UNIVERSITY OF RIJEKA – DEPARTMENT OF PHYSICS and FACULTY OF ENGINEERING

GRADUATE STUDY PROGRAMME ENGINEERING AND PHYSICS OF MATERIALS

MAY, 2020.

Sveučilište u Rijeci • University of Rijeka
Trg braće Mažuranića 10 • 51 000 Rijeka • Croatia
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GRADUATE STUDY PROGRAMME ENGINEERING AND PHYSICS OF MATERIALS

LIST OF MODULES/COURSES							
Year: 1.							
Semester: 1.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**[1]	
	Statistička fizika	30	15	0	6	C	
	Structure of Matter Lab	0	0	60	6	C	
	Metal Materials	30	15	0	4	C	
	Non-Metallic Materials	30	15	0	4	C	
	Elective courses * I-IFM				5 or 6	E*	
	Elective courses * II-IFM				4 or 3	E*	
ELECTIVE COURSES I-IFM							
* depending on the completed undergraduate study: (1a) students without the course related to classical electrodynamics during undergraduate study (1b) otherwise.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	(1a) Theoretical Physics and Applications I	30	30	0	6	E*	
	(1b) Control of Mechatronics Systems	30	15	0	5	E*	
ELECTIVE COURSES II-IFM							
* depending on the completed undergraduate study: (2a) students with completed undergraduate studies in technical sciences. (2b) students with completed undergraduate studies in natural sciences.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	(2a) Physics Laboratory I	0	0	45	3	E*	
	(2b) Engineering Visualization	15	30	0	4	E*	

[1] IMPORTANT: Insert C for compulsory course or E for elective course.

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LIST OF MODULES/COURSES							
Year: 1.							
Semester: 2.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	Solid State Physics	45	30	0	6	C	
	Experimental Methods in Physics I	30	15	15	6	C	
	Materials Protection	30	30	0	5	C	
	Forming Technology	30	30	0	5	C	
	Elective courses * III-IFM				5 or 6	E	
	Elective courses * IV-IFM				3	E	
ELECTIVE COURSES III-IFM							
* depending on the completed undergraduate study: (3a) students without the course related to quantum mechanics during undergraduate study (3b) otherwise.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	(3a) Theoretical Physics and Applications II	30	30	0	6	E*	
	(3b) Manufacturing Technologies	45	15	0	5	E*	
ELECTIVE COURSES IV-IFM							
* depending on the completed undergraduate study: (4a) students with completed undergraduate studies in technical sciences. (4b) students with completed undergraduate studies in natural sciences.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	(4a) Laboratory Project	0	0	30	3	E*	
	(4b) Project - Metal Materials	0	30	0	5	E*	

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LIST OF MODULES/COURSES							
Year: 2.							
Semester: 3.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	Physics of Materials	30	30	0	6	C	
	Semiconductors: Principles and Applications	30	15	15	6	C	
	Experimental Methods in Physics II	30	15	0	4	C	
	Quality Management	30	30	0	5	C	
	Thermal Processes of Materials	30	30	0	5	C	
	Elective courses V-IFM				Min. 5	E	
ELECTIVE COURSES V-IFM							
Students are required to take 1 course.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	Solid State Physics II	30	15	15	6	E	
	Magnetic Materials and Applications	30	15	15	6	E	
	Mechanical Behaviour and Selection of Materials	30	30	0	5	E	

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LIST OF MODULES/COURSES							
Year: 2.							
Semester: 4.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	Master Thesis				18	C	
	Elective courses VI-IFM				6	E	
	Elective courses VII-IFM				5	E	
ELECTIVE COURSES VI-IFM							
Students are required to take 1 course.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	Spintronics	30	15	15	6	E	
	Advanced Experimental Laboratory	0	0	60	6	E	
	Electronics	30	15	15	6	E	
ELECTIVE COURSES VII-IFM							
Students are required to take 1 course.							
MODULE	**COURSE**	**L**	**E**	**S**	**ECTS**	**STATUS**	
	Material Testing and Fracture Analysis	30	15	0	5	E	
	Production Management	30	15	0	5	E	
	Micro- and Nanoelectromechanical Systems	30	15	0	5	E	

UNIVERSITY OF RIJEKA

DEPARTMENT OF PHYSICS

and

FACULTY OF ENGINEERING

UNIVERSITY GRADUATE STUDY PROGRAM

ENGINEERING AND PHYSICS OF MATERIALS

Proposal

Rijeka, March 2010.

TABLE OF CONTENTS

Attachment: Written permission for lecturers from other institutions.

1. INTRODUCTION

1.1. Grounds for proposition of this program and the evaluation of its purpose

Exponential growth of science achievements in the fields of natural sciences and technologies requires a long-term and quality education of experts with a wide and diverse range of knowledge and skills. Accordingly, we propose the two-year university postgraduate program

Engineering and Physics of Materials

based on the multidisciplinary activity engaged in the application of basic sciences and engineering to understanding the behavior of materials, their development and applications. The modern society demand for a rapid and diverse succession of new, specialized materials has resulted in a concentrated, systematic approach to materials research and education of experts in the field of materials science and engineering. In the past, specialized materials were developed through a trial-and-error process. Today, this approach has been replaced with design of innovative materials for specific application in which the tools and expertise of scientists are being combined with those of engineers, resulting in productive cooperation in both applied and theoretical areas.

Materials science is an exciting sector, aiming to the development of new materials or changing the properties of existing ones for more efficient use or broader applications. Today, it is almost impossible to create a new generation of advanced materials, such as semiconductors, superconductors, polymers or ceramics, or even advanced devices, such as lasers, micromotors, or biological tissue replacements, without understanding and controlling the characteristics of materials, their surfaces and interfaces from atomic to macroscopic level. And this is the domain of engineering and physics of materials.

Engineering and physics of materials is a rapidly expanding area, focused on meeting the world's need for 21st century materials for use in sectors as diverse as energy, transportation, electronics, medicine or construction and civil engineering. Most American universities have developed programs in materials science or science and engineering of materials, and the same trend is present at a great number of European universities (for example, such programs exist at around twenty universities in Great Britain alone), strongly supporting the development of economy based on new scientific knowledge and advances in science. The host departments for such multidisciplinary programs are usually departments of natural sciences, engineering or materials science.

The multidisciplinary approach to materials science opens a possibility to all students having undergraduate degrees from a diversity of programs, including physics (or physics combined with some other fields), chemistry, materials science, engineering (from mechanical and electrical engineering to civil or naval engineering), biological sciences, as well as computer science or polytechnics. As the proposed program is the first of this kind in Croatia, it could possibly attract students from other Croatian universities, following the recommended trends in students mobility.

The university graduate program Engineering and Physics of Materials is proposed as a joint venture between the Department of Physics and the Faculty of Engineering of the University of Rijeka. This combination of program hosts ensures the integration of fundamental knowledge from physics and other sciences with the most recent advancement in engineering, analysis and processing of materials. Students graduating from this program will be trained to develop new technologies and materials and find their applications and will be able to find employment in academia or government, industry, research centers and institutes, or to continue with postgraduate studies. In all of Europe, including Croatia, there is already a significant shortage of

experts in the field of science and engineering of materials in industries involved in materials production, design, processing or application, such as car and airplane industries, shipbuilding, civil engineering and medical or semiconductor industry.

As a typical interdisciplinary program, the university graduate program Engineering and Physics of Materials is based mostly on the existing skills, expertise and knowledge of the teaching and research staff at the University of Rijeka, and, in a smaller extent, on the collaboration with the Institute of Physics in Zagreb.

1.2. Past experience of the host institutions in the implementation of similar programs

The foundation of the Faculty of Mechanical Engineering in Rijeka in 1960 with the aim to satisfy the requirements of the industry of Rijeka and the whole region can be regarded as the initiation of systematic engineering education and scientific research, particularly in the field of mechanical engineering and naval architecture. At first, only graduate engineers of Mechanical Engineering were educated. However, in 1969/70 the education of the graduate engineers of Naval Architecture has also started and the Faculty was then renamed into Mechanical Engineering & Naval Architecture Faculty in Rijeka. The opening of the study for graduate Civil Engineers in 1971/72 resulted in the establishment of the independent Faculty of Civil Engineering in the year 1976 and the Faculty was renamed into the Technical Faculty Rijeka. Finally, since 1994 the Faculty has been functioning under the name University of Rijeka – the Faculty of Engineering. In 1999/00 the education of graduate engineers in Electrical Engineering commenced, while in 2008/09 a new university undergraduate program Computer Science has been introduced. To enable the graduate engineers of Mechanical Engineering and Naval Architecture to deepen their acquired knowledge and scientific permanent education, the post graduate scientific study was inaugurated in 1971/72. Today, the Faculty of Engineering numbers 88 permanent employees at scientific, teaching and associate levels, 35 junior researchers, 46 associate lecturers and assistants, and 51 administrative employees and technical personnel.

Nowadays, the Faculty of Engineering is offering university undergraduate and university graduate studies of mechanical and electrical engineering and naval architecture, with curriculum fully adjusted to the Bologna Declaration. The university graduate program Engineering and Physics of Materials is coordinated with the Institute for Materials which is one of the Institutes established within the Faculty of Engineering with the aim to conduct all teaching and research activities of the Faculty in the field of materials science and engineering. Teaching activities are focused on courses from the module Engineering of Materials offered in the university graduate program Mechanical Engineering.

On the other hand, the study of physics at the University of Rijeka started in several higher-education institutions in 1953 (the two-year program at the Pedagogical College, the four-year programs at the Industrial Pedagogical College, the Faculty of Industrial Pedagogy, the Pedagogical Academy in Rijeka, Pula and Gospic and the Faculty of Pedagogy) with the aim to prepare students for the teaching profession. The four-year program in Mathematics and Physics started in the academic year 1964/65, following with the program in Physics and Technical Education in 1971/72 and Physics and Computer Science in 2004/05. The former Faculty of Pedagogy in Rijeka was also offering for several years, from 1979-1985, the combined program of Physics and Chemistry.

In 1988 the Faculty of Pedagogy in Rijeka changed its name into Faculty of Arts and Sciences. One of the founding members of the new Faculty was the Department of Physics. The Department of Physics organized the four-year graduate programs Mathematics and Physics and Physics and Computer science. Both programs were conducted in the form of lectures, seminars, practical work

and teaching practice, giving the students the qualification of high-school teachers of Mathematics and Physics or Physics and Computer Science. The teaching staff of the Department was also involved in teaching physics courses in other university programs, such as Physics and Polytechnics and Mathematics and Computer science, hosted at the Faculty of Arts and Sciences of the University of Rijeka by the Department of Polytechnic and the Department of Mathematics, respectively.

Following the recommendations of the Bologna declaration, the Department of Physics the Faculty of Arts and Sciences has started in 2005 the three-year undergraduate program in Physics, followed by the two-year graduate programs of Physics and Mathematics, Physics and Computer Science and Physics and Polytechnics. After completing the undergraduate studies of Physics (3 years), students are getting the degree of Bachelor of Physics, while at the end of the graduate program (5 years) they are getting the degree of Masters of Education in Physics and Mathematics, or Physics and Computer Science or Physics and Polytechnics.

In the education of students, the Department of Physics was giving special attention to demonstrational experiments and laboratory training, which is in accordance with contemporary methods of constructivist theory of studies of physics that enables better understanding of teaching contents and increases the level of knowledge while, at the same time, prepares student for the same methods of teaching in their future teaching profession. Students who have shown special predispositions and skills were involved in the scientific research with the possibility to enroll in some PhD programs at other Croatian Universities, a find employment academia or research institutes in Croatia or abroad.

In December 2007, the Senate of the University of Rijeka established the Department of Physics of the University of Rijeka, as an independent research and teaching University Department. All the programs and students from the Department of Physics of the Faculty of Arts and Sciences were transferred to the new University Department of Physics in April of 2008 when the old Department within the Faculty of Arts and Sciences was officially closed. At the same time, the new University Department of Physics was also entrusted with teaching of Physics courses in programs of all Faculties of the University of Rijeka and developing of teaching, research and professional curriculum in the field of Physics.

The Department of Physics of the University of Rijeka numbers 19 permanent employees at research, teaching and associate levels, 7 PhD students and 7 administrative employees and technical personnel.

1.3. Correlation with the modern scientific perceptions

The university graduate program Engineering and Physics of Materials focuses on understanding the relationships between the microstructure and the macroscopic properties of solids, as well as synthesis, processing, modification and characterization of materials. This includes a wide range of materials such as metals, polymers, ceramics or composite materials or semiconductors and magnetic materials. A wide choice of modules and courses offered in this program enables us to modernize the program in the future by integrating some new modules or courses following the new advances and knowledge in the field.

Modern fundamental and applied science is nowadays increasingly dependent on the multidisciplinary approach in solving problems and educating experts. The proposed program is multidisciplinary because it combines the knowledge of physical, structural, mechanical and electrical properties of materials from a range of natural sciences and engineering. It is multidisciplinary also in that it combines the theoretical and experimental capabilities of a variety of disciplines and applies them to the solution of complex scientific and engineering problems.

1.4. Compatibility with programs offered at other international universities

In most American and European universities we find programs of similar names, such as Materials Science or Materials Science and Engineering, with programs similar to the proposed program Engineering and Physics of Materials. All these program are based on the multidisciplinary approach and courses drawn from several different Departments (most often Departments of Physics, Engineering or Chemistry). Special attention is always given to courses of fundamental physics, laboratory work and fundamentals of technology of materials. Mandatory and elective courses covering fundamentals offered in our two-year graduate program Engineering and Physics of Materials are similar to courses offered in Physics or Engineering programs at Universities of Rijeka, Zagreb, Split and Osijek, and also at several distinguished European or USA universities (for example, Manchester in Great Britain, Trieste in Italy or MIT in USA).

Mandatory and elective courses covering more specific problems in materials processing, characterization or applications, are very similar to those offered at most international universities, from Europe and the USA to Australia.

1.5. Potential partners outside the academia

There is already a great demand in industry, academia and government in the Rijeka region, as well as in Croatia or Europe, for graduates and experts from the fields of Materials Science and Engineering which will graduate from our program Engineering and Physics of Materials. The Engineering and Physics of Materials program provides a multi-disciplinary foundation from which graduates can develop careers in a range of engineering and scientific roles in industry, academia, or government. Therefore, these institutions are potential partners of this program.

All branches of Croatian economy involved into design, production, processing or application of materials, or having R&D laboratories (it is hard to imagine nowdays any industry not involved into materials science, as materials design, processing and applications is important for industries such as car and airplane industries, shipbuilding, civil engineering or medical, pharmacology or semiconductor industry) are potential partners of the proposed program.

1.6. Openness to student mobility

The proposed program is in accordance with provisions of Croatian law regulating activities in the field of science and higher education (NN no. 123/2003(+), in accordance with the ECTS criteria (European Credit Transfer System) published in the University journal, vol. XLVI, 2000, and in accordance with The Statute of the University of Rijeka.

All courses within the two-year graduate program Engineering and Physics of Materials are planned as one-semester courses which enables dynamic exchange of contents as well as mobility of students and student exchange programs at any stage of their studies, with other Croatia or European Universities, upon completion of all chosen courses. An exceptional potential for student exchange program is opened by offering our students a wide range of elective courses.

In addition, the proposed program is designed for students having undergraduate degrees from a diversity of science and engineering disciplines, encouraging, therefore, student mobility within the University of Rijeka or other universities.

1.7. Other relevant information

The graduate university program Engineering and Physics of Materials has been planned and accomplished as a joint effort of the Department of Physics of the University of Rijeka and the Faculty of Engineering of the University of Rijeka, with the Institute of Physics from Zagreb as an external collaborator. The latter institution is in charge of three courses in our program and also provides several experimental facilities for experimental work, projects or thesis work for our students.

Multidisciplinary and interdisciplinary character of our program is also evident from the joint effort of the research and teaching staff from different Departments or Faculties within the University of Rijeka and respectable researchers from some other Croatian institutions. In this way, we are making a significant contribution towards the rapid and harmonic development of the University of Rijeka, but also towards economical and social development of Rijeka and surrounding region.

2. GENERAL PART

2.1. Program Title

The Graduate University Program Engineering and Physics of Materials.

2.2. Program Holders and Performers

Interdisciplinary university program Engineering and Physics of Materials is organized by two institutions: The Department of Physics of the University of Rijeka and The Faculty of Engineering of the University of Rijeka. Both institutions are equal performers of the program, but Program Holder is:

University of Rijeka
Department of Physics
Slavka Krautzeka bb
51000 Rijeka

2.3. Scientific Area and Field

Scientific areas: Natural Sciences and Engineering.
Fields: Physics, Materials Science

2.4. Program Duration

Two years (4 semesters).

2.5. Academic Title

Master of Engineering and Physics of Materials.

2.6. Enrolment Conditions

Enrolment is open to all students from Universities of Rijeka, Zagreb, Split or Osijek having undergraduate degree from a program containing courses on fundamentals of physics and mathematics, i.e. students with the Bachelor degree in Physics or Physics combined with any other field, Chemistry, Polytechnics or Computer Science, or the Bachelor degree of any engineering field.

2.7. Profile of the Academic Degree

The Graduate University Program Engineering and Physics of Materials provides the fundamental knowledge and competences in the fields of physics and materials science and engineering, focused on understanding of properties, synthesis, processing, modification and application of materials. This knowledge and competences will enable the graduated students to find employment in industry, research centers and institutes which are involved in development of new technologies or the application of new materials, or as research scientists in academic institutions, experts in government organizations or to continue with postgraduate studies.

2.8. General and Specific Competences

The knowledge and competences provided by the Graduate University Program Engineering and Physics of Materials include:

1. Obtaining the fundamental knowledge of science and technology important for understanding the properties of materials.
2. Ability to develop and apply that knowledge in order to synthesize and process different materials, or design or change materials properties.
3. Recognition of fundamental properties of materials and ability to choose analytical technique or design and conduct experiments for the characterization of materials and to analyze and interpret experimental results.
4. Ability to identify materials-related problems and formulate plans to solve such problems.
5. Ability to design optimal materials and processes for a specific application and to produce them.
6. Development of personal research and analytical skills by undertaking small research projects and thesis work in real experimental environment.

2.9. Level of Competence for Continuation of Studies

After completing this program, the graduated students with the degree of Master of Engineering and Physics of Materials will be able to continue their studies at any university PhD program compatible to materials science, physics, and environmental science or engineering.

3. CURRICULUM DETAILS

3.1. The List of Mandatory and Elective Courses with lesson times and ECTS Credits

Tables contain following abbreviations:

L – Lectures
S – Seminar
AE – Auditory Exercises
LE – Laboratory Exercises
CE – Construction Exercises

1. Semester							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
Theoretical Physics and Applications I	2	1	1	0	0	4	6
Statistical Physics	2	0	1	0	0	3	5
Metal Materials	2	0	0	1	0	3	5
Non-Metallic Materials	2	0	0	1	0	3	5
Elective Course I						3	4
Elective Course II						4	5
TOTAL						**20**	**30**

Elective Course I							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
(1) Fundamentals of Engineering Design	2	0	0	0	1	3	4
(2) Physics Laboratory	0	0	0	3	0	3	4
(1)For students with undergraduate degree in science. *(2)For students with undergraduate degree in engineering.*							

Elective Course II							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
Computational Physics	2	0	2	0	0	4	5
Measurements in Physics	2	1	1	0	0	4	5
Only one course to be elected.							

Tables contain following abbreviations:

L – Lectures
S – Seminar
AE – Auditory Exercises
LE – Laboratory Exercises
CE – Construction Exercises

2. Semester							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
Theoretical Physics and Applications II	2	1	0	0	0	3	5
Solid State Physics	2	1	1	0	0	4	6
Materials Protection	2	0	1	1	0	4	5
Organization of Production	2	0	2	0	0	4	5
Elective Course III						4	5
Elective Course IV						3	4
TOTAL						**22**	**30**

Elective Course III							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
(1) Manufacturing Technologies	3	0	0	0	1	4	5
(2) Experimental methods in physics	2	1	1	0	0	4	5
(1)*For students with undergraduate degree in science.* (2)*For students with undergraduate degree in engineering.*							

Elective Course IV							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
Laboratory Project	0	3	0	0	0	3	4
Fracture Mechanics	2	0	0	1	0	3	4
Free Elective Course						3	4
Only one course to be elected.							

Tables contain following abbreviations:

L – Lectures
S – Seminar
AE – Auditory Exercises
LE – Laboratory Exercises
CE – Construction Exercises

3. Semester							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
Physics of Materials I	2	0	2	0	0	4	6
Semiconductors: principles and applications	2	1	1	0	0	4	6
Mechanics of Materials	2	0	1	1	0	4	5
Testing of Materials	2	0	1	1	0	4	4
Elective Course V						4	5
Free Elective Course						3	4
TOTAL						**23**	**30**

Elective Course V							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
Magnetic Materials and Applications	2	1	1	0	0	4	5
Nanosciences and Nanotechnologies	2	1	1	0	0	4	5
Only one course to be elected.							

Tables contain following abbreviations:

L – Lectures
S – Seminar
AE – Auditory Exercises
LE – Laboratory Exercises
CE – Construction Exercises

4. Semester							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
Physics of Materials II	2	0	2	0	0	4	6
Heat Treatment of Metals and Surface Engineering	2	0	1	1	0	4	5
Elective Course VI						4	5
Elective Course VII						3	5
Master Thesis Seminar	0	6	0	0	0	6	9
TOTAL						**21**	**30**

Elective Course VI							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
Spintronics	2	1	1	0	0	4	5
Micro-Systems Technologies	2	0	2	0	0	4	5
Only one course to be elected.							

Elective Course VII							
Course Title	**Hours per Week**						**ECTS**
	L	**S**	**AE**	**LE**	**CE**	**L+S+AE+LE+CE**	
Materials Selection	2	0	0	1	0	3	5
Casting	2	0	0	1	0	3	5
Materials Characterization	2	0	0	1	0	3	5
Only one course to be elected.							

TOTAL FOR UNIVERSITY GRADUATE STUDY OF ENGINEERING AND PHYSICS OF MATERIALS	**Hours**	**ECTS**
	86	**120**

3.2. Description of Subjects

CASTING

Draft of subject contents

Patterns. Moulding processes and materials. Equipment and mechanization in foundry. Casting processes and procedures. Basic aspects and terminology. Sand casting. Solidification of metals. Pouring and feeding castings. Melting metalsand alloys. Fluidity of metals. Modeling and simulation of solidification of molten metal in mould. Casting-design considerations. Simplification of foundry practices. Defects in castings. Residual stressis in casting. Cleaning and inspection of castings. The effects of foundry to environment. Semisolid casting. Specificity of casting of hard melting alloys. Casting of metal foams. Casting of ceramics and composites.

Developing of general and specific competences (knowledge and skills)

Knowledge acquisition of casting processes and procedures regarding mould production. Understanding process of solidification. Knowledge acquisition of mould production principles. Skill acquisition in constructing pouring and powering systems.

Forms of tuition performing and manner of knowledge checking

Tuition is performed through lectures, auditorial and laboratory practice. Knowledge checking is done through the control tasks and the verbal exam.

List of literature needed for studies and sitting for an examination

Katavić I.: Ljevarstvo, Sveučilište u Rijeci, 1993.
Lyman T.: Metals Handbook, Melting And Casting, American Society For Metals.

List of literature that is recommended as supplemental

Pelhan C.: Livarstvo, Ljubljana 1983.
Ljevački priručnik, Savez ljevača Hrvatske.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.

Manner of sitting for an examination

Documentary and oral exam.

Manner of quality inspection and efficiency of subject performing

Conversation and polls with students througout the semester. Statistics about efficiency on control tasks, written and verbal examinations.

Prerequisites for subject enrolling

No prerequisites.

COMPUTATIONAL PHYSICS

Draft of subject contents

Basics of FORTRAN. Numerical methods in physics and mathematics. Monte Carlo simulation. Animation and visualisation of computer simulations. Numerical optimization methods of solving multidimensional physical problems. Simplex algorithm. Neural networks. Genetic algorithms. Simulations in high-energy physics. Computational analysis of simulated and measured physical data.

Developing of general and specific competences (knowledge and skills)

General competences: learning of methods for solving physical problems using numerical methods. Understanding of optimizations. Training programming skills.
Specific competences: students will be expected to describe numerical methods in physics and mathematics, write simple computer codes using simulations, use existing packages for simulations, animation and visualization, define optimization, distinguish different optimization methods, describe genetic algorithms, write a computer code which optimizes a non-liner problem using a chosen optimization methods, and perform a computational analysis of simulated and measured data using programming in FORTRAN.

Forms of tuition performing and manner of knowledge checking

Forms of tuition: lectures (2 hours per week); seminar (1 hour per week), exercise, recitations, independent work, tutorials, office hours (1 hour per week).
Manner of knowledge checking: class participation, homework, project, written and oral exam.

List of literature needed for studies and sitting for an examination

1. Web stranica i WebCT kolegija
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
4. M. Metcalf, Fortran 90 Tutorial, CERN

List of literature that is recommended as supplemental

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

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
ECTS credits distribution:
Class attendance: 0.5 ECTS; class participation: 0.5 ECTS; student project: 1.0 ECTS; written exam (2 midterm exams): 1.0; oral exam: 1.5 ECTS; continuous assessment: 0.5 ECTS.

Manner of sitting for an examination

Student is required to write practical projects in the field during the semester. The final exam is written and oral.

Manner of quality inspection and efficiency of subject performing

Interaction with students and student-faculty team work on quality of teaching process. Anonymous questionnaires on quality of teaching. Flexible adaptation of teaching to interests and needs of students.

Prerequisites for subject enrolling

General Physics Courses, Introductory Computer Science. Bascis of computer programming is desired, but not a requirement.

EXPERIMENTAL METHODS IN PHYSICS

Draft of subject contents

Statistical methods in experimental physics. Spectra and numerical methods of analysis. Particle accelerators, interaction of charged particles with matter, detection of charged particles and photons. Basic principles of accelerator based techniques PIXE, RBS, AMS and their applications in material, biomedical and environmental sciences, protection of cultural heritage. Synchrotron radiation, accelerators and their applications. Nuclear medicine and basic principles of nuclear magnetic resonance (NMR), Computer Tomography (CT), proton therapy, etc. Nondestructive techniques and their applications. Radioactivity, isotopes and basic principles of nuclear geochronology.

Developing of general and specific competences (knowledge and skills)

General competences: student should develop understanding of accelerator based analytical techniques, interaction of ions with matter, importance of related applications and its impact in modern society.

Specific competencies: students will acquire basic understanding of particle acceleration, specific applications of accelerator based analytical techniques, detecting, measuring and analysing related spectra. If time and conditions permits students will have a chance to perform hands on measurement and analysis of some real samples.

Forms of tuition performing and manner of knowledge checking

Forms of tuition: lectures (2 hours per week); independent work, tutorials, office hours (1 hour per week).
Manner of knowledge checking: class participation, written exam (2 midterm exams), oral exam.

List of literature needed for studies and sitting for an examination

1. S. A. E. Johansson and J. L. Campbell, PIXE: A novel technique for elem. analysis, J. Wiley & Sons, 1988
2. L.C. Feldman, J.W. Mayer, Fundamentals of Surface and Thin Film Analysis, Elsevier Sc Publ., NY 1986.
3. Melissinos, A. C., Napolitano, J., Experiments in Modern Physics, Academic Press,USA,2003.
4. Furić, M., Moderne eksperimentalne metode, tehnike i mjerenja u fizici, Školska knjiga, Zagreb, 1992.

List of literature that is recommended as supplemental

1. Squires, G. L. Practical Physics, Cambridge University Press, Cambridge, 2001.
2. Leo, W. R. Techniques for Nuclear and Particle Physics Experiments, Springer-Verlag, Berlin, 1994.
3. Dunlap, R. A. Experimental Physics: Modern Methods, Oxford University Press, 1989.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
ECTS credits distribution:
Class attendance: 0.5 ECTS; class participation: 0.5 ECTS; student project: 1.0 ECTS; oral exam: 2 ECTS; continuous assessment: 1 ECTS.

Manner of sitting for an examination

Student is required to write and present a project in the field, usually some reading from a paper or a section in well-known book. The final exam is oral exam.

Manner of quality inspection and efficiency of subject performing

Discussions with the students, questionnaires, achievements on the student projects and exams.

Prerequisites for subject enrolling

Prerequisites: Basic training in general physics.

FRACTURE MECHANICS

Draft of subject contents

Fracture definition. Fracture types. Brittle fracture. Brittle fracture micromechanics. Significance of transition temperature. Griffith brittle fracture theory. Energy balance and crack development. Energy release rate. Crack opening displacement. J-integral. Temperature related materials strength. Crack spreading. Fracture mechanics applications in construction design. Experimental methods of fracture mechanics values determination. Fracture analysis.

Developing of general and specific competences (knowledge and skills)

Student will acquire the knowledge of fracture mechanics. Moreover, student will acquire methods of fracture mechanics values determination.

Forms of tuition performing and manner of knowledge checking

Lectures, consultation, seminar work, oral exam.

List of literature needed for studies and sitting for an examination

Ewalds, H. and Wanhill, R., Fracture Mechanics, Edward Arnold, London, 1989.
Hertzberg, Richard W., Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons, 1996.

List of literature that is recommended as supplemental

ASM Handbook, Volume 19: Fatigue and Fracture, ASM International, Materials Park, OH, 1996.

ECTS credits attributed to subject and corresponding explanation

4 ECTS.

Manner of sitting for an examination

Documentary exam.

Manner of quality inspection and efficiency of subject performing

The analysis of subject metter adoption using periodical tests and by anonymous student's feedback.

Prerequisites for subject enrolling

No prerequisites.

FUNDAMENTALS OF ENGINEERING DESIGN

Draft of subject contents

Engineering design process. Types of designs. Basic principles of engineering design.
Stresses and strains in machine elements. Material characteristics.
Allowable stresses. Stress concentration.
Machine elements types. Joints.
Axes and shafts. Bearings. Mechanical transmissions. Clutches and couplings.
Precision engineering. Micro and MEMS devices.
Mechatronics systems. Elements of precision and micro mechatronics devices.
Production technologies of micro and precision devices.
Examples of high precision and micro-system devices.

Developing of general and specific competences (knowledge and skills)

Knowledge of appropriate and systematic design and production of mechanical, precision and micro components and devices. Skills in information management in engineering design. Team work and capability to communicate with experts in this and other technical fields.

Forms of tuition performing and manner of knowledge checking

TP: Lectures and construction exercises.
KC: Classes attendance, activity on lecturing, project assignments and midterms.

List of literature needed for studies and sitting for an examination

B. Križan: Osnove proračuna i oblikovanja konstrukcijskih elemenata , University of Rijeka, 1999.
K.-H. Decker: Elementi strojeva , Golden marketing - Tehnička knjiga, Zagreb, 2006.
M. J. Madou: Fundamentals of Microfabrication , CRC Press, Boca Raton (FL, USA), 2002.

List of literature that is recommended as supplemental

G. Pahl i W. Beitz: Engineering Design, Springer, London, 1996.
H. Slocum: Precision Machine Design , Soc. Manuf. Eng., Dearborn (MI, USA), 1992.

ECTS credits attributed to subject and corresponding explanation

4 ECTS. Active participation to classes and exercises: 45 hours (1,5 credits). Time needed to develop the project assignments: 25 hours (1 credits). Time needed to prepare midterms and final exam (readings and study of bibliographical references): 40 hours (1,5 credits).

Manner of sitting for an examination

Documentary exam.

Manner of quality inspection and efficiency of subject performing

Through institution's quality assurance system. Constant interaction and common work with students on improvement of quality of teaching. Flexible adaptation of teaching to interests and needs of students.

Prerequisites for subject enrolling

No prerequisites.

HEAT TREATMENT OF METALS AND SURFACE ENGINEERING

Draft of subject contents

Phase diagrams and possibilities of heat treatment application. Heat treatment of steel. Equilibrium and non-equilibrium microstructure transformations in steel. Applying of TTT-diagrams in heat treatment. Theory of heat treatment processes. Diffusion treatments. Specificity of heat treatment of cast steel. Heat treatment ability of cast iron. Austempered ductile iron (ADI). Heat treatment of aluminum, titanium, copper alloy. Selection criteria for heat treatment optimization. Prediction of results, residual stresses and distortions in heat treatment. Chemical vapor deposition (CVD). Physical vapor deposition (PVD). Theory of thin layers application by spraying technologies. Laser and Electron beam surface modifications. Laser surface hardening, structure fragmentation, melting, alloying and laser fusion of coating. Ion implantation. Surface layers characterization. Surface layer design.

Developing of general and specific competences (knowledge and skills)

Student will acquire the knowledge of heat treatment processes and surface engineering. Moreover, student will acquire methods of designing and spraying technologies of thin layers.

Forms of tuition performing and manner of knowledge checking

Lectures, consultation, seminar work, oral exam.

List of literature needed for studies and sitting for an examination

Smoljan, B.: Osnove toplinske obrade čelika, Pedagoški fakultet Rijeka, Rijeka, 1997.
Burakovski, T., Wierzchon, T.: Surface Engineering of Metals, CRC Press LLC, 1999.
Krumes, D.: Toplinska obradba, Strojarski fakultet u Slavonskom Brodu, Slavonski Brod 2000.

List of literature that is recommended as supplemental

Pirš, J.: Toplinska obrada metala, Tehnički fakultet Rijeka, Rijeka, 1992.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.

Manner of sitting for an examination

Documentary and oral exam.

Manner of quality inspection and efficiency of subject performing

The analysis of subject metter adoption using periodical tests and by anonymous student's feedback.

Prerequisites for subject enrolling

No prerequisites.

MAGNETIC MATERIALS AND APPLICATIONS

Draft of subject contents

Definitions and units. Magnetization measurement methods. Magnetic properties of matter. Models of magnetism in insulators and metals. Magnetic anisotropy. Magnetoelasticity. Magnetization processes. Soft magnetic materials. Amorphous magnetic materials. Hard magnetic materials. Surface and thin-film magnetism. Magnetotransport. Magneto-optical materials. Nanomagnetic materials. Magnetic recording and memories. Investigating properties of materials by magnetic methods.

Developing of general and specific competences (knowledge and skills)

General competences: student should develop physical intuition and gain adequate knowledge of solving problems in materials science from the physicist point of view.
Specific competences: student should acquire basic knowledge about physical principles of magnetism and related phenomena, and should learn about applications of magnetic effects in the process of production and selection of different materials, and in the fabricating devices.

Forms of tuition performing and manner of knowledge checking

Forms of tuition: lectures (2 hours per week); recitations (1 hour per week); independent work, tutorials, office hours (1 hour per week).
Manner of knowledge checking: class participation, written exam (2 midterm exams), oral exam.

List of literature needed for studies and sitting for an examination

O'Handley R. C., *Modern Magnetic Materials: Principles and Applications*, Wiley, New York, 2000.

List of literature that is recommended as supplemental

Cullity B.D., Graham C.D.: *Introduction to Magnetic Materials*, 2nd ed., Wiley-IEEE Press, 2009.
Jiles D. C., *Introduction to Magnetism and Magnetic Materials*, 2nd ed., CRC Press, London, 1998.
Spaldin N. A., *Magnetic Materials: Fundamentals and Device Applications*, Cambridge University Press, Cambridge, 2003.
Ashcroft N. W., Mermin N. D., *Solid State Physics*, Brooks Cole, New York, 1976.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
ECTS credits distribution:
Class attendance: 0.5 ECTS; class participation: 0.5 ECTS; student project: 1.0 ECTS; written exam (2 midterm exams): 1.0; oral exam: 1.5 ECTS; continuous assessment: 0.5 ECTS.

Manner of sitting for an examination

Student is required to write and present a project in the field, usually some reading from a paper or a section in well-known book. The exam consists of written part (or 2 midterm exams) and final (oral) exam.

Manner of quality inspection and efficiency of subject performing

Discussions with the students, questionnaires, achievements on the student projects and exams.

Prerequisites for subject enrolling

Prerequisites: *Theoretical physics and applications I, II.*
Related and recommended course: *Spintronics.*

MANUFACTURING TECHNOLOGIES

Draft of subject contents

Development and Classification of Manufacturing Technologies. Metal-Casting Processes. Forming Processes and Equipment: Bulk Forming and Sheet-Metal Forming Processes. Processing of Powder Metals. Processing of Ceramics and Glass. Forming and Shaping of Plastics and Composite Materials. Machining Processes: Conventional and Non-Conventional Processes. Competitive Aspect of Manufacturing. Processing of Composites. Processing of Metal Foams. Special Processing Technologies.

Developing of general and specific competences (knowledge and skills)

Developing theoretical knowledge and their application on real machining process examples with emphasis on their optimization and minimization of expenses to achieve competition of machining technology.

Forms of tuition performing and manner of knowledge checking

Lectures, tests and seminars, exercises (teaching, laboratory).

List of literature needed for studies and sitting for an examination

Katavić, I.: Ljevarstvo, Tehnički fakultet Sveučilišta u Rijeci, 2001.
Math, M.: Uvod u tehnologiju oblikovanja deformiranjem, Fakultet strojarstva i brodogradnje Sveučilišta u Zagrebu, 1999.
Kuljanić, E.: Površinska obradba metala odvajanjem čestica, Tehnička enciklopedija, 11(1988), 1-29.

List of literature that is recommended as supplemental

Kalpakjian, S., Schmid, S.R.: Manufacturing Processes for Engineering Materials, 4th ed., Prentice Hall, 2003.

ECTS credits attributed to subject and corresponding explanation

5 ECTS. Total of 45 hours of lectures and 15 hours of exercises. Structure of exercises: 100% laboratory. Self-preparation for the exam.

Manner of sitting for an examination

Documentary exam.

Manner of quality inspection and efficiency of subject performing

Quality inspection and efficiency are provided by anonymous screening as well as by students exam efficiency.

Prerequisites for subject enrolling

No prerequisites.

MATERIALS CHARACTERISATION

Draft of subject contents

Introduction. Importance of materials characterisation by surface characterisation. Industries where material characterisations is applied. Characterisation of specific materials (metals, polymers, semiconductors, composites, adhesives). Applications of material characterisation (adhesion, corrosion, surface treatments, fracture, surface chemistry). The origin, structure and character of surface. Microstructure and material properties. Methods and instrumentation of the surface microanalysis of materials. Sample cutting and their preparation for microanalysis. Electron and optical microscopy. The substance and the origin of spectra. Quantitative surface microanalysis by electron spectroscopy (AES) and x-ray photoelectron spectroscopy (ESCA). Acoustic spectroscopy.

Developing of general and specific competences (knowledge and skills)

Familiarisation with specific methods for the material characterisation.

Forms of tuition performing and manner of knowledge checking

Lectures, consultation, seminar work, oral exam.

List of literature needed for studies and sitting for an examination

Vickerman, J. C.: Surface Analysis-The principal Techniques, Jon Wiley & Sons, New York, 1997.
Bialkowski, S.E.: Photothermal Spectroscopy Methods for Chemical Analysis: A Series of Monographs on Analytical Chemistry and Its Applications, John Wiley & Sons, Inc., 1996.

List of literature that is recommended as supplemental

Smith, G. C. Quantitative Surface Microanalysis by Auger and x-ray Photoelectron Spectroscopy, Vol. 25, No.1, 1990.

ECTS credits attributed to subject and corresponding explanation

5 ETCS.

Manner of sitting for an examination

Documentary and oral exam.

Manner of quality inspection and efficiency of subject performing

Quality inspection is performed through the student and teaching staff evaluation in order to maintain and continuously improve the quality of the teaching process.

Prerequisites for subject enrolling

No prerequisites.

MATERIALS PROTECTION

Draft of subject contents

Cost of corrosion. Economics of corrosion. Kinds of corrosion damages (classification of corrosion damages). Definition of corrosion. Classification of corrosion processes. Thermodynamics and kinetics of metallic corrosion. Mechanisms of corrosion. Electrolytic corrosion. Corrosion cell. Definition of pH. Pourbaix diagram. Non-electrolytic corrosion. Pilling-Bedworth ratio. Corrosion rate. Causes of corrosion. Corrosion under stress: stress corrosion cracking, corrosion fatigue, erosion corrosion, cavitation corrosion. Corrosion protection methods: corrosion inhibitors. Protective coatings (metallic coatings, conversion layers, organic coatings, inorganic coatings), cathodic protection, anodic protection. Protection against stray currents. Designing to prevent corrosion. Corrosion testing. Corrosion monitoring. Failure analysis. Corrosion protection of polymers.

Developing of general and specific competences (knowledge and skills)

Student can be able to recognize corrosion problems of materials and choose the adequate protection measures.

Forms of tuition performing and manner of knowledge checking

Lectures, consultation, seminar work, oral exam.

List of literature needed for studies and sitting for an examination

Esih, I., Dugi, Z., Tehnologija zaštite od korozije, Sv. 1, Školska knjiga, Zagreb, 1990.
Roberge, P. R., Handbook of Corrosion Engineering, Mc Graw-Hill, New York, 2000.
Fontana M. G., Greene, N. D., Corrosion Engineering, Mc Graw-Hill, New York, 1978.

List of literature that is recommended as supplemental

Talbot, D., Talbot, J., Corrosion Science and Technology, CRC Press, 1998.
Schweitzer, P.A., Mechanical and Corrosion-Resistant Properties of Plastics and Elastomers, Marcel Dekker, Inc., New York, Basel, 2000.

ECTS credits attributed to subject and corresponding explanation

5 ETCS.

Manner of sitting for an examination

Documentary and oral exam.

Manner of quality inspection and efficiency of subject performing

Quality inspection is performed through the student and teaching staff evaluation in order to maintain and continuously improve the quality of the teaching process.

Prerequisites for subject enrolling

No prerequisites.

MATERIALS SELECTION

Draft of subject contents

Materials selection diagrams. Materials selection criteria. Design demands. Load-bearing capacity of materials. Role of toughness and yield strength in construction load bearing capabilities. Environmental demands. Technological demands. Economical demands. Other demands. Computer aided materials selection.

Developing of general and specific competences (knowledge and skills)

Student will be informed with demands and criteria of materials selection in engineering practice.

Forms of tuition performing and manner of knowledge checking

Lectures, consultation, seminar work, oral exam.

List of literature needed for studies and sitting for an examination

Filetin, T.:Izbor materijala pri razvoju proizvoda, FSB, Zagreb, 2000.

Ashby, M.F.: Materials Selection and Mechanical Design, 3rd ed., Butterworth Heinemann, Oxford, 2001.

List of literature that is recommended as supplemental

Farag, M.M.: Selection of Materials and Manufactoring for Engineering Design, Prentice Hall, London, 1989.

ECTS credits attributed to subject and corresponding explanation

5 ETCS.

Manner of sitting for an examination

Documentary exam.

Manner of quality inspection and efficiency of subject performing

The analysis of subject metter adoption using periodical tests and by anonymous student's feedback.

Prerequisites for subject enrolling

No prerequisites.

MEASUREMENTS IN PHYSICS

Draft of subject contents

The main goal of this course is to show to students the importance of experiments and measurements of physical quantities in development, testing and verifying of theoretical models. The course includes the basic concepts of Metrology and measurements methods from antics to modern time. Key experiments preceding development of fundamental physical laws or concepts, such as Newton laws, Maxwell equations or Bohr's model of atom. Examples of planning and design of experiments are given by the discovery of electron, proton, neutron and positron and measurements of their properties and by examples of measurements of mechanical, electrical, magnetic and optical properties of materials. Several modern analytical techniques using beams of atomic particles for the characterisation of materials, available in several Laboratories in Croatia, are introduced. Visits to several experimental laboratories (synchrotron Elettra in Trieste, Institute Ruder Boskovic and Institute of Physics in Zagreb, Department of Physics in Rijeka) are part of this course.

Developing of general and specific competences (knowledge and skills)

Develop understanding and interest for measurements; gain knowledge about key experiments in history of physics; recognise the key role of experiments and measurements in discovery of physical phenomena and the creation and verification of physical theory.

Forms of tuition performing and manner of knowledge checking

Tuitions in form of lectures, project work and students' seminar work. Knowledge checking via 2 partial exams and seminars.

List of literature needed for studies and sitting for an examination

A. S. Morris, *Measurement & Instrumentation Principles*, Butterwort-Heinemann, Oxford, (2001).
Springer Handbook of Materials Measurement Methods, Springer, Berlin, (2006).

For the seminar work, students shall be given references from textbooks or web sites.

List of literature that is recommended as supplemental

None

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
Active participation of students in classes and project work, with presentations of seminars. Acquirement, analysis and synthesis of competences in topics being taught via readings of bibliographical references. Discussion of these topics on lectures and exercises (1 ECTS) as well as via written and oral presentations, partial and final exams (4 ECTS).

Manner of sitting for an examination

Written and/or oral exam. Results of partial exams, seminars and level of active participation to classes contribute also to final mark.

Manner of quality inspection and efficiency of subject performing

Interaction with students and student-faculty team work on quality of teaching process. Anonymous questionnaires on quality of teaching. Flexible adaptation of teaching to interests and needs of students. Analysis of passing rates.

Prerequisites for subject enrolling

None.

MECHANICS OF MATERIALS

Draft of subject contents

Physical phenomena and processes, especially those at the microscopic, molecular and atomic scale, determining and explaining macroscopic behaviour of various kinds of solid materials under different types and modes of loading: kinds and mechanisms of deformation, alterations of mechanical properties, damaging, and failure; phenomenological characterisation of mechanical performance of materials: identification of mechanical behaviour and rheological classification of materials; constitutive modelling of solid materials; modelling damage; micromechanical material models.
By interrelating the concepts and principles of solid mechanics with the knowledge of materials sciences, within the frame of general themes special topics are addressed, like ductile and brittle failure, yield and failure criteria, strengthening, creep and stress relaxation, fatigue and ageing of different kinds of materials, internal stresses, shape memory and smart materials, etc.

Developing of general and specific competences (knowledge and skills)

Linking the knowledge and competences acquired from subjects on theoretical and applied mechanics of solid bodies with those from materials sciences, in order to understand the performance of engineering materials and properly select and apply adequate models for calculations and simulations.

Forms of tuition performing and manner of knowledge checking

Tuition is performed in form of lectures and tutorials, in which students are supposed to actively participate in discussions, workshops, and solving specific subject related problems. Knowledge is checked by final exam with a reward of the classwork.

List of literature needed for studies and sitting for an examination

M. A. Meyers, K. K. Chawla: Mechanical Behavior of Materials, Prentice-Hall, Upper Saddle River, NJ, 1999.
M. A. Meyers, R. W. Armstrong, H. O. Kirchner (eds.): Mechanics and Materials: Fundamentals and Linkages, Wiley, New York, 1999.

List of literature that is recommended as supplemental

H. Altenbach: Werkstoffmechanik, Deutscher Verlag für Grundstoffindustrie, Leipzig, 1993.
J. Lemaitre, J.-L. Chaboche: Mechanics of Solid Materials, Cambridge University Press, Cambridge, 1990.

ECTS credits attributed to subject and corresponding explanation

5 ECTS. Students have to attend 30 lecture units and 30 tutorial units, in which they are expected to actively participate in discussions, workshops, and solving specific subject related problems.

Manner of sitting for an examination

Written exam.

Manner of quality inspection and efficiency of subject performing

Course evaluation by students, and appointed institution's bodies, in accordance with accepted practice for quality inspection and efficiency of subject performing at the institution's level.

Prerequisites for subject enrolling

No prerequisites.

METAL MATERIALS

Draft of subject contents

Microstructure and properties of steels. Steels. Properties and application of constructional steels and high strength steels. Microstructure, properties and application of corrosion and acid resistant steels. Tool steels. Cast irons. Microstructure and properties of cast irons. Application of cast irons. Aluminium alloys. Microstructure and properties of alluminium alloys. Application of alluminium alloys. Magnesium alloys. Microstructure and properties of magnesium alloys. Application of magnesium alloys. Copper alloys. Varieties, properties and application of copper alloys. Varieties, properties and application of nickel and cobalt alloys. Super alloys. Varieties, properties and application of titanium alloys. Lead alloys. Tin alloys. Hard metals. Powder metallurgy products. Trends in development of new materials.

Developing of general and specific competences (knowledge and skills)

Student will get the knowledge of metal materials, their partition, properties, microstructure and application.

Forms of tuition performing and manner of knowledge checking

Lectures, consultation, seminar work, oral exam.

List of literature needed for studies and sitting for an examination

Novosel, M., Krumens, D.: Željezni materijali. II dio: Konstrukcijski čelici, Strojarski fakultet u Slavonskom Brodu, Slavonski Brod, 1995.
Hornobogen, E., Warlimont, W.: Metalkunde, Springer Verlag, Berlin, 2001.

List of literature that is recommended as supplemental

Pirš, J.: Tehnologija materijala, Nauka o metalima I, II, III, IV i V dio, Pedag. servis, Rijeka, 1965.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.

Manner of sitting for an examination

Documentary and oral exam.

Manner of quality inspection and efficiency of subject performing

The analysis of subject metter adoption using periodical tests and by anonymous student's feedback.

Prerequisites for subject enrolling

No prerequisites.

MICROSYSTEMS TECHNOLOGIES

Draft of subject contents

Emergence and role of microsystems. Definition of micro and nano electro-mechanical systems (MEMS & NEMS). Basic terminology.
Properties of used materials. Scaling laws in miniaturisation.
Production technologies for microsystems
Experimental validation of performances (measurement of high-precision displacements, characterisation of electro-mechanical systems, control systems).
Integration of mechanical components with actuating and measuring devices: micro (opto)-electro-mechanical systems.
Handling and assembly of elements of microsystems.
Examples of microsystems.

Developing of general and specific competences (knowledge and skills)

Knowledge of terminology pertaining to microsystems. Differentiation, understanding and use of microsystems. Knowledge about employment of microsystems. Assessment of advantages and disadvantages of microsystems technologies. Skills in information management. Team work. Written, oral and IT communication. Capability to communicate with experts in other fields. Portion of general skills: 1.5/5 ECTS.

Forms of tuition performing and manner of knowledge checking

Tuitions in form of lectures and exercises. Knowledge checking via 3 partial exams and seminars.

List of literature needed for studies and sitting for an examination

M. J. Madou, *Fundamentals of Microfabrication*, CRC Press, Boca Raton (FL, USA), 2002.
J. J. Allen, *Micro Electro Mechanical System Design*, CRC Press, 2005.
M. J. Jackson, *Microfabrication and Nanomanufacturing*, CRC Press, Boca Raton (FL, USA), 2006.
S. D. Senturia, *Microsystems Design*, Kluwer Academic Publishers, Doddrecht (NL), 2000.

List of literature that is recommended as supplemental

***, *Springer Handbook of Nanotechnology*, Springer Verlag, Berlin (D), 2004.
***, *Microsystems Mechanical Design – CISM No. 478*, Springer Verlag, Wien (A), 2006.
L. L. Howell, *Compliant Mechanisms*, J. Wiley, New York (NY, USA), 2001.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
Active participation of students to classes and exercises, with autonomous development of seminars. Acquirement, analysis and synthesis of competences in topics being taught via readings of bibliographical references (2 ECTS), discussion of these topics via written and oral presentations in seminars (1 ECTS), partial and final exams (2 ECTS). Structure of exercises: listening: 20%, seminars: 80%.

Manner of sitting for an examination

Written and/or oral exam. Results of partial exams and level of active participation to classes contribute also to final mark.

Manner of quality inspection and efficiency of subject performing

Interaction with students and student-faculty team work on quality of teaching process. Anonymous questionnaires on quality of teaching. Flexible adaptation of teaching to interests and needs of students. Analysis of passing rates.

Prerequisites for subject enrolling

None.

NANOSCIENCES AND NANOTECHNOLOGIES

Draft of subject contents

Physical foundations of nanosciences. Surface science and ultrathin layers: experimental methods, photoelectron spectroscopies, low energy electron diffraction, thermal desorption, work function. Single atom and molecule manipulation techniques: STM, AFM, MFM. Nanostructures: from atomic and molecular clusters to macroscopic structures, carbon-based nanostructures (fullerenes, CNT, graphene). Preparation methods: self-assembly and litography. Selected cases of nano-based applications from current literature.

Developing of general and specific competences (knowledge and skills)

General competences: students will learn the basic concepts relevant for nanotechnology.
Specific competences: students will learn about fundamental preparation and characterization techniques of nanosciences and nanotechnologies.

Forms of tuition performing and manner of knowledge checking

Forms of tuition: lectures (2 hours per week); independent work, tutorials, Internet and multimedia (1 hour per week).
This will be a combination of face-to-face and distant (e-) learning. Each student will be asigned a seminar to expose publicly.
Two intermediate written exams and the final written exam will be used to check the overall progress of a student. When necessary an oral examination may take place.

List of literature needed for studies and sitting for an examination

E. L. Wolf, *Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience*, 2nd edition, Wiley, New York, 2006.
M. Milun, lecture notes available at the course website (moodle.srce.hr).

List of literature that is recommended as supplemental

G. A. Mansoori, *Principles of Nanotechnology: Molecular-Based Study of Condensed Matter in Small Systems*, World Scientific, Singapore, 2005.
C. P. Poole, F. J. Owens, *Introduction to Nanotechnology*, Wiley-Interscience, New York, 2003.
M. Wilson, K. Kannangara, G. Smith, M. Simmon, B. Raguse, *Nanotechnology: Basic Science and Emerging Technologies*, CRC, London, 2002.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
ECTS credits distribution:
Class attendance: 0.5 ECTS; web-forum activity: 0.5 ECTS; student seminar: 1.0 ECTS; written exams (2 midterm exams): 1.0; oral exam: 1.5 ECTS; continuous assessment: 0.5 ECTS.

Manner of sitting for an examination

Student is required to write and present a seminar in the field, usually some reading from a paper or a section in well-known book. The exam consists of written part (or 2 midterm exams) and final exam.

Manner of quality inspection and efficiency of subject performing

Discussions with the students, questionnaires, achievements on the student projects and exams.

Prerequisites for subject enrolling

Basics of Condensed matter physics

NON-METALLIC MATERIALS

Draft of subject contents

Classification of non-metallic materials. Polymers (plastics; elastomers). Additives for polymers. Properties of polymers: mechanical, thermal, electrical, optical, chemical (corrosion resistance). Ageing of polymeric materials. Applications of polymeric materials. Manufacturing of products from polymeric materials. Review of polymeric materials. Polymeric materials for high temperatures. Structure and properties of wood. Applications of wood. Classification of ceramic materials. Properties of ceramic materials: mechanical, thermal and electrical. Application of ceramic materials in technique. Ceramic coatings. Glasses. Properties of glasses. Application of glasses. Composites (polymeric matrix). Classification, properties and application of composites. Designing and optimization of composites. Possibilities of replacing classical materials by composite materials. Trends in development of new materials.

Developing of general and specific competences (knowledge and skills)

Familiarisation with non-metallic materials and their possibilities of application in mechanical engineering.

Forms of tuition performing and manner of knowledge checking

Lectures, consultation, seminar work, oral exam.

List of literature needed for studies and sitting for an examination

Katavić, I. Uvod u materijale, Sveučilište u Rijeci, 1997.
Callister, W.D., Jr. Fundamentals of Material Science and Engineering, John Wiley & Sons, Inc. 2001.

List of literature that is recommended as supplemental

Schwartz, M.: Encyclopaedia of Materials, Part and Finishes, second edition, CRC Press, 2002.
Strong, A.B.: Plastics Materials and Processing, second edition, Prentice Hall, Columbus, Ohio, 2000. Lehman; R.L.: Materials Mechanical Engineering Handbook, CRC, 1999.

ECTS credits attributed to subject and corresponding explanation

5 ETCS.

Manner of sitting for an examination

Documentary and oral exam.

Manner of quality inspection and efficiency of subject performing

Quality inspection and efficiency is provided by anonymous screening as well as by students exam efficiency.

Prerequisites for subject enrolling

No prerequisites.

ORGANIZATION OF PRODUCTION

Draft of subject contents

Definition and task of production function in the enterprise. Influence variables on production organization. Technology preparation department: task, basic groups of work. Organization of preparation department. Basic documentation. Price of production. Structure and calculation of product price: method of average value of working hour, method of direct costs. Selling price.
Operative preparation department: task, basic groups of work. Definition of production planning and control. Planning of production and launching of production. Basic documents. Stock optimization. Organization of operative preparation department.
Production department: task, basic groups of work. Organization of production department. Tool department: task, basic groups of work and organization. Department for quality control: task, basic groups of work and organization. Maintenance department: task, basic groups of work and organization.

Developing of general and specific competences (knowledge and skills)

Qualification for analyzing the type of production function organization. Ability for calculating the price of production. Knowledge of planning and production control principles. Knowledge of organizing of production department, tool department, quality control and maintenance department.

Forms of tuition performing and manner of knowledge checking

Group form with continuous interactive teaching. Partial written examine and verbal examine.

List of literature needed for studies and sitting for an examination

Mikac, T.: Organizacija i upravljanje proizvodnjom, script, Tehnički fakultet Rijeka, Rijeka (editing).
Selaković, M.: Organizacija proizvodnje, Tehnički fakultet Rijeka, Rijeka, 1987.

List of literature that is recommended as supplemental

Žugaj, M.; Strahonja, V.: Informacijski sustavi proizvodnje, Informator, 1992.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.

Manner of sitting for an examination

Documentary exam.

Manner of quality inspection and efficiency of subject performing

Student's questionnaire.

Prerequisites for subject enrolling

No prerequisites.

PHYSICS LABORATORY

Draft of subject contents

Density of solid bodies and liquids. Harmonic oscillations. Torsion. Fluid flow. Specific heat of water vaporization and ice melting. Gas kinetic theory. Measurement of air humidity. Electrical resistance , inductive and capacitive reactance. Refraction of light (prism, lenses). Polarimeter, spectrometer, microscope. Diffraction of light. Laser. Semiconductor devices (diode, transistor). Hall effect.

Developing of general and specific competences (knowledge and skills)

Developing specific skills in carrying out experiment, gaining competence in statistical analysis, display and interpretation of experimental results, developing ability to connect theory and experiment and getting insight in the scientific methodology of natural sciences.

Forms of tuition performing and manner of knowledge checking

Exercises, independent laboratory work, consultations, preliminary exams, final exam.

List of literature needed for studies and sitting for an examination

1. Halliday D., Resnick R., Walker J., *Fundamentals of physics*, 6th ed., J.Wiley and Sons Inc., New York, 2003.
2. D. Kotnik-Karuza, *Osnove elektronike s laboratorijskim vježbama*, Filozofski fakultet u Rijeci, 2000.
3. Radni materijali za Fizički praktikum
4. Holjević S., Marković B., Stipčić-Šolić N., Milotić B., *Fizikalna mjerenja I*, Liber, Zagreb, 1980.
5. Holjević S., Marković B., Stipčić-Šolić N., Milotić B., Blažević J., *Fizikalna mjerenja II*, Liber, Zagreb,1990.
6. Marković B., Miler D., Rubčić A., *Račun pogrešaka i statistika*, Liber, Zagreb, 1987.

List of literature that is recommended as supplemental

1. Young H. D., Freedman R. A., *University physics*, 9th ed., Addison-Wesley Publ. Comp. Inc., 1996.
2. Wilson J. D., Physics Laboratory Experiments, 5th edition, Houghton Mifflin Company, Boston, 1998.
3. K. Seeger, *Semiconductor physics*, Springer 1991.

http://www.mip.berkeley.edu/physics/
http:://www.walter-fendt.de/ph11e/index.html

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
Experimental results evaluation 1 ECTS, experimental skills 1 ECTS, theoretical background (preliminary exams) 1 ECTS, final exam 2 ECTS.

Manner of sitting for an examination

Oral exam.

Manner of quality inspection and efficiency of subject performing

Students' work and progress is being permanently followed by assessment of their written preparations and evaluations and by checking their knowledge colloquially during the laboratory exercises, At the final exam an evidence of conceptual understanding and ability to establish relationship between experiment and theory is expected.

Prerequisites for subject enrolling

No formal prerequisites. Knowledge of general physics is assumed.

PHYSICS OF MATERIALS II

Draft of subject contents

Monocrystal surfaces (structure of ideal surfaces: metal surfaces, fcc, bcc, hcp; surface relaxation and reconstruction, vicinal surfaces; experimental techniques: HREM, XRD, LEED, STM.
Monocrystal surfaces (electronic structure of an ideal surface: periodic potential, concept of electron bands and band gaps, surface states, dipole layer, work function). Experimental techniques: ARPES, AES, XPS, STS
Interaction of adsorbates with surfaces (chemisorption, physisorption, thermodynamics and kinetics of adsorption, growth and structure of layers, classification of overlayer structures, growth of metallic clusters, nanoparticles, self-organization. Experimental techniques: LEED, HREED, AES.
Solid-vacuum interface, basics of vacuum technologies and techniques, why ultra high vacuum, sticking coefficient, surface coverage, residual gases, mass spectroscopy.
Solid-liquid interface: electrochemical STM, AFM
Experimental methods for surface analysis: electron spectroscopies, mass spectroscopies, thermal desorption spectroscopy, vibrational spectroscopies, investigation of surface topography by means of electronic and atomic microscopies, magnetic probes.
Polycrystalline surfaces, nitration, ionic implantation, nano-particles, nano-wires, nano-clusters, selected topics, experimental methodes, GISAX.

Developing of general and specific competences (knowledge and skills)

Development of basic knowledge about solid-vacuum, solid-gas, solid-liquid phases, effects of reduced dimensionality, experimental techniques for the investigation of electronic and structural properties of surfaces, ultrathin films and clusters on surfaces.

Forms of tuition performing and manner of knowledge checking

Forms of tuition: lectures (2 hours per week); recitations, independent work, tutorials, office hours (2 hour per week).
Manner of knowledge checking: class participation, written exam (2 midterm exams), oral exam.

List of literature needed for studies and sitting for an examination

M. Prutton, *Introduction to Surface Physics*, Clarendon Press, Oxford, 1992.
M. C. Desjonqueres, D. Spanjaard, *Concepts in Surface Physics*, Springer, Berlin, 1996.
J. Hoelzl, F. K. Schulte, H. Wagner, *Solid Surface Physics*, Springer, Berlin, 1979.

List of literature that is recommended as supplemental

G. A. Somorjai, *Introduction to Surface Chemistry and Catalysis*, Wiley-Interscience, New York, 1994.
G. Attard, C. Barnes, *Surfaces*, Oxford Universtiy Press, Oxford, 1998.

ECTS credits attributed to subject and corresponding explanation

6 ECTS.
ECTS credits distribution:
Class attendance: 0.5 ECTS; class participation: 0.5 ECTS; student project: 1.0 ECTS; written exam (2 midterm exams): 1.5; oral exam: 2 ECTS; continuous assessment: 0.5 ECTS.

Manner of sitting for an examination

Student is required to write and present a project in the field, usually some reading from a paper or a section in well-known book. The exam consists of written part (or 2 midterm exams) and final (oral) exam.

Manner of quality inspection and efficiency of subject performing

Discussions with the students, questionnaires, achievements on the student projects and exams.

Prerequisites for subject enrolling

Prerequisites: *Solid State Physics*

SEMICONDUCTORS: PRINCIPLES AND APPLICATIONS

Draft of subject contents

This course outlines the physics, modeling, application and technology of semiconductor materials in electronic, optoelectronic, and photonic devices and integrated circuits. Topics, related to the technologically important semiconductors such as Si, GaAs, GaN or GaAsN, include basic physical models describing electronic structure, charge carriers, effective mass, p-n junction, transport and optical properties, intrinsic and extrinsic semiconductors and defects in semiconductors. This course also gives a survey of growth techniques, such as MBE and MOCVD, dopping (by diffusion, ion implantation etc.) and manufacturing of semiconductor devices, such as LEDs, transistors or metal-semiconductor devices, photodetectors or modulators. The physical beckground is given for basic electronic devices, from diodes and transistors to solar cells and lasers. New trends and hot topics in semiconductor theory and applications are illustrated by the modern heterostructures at low dimensions, including quantum wells, quantum wires, and quantum dots together with their applications and recent advances in semiconductor nanostructures.

Developing of general and specific competences (knowledge and skills)

To gain knowledge and develp understanding of principles and application of semiconducting electronic materials. To understand fundamental properties of semiconducting materials and techniques for tailoring these properties for specific applications and design of electronic devices.

Forms of tuition performing and manner of knowledge checking

Tuitions in form of lectures, project work and students' seminar work. Knowledge checking via 2 partial exams and seminars.

List of literature needed for studies and sitting for an examination

P. Y. Yu i M. Cardona, *Principles of Semiconductors*, Springer, Berlin, 2005.
S. O. Kasap, *Principles of Electronic Materials and Devices*, McGraw-Hill, New York, 2002.

For the seminar work, students shall be given references from textbooks or web sites.

List of literature that is recommended as supplemental

J. W. Mayer i S. S. Lau, *Electronic Materials Science*, Macmillan, New York, 1990.

ECTS credits attributed to subject and corresponding explanation

6 ECTS.
Active participation of students in classes and project work, with presentations of seminars. Acquirement, analysis and synthesis of competences in topics being taught via readings of bibliographical references. Discussion of these topics on lectures and exercises (2 ECTS) as well as via written and oral presentations, partial and final exams (4 ECTS).

Manner of sitting for an examination

Written and/or oral exam. Results of partial exams, seminars and level of active participation to classes contribute also to final mark.

Manner of quality inspection and efficiency of subject performing

Interaction with students and student-faculty team work on quality of teaching process. Anonymous questionnaires on quality of teaching. Flexible adaptation of teaching to interests and needs of students. Analysis of passing rates.

Prerequisites for subject enrolling

Prerequisites: Fundamentals of physics from undergraduate studies, *Solid State Physics*.

SOLID STATE PHYSICS

Draft of subject contents

This course provides the basic knowledge of solid state physics by exploring the basic principles of crystal structure and chemical bonding, lattice dynamics, electrons in periodic potential, electrical, optical and thermal properties of materials, Fermi surfaces, and an introduction to magnetic properties of materials, semiconductors, superconductors, dielectrics and ferroelectrics and defects in crystal lattice. New trends in condensed matter theory and application are introduced by quantum structures, superlattices, nanostructures, amorphous semiconductors and magnets and liquid crystals and polimers.

Developing of general and specific competences (knowledge and skills)

Developing of physical and mathematical knowledge and skills to solve problems connected by many particles systems. Capability to communicate with experts in other fields. Team work by oral, written and IT communication.

Forms of tuition performing and manner of knowledge checking

Tuitions in form of lectures, project work and students' seminar work. Knowledge checking via partial exams and seminars.

List of literature needed for studies and sitting for an examination

V. Šips, *Uvod u fiziku čvrstog stanja*, Školska knjiga, Zagreb, 2003.
C. Kittel, *Introduction to Solid State Physics*, Wiley, 8. izdanje, New York, 2005.

List of literature that is recommended as supplemental

N. W. Ashcroft, N. D. Mermin, *Solid State Physics*, Holt, Rinehart and Winston, New York, 1976.
I. Kupčić, *Fizika čvrstog stanja, Zbirka riješenih zadataka*, HINUS, Zagreb, 1998.

ECTS credits attributed to subject and corresponding explanation

6 ECTS.
Active participation of students in classes and project work, with presentations of seminars. Acquirement, analysis and synthesis of competences in topics being taught via readings of bibliographical references. Discussion of these topics on lectures and exercises (1 ECTS) as well as via written and oral presentations (1.5 ECTS), partial (1.7 ECTS) and final exams (1.8 ECTS).

Manner of sitting for an examination

Written and/or oral exam. Results of partial exams, seminars and level of active participation to classes contribute also to final mark.

Manner of quality inspection and efficiency of subject performing

Interaction with students and student-faculty team work on quality of teaching process. Anonymous questionnaires on quality of teaching. Flexible adaptation of teaching to interests and needs of students. Analysis of passing rates.

Prerequisites for subject enrolling

Prerequisites: Fundamentals of physics from undergraduate studies.

SPINTRONICS

Draft of subject contents

Introduction. Spin and quantum physics. Spin valves: an example, Nobel prize in physics 2007. Nonequilibrium spin distribution in metals and semiconductors. Spin transport: diffusive and ballistic regimes. Measurements of spin and spin currents. Spin-orbit coupling. Spin relaxation. Spintronic materials. Magnetic heterostructures and nanostructures. Applications of spintronics: spin sensors, magnetic memory, spin transistors and spin lasers.

Developing of general and specific competences (knowledge and skills)

General competences: student should develop physical intuition and gain adequate knowledge in spintronics and nanotechnology from the physicist point of view.
Specific competences: student should acquire basic knowledge about spin degrees of freedom and their applications.

Forms of tuition performing and manner of knowledge checking

Forms of tuition: lectures (2 hours per week); recitations (1 hour per week); independent work, tutorials, office hours (1 hour per week).
Manner of knowledge checking: class participation, written exam (2 midterm exams), oral exam.

List of literature needed for studies and sitting for an examination

Maekawa S. (Ed.), *Concepts in Spin Electronics*, Oxford University Press, 2006.

List of literature that is recommended as supplemental

Žutić I., Fabian J., and Das Sarma S., *Spintronics: Fundamentals and applications*,
Reviews Modern Physics 76, 323-410 (2004).
Fabian J., Matos-Abiague A., Ertler C., Stano P., and Žutić I., *Semiconductor Spintronics*, Acta Physica Slovaca 57, 565-907 (2007).
Bandyopadhyay S. and Cahay M., *Introduction to Spintronics*, CRC Press, 2008.

Freely available papers at:
http://www.physics.sk/aps/pubs/2007/aps-07-04/aps-07-04.pdf
http://arxiv.org/abs/cond-mat/0405528

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
ECTS credits distribution:
Class attendance: 0.5 ECTS; class participation: 0.5 ECTS; student project: 1.0 ECTS; written exam (2 midterm exams): 1.0; oral exam: 1.5 ECTS; continuous assessment: 0.5 ECTS.

Manner of sitting for an examination

Student is required to write and present a project in the field, usually some reading from a paper or a section in well-known book. The exam consists of written part (or 2 midterm exams) and final (oral) exam.

Manner of quality inspection and efficiency of subject performing

Discussions with the students, questionnaires, achievements on the student projects and exams.

Prerequisites for subject enrolling

Prerequisites: *Theoretical physics and applications.*
Related and recommended course: *Magnetic materials and applications.*

STATISTICAL PHYSICS

Draft of subject contents

The laws of thermodynamics. Entropy. Thermodynamical potentials. The statistical approach. Preasure of an ideal gas. Equipartition of energy. Maxwell distribution of speed. Boltzmann statistics. Partition function. Quantum statistics: Fermi–Dirac distribution function. Bose–Einstein distribution function. Thermodynamics of ideal fermion and boson gases. Heat capacities of solids and gases. Comparison of the Einstein and Debye models.

Developing of general and specific competences (knowledge and skills)

Developing of physical and mathematical knowledge and skills to solve problems connected by many particles systems. Capability to communicate with experts in other fields. Team work by oral, written and IT communication.

Forms of tuition performing and manner of knowledge checking

Tuitions in form of lectures, project work and students' seminar work. Knowledge checking via partial exams and seminars.

List of literature needed for studies and sitting for an examination

V. Šips, *Uvod u statističku fiziku*, Školska knjiga,, Zagreb, 1990.
K. Huang, *Introduction to Statistical Physics*, Taylor and Francis, New York, 2001.

List of literature that is recommended as supplemental

C. Garrod, *Statistical Mechanics and Thermodynamics*, Oxford University Press, New York, 1995.
F. Reif, *Fundamentals of Statistical and Thermal Physics*, McGraw-Hill, New York, 1965.
Y. B. Rumer, M. Sh. Rivkin, *Thermodynamics, Statistical Physics and Kinetics*, Mir Publishers, Moscow, 1980.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
Active participation of students in classes and project work, with presentations of seminars. Acquirement, analysis and synthesis of competences in topics being taught via readings of bibliographical references. Discussion of these topics on lectures and exercises (1 ECTS) as well as via written and oral presentations (1 ECTS), partial (1.5 ECTS) and final exams (1.5 ECTS).

Manner of sitting for an examination

Written and/or oral exam. Results of partial exams, seminars and level of active participation to classes contribute also to final mark.

Manner of quality inspection and efficiency of subject performing

Interaction with students and student-faculty team work on quality of teaching process. Anonymous questionnaires on quality of teaching. Flexible adaptation of teaching to interests and needs of students. Analysis of passing rates.

Prerequisites for subject enrolling

Prerequisites: Fundamentals of physics from undergraduate studies.

TESTING OF MATERIALS

Draft of subject contents

Technical materials and their properties. Testing of materials. Normed methods of testing of materials. Mechanical testing of materials. Tension test. Impact toughness testing. Fatigue testing. Estimation of creep deformation resistance. Definition and estimation of fracture toughness. High and low temperature properties testing. Mechanical properties testing machines. Qualitative and quantitative chemical analysis. Penetrant testing methods. Definition, importance and role of ultrasonic testing methods. Ultrasonic testing methods. Ultrasonic testing machines. Sensitivity limits and ultrasonic testing possibilities. Advantages and limitations of ultrasonic testing. Magnetic and electromagnetic testing of metals. Magnetic testing devices. Radiation methods of materials testing. Principles of nondestructive materials testing methods selection. Materials wear and tear. Fracture, deformation. Macro and micro analysis of fracture surfaces. Specificity of testing of metallic, polymeric, ceramic and composite materials as well as special materials, glasses and metal foams.

Developing of general and specific competences (knowledge and skills)

Student will be informed with the methods of testing of materials. In engineering practice student will be skilled for acquiring of materials testing.

Forms of tuition performing and manner of knowledge checking

Lectures, consultation, seminar work, oral exam.

List of literature needed for studies and sitting for an examination

Franz, M.: Mehanička svojstva materijala, FSB, Zagreb, 1998.
Becker, E., Michalzik, G., Morgner, W.: Praktikum Werksofoffpruefung, VEB Deutscher Verlag fuer Grundstoffindustrie, Leipzig, 1997.

List of literature that is recommended as supplemental

ASM Handbook Volume 8, Mechanical Testing and Evaluation, ASM International
ASM Handbook Volume 9, Metallography and Microstructures, ASM International

ECTS credits attributed to subject and corresponding explanation

4 ECTS.

Manner of sitting for an examination

Documentary exam.

Manner of quality inspection and efficiency of subject performing

The analysis of subject metter adoption using periodical tests and by anonymous student's feedback.

Prerequisites for subject enrolling

No prerequisites.

THEORETICAL PHYSICS AND APPLICATIONS I

Draft of subject contents

THEORETICAL MECHANICS Classical Physics: Newton's, Lagrange's and Hamilton's equations of motion. Harmonic oscillator.
ELECTRODYNAMICS Electric field, scalar potential, multipole expansion. Electrostatics equations. Dielectrics, ferroelectrics. Current. Continuity equation. Magnetic induction, vector potential, multipole expansion. Magnetostatics equations. Diamagnetics, paramagnetics, ferromagnetic. Maxwell's equations. Energy and momentum of electromagnetic field. Radiation of electromagnetic waves. Poynting's theorem. Special theory of relativity.

Developing of general and specific competences (knowledge and skills)

Basic knowledge of fundaments of theoretical physics (theoretical mechanics and electrodynamics) and understanding of fundamental principles that connect different fields of physics. Developing the cognizance how simple fundamental equations can explain complex physical phenomenon and lead to concrete applications.

Forms of tuition performing and manner of knowledge checking

Tuitions in form of lectures (2 hours/week), seminars (1 hour/week) and exercises (1 hour/week). Knowledge checking via 2 partial exams and seminars.

List of literature needed for studies and sitting for an examination

I. Supek, *Teorijska fizika i struktura materije*, 1. and 2. part, Školska knjiga, Zagreb, 1977.
D. J. Griffiths, *Introduction to Electrodynamics*, 3. edition, Prentice-Hall, New Jersey, 1999.

List of literature that is recommended as supplemental

Jackson J. D., *Classical Electrodynamics*, 3. edition, John Wiley, New York, 1999.
Reitz J. R., Milford F. J., *Foundations of Electromagnetic Theory*, 4. edition, Addison-Wesley, Reading, 2000.

ECTS credits attributed to subject and corresponding explanation

6 ECTS.
Student's active participation to classes and exercises, with autonomous development of seminars. Analysis and synthesis of acquired knowledge. Active approach to lectures (0.5 ECTS), seminars (1 ECTS) and exercises (0.5 ECTS) as well as to partial exams (2 ECTS) and final exam (2 ECTS).

Manner of sitting for an examination

Level of active participation to lectures, seminars and exercises contribute to final mark. Partial exams: written, final exam: written and oral.

Manner of quality inspection and efficiency of subject performing

Permanent interaction with students. Anonymous questionnaires on quality of teaching. Flexible adaptation of teaching to interests and needs of students. Analysis of passing rates.

Prerequisites for subject enrolling

Diploma from the bachelor study that contains exams regarding the general physics.

THEORETICAL PHYSICS AND APPLICATIONS II

Draft of subject contents

Inadequacy of classical physics, uncertainty and complementarity principle, Schrodinger equation. Operators and eigenvalues. Measurements. Potential step and potential valley. Harmonic oscillator. Energy, momentum and angular momentum operators. Rotational invariance. Hydrogen atom. Spin. Zeeman effect. Helium. Periodic system of elements. Approximation methods. Stark effect. Collision theory. Scattering cross section. Second quantization. Quasi-particles. Photons. Applications. Photo-effect. Laser. STM. NMR.

Developing of general and specific competences (knowledge and skills)

Basic knowledge of fundaments of theoretical physics (quantum physics) and understanding of fundamental principles that connect different fields of physics. Developing the cognizance how simple fundamental equations can explain complex physical phenomenon and lead to concrete applications

Forms of tuition performing and manner of knowledge checking

Tuitions in form of lectures (2 hours/week) and exercises (1 hour/week). Knowledge checking via 2 partial exams and seminars.

List of literature needed for studies and sitting for an examination

I. Supek, *Teorijska fizika i struktura materije*, 1. and 2. part, Školska knjiga, Zagreb, 1977.
D. J. Griffiths, *Introduction to Quantum Mechanics*, Prentice-Hall, New Jersey, 1994.
W. A. Harrison, *Applied quantum mechanics*, World Scientific, Singapore, 2001.

List of literature that is recommended as supplemental

L. I. Schiff, *Quantum Mechanics*, 3. edition, McGraw-Hill, New York, 1968.
J. J. Sakurai, *Modern Quantum Mechanics*, 2. edition, Addison-Wesley, Reading, 1994.
A. F. J. Levi, *Applied Quantum Mechanics*, 2. edition, Cambridge University Press, Cambridge, 2006.

ECTS credits attributed to subject and corresponding explanation

5 ECTS.
Student's active participation to classes and exercises, with autonomous development of seminars. Analysis and synthesis of acquired knowledge. Active approach to lectures (0.5 ECTS) and exercises (0.5 ECTS) as well as to partial exams (2 ECTS) and final exam (2 ECTS).

Manner of sitting for an examination

Level of active participation to lectures and exercises contribute to final mark. Partial exams: written, final exam: written and oral.

Manner of quality inspection and efficiency of subject performing

Permanent interaction with students. Anonymous questionnaires on quality of teaching. Flexible adaptation of teaching to interests and needs of students. Analysis of passing rates.

Prerequisites for subject enrolling

Diploma from the bachelor study that contains exams regarding the general physics.

3.3. Structure of Program, Study Schedule and Student Obligations

As all other university programs in Croatia, the graduate university program Engineering and Physics of Materials is organized as a regular full-time study over four semesters. Students are given the Thesis work during the last semester. In each semester, students acquire at least 30 ECTS credits, i.e. 120 ECTS credits for the entire course of the graduate study.

The loading is around 20-23 hours of lectures per week with 5-6 exams per semester, with total of 86 hours of lectures. The total number of exams is 22 with additional final exam and production of Thesis valued at 9 ECTS credits. The percentage ratio of lectures and tutorials is 53% to 47%, which is favorable for graduate programs. There are 14 mandatory (64%) and 8 elective subjects with one elective project (36%), which fully satisfies the required ratio of mandatory to elective subjects.

In order to provide the best possible training for practical work and the application of knowledge gained through this program, we have included some elective laboratory work in this program with 5 ECTS assigned to it.

To encourage students to study continuously throughout the academic year and ensure the high completion rate within the prescribed period of time, enrolment for this program is carried out in the following way:

- Enrolment is done year by year whereas attendance and fulfillment of obligations during each semester is verified by the signature of lecturer in the student book;
- The required enrolment conditions for the second year of this graduate program are regulated by the Book of study regulations;
- Preconditions for subject enrolment, if they exist, are listed in the Description of subjects section 3.2.;
- Elective subjects are chosen in consultation with the Head of graduate program.

3.4. Elective Courses from Other University Programs

When entering the elective project or elective subject, the student takes advice from the Head of the Program coordinating committee who approves the enrolment on the basis of the interest and preconditions for enrolment for subjects in question, and current capacities of Faculty or Department for execution of the subject in question.

Apart from the list of elective subjects provided by the program Engineering and Physics of Materials, students have the opportunity to draw as elective subjects any subjects from the graduate university programs offered at the University of Rijeka, provided an approval is given by the Head of the Program coordinating committee.

3.5. Lecturing in Foreign Languages

If required, lectures in languages other than Croatian can be arranged in agreement with lecturers.

3.6. Criteria for ECTS Credits and Conditions for Transfer of Credits

ECTS credits obtained from a given subject at any university program of the University of Rijeka or any other higher education institution will be fully recognized and transferred.

3.7. Completion of Program and Graduation

To complete the program and graduate, students are required to submit the Thesis. The subject and scope of the Thesis is defined by the given assignment. The study is completed with the final exam, consisting of the mark for the Thesis and defending the Theses in front of the Committee for the final exam. This can be done only after passing all exams and obligations required by the program.

3.8. Continuation of Study after Interruption

Students with suspended academic requirements are allowed to continue the same university program under the condition that they take all the differential and additional exams, if the difference exists between the curriculum they used to attend and the current curriculum. The issue about the continuation of the study is settled by the Head of Department of Physics in the written form, defining the semester of enrolment, the differential exams required and the timeframe for their completion.

The status of students willing to continue the study after the interruption period, and conditions under which they can continue the study, are to be defined by a formal decision issued by the Head of Department of Physics.

Students who lost the right to continue one university program can enrol to any other university program in the status of part-time students with fully or partially recognised all passed exams, depending on whether the old and new subjects are compatible by their syllabus and scope. The part-time students are required to pay the tuition fee. The issue about registration is settled by the Head of Department of Physics, defining the year the student is to be enrolled into, differential exams and the timeframe for their completion.

4. REQUIREMENTS FOR THE EXECUTION OF PROGRAM

4.1. Location

All the lecture theatres and classrooms will be available in the building of the Department of Physics on the University Campus of the University of Rijeka or at the existing facilities of the Faculty of Engineering of the University of Rijeka.

4.2. Space and Equipment

The new building for the University Departments of more than 10.000 m^2, which will host the Department of Physics on three floors of area of more than 2.000 m^2, will be completed in spring of 2009. The Department of Physics area consists of office and laboratory space and a number of lecturing and tutorial rooms. There will be a large number of lecturing theatres of different capacities to be shared among all University Departments. For the predicted number of students, lectures, tutorials and practical work will be organized in these modern and well-equipped lecture rooms and laboratories. There will be four cutting edge experimental laboratories there: Laboratory for surface and materials science, Laboratory for elemental microanalysis, Laboratory for physics of environment and Laboratory for micro and nano technology.

The Faculty of Engineering has at its disposal 11.922 m^2 of space, of which 8062 m^2 covers the main building of the Faculty and 3860 m^2 the building for the laboratories. 6726 m^2 of space is used for lecture rooms (some of which have the equipment for teleconferencing), offices, laboratories, computer centre and library. In terms of quality, for the predicted number of students, lectures and tutorials can be organized in modern and well equipped lecture rooms and in 46 laboratories: Laboratory of Ship Hydromechanics, Laboratory of Ocean Engineering, Laboratory of Shipbuilding and Laboratory of Computing Engineering in Naval Architecture at the Department of Naval Architecture and Ocean Engineering; Laboratory of Measuring in Electrical Engineering, Laboratory of Analog and Digital Signal Processing, Laboratory of Electronics, Laboratory of Automatics and Robotics, Laboratory of Computing Systems and Laboratory of Applied Information Technologies at the Department of Automation, Electronics and Computing; Laboratory of Application of Power Electronics, Laboratory of Electric Engines and Drives, Laboratory of Electric Power Systems and Laboratory of Low-Frequency Electric and Magnetic Fields at the Department of Electric Power Systems; Laboratory of Computer Aided Construction, Laboratory of Acoustics, Laboratory of Asperities Measurement, Laboratory of Photoelasticity, Laboratory of Accurate Engineering, Laboratory of Strain Measurement and Laboratory of Hydraulics and Pneumatics at the Department of Mechanical Engineering Design; Laboratory of Fluid Mechanics and Hydraulic Engines and Laboratory of Computational Engineering at the Department of Fluid Mechanics and Computational Engineering; Laboratory of Technical Measurements, CIM Laboratory, Laboratory of Artificially Intelligent Machines and Processing Systems, Laboratory of Metal Cutting Processes, Laboratory of Plastic Forming and Processing Machines and Laboratory of Welding and Quality Assurance at the Department of Industrial Engineering and Management; Laboratory of Structural Strength Testing, Laboratory of Numerical Structural Analysis, Laboratory of Machine Dynamics, Laboratory of Thermomechanics, Laboratory of Measurements and Strains Analysis and Laboratory of Mechatronics in Mechanical Engineering at the Department of Engineering Mechanics; Laboratory of Heating, Ventilation and Air-Conditioning, Laboratory of Refrigeration, Laboratory of Internal Combustion Engines, Laboratory of Industrial Energy Engineering, Laboratory of Thermal Measurements and Laboratory of Thermal Turbo Engines at the Department of Thermodynamics and Energy Engineering; Laboratory of Heat Treatment, Laboratory of Material Testing and Chemical Laboratory at the Department of Materials Science and Engineering; Laboratory of

Physics and Environment Protection and Fonolaboratory at the Department of Mathematics, Physics, Foreign Languages and Kinesiology. Three computer cabinets are also available.

4.3. List of Teaching Staff

The current teaching staff of the Faculty of Engineering and the Department of Physics will give most of the lectures, while some more specialized lectures will be given by some prominent lecturers from the Institute of Physics from Zagreb.

4.5. Location of practical work

Practical work and teaching will be performed mostly at the Faculty of Engineering and the Department of Physics of the University of Rijeka, and partially at the Institute of Physics in Zagreb.

4.6. Optimal Number of Students

Considering the available space, equipment and number of teaching staff, the optimal number of students to be enrolled is 20.

4.7. Evaluation of Cost per Student

Anticipated cost per student is 23.000,00 kunas.

4.8. Quality and Efficiency Monitoring

Monitoring of quality and the performance efficiency of the university program represents the basic element of the quality assurance system defined by the University and in accordance with the University mission and vision, accepted strategy, the Statute of the Quality Assurance Committee and the Reference book on quality assurance of the Faculty of Engineering.

The mechanism for quality and efficiency monitoring includes:

- permanent data compiling and performance evaluation by students for all lecturers and courses within this program,
- developing, defining and publishing of planned study outcomes,
- making available all the necessary resources used in this program,
- periodic, formal approving of syllabus by jurisdiction bodies outside the Faculty of Engineering and the Department of Physics,
- permanent monitoring and informing about students efficiency and exam passing rates,
- periodic revision of syllabus and adjustment to the current trends and needs of all participants of the process as well as to the good European/international high-educational practice in the area of engineering and physics of materials,
- occasional questionnaires and other styles of communication with the potential employers and other interested parties,
- active involving of students' representatives into the quality assurance bodies.