerthsen Physik», Springer Verlag, Berlin
3. http://www.physics.harvard.edu/problems.htm

http://astrowww.phys.uvic.ca/~tatum/intro.html

Quality assurance of course and/or module

Continuous feedback from the students; rating by the participants at the end of the course

Course code	
Course title	COMPUTER LABORATORY I

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	3	
Hours/semester	15+0+30	

Course objectives

- develop the skills for practical usage of theoretical knowledge of computer science and abilities of problem solving with the aid of a computer

Correspondence and correlation with the program

This course is in correlation with most of other courses, in sense that most of other courses will use computer for problem solving.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course, it is expected students to have theoretical knowledge of computer science and skills for solving problems with the aid of a computer.

Course content

Computers architecture: processor, memory, input-output units, links and communication between parts of computer; operating systems and executing user's applications.
Getting started: operating systems, text editing, files, saving the data on various medias, graphical interface.
Applying computers: texts and documents editing, spreadsheets, basic net services, electronical mail, Internet connection, searching Internet.
Medias for storing image and sound.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	**Exercises**	**Independent work**	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

4. Student requirements

Students are obligated to attend classes, actively participated in any form of work that is required and pass the exam.
Exam:
Written and oral exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance Ø	Class participation Ø	Seminar paper Ø	Experiment Ø
Written exam **1**	**Oral exam** **2**	Essay Ø	Research work Ø
Project work Ø	Continuous assessment	Presentation Ø	Practical work Ø

Comments:

Required literature

3. D. Sušanj, PC računala izvana i iznutra, BUG i SysPrint, Zagreb, 2002.
4. D. Petric, Internet uzduž i poprijeko, BUG i SysPrint, Zagreb, 2002.

Recommended literature

Original product handbooks and tutorials for operating systems and programs that are used in class.

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	ANALYSIS I

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	7	
Hours/semester	45+0+45	

Course objectives

This course aims to give students the basic knowledge about:
-functions of a real variable,
-numerical sequences,
-differential calculus and its application.

Correspondence and correlation with the program

Course program is correspondent to the program of similar courses in the other mathematics studies.
There exists a correlation with the following courses: Analysis II and Analysis III, Complex Analysis, Differential Geometry, Differential Equations and Numerical Mathematics.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

To introduce students to the ideas of *formal* definitions and *rigorous* proofs and to develop their powers of logic thinking.
To get the knowledge to use Analysis in other disciplines.

Course content

Real numbers. Axioms of real numbers. Supremum and infimum. Field of complex numbers. Trigonometric form of a complex number. Binomial theorem. Function, bijection, inverse function and composite functions. Sequence and limit. Limit of function in a point. Continuity of function in a point and on closed interval. Continuous and monotone functions. Derivate, basic rules and applications. The intermediate value theorem. Local maximum and minimum. Concavity. Points of inflection. Asymptotes.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected.
Student gets a grade after written and oral exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation** **0.5**	Seminar paper	Experiment
Written exam **3**	**Oral exam** **3.5**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments : Students are encouraged to active participate at a class and it influences to a final assessment.

Required literature

1. S.Kurepa:Matematička analiza I, II, Tehnička knjiga, Zagreb.(more publications)
2. B.P.Demidovič: Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb (more publications)

Recommended literature

Quality assurance of course and/or module

- questionnaire at the end of the course aimed to assess students' understanding,
- questionnaire designed to evaluate course program, lectures and lecture materials, teaching methods and interaction with students.

Course code	
Course title	LINEAR ALGEBRA I

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	7	
Hours/semester	45+0+45	

Course objectives

- to learn elementary notions of vector spaces and linear operators
- to learn characteristics of linear operators and matrices

Correspondence and correlation with the program

Course program is correspondent to the program of other mathematics' studies, especially to Linear algebra II, Euclidean Spaces and Analysis I.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this class, students are expected to know the basis of vector spaces, linear operators and matrices. Students have to be able to use learned material for doing exercises.

Course content

Basis algebraic structures, vector space, base and dimension, subspace, factor space, linear operators, description of linear operator in different bases, inverse of operator, minimal polynomial, rank and defect of operator, rank of matrix.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	Consultations	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Every student have to satisfy student's obligations: attendance at all classes and active participation.
Exam: written and oral.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation 0.5**	Seminar paper	Experiment
Written exam 3	**Oral exam 3.5**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Students' work is followed continuousely. The main part of the evaluation and assessment of students is the quality of active participation in lectures and exercises. The complete knowledge of students is evaluated on the exam.

Required literature

1. S.Kurepa: Uvod u linearnu algebru, Školska knjiga, Zagreb, 1975.
2. S.Kurepa: Konačnodimenzionalni vektorski prostori, Liber, Zagreb, 1992
3. K.Horvatić: Linearna algebra I, II i III, Sveučilište u Zagrebu, PMF, Matematički odjel, Zagreb, 1995.

Recommended literature

1. J. Dieudonne: Linearna algebra i elementarna geometrija, Školska knjiga, Zagreb, 1977.
2. L. Čaklović: Zbirka zadataka iz linearne algebre, Školska knjiga, Zagreb, 1976.

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	PHYSICS II

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		7
Hours/semester	/	60+0+30

Course objectives

Objectives of this course are to introduce fundamental knowledge of electricity, magnetism and optics required for continuing of physics program.

Correspondence and correlation with the program

Knowledge of basic algebra and differential calculus is required. The course is connected with courses Physics III and Physics IV as well as Physics practicum I and II, Theoretical physics II and elective course of Electronics.
The course content represent basic knowledge for postgraduate courses of Educational Physics, Physics and materials and Physics and environmental studies.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Understanding of basic concepts and features of electricity, magnetism and optics.
Development of physical way of thinking as well as skills for solving numerical and conceptual problems of electricity, magnetism and optics.

Course content

Electric charge. Coulomb's law. Electric field. Gauss's law. Electric potential. Electric dipole. Capacitance and capacitors. Direct current. Ohm's law. Resistance. Electric current loops. Current in gases. Electrical conductivity of electrolytes. Electrical conduction in solids. Magnetism. Geomagnetism. Lorenz's force. Magnetic induction. Magnetic materials. Faraday's law of electromagnetic induction. Ampere's law. Maxwell's equations. Alternating current. Electromagnetic waves. Polarization. Reflection and refraction. Images. Mirrors. Lenses. Optical instruments. Interference. Diffraction.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected. Final written and oral exam.
The Physics I course is required to enroll this course.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance **1**	**Class participation** **1**	Seminar paper	Experiment
Written exam **2.5**	**Oral exam** **2.5**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:
Regular class attendance is required for course signing. To final exam only students with Physics I course done.

Required literature

Halliday D., Resnick R., Walker J., *FUNDAMENTALS OF PHYSICS* ,6th ed. J.Wiley and Sons Inc, New York, 2003.
Kulišić P., Lopac V. *ELEKTROMAGNETSKE POJAVE I STRUKTURA TVARI*, ŠK, Zagreb, 1991.

Recommended literature

Cindro N. *FIZIKA 2*, ŠK, Zagreb, 1985.
Purcell E. M. *ELECTRICITY AND MAGNETISM*, Berkeley Physics Course, Vol 2., Mc Graw Hill, New York, 1965.
Yavorski B. and Pinsky A. *FUNDAMENTALS OF PHYSICS* Vol.1., MIR Pub., Moscow, 1975.
http://www.mip.berkeley.edu/physics/
http://www.walter-fendt.de/ph11e/index.html

Quality assurance of course and/or module

Students' portfolio: Continous assessment of students' work.
Questionnaires: Questionnaire on student's expectations at the beginning of the course. Questionnaire at the end of the course designed to evaulate quality of course program, lectures and lecture materials, teaching methods and interaction with students.
After oral exam student is asked to comment course program and to give suggestions about lectures and lecture materials, teaching methods and possible individual difficulties met during process of learning.

Course code	
Course title	PHYSICS LABORATORY I

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	**Summer semester**
ETCS credits / student workload		4
Hours/semester		0 + 45 + 0

Course objectives

Introducing the student to the skills in measurement, statistical analysis of results, display and interpretation of measurement results, establishing a connection of experimental to theoretical approach to the subject, developing an conceptual understanding.

Correspondence and correlation with the program

The course program is correlated to Statistics, directly follows the content of General Physics I course, and is required for all other core Laboratories in the program, as well as for Methodical laboratory and Methodic in physics.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Developing specific skills in experimental measurement, gaining competence in statistical analysis, display and interpretation of experimental results, as well as developing ability to connect theory to experimental measurement.

Course content

Introduction to measurement and correct display of experimental results.
Calculation of experimental errors and statistical analysis of experimental results.
Direct measurement of length. Indirect measurement of distances and radii of spherical surfaces. Measurement of weight and inertia. Density of solid bodies and liquids. Uniformly accelerated motion (Atwood's free fall device). Checking the 2nd Newton's law. Harmonic oscillation. Torsion. Rotational motion of objects. Measurement of rotational inertia for different objects. Measurement of gravitational acceleration by pendulum. Surface tension of liquids. Viscosity. Fluid flow. Aerodynamic buoyancy.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	Exercises	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	**Laboratory work**	Tutorials	Field work

Comments:
Students are obliged to write a lab preparation in advance. Measurements and statistical evaluation of results is done in laboratory. A completed measurement evaluation and discussion is submitted in the form of seminar paper. The corrections and assessment of work on consultation hours.

Student requirements

The General Physics I is required to enroll this course. Written preparation for every lab work is needed. Measurement results need to be within expected experimental errors, evaluation and calculation done precisely, discussion and conclusions drawn correctly. Finished previous and prepared next lab exercise is required for access to measurement. Obligatory consultations for correction of negatively assessed papers. Students are obliged to attend laboratory classes regularly; missing the class possible twice in semester, but all the measurements should be done during the semester. All seminar papers should be approved and signed in order to access the final course exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	Seminar paper	**Experiment 1**
Written exam	**Oral exam 1**	Essay	Research work
Project work	**Continuous assessment 1**	Presentation	Practical work
Experimental results evaluation 1			

Comments:
Student's work and progress is followed continuously: the knowledge is assessed colloquially during the laboratory measurements, written preparations and evaluations are assessed regularly. Organized and connected knowledge, as well as conceptual understanding on subject is assessed on final course exam.

Required literature

Laboratory I working materials.
Holjević S., Marković B., Stipčić-Šolić N., Milotić B., Fizikalna mjerenja I, Liber, Zagreb, 1980.
Marković B., Miler D., Rubčić A., Račun pogrešaka i statistika, Liber, Zagreb, 1987.

Recommended literature

Required literature for Physics I course.
Wilson J. D., Physics Laboratory Experiments, 5th edition, Houghton Mifflin Company, Boston, 1998.
Gymnasium textbooks in physics.
http://www.mip.berkeley.edu/physics/
http://www.walter-fendt.de/ph11e/index.html

Quality assurance of course and/or module

Feedback on course quality and achievements is obtained from permanent communication to students in lab and on consultation hours. Student's progress and adopted level of integrated thinking is being followed during the course.

Course code							
Course title	COMPUTER LABORATORY II						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	I
Course status	**X**	**Core**		Elective			
Credits and Teaching							
				Winter semester		Summer semester	
ETCS credits / student workload						4	
Hours/semester						15+0+30	
Course objectives							
- develop the skills for advance practical usage of theoretical knowledge of computer science and abilities of problem solving with the aid of a computer							
Correspondence and correlation with the program							
Prerequisite for this course is Computer Laboratory I.							
Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)							
After completing this course, it is expected students to have advance theoretical knowledge of computer science and skills for advance solving problems with the aid of a computer.							
Course content							
Advance usage of spreadsheets and basics facts about databases. Data structuring, filtrating, visualization. Web design: making web pages, data structuring. Presentations: making presentations, data structuring. Introduction to multimedia, image and sound editing. Introduction to programming package Mathematica.							
Modes of instruction (mark in bold)							
Lectures	**Seminars and workshops**		**Exercises**	**Independent work**	**Multimedia and the Internet**		
Distance learning	**Consultations**		Laboratory work	Tutorials	Field work		
Comments:							
5. Student requirements							
Students are obligated to attend classes, actively participated in any form of work that is required and pass the exam. Exam: Written and oral exam.							

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance Ø	Class participation Ø	Seminar paper Ø	Experiment Ø
Written exam **1**	**Oral exam** **2**	Essay Ø	Research work Ø
Project work Ø	**Continuous assessment** **1**	Presentation Ø	Practical work Ø

Comments:

Required literature

5. T. D. Gray, Exploring Mathematics with Mathematica, Addison – Wesley, New York, 1991.
6. S. Wolfram, The Mathematica Book, Wolfram/Cambridge University Press, Cambridge, 1999.

Recommended literature

Original product handbooks and tutorials for operating systems and programs that are used in class.

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	ANALYSIS II

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		7
Hours/semester		45 + 0 + 45

Course objectives

- learning of numeric series, function sequences and series theory
- learning of integration methods
- learning applications of integration

Correspondence and correlation with the program

Program of Calculus II is correlated with other mathematical courses, especially Analysis I and Analysis III, Complex Analysis, Differential Geometry, Differential Equations and Numerical Mathematics.
Prerequisite courses: Analysis I.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to:

- know and understand notions of numeric series, function sequences and series theory
- know how to use different integration methods and its various applications.

Course content

Indefinite integral. Integration methods. Definite integral. Newton-Leibniz formula. Integrability of monotone and continuous functions. Applications of integration. Improper integrals. Numeric series and convergence criteria. Sequences and series of functions. Convergence and uniform convergence of function series. Taylor's Theorem. Power series and Taylor series of elementary functions. Fourier series.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Every student is obliged to fulfill conditions for signature in Calculus II and to pass the exam.
Conditions for signature: Students are expected to attend and actively participate at all classes.
Exam: written and oral.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation 1**	Seminar paper	Experiment
Written exam 2.5	**Oral exam 3.5**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:
Students' work is continually observed. Integral part of observing and evaluating of students is the quality of active contribution in work on the lectures and exercises. Student's integral knowledge is evaluated in the exam.

Required literature

1. S.Kurepa: Matematička analiza I, II, Tehnička knjiga, Zagreb (više izdanja)
2. B.P.Demidovič: Zadaci i riješeni primjeri iz više matematike, Tehnička knjiga, Zagreb (više izdanja)

Recommended literature

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	LINEAR ALGEBRA II

General Information

Program	UNDERGRADUATE PHYSICS				Year	I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		7
Hours/semester		45 + 0 + 45

Course objectives

- to acquaint students with basics of systems of linear equations, matrices, determinants and linear operators

Correspondence and correlation with the program

The program is correspondent to the program of other mathematical courses, especially Analysis I, Analysis II and Euclidean Spaces.
Prerequisite for this course is Linear Algebra I.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand and apply basic properties of linear operators, matrices and determinants, and to solve a system of linear equation and analyze its solution.

Course content

Solving systems of linear equations, the existence and properties of solutions of such systems, matrices and determinants, Schwartz-Cauchy-Bunjakovki inequality, norm, metric functions, Gram-Schmidt orthogonalization process, quadratic forms.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Students must attend the lectures and participate in all activities required for the course.
Exam: written and oral.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation 1**	Seminar paper	Experiment
Written exam 3	**Oral exam 3**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:
Student's activities are evaluated during the semester. Final exams are written and oral.

Required literature

4. S.Kurepa: Uvod u linearnu algebru, Školska knjiga, Zagreb, 1975.
5. S.Kurepa: Konačnodimenzionalni vektorski prostori, Liber, Zagreb, 1992
6. K.Horvatić: Linearna algebra I, II i III, Sveučilište u Zagrebu, PMF, Matematički odjel, Zagreb, 1995.

Recommended literature

3. J. Dieudonne: Linearna algebra i elementarna geometrija, Školska knjiga, Zagreb, 1977.
4. L. Čaklović: Zbirka zadataka iz linearne algebre, Školska knjiga, Zagreb, 1976.

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	PHYSICS III

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	7	
Hours/semester	60+0+30	

Course objectives

To teach the students the essentials of atomic and crystal structure from the experimental and theoretical point of view.

Correspondence and correlation with the program

A foreknowledge from Physics I, Physics II and Elementary mathematics is required. Knowledge acquired in this course is indispensable in Physics IV, Basic practica III and IV, Advanced practicum, as well as for a deepened approach to specialized fields of physics provided by elective courses.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The students are expected to get a broad basic education in the fields of modern physics and to gain ability to follow its future development.

Course content

Periodic system. Bohr theory, hydrogen atom. Optical spectroscopy. Atomic processes – excitation (radiative, collisional), ionization, recombination, fluorescence, phosphorescence, Brehmsstrahlung. Franck-Hertz experiment. X-rays, Moseley's law. Compton effect. Correspondence principle. Wave-particle dualism. Uncertainty relations. Schrödinger equation. Angular momentum. Magnetism. Electron spin. Stern-Gerlach experiment. Fine structure. Zeeman effect. Stark effect.
Crystals. X-ray diffraction, Bragg law.
Energy-band theory. Metals, semiconductors, insulators. Electrons and holes. Pure and doped semiconductors. Hall effect. *p-n* junction.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	Consultations	Laboratory work	Tutorials	Field work

Comments:

Student requirements

To attend the lectures and exercises and to pass the examination

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 1.5	**Class participation 1.5**	Seminar paper	Experiment
Written exam 1.5	**Oral exam 2.5**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Required literature

Halliday D., Resnick R., Walker J., *FUNDAMENTALS OF PHYSICS* , 6th ed., J.Wiley and Sons Inc., New York, 2003.
Haken H., Wolf H.C., *ATOMIC AND QUANTUM PHYSICS,* 2nd ed., Springer-Verlag, 1984
Thorne A., Litzén U., Johansson S., *SPECTROPHYSICS*, Springer-Verlag, 1999

Recommended literature

Bueche F.J., PRINCIPLES OF PHYSICS, 5th ed., McGraw-Hill, 1988
Gettys W.E., Keller F.J., Skove M.J., *PHYSICS CLASSICAL AND MODERN*, McGraw-Hill, 1989
K. Seeger: *SEMICONDUCTOR PHYSICS*, Springer 1991
Beiser A., THEORY AND PROBLEMS OF PHYSICAL SCIENCE, Schaum's Outline Series, McGraw-Hill, 1974
http://www.physics.nmt.edu/~raymond
http://www.croeos.net/

Quality assurance of course and/or module

The quality of the course will be permanently verified by the student progress which is controlled through examinations and other achievement records (solving problems during the course exercises and written tests).

Course code	
Course title	PHYSICS LABORATORY II

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	4	
Hours/semester	0 + 45 + 0	

Course objectives

Introducing the student to the skills in measurement, statistical analysis of results, display and interpretation of measurement results, establishing a connection of experimental to theoretical approach to the subject, developing a conceptual understanding.

Correspondence and correlation with the program

The course program is corresponds to Physics Laboratory I, directly follows the content of General Physics II course, and is required for all other core Laboratories in the program, as well as for Methodical laboratory and Methodic in physics.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Developing specific skills in experimental measurement, gaining competence in statistical analysis, display and interpretation of experimental results, as well as developing ability to connect theory to experimental measurement.

Course content

Simple electric circuits. Complex electric circuits. Internal electrical resistance of voltage sources. Ampermeter and voltmeter measurement range extension. Measurement of electrical resistance, coil inductivity and capacitor capacity. Reflection of light on plane mirror. Refraction of light on prism and half sphere. Refraction of light on lenses. Plane and spherical mirrors on optical bench. Lenses on optical bench. Microscope.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	Exercises	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	**Laboratory work**	Tutorials	Field work

Comments:
Students are obliged to write a lab preparation in advance. Measurements and statistical evaluation of results is done in laboratory. A completed measurement evaluation and discussion is submitted in the form of seminar paper. The corrections and assessment of work on consultation hours.

Student requirements

The General Physics II is required to enroll this course. Written preparation for every lab work is needed. Measurement results need to be within expected experimental errors,

evaluation and calculation done precisely, discussion and conclusions drawn correctly. Finished previous and prepared next lab exercise is required for access to measurement. Obligatory consultations for correction of negatively assessed papers. Students are obliged to attend laboratory classes regularly; missing the class possible twice in semester, but all the measurements should be done during the semester. All seminar papers should be approved and signed in order to access the final course exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	**Seminar paper 1**	**Experiment 1**
Written exam	**Oral exam 1**	Essay	Research work
Project work	**Continuous assessment 0,5**	Presentation	Practical work
Experimental results evaluation 0,5			

Comments:
Student's work and progress is followed continuously: the knowledge is assessed colloquially during the laboratory measurements, written preparations and evaluations are assessed regularly. Organized and connected knowledge, as well as conceptual understanding on subject is assessed on final course exam.

Required literature

Laboratory II working materials.
Holjević S., Marković B., Stipčić-Šolić N., Milotić B., Fizikalna mjerenja I, Liber, Zagreb, 1980.
Holjević S., Marković B., Stipčić-Šolić N., Milotić B., Blažević J., Fizikalna mjerenja II, Liber, Zagreb, 1990.
Marković B., Miler D., Rubčić A., Račun pogrešaka i statistika, Liber, Zagreb, 1987.

Recommended literature

Required literature for Physics II course.
Wilson J. D., Physics Laboratory Experiments, 5th edition, Houghton Mifflin Company, Boston, 1998.
Gymnasium textbooks in physics.
http://www.phy.ntnu.edu.tw/java/index.html
http://webphysics.davidson.edu/Applets/Applets.html

Quality assurance of course and/or module

Feedback on course quality and achievements is obtained from permanent communication to students in lab and on consultation hours. Student's progress and adopted level of integrated thinking is being followed during the course.

Course code	
Course title	THEORETICAL PHYSICS I

General Information

Program	UNDERGRADUATE PHYSICS				Year	1I
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	8	
Hours/semester	60+0+30	

Course objectives

Developing mechanical concepts. To acquaint the students with mathematical skills as the basis for the theoretical physics.

Correspondance and correlation with the program

Prerequesits for this course are following: *Physics I, basics mathematics, Matematical Analisys I,II, Linear algebra I,II.*
Course is in korelation with *Theoretical physics II, III, IV*.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Higher and deeper understanding of Mechanics. It is expected that student will learn mathematical knowledge and neccessary notions for the next courses in theoretical physics. Developing of physical chain of reasoning. Student must learn to solve numerical problems.

Course content

Tensor calculus. Point dynamics in one dimension – Newtonian formulation of mechanics, integration of Newton's equation of motion, linear oscillations. Conservation laws. Generalized coordinates. Analytical mechanics. Classical dynamics of point systems. Central force. The theory of special relativity. The theory of general relativity.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Excercises**	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	Labratory work	**Tutorials**	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected. Final oral and written exam. Written exam is solving of numerical exercises.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance **0.2**	**Class participation** **0.3**	Seminar paper	Experiment
Written exam **3**	**Oral exam** **4**	Essay	Research work
Project work	**Continuous assessment** **0.5**	Presentation	Practical work

Comments:

Required literature

Kaliman Z., *Teorijska mehanika*, Filozofski fakultet u Rijeci, Rijeka, 2002.
Spiegel M. R., *Theoretical mechanics*, Schaum Outline Series, McGraw-Hill Book Company, New York, 1967.
Wells D. A., *Lagrangian Dynamics*, Schaum Outline Series, McGraw-Hill Book Company, USA, 1967.

Reccomended literature

Bradbury T. C., *Theoretical Mechanics*, John Wiley & Sons, New York, 1968.
Chow T. L., *Classical Mechanics*, John Wiley & Sons, USA, 1995.

Barger V. D., Olsson M. O., *Classical mechanics, A Modern Perspectives,* McGraw-Hill Book Company, New York, 1995.
José J. V., Saletan E. J., *Classical Dynamics : A Contemporary Approach* Cambridge Univ Pr,1998.
Feynman R., *Osobitosti fizikalnih zakona*, Školska knjiga, Zagreb, 1991.

Goldstein H., *Classical Mechanics*, Addison-Wesley Publishing Company, USA, 2nd edition, 1980.

Janković Z., *Teorijska mehanika*, Skripta PMF, Sveučilišna naklada Liber, Zagreb, 1976.

Landau L. D., Lifšic E. M., *Mehanika*, Građevinska knjiga, Beograd, 1961.

Barger V. D., Olsson M. O., *Classical mechanics, A Modern Perspectives,* McGraw-Hill Book Company, New York, 1995.
Supek I., *Teorijska fizika i struktura materije*, Tisak, Zagreb, 1974.
http://www.courses.fas.harvard.edu/~phys16/
http://mitpress.mit.edu/SICM/book-Z-H-4.html#%_toc_start

Quality assurance of course and/or module

Discussions with the students, questionnaires, achievements on the exams.

Course code	
Course title	ANALYSIS III

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	6	
Hours/semester	45+0+45	

Course objectives

This course aims to give students the basic knowledge about:
-sequences in R^n,
-real and vector functions of one or several variables,
-differential calculus and its application,
-multiple Riemann's integrals and applications.

Correspondence and correlation with the program

Course program is correspondent to the program of similar courses in the other mathematics studies.
There exists a correlation with the following courses: Analysis I and Analysis II, Complex Analysis.
This course is based to Analysis I and Analysis II.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

-To introduce students to the ideas of *formal* definitions and *rigorous* proofs and to develop their powers of logic thinking.
-To get the knowledges to use differential and integral calculus in other disciplines.

Course content

Limit and continuity of real and vector functions of one or several variables. Differential and partial derivations. Schwartz's theorem. The intermediate value theorem and its consequences. The implicit function theorem. The inverse function theorem. Maximum and minimum of a function. Taylor's theorem .Sequences and compact sets in R^n. Continuous functions on a compact. Multiple Riemann's integrals. Vector functions. Curves and integrals by curves. Vector and scalar fields. Green's theorem.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected.
Student gets a grade after written and oral exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation 0.5**	Seminar paper	Experiment
Written exam 2.5	**Oral exam 3**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments: Students are encouraged to active participate at a class and it influences to a final assessment.

Required literature

1. S.Kurepa: Matematička analiza, Tehnička knjiga, Zagreb, 1975.
2. S.Mardešić: Matematička analiza, I. dio, Školska knjiga, Zagreb, 1974.
3. V.A.Zoric :Matematyceskih analiz, I. Nauka, Moskva, 1981.

Recommended literature

Quality assurance of course and/or module

- questionnaire at the end of the course aimed to assess students' understanding,
- questionnaire designed to evaluate course program, lectures and lecture materials, teaching methods and interaction with students .

Course code	
Course title	MATHEMATICAL METHODS IN PHYSICS I

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	6	
Hours/semester	45+0+45	

Course objectives

To acquaint the students with mathematical skills as the basis for the theoretical physics.

Correspondance and correlation with the program

Prerequesits for this course are following: *Elementary mathematics, Matematical Analisys I,II, Linear algebra I,II.*
Course is in korelation with *Theoretical physics I,II, III, I, Mathematical methods in physics I.*

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

It is expected that student will learn mathematical knowledge courses in theoretical physics.

Course content

Limit and continuity of real and vector functions of one or several variables. Differential and partial derivations. Schwartz's theorem. The inverse function theorem. Maximum and minimum of a function. Taylor's theorem. Vector functions. Curves and integrals by curves. Vector and scalar fields. Vector and tensor analysis. Special orthogonal coordinate systems. Integral theorems. Fourier series and integrals. Numerical methods.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Excercises**	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	Labratory work	**Tutorials**	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected. Final oral and written exam. Written exam is solving of numerical exercises.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance **0.2**	**Class participation** **.3**	Seminar paper	Experiment
Written exam **2**	**Oral exam** **3**	Essay	Research work
Project work	**Continuous assessment** **0.5**	Presentation	Practical work

Comments:

Required literature

1. Kurepa, S: *Matematička analiza III*, Tehnička knjiga, Zagreb, 1975.
2. Chow. T. L.: *Mathematical Methods for Physicists*, Cambridge University Press, 2003.

Reccomended literature

1. Mardešić S.: *Matematička analiza, I. dio*, Školska knjiga, Zagreb, 1974.
2. Zoric V.A.: *Matematyceskih analiz, I.* Nauka, Moskva, 1981.
3. Kreyszig E.: *Advanced engineering mathematics*, John Wiley & Sons, 1993.

http://functions.wolfram.com/

http://www.iop.org/Select/

Quality assurance of course and/or module

Discussions with the students, questionnaires, achievements on the exams.

Course code	
Course title	COMBINATORICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	4	
Hours/semester	30 + 0 + 30	

Course objectives

In this course we will study and apply combinatorial techniques in a variety of settings.

Correspondence and correlation with the program

The program is correspondent to the program of other mathematical courses, especially to Discrete mathematics.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this class, students should be able to:

- describe and compare various forms of the Pigeonhole principle,
- discuss and solve different counting problems,
- apply recursive relations and generating functions in solving mathematical problems,
- analyse problems; formulate them into mathematical terms and use the appropriate strategies to solve them; verify and interpret the solutions; and present their mathematical arguments and solutions in a logical and clear fashion.

Course content

Pigeonhole principle. Ramsey theorem. Basic counting techniques. Permutations and combinations of the sets and multisets. Binomial and multinomial coefficients. Including-excluding principle and applications. Möbius inversion. Reccurence relations. Generating functions. Some combinatorial structures.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected; final written and oral exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance **0.5**	**Class participation** **0.5**	Seminar paper	Experiment
Written exam **1**	**Oral exam** **1**	Essay	Research work
Project work	**Continuous assessment** **0.5**	Presentation	Practical work

Comments:
Student's activities are evaluated during the semester. Final exams are written and oral.

Required literature

1. D.Veljan, Kombinatorna i diskretna matematika, Algoritam, Zagreb, 2001.
2. D.Veljan, Kombinatorika s teorijom grafova, Školska knjiga, Zagreb, 1989.
3. M.Cvitković, Kombinatorika, zbirka zadataka, Element, Zagreb, 2001.

Recommended literature

1. D. Žubrinić, Diskretna matematika. Element, Zagreb, 1997.

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	PROGRAMMING

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	4	
Hours/semester	30+0+30	

Course objectives

This course provides basic comprehension of approaches, concepts and methods in programming and gives an introduction to modular program construction.
The course familiarises the student with commonly used algorithms, using the C++ programming language.

Correspondence and correlation with the program

Course program is in correlation with the programs of the courses: Objektno orijentirano modeliranje i programiranje (Object-oriented modelling and programming) and Algoritmi i strukture podataka (Algorithms and Data Structures).
This course provides the necessary background for these courses.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The student should become familiar with the:
- basic operation of the programming environment and computer literacy.
- Boolean expressions, variable types and
memory storage.

The student should learn:
- how to develop an algorithm and implementation to compute a mathematical function.
- to convert a set of Mathematical statements into a C++ Boolean expression.
- to develop an algorithm using programming language selection constructs.
- to develop an algorithm and implementation that repeatedly executes a sequence of steps.
- to debug a simple program and remove all syntax errors and all logic errors.
- to use preprogrammed functions to implement an algorithm.
- to implement a hierarchical design using methods/functions.
- to properly document code to a given standard.
- to develop and write a program that uses one or more array structures to store information.
- to develop and write a program that uses simple data files to store and retrieve information.

Course content

Historical survey of programming languages. Procedural and object-oriented languages. General or multipurpose languages. Special-purpose languages.

The software development process. Developing programs interactively. Concepts of imperative, structured programming. The notion of the algorithm.

Syntax and semantix of C++. Types, values and declarations: Names. Declarations. Type definitions. Numeric data types. Logical types. Character types. Enumeration types. Expressions and statements: Expressions. Statements. Sequencing and control. Iterative

statements.

Program structure: Procedural architecture. Alternative program architectures. Simple algorithms for search and sort. Parameters. Functions. Separate Compilation. Modules. Storage management. Recursion. Structured data: Arrays. Records. Strings. Files. Pointers. Dynamic data structures.

Modes of instruction (mark in bold)

Lectures 2 hours	Seminars and workshops	Exercises	Independent work	Multimedia and the Internet
Distance learning	Consultations	**Laboratory work 2 hours**	Tutorials	Field work

Comments:
Laboratory work will be done in a computer laboratory.

Student requirements

Students are expected to:
- attend classes regularly
- make necessary preparations for classes
- do practical work
- present seminar paper
- pass two midterm exams and a final exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 0.7	**Class participation 0.3**	Seminar paper	Experiment
Written exam 1	**Oral exam 1**	Essay	Research work
Project work	**Continuous assessment 0.5**	Presentation	**Practical work 0.5**

Comments:

Required literature

1. Julijan Šribar, Boris Motik:
Demistificirani C++, Dobro upoznajte protivnika da biste njime ovladali, Element, Zagreb, 2001.

Recommended literature

1. Jesse Liberty, Teach Yourself C++ in 24 Hours, SAMS, 1999.
2. Leslie B.Wilson and Robert G.Clark: Comparative Programming Languages, Third Edition, Addison-Wesley, 2001.

Quality assurance of course and/or module

Quality of the course will be monitored and measured through the success of examinations and through the anonymous inquiry reflecting students opinions regarding the course.

Course code							
Course title	INTRODUCTION TO POLYTECHNICS						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	II
Course status		Core	**X**	**Elective**			
Credits and Teaching							
					Winter semester	Summer semester	
ETCS credits / student workload					4		
Hours/semester					30 + 0 + 0		

Course objectives

Introduce students to the basic methodological approach to the scientific study of history of Technic. Enable students to understand specific laws of correlation in the development of science. Enable students to independently research the history of Technics.

Correspondence and correlation with the program

Correspondence: Program of the course corresponds to the content of similar courses in other Technical programs. **Correlation:** There are no prerequisites for this course.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Understanding fundamentals of today used technic achievements.

Course content

Human environment in context of biosphere and its characteristics: Nature, Society, Technic. Three layers of human development: cognitive, affective and psychomotoric. Development, differentiation and specific systematization of Science. Meaning and tasks of the specific scientific fields. Tasks and historical development of technical sciences. Definition and field of study of technics and technology in the contemporary context. Laws of technical development: from elements, through machines, to production systems.

Basic technical inventions and their function. Tools, mechanism, apparatus, machines and aggregates. Principles of periodisation and major technical inventions of to various periods of development. Inter-relation between technical and other sciences.

Factors that influence technical development. Production relations and technical development. Technical and tehnological processes and limitations of development. Directions of further development and the role of tehnology in society.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	Exercises	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Student requirements

Students are required to attend lectures and to pass the exam. Exam consists of written and oral parts.

Evaluation and Assessment

Class attendance **0.5**	Class participation Ø	Seminar paper Ø	Experiment Ø
Written exam **1.5**	**Oral exam** **2**	Essay Ø	Research work Ø

Project work	Continuous assessment	Presentation	Practical work
Ø	Ø	Ø	Ø

Required literature

V. Bazala, Pregled povijesti znanosti, ŠK, Zagreb, 1980.
H. Burger, Filozofija tehnike, Naprijed, Zagreb, 1989.

Recommended literature

P. Naville, U susret automatiziranom društvu, ŠK, Zagreb, 1989.

Quality assurance of course and/or module

Anonymous survy at the end of each semester. Analysis of results achived by students during a semester. Statistic analysis of the percentage of students that have passed the exam after the final exam date.

Course code							
Course title	PHYSICS IV						

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	**Summer semester**
ETCS credits / student workload		7
Hours/semester		60+0+30

Course objectives

This course is designed to give the fundamental knowledge in some parts of modern physics. Development of analytical, logical and abstract opinions (indispensable in physical considerations) are important too.

Correspondance and correlation with the program

Course program is correspondent to the program of similar courses in the other studies of natural science.
Preconditions for this course are following : Physics I and fundamental mathematical knowledge.
The course is in correlation with Physics II and Physics III.
It presents the basis for following courses : Physical practicum III, Higher (Progressive) physical practicum, several third year elective courses as well as for the certain courses of graduate physics' studies.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The following outcomes are expected :
Realization of previous quoted objectives.
Adoption of course program and possibility to use the knowledge in the other parts of physics and interdisciplinary fields.

Course content

Many-electron systems. Laser. Molecular structure. Molecular energy states and transitions (electronic, rotation, vibration). Raman effect.
Photons. Blackbody radiation. Interaction of electromagnetic radiation with matter (Photoelectric effect; Comptonov eeffect; Pair production of electron and positron).
Structure of atomic nuclei. Nuclear forces. Radioactivity. Nuclear models. Nuclear reactions. Mössbauer effect.
Elementary particles. Conservation laws. Classification of elementary particles. Mechanism of interaction between elementary particles.
Plasma.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Excercises**	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	**Labratory work**	Tutorials	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected ; tests and homeworks during the semester. Written and oral exams.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 1.25	**Class participation 0.50**	Seminar paper	Experiment
Written exam 2.25	**Oral exam 2.25**	Essay	Research work
Project work	**Continuous assessment 0.75**	Presentation	Practical work

Comments:

Required literature

Krane, K. S**.** *Modern physics*, John Wiley& Sons, New York, 1995.
Eisberg, R., Resnick, R. *Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles*, John Wiley& Sons, New York, 1985.

Reccomended literature

Gautreau, R. *Schaum's Outline of Modern Physics*, McGraw-Hill, New York, 1999.
Bransden, B.H., Joachain, C. J. *Physics of Atom and Molecules*, Prentice Hall, 2002.
Serway, R. A., Moses, C. J., Moyer, C. A. *Modern Physics*, Brooks Cole, 2004.
Llewellyn, R., Tipler, P. A. *Modern Physics*, W. H. Freeman & Co., 2002.
http://www.dse.nl/~motion/welcome.html
http://www.physics.uc.edu/~johnson/qualifying.exams/Index.html

Quality assurance of course and/or module

Discussions with students about difficulties, origin eventually in course objectives realization.
The questionnaire about students' expectation at the beginning of the course.
The questionnaire designed to evaluate quality of course program, lectures and lecture materials, teaching methods and interaction with students at the end of the course.

Course code	
Course title	PHYSICS LABORATORY III

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	**Summer semester**
ETCS credits / student workload		4
Hours/semester		0 + 45 + 0

Course objectives

Introducing the student to the skills in measurement, statistical analysis of results, display and interpretation of measurement results, establishing a connection of experimental to theoretical approach to the subject, developing an conceptual understanding.

Correspondence and correlation with the program

The course program directly follows the content of General Physics I, II and III courses, and is required for Methodical laboratory in physics and Methodic in physics.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Developing specific skills in experimental measurement, gaining competence in statistical analysis, display and interpretation of experimental results, as well as developing ability to connect theory to experimental measurement.

Course content

Mechanical waves and sound waves. Colorimetric measurements (absorption of light). Diffraction of light on slit, optical grid and fiber. Polarimeter. Determination of coil magnetic field. Determination of electron mass. Photoelectric effect. Determination of specific heat capacity. Specific heat of water vaporization and ice melting. Checking the gas laws. Checking the gas laws in terms of gas kinetic theory. Measurement of air humidity.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	Exercises	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	**Laboratory work**	Tutorials	Field work

Comments:
Students are obliged to write a lab preparation in advance. Measurements and statistical evaluation of results is done in laboratory. A completed measurement evaluation and discussion is submitted in the form of seminar paper. The corrections and assessment of work on consultation hours.

Student requirements

The General Physics I and II are required to enroll this course. Written preparation for every lab work is needed. Measurement results need to be within expected experimental errors,

evaluation and calculation done precisely, discussion and conclusions drawn correctly. Finished previous and prepared next lab exercise is required for access to measurement. Obligatory consultations for correction of negatively assessed papers. Students are obliged to attend laboratory classes regularly; missing the class possible twice in semester, but all the measurements should be done during the semester. All seminar papers should be approved and signed in order to access the final course exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	**Seminar paper 1**	**Experiment 1**
Written exam	**Oral exam 1**	Essay	Research work
Project work	**Continuous assessment 0,5**	Presentation	Practical work
Experimental results evaluation 0.5			

Comments:
Student's work and progress is followed continuously: the knowledge is assessed colloquially during the laboratory measurements, written preparations and evaluations are assessed regularly. Organized and connected knowledge, as well as conceptual understanding on subject is assessed on final course exam.

Required literature

Laboratory III working materials.
Holjević S., Marković B., Stipčić-Šolić N., Milotić B., Fizikalna mjerenja I, Liber, Zagreb, 1980.
Holjević S., Marković B., Stipčić-Šolić N., MilotiB. ć, Blažević J., Fizikalna mjerenja II, Liber, Zagreb, 1990.
Marković B., Miler D., Rubčić A.: Račun pogrešaka i statistika, Liber, Zagreb, 1987

Recommended literature

Required literature for Physics I and II courses.
Wilson J. D., Physics Laboratory Experiments, 5th edition, Houghton Mifflin Company, Boston, 1998.
Gymnasium textbooks in physics.
http://physicsweb.org/
http://www.physics.nmt.edu/~raymond

Quality assurance of course and/or module

Feedback on course quality and achievements is obtained from permanent communication to students in lab and on consultation hours. Student's progress and adopted level of integrated thinking is being followed during the course.

Course code	
Course title	THEORETICAL PHYSICS II (STATISTICAL PHYSICS)

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	-	8
Hours/semester	-	60+0+30

Course objectives

Introduction to concepts and methods used in investigations of the systems with large numbers of particles in physics and inter-disciplinary fields

Correspondence and correlation with the program

Preconditions are the courses: Physics I, II, III, Theoretical Physics I, the first year mathematical courses.
This course is important for the third year elective courses: Computational Physics, Atomic and Molecular Physics, Condensed Matter Physics, Nuclear Physics, Elementary Particle Physics, as well as for the postgraduate studies: Master of Science in Physics and Environmental Studies, Master of Science in Physics and Materials.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

It is expected that students will develop the knowledge and mathematical skills in the analysis of systems of many particles, and concepts about applications of statistical physics and physics in related inter-disciplinary fields.

Course content

Thermodynamics. Classical Statistical Physics. Quantum Systems. Quantum Statistical Physics. Irreversible Statistical Mechanics. Phase Transitions and Critical Phenomena. Statistical Physics in Econophysics and Biophysics.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	**Exercises**	**Independent work**	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	**Tutorials**	Field work

Comments:

Student requirements

Class attendance, homeworks and projects during the semester, tests, questionnaires, written and oral exams

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance **1**	**Class participation** **1**	Seminar paper	Experiment
Written exam **1.5**	**Oral exam** **1.5**	Essay	**Research work** **0.5**
Project work **1**	**Continuous assessment** **1.5**	Presentation	Practical work

Comments:

Required literature

1. Yu. B. Rumer, M. Sh. Ryvkin, Thermodynamics, Statistical Physics, and Kinetics, Mir Publishers, Moscow.
2. R. Kubo, Thermodynamics, North-Holland, Amsterdam
3. R. Kubo, Statistical Mechanics, North-Holland, Amsterdam
4. Web page and WebCT of the course

Recommended literature

1. R. N. Mantegna, H. E. Stanley, Introduction to Econophysics: Correlations and Complexity in Finance, Cambridge University Press
2. C. J. Thompson, Mathematical Statistical Mechanics, The Macmillan Company, New York
3. F. Reif, Fundamentals of Statistical and Thermal Physics, McGraw-Hill

http://scienceworld.wolfram.com/physics/
http://physics.weber.edu/thermal/

Quality assurance of course and/or module

Discussions with the students, questionnaires, homeworks and projects, achievements on the exams

Course code	
Course title	MATHEMATICAL METHODS IN PHYSICS II

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		6
Hours/semester		45+0+30

Course objectives

To acquaint the students with mathematical skills as the basis for the theoretical physics.

Correspondance and correlation with the program

Prerequesits for this course are following: *Elementary mathematics, Matematical Analisys I,II, Linear algebra I,II, . Mathematical methods in physics I.*
Course is in korelation with *Theoretical physics II, III, IV*

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

It is expected that student will learn mathematical knowledge courses in theoretical physics.

Course content

Differential equations: Ordinary differential equations of the first order: Existence and uniqueness of the solution. Elementary methods of solving: Equations with variables separable. Homogeneous equations. Linear equations. Exact equations, integrating factor. Equations of higher orders: Equations solvable by a highest derivative. Linear differential equations of the n-th order. Homogeneous and nonhomogeneous linear equations with constant coefficients. Equations in the mathematical physics.

Complex analysis: Holomorphic functions. Cauchy- Riemann's conditions. Elementary functions. Differential calculus of functions of a complex variable. Complex integration. Series representation of analytic functions. Laurent series. Residue Theorem and applications. Poles of meromorphic functions. Evaluation of real definite integrals.

Special functions of mathematical physics: Gamma function. Legendre's polynomials and functions. Spherical harmonics. Bessel functions. Hypergeometric functions.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Excercises**	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	Labratory work	**Tutorials**	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected. Final oral and written exam. Written exam is solving of numerical exercises.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance **0.2**	**Class participation** **0.3**	Seminar paper	Experiment
Written exam **2**	**Oral exam** **3**	Essay	Research work
Project work	**Continuous assessment** **0.5**	Presentation	Practical work

Comments:

Required literature

3. Chow T. L.: *Mathematical Methods for Physicists*, Cambridge University Press, 2003.
4. Wylie C., R.: *Differential equations*, Mc Graw Hill, New York, 1979.
5. Kraljević H., Kurepa, S: *Matematička analiza IV (funkcije kompleksne varijable)*, Tehnička knjiga, Zagreb, 1984.
6. Abramowitz M., Stegun I. A.: *Handbook of mathematical Functions,*

Reccomended literature

4. Mardešić S.: *Matematička analiza, I. dio*, Školska knjiga, Zagreb, 1974.
5. Zoric V. A.: *Matematyceskih analiz, I*. Nauka, Moskva, 1981.
6. Brown J., W., Churchill V. R.: *Complex Variables and Applications*, McGraw-Hill, Inc., 1996.
7. Kreyszig E.: *Advanced engineering mathematics*, John Wiley & Sons, 1993.

http://electron6.phys.utk.edu/phys594/Arrchives.htm
http://ocw.mit.edu/index.html

Quality assurance of course and/or module

Discussions with the students, questionnaires, achievements on the exams.

Course code	
Course title	MATHEMATICAL LOGIC

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		4
Hours/semester		30 + 0 + 30

Course objectives

- to acquaint students with basic notions of mathematical logic

Correspondence and correlation with the program

The programme of the course Set theory is in correlation with the other mathematical courses, especially Set theory and Algebra.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand and apply basic notions of mathematical logic.

Course content

Classical sentential logic: syntax, semantics, alternational and conjunctional normal form, Craig lemma, compactness theorem, validity tests, Hilbert's formal system for sentential logic (deduction theorem, soundness and completeness theorems).
First order logic: syntax, semantics, prenex normal form, validity test for first order logic, , Hilbert's formal system for first order logic (deduction theorem, soundness theorem), generalized completeness theorem (sketch of Henkin's proof). Consequences: Gödel's completeness theorem, compactness theorem. Limits of first order logic.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	**Independent work**	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Students must attend the lectures and participate in all activities required for the course.
Exam: written and oral.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation **0.5**	Seminar paper	Experiment
Written exam **1.5**	Oral exam **2**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:
Student's activities are continuously being monitored. Quality of student's active participation during classes and exercises is a component of the monitoring and evaluation. Complete knowledge of the student is evaluated at the exam.

Required literature

1. M.Vuković: (2000.) Matematička logika I - Skripta, Sveučilište u Zagrebu, PMF, Matematički odjel

Recommended literature

1. A.G.Hamilton: (1988.) Logic for Mathematicians (Cambridge University Press)
2. E.Mendelson: (1964.) Introduction to mathem. Logic (D. van Nostrand Reihold Company, New York)
3. Joel V.Robbin: (1969.) Mathem. Logic (W.A.Benjamin Inc. New York)

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	ALGORITHMS AND DATA STRUCTURES

General Information

Program	UNDERGRADUATE PHYSICS				Year	II
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		4
Hours/semester		30 + 0 + 30

Course objectives

The course studies the concept of an algorithm, some basic algorithms commonly used in programming, and the efficiency of these algorithms. It introduces abstract data types and the data structures commonly used to represent them.
The student should become familiar with the basic data structures, the operations that are naturally connected to these structures, and how they can be used in solving a number of algorithmic problems.

Correspondence and correlation with the program

Course program is in correlation with the program of the course Programiranje (Programming) which provides the necessary background for this course.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The student should become familiar with the:
- fundamental data types of computing (lists, stacks, queues, priority queues, sets, maps, trees, etc.)
- major techniques for implementing the fundamental data types (linked lists, binary search trees, hashing, heaps, etc.)
- fundamental sorting and searching algorithms of computing and how to analyze them.

The student should understand how recursion works and how to write recursive algorithms.

The student should learn:
- to use language-provided data structure libraries
- basic algorithm analysis
- to identify the most important abstract data types and the ways in which they may be implemented
- to describe an implementation using plain natural language or pseudocode.

Course content

Abstract Data Type. Algorithm Efficiency. Searching. Linear Lists. Stacks. Queues. Recursion. Introduction to Trees. Search Trees. Heaps. Advanced Sorting Concepts. Graphs.

Modes of instruction (mark in bold)

Lectures 2 hours	Seminars and workshops	Exercises	Independent work	Multimedia and the Internet
Distance learning	Consultations	**Laboratory work 2 hours**	Tutorials	Field work

Comments:
Laboratory work will be done in a computer laboratory.

Student requirements

Students are expected to:

- attend classes regularly
- make necessary preparations for classes
- do practical work
- present seminar paper
- pass a final exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 0.25	**Class participation 0.75**	**Seminar paper 0.5**	Experiment
Written exam 1	**Oral exam 1**	Essay	Research work
Project work	Continuous assessment	Presentation	**Practical work 0.5**

Comments:

Required literature

1. Richard F. Gilberg, Behrouz A. Forouzan: Data Structures: A Psuedocode approach with C, Brooks/Cole, 1998.
2. Robert Sedgewick: Algorithms in C, Parts 1-5 (Bundle): Fundamentals, Data Structures, Sorting, Searching, and Graph Algorithms, Addison-Wesley Professional, 2001.

Recommended literature

1. Mark Allen Weiss: Data Structures and Algorithm Analysis in C, Addison Wesley, 1996.

Quality assurance of course and/or module

Quality of the course will be monitored and measured through the success of examinations and through the anonymous inquiry reflecting students opinions regarding the course.

Course code							
Course title	THERMODYNAMICS						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	II
Course status		Core		**X**	**Elective**		

Credits and Teaching		
	Winter semester	Summer semester
ETCS credits / student workload		4
Hours/semester		30 + 0 + 30

Course objectives

Introduce Students with the basic terms of thermal processes. Enable students to apply their knowledge through the completion of practical tasks.

Correspondence and correlation with the program

Correspondence: Program of the course corresponds to the content of similar courses in other technical programs **Correlation:** Prerequisites for this course are: Physics I, this course also correlates with the following courses: Energetics.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Understanding thermal processes theory. Develop abilities to apply gained knowledge.

Course content

The sizes of the physical conditions of matter: Pressure, Temperature and Volume. Instruments used for the measurement of Pressure, Temperature and the flow of Fluids. The first law of Thermodynamics. Conducting, transport, radiation and the transfer of Heat. Changes of condition of the working Matter: Isobars, Isohors, Isotherms, Adiabatic and Polythrops. Cyclic processes of Engines with internal combustion and Gas turbine.

Water vapor. Thermal diagrams of water Vapor. Cyclic processes of the Steam powered plant. Adiabatic circulation of gases and vapors. Circulation through nozzles.

Cold vapors. Cold vapors diagrams. Cyclic processes of the compressor cooler device. Humid air. measuring of the relative humidity. Molier s (i - x) - Diagram of the humid Air. Basics of the central heating and the climatisation of Rooms.

Combustion of fossil fuels: contents of fuels, Air quantity, quantity of the smoke Gas, thermal value of fuel, combustion Temperature, combustion control.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Student requirements

Students are required to attend numeric excercises and, as far as the homework coes - they have to make one larger Thermodynamical calculation of the chosen thermal process (calculation of the cyclic process of the thermal machine, simplified calculation for the central heating of the family house, or similar). Upon the completion of their obligations, students take the exam. The exam consists of both written and oral parts.

Evaluation and Assessment

Class attendance	Class participation	**Seminar paper**	Experiment
Ø	Ø	**1**	Ø

Written exam **1**	**Oral exam** **2**	Essay Ø	Research work Ø
Project work Ø	Continuous assessment Ø	Presentation Ø	Practical work Ø

Required literature

L. Majetić, "200. zadataka iz Termodinamike", Pedagoški fakultet u Rijeci, Rijeka, 1998.

Recommended literature

M. Jurjević, Termodinamika I., II., Viša pomorska škola u Rijeci, 1985.

Quality assurance of course and/or module

Anonymous survy at the end of each semester. Analysis of results achieved by students during a semester. Statistic alalysis of the percentage of students that have passed the exam after the final exam date.

Course code						
Course title	THEORETICAL PHYSICS III					

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	8	
Hours/semester	60+0+30	

Course objectives

- giving the basic knowledge of classical electrodynamics and special theory of relativity
- connecting the exact theoretical results with the relevant objects from electricity and magnetism that students have learned in earlier courses

Correspondence and correlation with the program

Prerequisites for attending the course are courses:
- Physics I,II,III
- Theoretical physics I

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

- understanding the idea how simple and basic equations for the electromagnetic field, with the help of mathematical methods, can explain complex physical phenomenon's
- understanding of the significance of the exact definition of physical quantities for their correct interpretation

Course content

Electrostatics
Coulomb's law, electric field, scalar potential, basic equation of electrostatics, electrostatic potential energy, multipole expansion, macroscopic electrostatics, dielectrics, boundary-value problems
Magnetostatics
Current, continuity equation, Biot and Savart law, vector potential, basic equations of magnetostatics, macroscopic magnetostatics, paramagnetics, diamagnetics, feromagnetics
Maxwell equations
Faraday's law, energy of the magnetic field, basic Maxwell's equations, scalar and vector potential, gauge transformations, Poynting's theorem, conservation laws, electromagnetic momentum, macroscopic electrodynamics
Electromagnetic waves
Wave equation, plane waves, polarization, group velocity, reflection and refraction, energy of the electromagnetic field, retarded vector potential, radiation of a localized source
Special theory of relativity
Postulates of special relativity, Lorentz transformation, length contraction and time dilatation, addition of velocities, light cone, 4-vectors and tensors, covariance of electrodynamics,

transformation of electromagnetic field.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments: The course Theoretical physics II (Classical electrodynamics) is realized through lectures and exercises. In addition, the consultations with students are obligatory, as well as some multimedia presentations (e.g. the demonstration of electric and magnetic field)

Student requirements

Determined by the Statute. The exam consists of two parts: the written part (with numerical tasks) and oral part.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 0.25	**Class participation 0.25**	**Seminar paper 0.25**	Experiment
Written exam 3	**Oral exam 4**	Essay	Research work
Project work	**Continuous assessment 0.25**	Presentation	Practical work

Comments: The accepted knowledge is tested continuously on exercises and consultations. The total level of understanding and knowledge of the course is finally tested on the exam.

Required literature

- Supek I., *Teorijska fizika i struktura materije*, 1. part, Školska knjiga, Zagreb, 1977.
- Griffiths D. J., *Introduction to Electrodynamics*, 3. izdanje, Prentice-Hall, New Jersey, 1999.
- Jackson J. D., *Classical Electrodynamics*, 3. edition, John Wiley, New York, 1999.
- Feynman R. P., *Lectures on Physics*, vol.2, Addison-Wesley, Readings, 1964.

Recommended literature

- Purcell E., *Electricity and Magnetism*, Berkeley Physics Course, vol. 2, McGraw-Hill, New York.
- Straton J. A., *Electromagnetic Theory*, McGraw-Hill, New York, 1941.
- Reitz J. R., Milford F. J., *Foundations of Electromagnetic Theory*, 4. edition, Addison-Wesley, Reading, 2000.
- Landau L.D., Lifshitz E.M., *Electrodynamics of Continuous Media*, Addison-Wesley, Reading, Mass. 1960.

http://www.tphys.uni-heidelberg.de/~wegner/e.dyn/
http://fermi.la.asu.edu/schmidt/index.html

Quality assurance of course and/or module
Realized through consultations and tests.

Course code							
Course title	BASIC PRACTICUM IV						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	III
Course status	**X**	**Core**		Elective			
Credits and Teaching							
			Winter semester		Summer semester		
ETCS credits / student workload			4				
Hours/semester			0+45+0				
Course objectives							
By use of experimental approach to improve student knowledge on current electricity in vacuum, gases and solids, to make him understand the structure and function and practical application of the basic electronic devices, circuits and systems.							
Correspondence and correlation with the program							
This course relies heavily on basic ideas of current electricity and its properties in vacuum, gases and solids which have been studied in the preceding Physics II, Physics III and Basic practicum II							
Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)							
The student is expected to develop the ability to assemble experimental sets for specific purpose and to construct simple electronic circuits of assigned function.							
Course content							
Student practical construction tasks consisting of ten experimental units for individual performance: - electronic tubes (vacuum, gas-filled) - semiconductor devices (diode, transistor) - rectifier circuits - low signal transistor amplifier - basic operational amplifier circuits - electronic filters (passive, active) - shaping of electronic signals (differentiating, integrating, cutting) - oscillator - multivibrators (bistable, monostable, astable) - digital circuits (logic gates)							
Modes of instruction (mark in bold)							

Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet
Distance learning	Consultations	**Laboratory work**	Tutorials	Field work

Comments:

Student requirements

To go through all experimental units one by one: by preparing the basic theory, carrying out the required observations and measurements, writing a report on the results and their discussion. Each of these steps is verified by the teacher, including the final examination.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 0.8	Class participation	Seminar paper	**Experiment 0.8**
Written exam	**Oral exam 0.8**	Essay	Research work
Project work	**Continuous assessment 0.8**	**Presentation 0.8**	Practical work

Comments:

Required literature

D. Kotnik-Karuza: Osnove elektronike s laboratorijskim vježbama, Filozofski fakultet u Rijeci, 2000

P. Biljanović: Elektronički sklopovi, Školska knjiga, Zagreb, 2001

P. Biljanović: Mikroelektronika (Integrirani elektronički sklopovi), Školska knjiga, Zagreb, 2001

Recommended literature

H. Schwetlick, W.Kessel: Elektronikpraktikum für Naturwissenschaftler, Vieweg&Sohn, Braunschweig/Wiesbaden, 1993

D.V. Hall: Digital circuits and systems, Mc Graw-Hill, 1989

Millman-Halkias: Integrated electronics, Analog and digital circuits and systems, Mc Graw-Hill Kogakusha, 1972

D.L. Schilling, C.Belove: Electronic circuits, Mc Graw-Hill, 1989

K. Seeger: Semiconductor physics, Springer 1991

B. Juzbašić: Elektronički elementi, Školska knjiga, Zagreb, 1980

Nuffield Advanced Science PHYSICS: Teacher's Guide 1,2, Longman Group Ltd, Hong Kong 1988

Nuffield Advanced Science PHYSICS: Sudent's Guide 1,2, Longman Group Ltd, Hong Kong

1988
University Laboratory Experiments PHYSICS 1-5, PHYWE AG, Göttingen, 1995
http://www.fearofphysics.com/Atom/atom1.html
http://www.ba.infn.it/www/didattica.html

Quality assurance of course and/or module

It is achieved through permanent monitoring of students' laboratory work, development of their experimental skills, progress in finding the correlation of observations and measurements with theory, thus improving its comprehension.

Course code	
Course title	ADVANCED PRACTICUM

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	4	
Hours/semester	0+45+0	

Course objectives

- To improve the understanding of physics theory
- To shed light on the microscopic scale of phenomena that are unavailable to usual everyday perception
- To repeat and to confirm elementary knowledge of physics
- To help the construction of physical models using the simplest possible mathematical formalism
- To give insight in the scientific methodology of natural sciences based on active relations between theory and experiment.

Correspondence and correlation with the program

Knowledge of basic Physics I, II, III, IV, Mathematical methods and completed Basic practica I, II, III and IV. Facilitates the understanding of relevant subjects in theoretical physics.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The student is expected to improve his understanding of the theory, to confirm his elementary knowledge of modern physics, to become able to construct physical models using the simplest possible mathematical formalism and to get insight in the scientific methodology of natural sciences.

Course content

The students are given a set of basic experiments to be carried out individually. They are dealing with subjects and phenomena of modern physics: Zeeman effect, Compton effect, Franck-Hertz experiment, Moseley's law and Hall effect. The number and content of experimental units will be extended with time.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet
Distance learning	Consultations	**Laboratory work**	**Tutorials**	Field work

Comments:

Student requirements

To go through all experimental units one by one: by preparing the basic theory, carrying out the required observations and measurements, writing a report on the results and their discussion. Each of these steps is verified by the teacher, including the final examination.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 0.8	Class participation	Seminar paper	**Experiment 0.8**
Written exam	**Oral exam 0.8**	Essay	Research work
Project work	**Continuous assessment 0.8**	**Presentation 0.8**	Practical work

Comments:

Required literature

Halliday D., Resnick R., Walker J., *FUNDAMENTALS OF PHYSICS* , 6th ed., J.Wiley and Sons Inc., New York, 2003.
Haken H., Wolf H.C., *ATOMIC AND QUANTUM PHYSICS,* 2nd ed., Springer-Verlag, 1984
Thorne A., Litzén U., Johansson S., *SPECTROPHYSICS*, Springer-Verlag, 1999

Recommended literature

Bueche F.J., PRINCIPLES OF PHYSICS, 5th ed., McGraw-Hill, 1988
Gettys W.E., Keller F.J., Skove M.J., *PHYSICS CLASSICAL AND MODERN*, McGraw-Hill, 1989
K. Seeger: *SEMICONDUCTOR PHYSICS*, Springer 1991
Beiser A., THEORY AND PROBLEMS OF PHYSICAL SCIENCE, Schaum's Outline Series, McGraw-Hill, 1974
http://www.phys.ksu.edu/perg/vqm/laserweb/
http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Quality assurance of course and/or module

It is achieved through permanent monitoring of students' laboratory work, development of their experimental skills, progress in finding the correlation of observations and measurements with theory, thus improving its comprehension.

Course code	
Course title	MEASUREMENTS IN PHYSICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	4	
Hours/semester	30+30+0	

Course objectives

To develop an interest and appreciation for the measurement and its key role in all stages of building a physical theory (discovering an unexplained phenomenon, sorting between the proposed theories, perpetual efforts on verifying the current theory in progressively more extreme conditions, investigating its validity domain, initiating the work on the more general theory).

Correspondence and correlation with the program

Parts of this course overlap with (complement the) certain themes from the "Physics foundation course" (atoms and nuclei, particle physics).
The historic overview in the first half of the course is in correlation with the course "History of physics" (5^{th} year).

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

On completion of the course the students should be able to identify the key experiments which were fundamental for the development of modern physical theories and to describe those experiments and the significance of their results.
Furthermore, the students learn in considerable detail about the basic procedures and instrumentation in producing, manipulating and using the monochromatic beams of charged particles and photons for the experiments in basic research and application fields.

Course content

1. Selection from the methods of measuring physical quantities from antiquity to the beginning of the modern age.
2. Overview of the experiments essential for the development of the modern physics (measurements of the velocity of light, measurement of the gravitational constant, confirmations of the special relativity and general theory of gravitation, discoveries of the constituents of atoms, discovery of the first antiparticle (positron), measurements of the structure of the proton and neutron (quarks), proofs of quantum mechanics, measurements of the relics of the big bang and the early conditions in our universe.
3. Methods of production of beams of particles (electrons, photons) with desired characteristics (monochromatic, focused) and their use in modern instrumentation, from small, laboratory instruments to the national experimental facilities (electronic, mass and optical spectrometers, synchrotrons, big colliders).

4. Study visit to the synchrotron laboratory ELETTRA near Trieste, Italy.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	Exercises	Independent work	Multimedia and the Internet
Distance learning	Consultations	**Laboratory work**	Tutorials	**Field work**

Comments:
20 hours of lectures, 10 hours of seminars, one laboratory project or a research of a particular experimental subject to be described in the form of an essay, preparation for the synchrotron visit.

Student requirements

To choose a subject for the research project and to work towards its completion with their team-mates (2-3 students in a team). To divide the work towards the project completion according to their personal skills and preferences.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation 0.5**	Seminar paper	Experiment
Written exam	**Oral exam 2**	**Essay 0.5**	Research work
Project work 1	Continuous assessment	Presentation	Practical work

Comments:
Students choose to participate either in the laboratory project or the literature study for the essay. The oral exam is obligatory for all. The overall mark for the course is a weighted mean of the two marks earned.

Required literature

No single text-book applies. The lecturer will further specify the chapters from the available literature during the course, in consultation with the students.

Recommended literature

Consider as an example:
1. Fizika II (Elektromagnetizam i optika), Ivanović D. i Vučić V.
2. Experimental Atomic Physics, Harnwell GP and Livingwood JJ, McGraw-Hill (1933)
3.The Particle Connection, C. Sutton, Hutchinson (1984)
4. Prve tri minute svemira, Weinberg S, MISL – Zagreb (1994)
5. The Internet.
http://physics.kenyon.edu/EarlyApparatus/Titlepage/Optics.html
http://xxx.lanl.gov/

Quality assurance of course and/or module

Surveys of the student opinions during the course and after its completion, success rate analysis.

Course code	
Course title	COMPUTATIONAL PHYSICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	4	-
Hours/semester	30+30+0	-

Course objectives

Introduction to the analysis of simple and complex physical problems by numerical methods.

Correspondence and correlation with the program

Preconditions are the courses: Computer Lab I, II, Physics I, II, III, IV, mathematical courses, Theoretical Physics I, II, Programming.
This course is important for all postgraduate studies.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

It is expected that students will synthesize the knowledge and mathematical skills from various courses, develop skills in the analysis of complex physical problems and concepts about importance of computer simulations and methods in modern technologically oriented society and scientific research.

Course content

Numerical methods in physics and mathematics. Molecular dynamics computer simulation. Monte Carlo simulation. Simulations of quantum systems. Animation and visualization in computer simulation.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	Exercises	**Independent work**	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	**Tutorials**	Field work

Comments:

Student requirements

Class attendance, homeworks and projects during the semester, tests, questionnaires

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 0.4	**Class participation 0.4**	Seminar paper	Experiment
Written exam	Oral exam	Essay	**Research work 0.4**
Project work 2	**Continuous assessment 0.8**	Presentation	Practical work

Comments:

Required literature

1. Web page and WebCT of the course
2. H. Gould and J. Tobochnik, An Introduction to Computer Simulation Methods, Addison-Wesley, Reading, Massachusetts
3. D. W. Heermann, Computer Simulation Methods in Theoretical Physics, Springer-Verlag, Berlin

Recommended literature

1. W. H.Press, B. P. Flannery, S. A. Teukolsky, W. T. Vetterling, Numerical Recipes, Cambridge University Press
2. D. Frenkel, B. Smit, Understanding Molecular Simulation (from algorithms to applications), Academic Press
3. M. P. Allen, D. J. Tildesley, Computer Simulation of Liquids, Clarendon Press, Oxford
4. D. C. Rapaport, The Art of Molecular Dynamics Simulation, Cambridge University Press
5. S.E.Koonin, Computational Physics, Benjamin Cummings

http://www.pefri.hr/~goranka/phys2comp.html
http://www.pefri.hr/~goranka/comp2phys.html

Quality assurance of course and/or module

Discussions with the students, questionnaires, homeworks and projects, achievements on the exams

Course code	
Course title	INTRODUCTION TO DIGITAL SYSTEMS

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	5	
Hours/semester	30+0+30	

Course objectives

The aim of this course is to present the fundamental knowledge about digital systems and their functioning.

Correspondence and correlation with the program

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The students will be introduced to basic terms in digital system design.

Course content

Information and number systems. Design of combinational logic. Boolean algebra basics. Truth tables. K Maps. Arithmetic Logic unit. Decoders. Multiplexers. Read Only memory. Sequential Devices. Flip-Flops. Combinations of Flip-Flops. Programmable Array Logic. Gate Arrays. Design of simple state machines.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	Consultations	Laboratory work	**Tutorials**	Field work

Comments:

Student requirements

It is compulsory for students to attend exercises. A student has to pass the written (practical) part of the examination which regards the exercises, as the precondition to take the oral part of examination where the complete knowledge of the student is examined and evaluated

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation**	Seminar paper	Experiment
Written exam	Oral exam	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Required literature

1. J. Župan, M. Tkalić, M. Kunštić. Logičko projektiranje digitalnih sustava. Školska knjiga Zagreb, 1995.
2. U. Peruško: Digitalna elektronika, Školska knjiga Zagreb, 1996.

Recommended literature

3. Palmer, D.E. Perlman. Introduction to Digital Systems. McGraw-Hill, 1993

Quality assurance of course and/or module

Annonimus poll in the end of semester. Statistical reports on results obtained on quizies, partial exams, homeworks and final project. In the end statistical report on passing.

Course code	
Course title	EUCLIDEAN SPACES

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	5	
Hours/semester	30 + 0 + 30	

Course objectives

Objective of this course is to introduce basic properties of affine spaces and Euclidean spaces.

Correspondence and correlation with the program

The program is correspondent to the program of other mathematical courses, especially to Linear Algebra I, Linear Algebra II and Geometry.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand basic properties of affine and Euclidean spaces.

Course content

Definition of affine and Euclidean spaces. Affine subspaces (k-planes). Intersection and sum of affine subspaces and their dimension. Parallel planes. Coordinates. Transformation of coordinates. Convexity. Half spaces. Parallelotops. Simplexes. Affine mappings. Translation. Euclidean spaces. Distance and angle between planes. Orthogonal planes. Volume of parallelotop and simplex. Isometries. Classification of isometries of Euclidean space.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Students must attend the lectures and participate in all activities required for the course.
Exam: written and oral.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	Seminar paper	Experiment
Written exam **2**	**Oral exam** **3**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:
Student's activities are evaluated during the semester. Final exams are written and oral.

Required literature

1. S.Kurepa: Konačno dimenzionalni vektorski prostori i primjene, Liber, Zagreb, 1992.
2. M.Audin: Geometry, Springer-Verlag, Heidelberg, 2002.
3. D.M.Bloom: Linear Algebra and Geometry, Cambridge University Press, Cambridge, 1988.
4. K.W.Gruenberg, A.J.Weir: Linear Geometry, Springer, New York, 1977.

Recommended literature

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	INTRODUCTION TO DIFFERENTIAL GEOMETRY

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	5	
Hours/semester	45 + 0 + 30	

Course objectives

- acquisition a fundamental terms of curves in the plane and in the space and theirs differential attributes
- acquisition a fundamental terms of surface, her submitting, differential attributes and a special category of surfaces
- acquisition a types of curves on surfaces

Correspondence and correlation with the program

Program of the course Introduction to Differential Geometry is in the correlation with other mathematical courses, especially with the courses: Analysis II, Analysis III and Linear Algebra I.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand basic properties of curves and surfaces and to apply this knowledge.

Course content

Vector fields. Covariant derivatives. Curves in the plane and in the space. Curvature of curves. Frenet's formulas. Fundamental theorems of theory of curves. Surfaces. The tangent plane to surface. The first and the second quadratic form of a surface. The shape operator of a surface. The spectar of shape operator. The total (Gaussian) and mean curvatures. The three fundamental forms. The types of curves on surfaces: asymptotic curves, geodesic curves. A special category of surfaces: surfaces of constant curvature, ruled surfaces, revolution surfaces.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected. Participation in continuous assessment and final written and oral exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance ∅	**Class participation** **1**	Seminar paper ∅	Experiment ∅
Written exam **2**	**Oral exam** **2**	Essay ∅	Research work ∅
Project work ∅	Continuous assessment ∅	Presentation ∅	Practical work ∅

Comments:

Required literature

1. A. Gray: Modern Differential Geometry of Curves and Surfaces with *Mathematica*, CRC Press, Boca Raton - Boston - London - New York - Washington, 1998.
2. R. S. Miliman, G. D. Parker: Elements of Differential Geometry, Prentice - Hall, Engelwood Cliffs - New Yersey, 1997.
3. I. Kamenarović: Diferencijalna geometrija, Sveučilište u Rijeci, Pedagoški fakultet, Rijeka, 1990.

Recommended literature

1. B. O'Neil: Elementary Differential Geometry, Acad. Press, New York - San Francisco - London, 1966.
2. B. Žarinac-Frančula: Diferencijalna geometrija, Zbirka zadataka i repetitorij, Sveučilište u Zagrebu, Geodetski fakultet, Zagreb, 1980.

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code							
Course title	GRAPHICAL COMMUNICATION 1						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	III
Course status		Core		**X**	**Elective**		
Credits and Teaching							
				Winter semester		Summer semester	
ETCS credits / student workload				3			
Hours/semester				30 + 0 + 15			

Course objectives

The objective of the course in to educate students for graphic solutions of technical problems in the space geometry by means of drawings in the plane and the application of the acquired knowledge and skills in elementary and secondary schools.

Correspondence and correlation with the program

The programmes correspondents to the programmes of the relevant universities.

The subject is in the correlation with the teaching programmes of the engineering elements and engines.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Understanding of graphic solutions to the technical problems. Master basic skills needed for using PC based CAD programs.

Course content

The rules and recommendations ISO and DIN norm for technical designs (lines, formats and measures). The orthogonal projection in two and three planes (point, length, plane and engineering elements). Pictorial projections (isometric, oblique and diametric projection). Drawing sections and dimensioning. Tolerances and harshness surface.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Student requirements

Obedience attendance of the lectures and graphical exercises.

Compulsory or optional cause units (Lectures- graphical exercises-make thesis- written examination-oral examination).

Graphical program (I – Orthogonal projection, II – Pictorial projection and III – complex drawings and workshop drawing (Tolerances and harshness surface).

Evaluation and Assessment

Class attendance	**Class participation 0,5**	**Graphical program 0.5**	Experiment Ø
Written exam 1	**Oral exam 1**	Essay Ø	Research work Ø
Project work Ø	Continuous assessment Ø	Presentation Ø	Practical work Ø

Required literature

Ć. Koludrović, *Tehničko crtanje u slici s kompjutorskim aplikacijama,* Zagreb, 1994.

A. Bukša, *Grafičke komunikacije – Zbirka zadataka*, Rijeka, Pomorski fakultet, 2001.

Recommended literature

MICROSTATION, Osnove CAD projektiranja, INA – INFO, Zagreb, 1994.

B. Burchard, D. Pitzer, Od ideje do projekta – AutoCAD 2000, Zagreb, Algoritam 2000.

Parker M.- Pickup F., *Engineering drawing with worked examples 1*, Cheltenham, Stanley Thorns, 1990.

Hercigonja, Eduard, *Tehnička grafika*, Zagreb, Školska knjiga, 1996.

Kovač, Branko, *Tehničko crtanje*, Zagreb, Školska knjiga, 1975.

Quality assurance of course and/or module

An anonymous questionnaire at the and of each semester. Following the student's results during the semester. Statistical review of the examination.

Course code							
Course title	STRENGTH OF MATERIAL						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	III
Course status		Core	**X**	**Elective**			

Credits and Teaching		
	Winter semester	Summer semester
ETCS credits / student workload	4	
Hours/semester	30+0+15	

Course objectives

To teach students elementary concepts in stress-strain analysis. In addition, students are required to solve numerical problems.

Correspondence and correlation with the program

The program corresponds with similar courses in strength of materials offered by faculties of civil and mechanical engineering. The program correlates with the course in mathematics.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Ability to understand fundamental areas in stress-strain analysis and developing necessary skills needed for solving numerical problems.

Course content

Basic concepts. Definition of stress and strain. Axial stresses and deformation. Hooke`s law. Allowed stresses. Statically undefined structures. Sliding. Torsion. Bending. Elastic lines. Twisting.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Student requirements

Attendance to exercises is mandatory.

Evaluation and Assessment

Class attendance Ø	Class participation Ø	Seminar paper Ø	Experiment Ø
Written exam **2**	**Oral exam** **2**	Essay Ø	Research work Ø
Project work Ø	Continuous assessment Ø	Presentation Ø	Practical work Ø

Required literature

Brnić,J.: Nauka o čvrstoći, ŠK, Zagreb, 1991.

Recommended literature

Sapunar,Z.: Zbirka zadataka iz čvrstoće materijala, Viša pomorska škola u Rijeci,Rijeka,1986.

Quality assurance of course and/or module

Exam grades (% of students who successfully completed the course and passed the exam), and the anonymous student evaluation poll.

Course code							
Course title	MACHINE ELEMENTS AND MECHANISMS 1						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	III
Course status		Core	**X**	**Elective**			
Credits and Teaching							
					Winter semester	Summer semester	
ETCS credits / student workload					3		
Hours/semester					30 + 0 + 15		
Course objectives							
Knowledge about types of machine elements and their functions, designs, materials and calculations.							
Correspondence and correlation with the program							
The course is correspondent with similar courses in mechanical engineering, electrical engineering or naval architecture. Preconditions for enrolling: courses about engineering design communication and, mechanics.							
Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)							
General knowledge about machine elements. Basic knowledge about design and calculation of machine elements.							
Course content							
Types of load. Stresses and deformations of machine elements. Types of loads regarding their change during time. Material characteristics. Allowable stresses. Stress concentration. Thermal stresses. Types of machine elements. Welded joints. Bonded joints. Riveted joints. Bent sheet metal joints. Snap joints. Threaded fasteners. Power screws. Pins. Shaft-hub connections. Springs. Axes and shafts, critical speed. Lubricants, friction, lubrication.							
Modes of instruction (mark in bold)							
Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet			
Distance learning	Consultations	Laboratory work	Tutorials	Field work			
Student requirements							
Attendance at lectures and exercises, making of design projects, written and oral exam.							
Evaluation and Assessment							
Class attendance Ø	Class participation Ø	**Seminar paper** **1**	Experiment Ø				
Written exam **1**	**Oral exam** **1**	Essay Ø	Research work Ø				
Project work Ø	Continuous assessment Ø	Presentation Ø	Practical work Ø				
Required literature							
B. Križan: *Osnove proračuna i oblikovanja konstrukcijskih elemenata*, Sveučilište u							

Rijeci, Rijeka, 1999.

H. Decker: *Elementi strojeva*, Tehnička knjiga, Zagreb, 1985.

Recommended literature

M. Opalić, M. Kljajin, S. Sebastijanović: *Tehničko crtanje*, Sveučilište u Zagrebu, Sveučilište J.J. Strossmayer u Osijeku, Čakovec 2003.

Quality assurance of course and/or module

Anonymous questionnaires at the end of the semester. Control of results achieved during semester. Analysis of exams efficiency.

<table>
<tr><td>Course code</td><td colspan="6"></td></tr>
<tr><td>Course title</td><td colspan="6">THEORETICAL PHYSICS IV</td></tr>
<tr><td colspan="7">General Information</td></tr>
<tr><td>Program</td><td colspan="4">UNDERGRADUATE PHYSICS</td><td>Year</td><td>III</td></tr>
<tr><td>Course status</td><td>X</td><td>Core</td><td></td><td>Elective</td><td colspan="2"></td></tr>
<tr><td colspan="7">Credits and Teaching</td></tr>
<tr><td colspan="3"></td><td colspan="2">Winter semester</td><td colspan="2">Summer semester</td></tr>
<tr><td colspan="3">ETCS credits / student workload</td><td colspan="2"></td><td colspan="2">8</td></tr>
<tr><td colspan="3">Hours/semester</td><td colspan="2"></td><td colspan="2">60+0+30</td></tr>
<tr><td colspan="7">Course objectives</td></tr>
<tr><td colspan="7">- giving the basic knowledge of the concept of quantum physics and the deep insight into the quantum nature (dualism) of fields and particles
- explaining how the proper understanding of microscopic phenomena can lead to the well controlled macroscopic phenomena</td></tr>
<tr><td colspan="7">Correspondence and correlation with the program</td></tr>
<tr><td colspan="7">Prerequisites for attending the course are courses:
- Physics I,II,III,IV
- Theoretical physics I,II</td></tr>
<tr><td colspan="7">Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)</td></tr>
<tr><td colspan="7">- understanding the significance of the experiment (observation) in physics and its influence to the new theoretical predictions
- understanding the significance of the abstract way of thinking</td></tr>
<tr><td colspan="7">Course content</td></tr>
<tr><td colspan="7">The physical basis of quantum mechanics
Inadequacy of classical physics, Bohr-Sommerfeld quantization rules, uncertainty and complementarity principle, limitations on experiment, space and time packets
The Schrodinger equation
The properties of the Schrodinger wave equation, interpretation of the wave function, Hermitean operators and physical quantities, eigenfunctions and eigenvalues, problem of measurement, motion of a free wave packet in one dimension, harmonic oscillator, spherically symmetric potentials, angular momentum, the hydrogen atom
The periodic table of elements and spin
The definition of spin, Pauli spin matrices, total angular momentum, Zeeman effect, identical particles: spin and statistics, the helium atom, periodic table of elements
Approximation methods for bound states
The variation method, stationary perturbation theory, Stark effect, the WKB approximation, time-dependent perturbation theory, interaction picture, transition probability
Collision theory
Green’s function, scattering cross section, scattering amplitude, S matrix, Born approximation, electron scattering from hydrogen
Modern quantum physics</td></tr>
</table>

Second quantization, field quantization, relativistic quantum physics, elementary particles, astrophysics

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments: The course Theoretical physics IV (Quantum mechanics) is realized through lectures and exercises. In addition, the consultation with students is obligatory as well as some multimedia presentations (e.g. probability densities for various systems). The part *Modern quantum physics* is given to students only as information.

Student requirements

Determined by the Statute. The exam consists of two parts: the written part (with numerical tasks) and oral part

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 0.25	**Class participation 0.25**	**Seminar paper 0.25**	Experiment
Written exam 3	**Oral exam 4**	Essay	Research work
Project work	**Continuous assessment 0.25**	Presentation	Practical work

Comments: The accepted knowledge is tested continuously on exercises and consultations. The total level of understanding and knowledge of the course is finally tested on the exam.

Required literature

- Supek I., *Teorijska fizika i struktura materije*, 2. part, Školska knjiga, Zagreb, 1977.
- Griffiths D. J., *Introduction to Quantum Mechanics*, Prentice-Hall, New Jersey, 1994.
- Gasiorowicz S., *Quantum Physics, John Wiley*, New York, 1996.
- Eisberg R., Resnick R., *Quantum Physics, John Wiley*, New York, 1974.
- Feynman R. P., *Lectures on Physics*, vol.3, Addison-Wesley, Readings, 1964.
- Schwabl T., *Quantum Mechanics*, Springer-Verlag, Berlin, 1995.
- Schiff L. I., *Quantum Mechanics*, 3. edition, McGraw-Hill, New York, 1968.

Recommended literature

- Park D., *Introduction to Quantum Theory*, 3. edition, McGraw-Hill, 1992.
- Messiah A., *Quantum mechanics*, Dover, New York, 2000.
- Merzbacher E., *Quantum Mechanics*, 3. edition, John Wiley, New York, 1998.
- Sakurai J. J., *Modern Quantum Mechanics*, Addison-Wesley, Reading, 1994.
- Landau L., *Quantum Mechanics*, 3. edition, Butterworth-Heinman, Oxford, 1977.

http://socrates.berkeley.edu/~budker/Tutorials/index.html
http://electron6.phys.utk.edu/phys594/Arrchives.htm

Quality assurance of course and/or module
Realized through consultations and tests.

Course code	
Course title	B. Sc. THESIS SEMINAR

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status	**X**	**Core**		Elective		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	-	2
Hours/semester	-	0+30+0

Course objectives

Introduction to written and oral presentations of scientific subjects. Preparation for the B.Sc. thesis.

Correspondence and correlation with the program

Preconditions are the courses of the first and second year. This course is important for the B. Sc. thesis. It is strongly correlated with the courses related to the thesis subject.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

It is expected that students will learn new methods in the analysis of scientific topics and develop skills of written and oral presentations.

Course content

Defined by the B.Sc. thesis advisor.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	Exercises	**Independent work**	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	**Tutorials**	Field work

Comments:

Student requirements

Student prepares a written and oral seminar in the field of B.Sc. thesis. Consultations with the advisor.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	**Seminar paper 1.4**	Experiment
Written exam	Oral exam	Essay	**Research work 0.4**
Project work	**Continuous assessment 0.2**	Presentation	Practical work

Comments:

Required literature

Depends on the topic of the B.Sc. thesis.

Recommended literature

Depends on the topic of the B.Sc. thesis.

Quality assurance of course and/or module

Discussions with the students, questionnaires, achievements on the B.Sc. thesis exam.

Course code	
Course title	ELECTRONICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		5
Hours/semester		30+0+30

Course objectives

Starting from the basic knowledge of semiconductor physics to acquaint the students with electronic devices, models, circuits and systems through a step-by-step approach.

Correspondence and correlation with the program

A foreknowledge from Physics II, Physics III, Basic practicum IV and Mathematical methods is required. Knowledge acquired in this course finds its application in the study of instrumental methods and techniques in physics and chemistry.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The student is expected to acquire knowledge on basic electronic devices, circuits and systems to be ready for their practical application.

Course content

Analog and digital electronics. Basic devices, circuits and systems. Transistor amplifiers, emitter follower, feedback amplifiers, differential amplifier, cascading amplifiers. Operational amplifier. Multivibrators. Logic gates.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	Consultations	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Attendance at lectures and exercises and passing the examination.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance **1**	**Class participation** **1**	Seminar paper	Experiment
Written exam **1**	**Oral exam** **2**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Required literature

D. Kotnik-Karuza: Osnove elektronike s laboratorijskim vježbama, Filozofski fakultet u Rijeci, 2000
P. Biljanović: Elektronički sklopovi, Školska knjiga, Zagreb, 2001
P. Biljanović: Mikroelektronika (Integrirani elektronički sklopovi), Školska knjiga, Zagreb, 2001
P. Biljanović, I. Zulim: Elektronički sklopovi (zbirka zadataka), Školska knjiga, Zagreb, 1994
G. Smiljanić: Impulsna i digitalna elektronika, Školska knjiga Zagreb, 1976

Recommended literature

D.V. Hall: Digital circuits and systems, Mc Graw-Hill, 1989
Millman-Halkias: Integrated electronics, Analog and digital circuits and systems, Mc Graw-Hill Kogakusha, 1972
D.L. Schilling, C.Belove: Electronic circuits, Mc Graw-Hill, 1989
K. Seeger: Semiconductor physics, Springer 1991
B.V.Stanić, M.I.Marković: Zbirka rešenih zadataka iz atomske fizike, Naučna knjiga Beograd, 1984
K.H.Rohe: Elektronik Digitalelektronik, Teubner, Stuttgart, 1985
http://wnt.cc.utexas.edu/~wlh/index.cfm
http://viper.hep.princeton.edu/~mcdonald/examples/

Quality assurance of course and/or module

The quality of the course will be permanently verified by the student progress which is controlled through examinations and other achievement records (solving problems during the course exercises and written tests).

Course code	
Course title	ASTROPHYSICS AND ASTRONOMY

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		5
Hours/semester		30+0+30

Course objectives

Introduce the students into general astronomy, its basic methods and instruments, with an emphasis on the recent development of astrophysical research.

Correspondence and correlation with the program

Foreknowledge from the preceding courses of basic Physics, Mathematical methods, Statistical physics and History of physics is expected.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The students are expected to improve their knowledge of areas of physics which are necessary to understand the dynamic and physical properties of different components of the Universe and to raise their interest for the scientific and technical achievements of modern astrophysical research.

Course content

Astronomical distances, units and methods of measurement. Instruments. Methods (spectroscopy, photometry). Solar system: dynamic and physical characteristics. Sun. stars: spectral classification, HR diagram. Stellar structure and evolution. Interstellar matter. Milky way. Extragalactic systems. Cosmology.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	Consultations	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Attendance at lectures and exercises and passing the examination.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance **1**	**Class participation** **1**	Seminar paper	Experiment
Written exam **1**	**Oral exam** **2**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Required literature

V. Vujnović: Astronomija I, Školska knjiga, Zagreb 1989.
V. Vujnović: Astronomija II, Školska knjiga, Zagreb 1990.

Recommended literature

A.Unsold, B.Baschek: The new cosmos, Springer 1991.
M. Harwit: Astrophysical concepts, Springer 1988.
E. Boehm-Vitensee: Introduction to stellar astrophysics, Cambridge University press 1989.
H. Scheffler, H. Elsasser : Physics of the Galaxy and Interstellar matter, Springer 1987.
P. Lena: Observational astrophysics, Springer 1988.
H. Karttunen, P. Kroger, M. Pontanen, K.J. Donner: Fundamental astronomy, Springer 1994.
H. Schäfer: Astronomische Probleme und ihre physikalische Grundlagen, Vieweg&Sohn, 1980
H. Schäfer: Elektromagnetische Strahlung: Informationen aus dem Weltall, Vieweg&Sohn, 1985
http://www.iop.org/Select/

Quality assurance of course and/or module

The quality of the course will be permanently verified by the student progress which is controlled through examinations and other achievement records (solving problems during the course exercises and written tests).

Course code	
Course title	ATOMIC AND MOLECULAR PHYSICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		5
Hours/semester		30+0+30

Course objectives

1. The student should understand the basic principles governing the electronic structure of simple atoms and molecules and their energy spectra.
2. Become acquainted with the main processes accompanying collisions of electrons and photons with individual atoms and molecules.

Correspondence and correlation with the program

This course doesn't correspond directly to other courses of the program, but it builds on the backgrounds laid down in the "Physics foundation course" and is in correlation with part of the Theoretical Physics course dealing with the application of the quantum mechanics to atoms.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

On completion of the course the successful students should be able to:

1. recognize and understand the optical spectra of simple atoms in absorption and emission, as well as their disturbance in the presence of external electric and magnetic fields.
2. recognize and understand the main features of the molecular spectra involving the electronic transitions as well as the nuclear motion (vibrations, rotations).
3. Understand the dynamics of the main scattering processes involving interactions of the beams of monochromatic electrons with atoms and molecules.
4. Learn about the principles and basic instrumentation in the field of electron-impact spectroscopy.

Course content

1. The structure of atoms and molecules and their spectra - electrons, photons and atoms, the elements of quantum mechanics; one-electron atoms, interaction with electromagnetic radiation, fine and hyper-fine structure, atoms in external fields (Zeeman effect, Stark effect, Lamb shift): two-electron atom and its spectra, perturbative and variational methods; many electron atoms, the method of self-consistent field. Fundamentals of the laser physics, atoms in the laser field.
2. Molecular forces and structure, molecular spectra (electronic, vibrational, rotational). The Born-Openheimer approximation. Molecular pre-dissociation.
3. Electronic collisions with atoms and molecules – experimental methodology of

electron spectroscopy, basic techniques and instrumentation; basic description of the scattering theory and observed phenomena –approximative methods in the scattering theory, partial-wave analysis, elastic scattering and angular distributions, excitation and ionization, molecular dissociation, resonant scattering processes, electron correlations.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	Exercises	Independent work	Multimedia and the Internet
Distance learning	Consultations	**Laboratory work**	**Tutorials**	Field work

Comments:
From the total of 60 hours of tuition, lectures take at most 30, and the rest is distributed over seminars, tutorials and the work in the laboratory. Should circumstances allow, the classic laboratory exercises might be substituted by a more demanding laboratory project, involving a team work (up to 3 students).

Student requirements

To choose a subject for the laboratory- or research-project and to work towards its completion with other team-mates (2-3 students in a team). The students should divide the work required for the completion of the project according to their personal skills and preferences. The completed work will be presented in a written form (essay) and orally, in a seminar for the other students.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	Seminar paper	Experiment
Written exam	**Oral exam** **3**	**Essay** **0.5**	Research work
Project work 2	Continuous assessment	**Presentation** **0.5**	**Practical work** **1**

Comments:
Students choose to participate either in the laboratory project or the literature research study for the essay. The oral exam is obligatory for all. The overall mark for the course is a weighted mean of the two marks earned.

Required literature

No single text-book applies. The lecturer will further specify the selected chapters from the available literature during the course, from the recommended list and other sources.

Recommended literature

1. Physics of Atoms and Molecules, B.H. Bransden and C.J. Joachain, Prentice Hall (2003)
2. Atomic Collisions (Electron and Photon Projectiles), Earl W. McDaniel, John Willey

and Sons (199?)
3. Modern Physics, F. J. Blatt, McGraw-Hill (1992), or similar.
4. Atomska fizika - Mira Jurić, Naučna knjiga Beograd (1976).
http://www.iop.org/Select/

Quality assurance of course and/or module

Surveys of the student opinions during the course and after its completion, success rate analysis.

Course code	
Course title	CONDENSED MATTER PHYSICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload	-	5
Hours/semester	-	30+0+30

Course objectives

Introduction to the properties and applications of materials

Correspondence and correlation with the program

Preconditions are the courses: Physics I, II, III, IV, Theoretical Physics I, II, III, mathematical courses.
This course is important for the postgraduate studies Master of Science in Physics and Materials.
It is useful (but it is not compulsory) to chose undergraduate courses in Chemistry and Biology.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

It is expected that students will develop the knowledge of condensed matter physics and materials science, synthesis of the knowledge from various fields of physics, and concepts about applications of physics in one complex field that is very important for advanced technologies and scientific research.

Course content

Materials. Structure of crystals, liquids and disordered materials. Chemical bonds in materials. Dynamics of crystal lattice. Electrical properties of materials. Electrical transport. Thermal transport. Optical, dielectric, magnetic, and mechanical properties of materials. Superconductivity. Superfluidity. Nanostructures. Materials science and applications.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	**Exercises**	**Independent work**	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	**Tutorials**	Field work

Comments:

Student requirements

Class attendance, homeworks and projects during the semester, tests, questionnaires, written and oral exams

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance **5**	**Class participation** **0.5**	Seminar paper	Experiment
Written exam **1**	**Oral exam** **1**	Essay	**Research work** **0.25**
Project work **0.75**	**Continuous assessment** **1**	Presentation	Practical work

Comments:

Required literature

1. C.Kittel, Introduction to Solid State Physics, John Wiley and Sons, New York
2. H. Ibach and H. Luth, Solid State Physics, Springer, Berlin
3. L. Mihaly and M. C. Martin, Solid State Physics: Problems and Solutions
4. I. Kupčić, Solid State Physics, Problems and Solitions, HINUS, Zagreb (in Croatian)
5. Web page and WebCT of the course

Recommended literature

1. N.W.Aschroft, N.D.Mermin, Solid State Physics, Holt, Rinehart and Winston, New York
2. R. H. Silsbee and J. Drager, Simulations for Solid State Physics, Cambridge University Press

http://www.physics.uc.edu/~jarrell/

Quality assurance of course and/or module

Discussions with the students, questionnaires, homeworks and projects, achievements on the exams

Course code	
Course title	NUCLEAR PHYSICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	**Summer semester**
ETCS credits / student workload		5
Hours/semester		30+0+30

Course objectives

Deepened insight in behaviour of atomic nuclei.

Correspondance and correlation with the program

Preconditions for this course are following : Physics I,II,III,IV; Theoretical physics I,II; suitable mathematical knowledge.
Course program is in correlation with Theoretical physics III,IV and several elective courses: Elementary particles, Experimental methods in physics, …

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Adoption of course program and possibility to use the knowledge in certain interdisciplinary fields. It is expected that students will develop the knowledge and mathematical skills in the description of microscopics systems.

Course content

Composition of nuclei. Binding energy. Nuclear spins. Nuclear magnetic dipole moments. Parity. Nuclear models.Deuteron. Neutron – proton scattering at low energies. Proton – proton scattering at low energies. Nucleon – nucleon scattering at high energies. Properties of nuclear forces. Theory of nuclear forces. Laws of radioactive decay. Kinds of radioactive decay. Radioactive series. Nuclear reactions.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Excercises**	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	Labratory work	Tutorials	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected : tests and homeworks during the semester. Written and oral exams.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 0.75	**Class participation 0.25**	Seminar paper	Experiment
Written exam 1.75	**Oral exam 1.75**	Essay	Research work
Project work	**Continuous assessment 0.50**	Presentation	Practical work

Comments:

Required literature

Krane, K. S. *Introductory Nuclear Physics*, John Wiley & Sons, New York, 1987.
Shirokov, Z. M., Yudin, N. P. *Nuclear Physics*, MIR, Moskow, 1982.

Reccomended literature

Wong, S. S. M. *Introductory Nuclear Physics*, John Wiley & Sons, New York, 1999.
Heyde, K. *Basic Ideas and Concepts in Nuclear Physics: An Introductory (Series in Fundamental and Applied Nuclear Physics)*, Institute of Physics Publishing, 2004.
Lilley, J. S. *Nuclear Physics: Principles and Applications*, John Wiley, New York, 2001.
http://pdg.lbl.gov
http://particleadventure.org/

Quality assurance of course and/or module

Discussions with students about difficulties, origin eventually in course objectives realization.
The questionnaire about students' expectation at the beginning of the course.
The questionnaire designed to evaluate quality of course program, lectures and lecture materials, teaching methods and interaction with students at the end of the course.

Course code	
Course title	ELEMENTARY PARTICLES AND THEIR INTERACTIONS

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		5
Hours/semester		45+0+15

Course objectives

Presentation of general picture of the material world in terms of elementary particles and their interactions. Understanding material structures in the Universe. The main ideas and frameworks for description of particles and their interactions with restricted mathematical apparatus.

Correspondance and correlation with the program

The program is corresponding and it is correlated to all other programs of general physics and chemistry e.g. ...

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

General understanding of phenomena and ideas about forces and particles in Nature. Knowledge about basic facts. Skill in setting and solving simple examples.

Course content

On basic interactions – forces in Nature: gravitation (GTR), electromagnetic interaction, week and strong interactions. Their main characteristics: range of forces and relative importances, particles involved as source or carriers of force. The structure and/or processes characteristic for particular interaction: planetary system – Universe, atomic system – molecules – radiation, atomic nucleus - β-decay, nucleons, quarks. Standard model of elementary particles. Theoretical frameworks, the role of symmetries, unification of forces, Feynman diagrams.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	Excercises	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	**Seminar paper 1**	Experiment
Written exam	**Oral exam 3.5**	Essay	Research work
Project work	**Continuous assessment 0.5**	Presentation	Practical work

Comments:

Required literature

1. Ivica Picek: Fizika elementarnih čestica, Kratis, 1997.
2. Ivan Supek: Teorijska fizika i struktura materije I. i II. dio, ŠK

Recommended literature

1. L. Bergstrom and A. Goobar: Cosmology and particle astrophysics, Johny Willey and Sons, 1999.

http://pdg.lbl.gov
http://particleadventure.org/

Quality assurance of course and/or module

Discussions with the students, questionnaires, achievements on the exams.

Course code	
Course title	EXPERIMENTAL METHODS IN PHYSICS

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	**Summer semester**
ETCS credits / student workload		5
Hours/semester		30+30+0

Course objectives

This course is designed to give the knowledge about experimental methods in some parts of physics.

Correspondance and correlation with the program

Presumptions for this program are fundamental knowledge from following courses: Physics I,II,III.IV, Physical practicum I,II,III,IV and Theoretical physics II.
The course is in the correlation with Theoretical physics III,IV and some elective courses : Atomic and molecular physics, Nuclear physics, Elementary particles,…
It presents the basis for laboratory investigations of physical lawfulness.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Developing of comprehension about significances of experiment and experimental methods in new physical lawfulness forming

Course content

Statistical treatment of experimental data. Optical spectroscopy. Lasers and holography. Nuclear magnetic resonance. Particle and radiation detectors. Interactions of charged particles and photons with matter. Nuclear half – life measurements. X-ray diffraction methods. Vaccum technology. Low temperatures. Scattering and coincidence experiments : Compton scattering, Mössbauer effect, detection of cosmic rays, $\gamma - \gamma$ angular correlation measurements.

Modes of instruction (mark in bold)

Lectures	**Seminars** and workshops	Excercises	Independent work	**Multimedia and the Internet**
Distance learning	**Consultations**	**Labratory work**	Tutorials	Field work

Comments:

Student requirements

Attendance at all classes and active participation is expected : one seminar paper will be required. Oral exam.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance 1.0	**Class participation 0.5**	**Seminar paper 0.5**	Experiment
Written exam	**Oral exam 3.0**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Required literature

Melissinos, A. C., Napolitano, J.*Experiments in Modern Physics*, Academic Press,USA,2003.
Furić, M. *Moderne eksperimentalne metode, tehnike i mjerenja u fizici*, Školska knjiga, Zagreb, 1992.

Reccomended literature

Squires, G. L. *Practical Physics*, Cambrige University Press, Cambridge, 2001.
Leo, W. R. *Techniques for Nuclear and Particle Physics Experiments: A How-to Approach*, Springer-Verlag, Berlin, 1994.
Dunlap, R. A. *Experimental Physics: Modern Methods,* Oxford University Press, 1989.
http://www.physics.it/

Quality assurance of course and/or module

Discussions with students about difficulties, origin eventually in course objectives realization.
The questionnaire about students' expectation at the beginning of the course.
The questionnaire designed to evaluate quality of course program, lectures and lecture materials, teaching methods and interaction with students at the end of the course.

Course code	
Course title	COMPUTER ORGANIZATION AND ARCHITECTURE

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		5
Hours/semester		30+0+30

Course objectives

The aim of the course is to introduce basic computer stucture and organisation principles.

Correspondence and correlation with the program

The course corresponds to the course Introduction to Digital Systems.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

The students will have basic knowledge of computer system architectures and organization.

Course content

History of Computers. Architecture of a simple microprocessor. The central processing unit. Arithmetic – logic unit. Instruction set. Addressing modes and formats. Von Neumann computer model. System Buses. Memories. Input/Output. Operating system support. Microprocessor programming.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet
Distance learning	Consultations	Laboratory work	**Tutorials**	Field work

Comments:

Student requirements

It is compulsory for students to attend exercises. A student has to pass the written (practical) part of the examination which regards the exercises, as the precondition to take the oral part of examination where the complete knowledge of the student is examined and evaluated

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation**	Seminar paper	Experiment
Written exam	Oral exam	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Required literature

1. S. Ribarić. Naprednije arhitekture mikroprocesora, Element Zagreb, 1997.
2. S. Ribarić. Arhitekture računala RISC i CISC, Školska knjiga Zagreb, 1996.
3. W. Stallings. Computer Organization and Architecture, Prentice Hall, 2000.

Recommended literature

4. A.S. Tannenbaum, J. Goodman: Structured Computer Organisation, Prentice Hall, 1999.

Quality assurance of course and/or module

Annonimus poll in the end of semester. Statistical reports on results obtained on quizies, partial exams, homeworks and final project. In the end statistical report on passing.

Course code	
Course title	DIGITAL SIGNAL PROCESSING

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		5
Hours/semester		2+0+2

Course objectives

The purpose of the course is to introduce students with basic principles of digital dignal processing.

Correspondence and correlation with the program

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Course content

Signal classification. Matematical model. The Fourier Transform.
Stohastic signals. Corerelation. Covariance.
Ergodic signals. Stationary signals.
Spectrum. Discrete Fourier Transform.
The sampling theorem.
Digital filter design. The Fast Fourier Transform.
Speeech signal processing. Video signal processsing.
Signal compression algorithms.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet
Distance learning	Consultations	Laboratory work	**Tutorials**	Field work

Comments:

Student requirements

It is compulsory for students to attend exercises. A student has to pass the written (practical) part of the examination which regards the exercises, as the precondition to take the oral part of examination where the complete knowledge of the student is examined and evaluated.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation**	**Seminar paper**	Experiment
Written exam	**Oral exam**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:

Required literature

1. L.R. Rabiner. Theory and Application of Digital Signal Processing. Prentice-Hall, 1975.
2. L.R. Rabiner, R. W. Schafer: Digital Processing of Speech Signals, Prentice Hall; 1 edition, 1978.

Recommended literature

3. A. V. Oppenheim, R. W.Schafer, J. R. Buck: Discrete-Time Signal Processing, Prentice Hall, Englewood Cliffs, 2 edition ,1999.
4. S. K. Mitra: Digital Signal Processing: a Computer-Based Approach, McGraw-Hill Co. Inc. New York, 1998.

Quality assurance of course and/or module

Annonimus poll in the end of semester. Statistical reports on results obtained on quizies, partial exams, homeworks and final project. In the end statistical report on passing.

Course code	
Course title	ALGEBRAIC STRUCTURES

General Information

Program	UNDERGRADUATE PHYSICS				Year	III
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		5
Hours/semester		30 + 0 + 30

Course objectives

Objective of this course is to introduce basic properties of some algebraic structures; groups, rings, fields and algebras.

Correspondence and correlation with the program

The program is correspondent to the program of other mathematical courses, especially to Linear Algebra I, Linear Algebra II and Algebra.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to understand some properties of groups, rings and fields.

Course content

Grupoids. Semigroups. Monoids. Groups. Finite groups. Permutation groups. Rings. Fields. Finite fields. Polynomials. Ideals. Integral domains. Modules. Algebras. Lie algebras. Partially ordered sets. Categories. Functors.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Students must attend the lectures and participate in all activities required for the course. Exam: written and oral.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	**Class participation 1**	Seminar paper	Experiment
Written exam 2	**Oral exam 2**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:
Student's activities are evaluated during the semester. Final exams are written and oral.

Required literature

1. I.Vidav: Algebra, Mladinska knjiga, Ljubljana, 1989.
2. B.L. van der Waerden: Algebra I, Springer, Berlin, 1985.

Recommended literature

1. G.Birkhoff, S.MacLane: A Survey of Modern Algebra, MacMillan, New York, 1985.

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code	
Course title	METRIC SPACES

General Information

Program	UNDERGRADUATE PHYSICS				Year	**III**
Course status		Core	**X**	**Elective**		

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		5
Hours/semester		45+0+30

Course objectives

- learning of elementary notions and characteristics of metric and topological spaces
- learning of notion of uniformly continuous function and convergence of functional sequence
- learning of Banach's Fix Point Theorem

Correspondence and correlation with the program

Program of course Metric Spaces is correlated with other mathematical courses, especially with Analysis I, Analysis II and Analysis III.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

After completing this course students will be able to:

- know and understand elementary notions and characteristics of metric and topological spaces
- know and understand notion of uniformly continuous function and convergence of functional sequence
- know and understand Banach's Fix Point Theorem.

Course content

Metric spaces, definition and examples. Bounded and completely bounded spaces. Topological structure. Equivalent metrics. Direct product of spaces. Subspace. Topological space. Basis of topology. Interior and closure of the set. Closed sets. Separability. Product and quotient of spaces. Axioms of separation. Convergence of sequences. Accumulation point. Bolzano-Weierstrass Theorem. Sequences of functions, uniform convergence. Cauchy's sequence. Complete metric space. Banach's Fix Point Theorem. Continuous maps. Characterizations. Homeomorphism. Uniform continuity. Connected spaces. Compactness. Characterization of compact sets in $\mathbf{R}^n$. Tychonoff Theorem. Continous functions on the compact.

Modes of instruction (mark in bold)

Lectures	**Seminars and workshops**	Exercises	Independent work	Multimedia and the Internet
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Comments:

Student requirements

Every student is obliged to fulfill conditions for signature in Metric Spaces and to pass the exam.
Conditions for signature: Students are expected to attend and actively participate at all classes.
Exam: written and oral.

Evaluation and Assessment

Mark in **bold** only the relevant categories and fill in the appropriate number of points for each of the chosen categories so that the sum of the allocated points corresponds to the course credit value. Add new categories, if necessary.

Class attendance	Class participation	Seminar paper	Experiment
Written exam **2**	**Oral exam** **3**	Essay	Research work
Project work	Continuous assessment	Presentation	Practical work

Comments:
Students' work is continually observed. Integral part of observing and evaluating of students is the quality of active work contribution at the lectures and exercises. Student's integral knowledge is evaluated in the exam.

Required literature

1. S.Mardešić: Matematička analiza u n-dimenzionalnom realnom prostoru I, Školska knjiga, Zagreb, 1974.
2. Zbirka rešenih zadataka iz topologije, Naučna knjiga, Beograd, 1977.
3. J.Dugandi: Topology, Allyn and Bacon, Boston, 1968.

Recommended literature

Quality assurance of course and/or module

After the last lecture of the course students will be asked to fulfill a questionnaire about the quality of the lectures. At the end of each semester results of the exams will be analyzed.

Course code							
Course title	GRAPHICAL COMMUNICATION 2						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	III
Course status		Core		**X**	**Elective**		
Credits and Teaching							
				Winter semester		Summer semester	
ETCS credits / student workload						4	
Hours/semester						30 + 0 + 15	
Course objectives							
The objective of the course in to educate students for graphic solutions of technical problems in the space geometry by means of drawings in the plane and the application of the acquired knowledge and skills in elementary and secondary schools.							
Correspondence and correlation with the program							
The programmes correspondents to the programmes of the relevant universities. The subject is in the correlation with the teaching programmes of the engineering elements and engines.							
Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)							
Understanding of graphic solutions to the technical problems. Master basic skills needed for using PC based CAD programs.							
Course content							
Sketching objects in orthogonal and pictorial projections. Symbols in mechanical engineering, electrotechnics, architecture and marine engineering. Drawing in the AutoCAD (adjusting parameters, coordinative system, handling of drawing, basic orders for drawings, basic orders for changing drawings, writing texts, blocks, dimensioning, sketching and the basic of the drawing in three dimensions).							
Modes of instruction (mark in bold)							
Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet			
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work			
Student requirements							
Obedience attendance of the lectures and graphical exercises. Compulsory or optional cause units (Lectures- graphical exercises-make thesis- written examination-oral examination). Graphical program (I – Orthogonal projection, II – Pictorial projection and III – complex drawings and workshop drawing (Tolerances and harshness surface).							
Evaluation and Assessment							
Class attendance **0,5**	**Class participation** **0,5**	**Graphical program** **1**	Experiment Ø				
Written exam **1**	**Oral exam** **1**	Essay Ø	Research work Ø				
Project work Ø	Continuous assessment Ø	Presentation Ø	Practical work Ø				
Required literature							

Ć. Koludrović, *Tehničko crtanje u slici s kompjutorskim aplikacijama,* Zagreb, 1994.

A. Bukša, *Grafičke komunikacije – Zbirka zadataka*, Rijeka, Pomorski fakultet, 2001.

Recommended literature

MICROSTATION, Osnove CAD projektiranja, INA – INFO, Zagreb, 1994.

B. Burchard, D. Pitzer, Od ideje do projekta – AutoCAD 2000, Zagreb, Algoritam 2000.

Parker M.- Pickup F., *Engineering drawing with worked examples 1*, Cheltenham, Stanley Thorns, 1990.

Hercigonja, Eduard, *Tehnička grafika*, Zagreb, Školska knjiga, 1996.

Kovač, Branko, *Tehničko crtanje*, Zagreb, Školska knjiga, 1975.

Quality assurance of course and/or module

An anonymous questionnaire at the and of each semester. Following the student's results during the semester. Statistical review of the examination.

Course code							
Course title	MATERIALS SCIENCE AND ENGINEERING						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	III
Course status		Core		**X**	**Elective**		
Credits and Teaching							
				Winter semester		Summer semester	
ETCS credits / student workload						3	
Hours/semester						**30 + 0 + 15**	

Course objectives

The goal of the course is to invoke interest of the student for Materials Science and Engineering as well as help them to acquire the knowledge needed for contemporary computer aided selections of the optimal material for actual part or system manufacturing.

Correspondence and correlation with the program

Syllabus of the course corresponds with Materials Science and Engineering courses in technical faculties (mechanical, electrical and civil engineering), but its contents is wider and more concise.

Course prerequisite are professors signature for courses: Introduction to Polytechnic, Mechanical Elements and Mechanisms 1 and 2, Physics 1 and 2, Mechanic, Engineering Mechanics. Course correlated with following courses: Chemical Technology Fundamentals 1 and 2, Mechanical engineering technologies 1 and 2, Electrical engineering 1 and 2, Engineering electronics 1 and 2.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

Understanding of the way different materials are used in today's industry. Working with PC based applications.

Course content

Course include eleven parts. First four parts elaborate topics needed for understanding of the fundaments of materials: Introduction to materials and their application, Structure of substances – materials building, Physico-chemical fundamentals of materials, Properties, characteristics and selection of materials. Follows five parts including: (a) definitions, core properties and classification, (b) most frequently used members with materials processing technologies and (c) properties change during exploitation, for construction materials classified in groups: Natural materials, Metals, Ceramics, Polymers, Composits. Course include also Maintenance materials.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	**Independent work**	**Multimedia and the Internet**
Distance learning	**Consultations**	Laboratory work	Tutorials	Field work

Student requirements

Students are required to attend classes and to independently work on described topics. During the course students must prepare and write two seminar papers and take an oral exam at the end of the course.

Evaluation and Assessment

Class attendance	**Class participation**	**Seminar paper**	Experiment

Ø	**0,5**	**1**	Ø
Written exam Ø	**Oral exam** **1**	Essay Ø	Research work Ø
Project work Ø	**Continuous assessment** **0,5**	Presentation Ø	Practical work Ø

Required literature

Z. Kolumbić, N. Tomac: Materijali – podloge za diskusiju, pohranjeno na Internet adresi: http://www.pefri.hr/~zvonimir/materijali/

Recommended literature

T. Filetin, F. Kovačiček, J. Indof: Svojstva i primjena materijala; Sveučilište u Zagrebu, Fakultet strojarstva i brodogradnje, Zagreb, 2002.

T. Filetin: Pregled razvoja i primjene suvremenih materijala, Hrvatsko društvo za materijale i tribologiju, Zagreb, 2000.

Inženjerski priručnik ip4, uredništvo sveska: A. Mulc, D. Taboršak, I. Budin: Proizvodno strojarstvo, prvi svezak – Materijali, 1. izdanje; Školska knjiga, Zagreb, 1998.

M. F. Ashby: Materials Selection in Mechanical Design, 3rd Edition, Butterworth Heinemann, 2005.

W. D. Callister, Jr.: Materials Science and Engineering – An Introduction, Fifth Edition; John Wiley & Sons, New York, 2000.

M. Schwartz: Encyclopedia of Materials, Parts, and Finishes, Second Edition, CRC Press LLC, 2002.

W. Alexander, J. Shackelford: CRC Materials Science and Engineering Handbook, Third Edition, CRC Press LLC, 2002.

Internet addresses:

http://www.matweb.com/

http://www.psigate.ac.uk/newsite/

http://www.nap.edu/

Quality assurance of course and/or module

Continuous tracking of students' success during semester. Anonymous surveys of students at semester end.

Course code							
Course title	MACHINE ELEMENTS AND MECHANISMS 2						
General Information							
Program	UNDERGRADUATE PHYSICS					Year	III
Course status		Core	**X**	**Elective**			

Credits and Teaching

	Winter semester	Summer semester
ETCS credits / student workload		3
Hours/semester		30 + 0 + 15

Course objectives

Knowledge about types of machine elements and their functions, designs, materials and calculations. Knowledge about basic types of mechanisms.

Correspondence and correlation with the program

The course is correspondent with similar courses in mechanical engineering, electrical engineering or naval architecture.

Preconditions for enrolling: courses about engineering design communication, mechanics and strength of materials.

Expected outcomes of the course and/or module (development of general and specific competencies, knowledge and skills)

General knowledge about machine elements and mechanisms. Basic knowledge about design and calculation of machine elements.

Course content

Rolling bearings. Sliding bearings. Bearings lubrication. Sealing of bearings, axes and shafts.

Mechanical transmissions. Gears. Spur gears. Worm gears. Belts. Chains. Clutches and couplings. Pipings. Other basic mechanisms types.

Modes of instruction (mark in bold)

Lectures	Seminars and workshops	**Exercises**	**Independent work**	Multimedia and the Internet
Distance learning	Consultations	Laboratory work	Tutorials	Field work

Student requirements

Attendance at lectures and exercises, making of three design projects, written and oral exam.

Evaluation and Assessment

Class attendance Ø	Class participation Ø	**Seminar paper** **1**	Experiment Ø
Written exam **1**	**Oral exam** **1**	Essay	Research work Ø
Project work Ø	Continuous assessment Ø	Presentation Ø	Practical work Ø

Required literature

B. Križan: *Osnove proračuna i oblikovanja konstrukcijskih elemenata*, Sveučilište u Rijeci, Rijeka, 1999.

H. Decker: *Elementi strojeva*, Tehnička knjiga, Zagreb, 1985.

Recommended literature
M. Opalić, M. Kljajin, S. Sebastijanović: *Tehničko crtanje*, Sveučilište u Zagrebu, Sveučilište J.J. Strossmayer u Osijeku, Čakovec 2003.
Quality assurance of course and/or module
Anonymous questionnaires at the end of the semester. Control of results achieved during semester. Analysis of exams efficiency.