University of Rijeka
FACULTY OF ENGINEERING

Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences

Study programme

Rijeka, April 2020

Basic information	
Title of study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences
Study programme coordinator	University of Rijeka – Faculty of Engineering
Study programme implementor	University of Rijeka – Faculty of Engineering
Type of study programme	Postgraduate University Doctoral Study
Level of study programme	Level 8.2
Academic/professional degree awarded upon completion of study	Doctor of Science
Title and code of the qualification standard acquired upon the finishing od the study (if the programme is enrolled in the CROQF Register)	-

1. INTRODUCTION

1.1. Study goals and learning outcomes

The University of Rijeka Faculty of Engineering (hereinafter: the Faculty) is the issuing institution of the Postgraduate Doctoral Study Programme in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences. The programme is based on the tradition of postgraduate studies at the Faculty (since 1971) and on the needs of the Croatian society for science and research resources today and in the near future. Current aims of Croatian society are transformation into a knowledge society and European and global integration. Croatia needs to develop into a modern society and the economy of experts, and a country of wise international political partner of large systems and mature democracies. The weakening of the productive sector in the economy and the decline in the number of students enrolled into programmes in the fields of technical and natural sciences must be stopped in the same way that was done in the countries which have successfully completed the aforementioned transformation. The study programme will educate researchers who will be able to contribute to the accomplishment of the aforementioned aims. Some researchers who remain in the higher education and scientific research system will educate new generations of engineers and scientists, but they will also generate new research results, enable the transfer of knowledge and, through their research and contacts with foreign researchers, help Croatia with European and global integration. There is even a greater need of our economy for creative and enterprising young researchers who will help the economy grow. The key element in the future of Croatia are awakened creators, expert engineers and capable entrepreneurs whose technological creations can be sold all over the world.
Furthermore, the entire study programme is based on and closely tied to the scientific research carried out through internationally competitive projects. Current research and development projects at the Faculty indicate by the number and quality of published scientific papers that our institution is already a home to competitive scientific research. The transfer of knowledge from older to younger generations of researchers and the continuity of scientific research are a guarantee that this will carry on and that competitiveness will in fact increase with time. In addition, a relatively large number of researchers at the Faculty and the coverage of different fields and branches of engineering sciences are related through research as well as the proposed modules and courses to specific competencies which will be developed in doctoral students. Moreover, special attention is given to general competences which prospective young researchers will have to acquire through the study programme.
The Faculty still has established cooperation with other higher education institutions, institutes and companies. Thanks to the adjustment to the Bologna Process, the cooperation will be strengthened further because of the

integration into the European Higher Education Area and because of the incentives for cooperation which need to become much stronger with time.
As we are witnessing the rapid development of new technologies, methods and procedures, as well as scientific advances in the STEM field today, the directions of scientific research have crystallised, towards accomplishing new goals and which can make a significant scientific contribution within the already existing structure of study programmes. Furthermore, since the Faculty of Engineering in Rijeka has been investing significant funds in the procurement of scientific research and teaching equipment, the foundations for scientific research have been expanded. Also, the Faculty is actively supporting a large number of scientific research projects in which research recognised in international scientific circles is carried out, and in this connection the study programme follows the modern trends of research recognised. The learning outcomes of individual subjects were determined in a way that their descriptors clearly express the level of study and clearly mark the way of achieving the learning outcomes of the whole study, which are harmonised with the CROQF methodology and defined as follows:

Scientific research contribution

- Formulate a hypothesis for scientific research
- Apply a scientific method (theoretical, experimental, analytical, numeric, or similar) with the aim of confirming or rejecting the hypothesis
- Create one's own theories, methods, procedures, models, and other scientific results
- Analyse and revise existing sources and databases with the aim of collecting data needed for carrying out own research

Scientific collaboration

- Establish collaboration with other researchers from the country and abroad
- Apply and lead a national/international research project – prepare the project proposal, establish a financial plan, achieve project goals, report regularly on project work
- Independently or as a member of a research group, carry out scientific research and critically evaluate existing theories and research results

Dissemination skills

- Present to the wider public and popularise the results of own scientific research
- Publish a research paper in a major international journal
- Publish and present a research paper at an international scientific event (workshop, congress, conference)

Social responsibility

- Develop innovative solutions through creative activities with the aim of increasing the knowledge of the society
- Use scientific methods to solve complex economic and other problems
- Take ethical and social responsibility in carrying out scientific research successfully, especially taking into consideration the social relevance of research results

The achievement of such learning outcomes will further contribute to: improving postgraduate education in Croatia, increasing the comparability of postgraduate programs with similar programs in the EU, further promoting cooperation with other universities and institutes at home and abroad, increasing the quality of research work, educating doctoral students who should be at a similar level of education as those in Western Europe and the USA, educating professionals who will further enhance education, science, the economy and other segments of our society.

1.2. *Experience to date*

Master of Engineering postgraduate study programme was started at the Faculty in 1971 with the aim of providing graduate mechanical and naval engineers with the opportunity to broaden their knowledge and undergo scientific training. Classes were started in the 1971/1972 academic year in the module Construction Theory. Planned duration of the study was four semesters. In the 1975/1976 academic year, classes began in the modules Metal-cutting Processes and Thermal-Based Manufacturing Technology. Changes in the concept and courses of the postgraduate study programme were made in 1977. Postgraduate doctoral study programme (for Masters of Science and specialisation in the fields of Mechanical Engineering and Naval Architecture were started. In the 1981/1982 academic year, significant changes were made to the curriculum which had seven majors and a further division into modules. Since the 1995/1996 academic year, teaching has been conducted according to the amended Curriculum in line with the Law on Higher Education. At its session held on 10 March 1999, the Croatian National Council for Higher Education adopted the Report of the Committee for Curriculum Evaluation and positively evaluated the Faculty's Postgraduate Study Programme in the area of Engineering Sciences, in the fields of Mechanical Engineering and Naval Architecture. In 2002, a new postgraduate study curriculum was implemented. This enabled the postgraduate study programme for Doctors of Engineering Sciences. In the 2002/2003 academic year, the Faculty began working on acquiring the license for carrying out the programme in the field of Other Fundamental Engineering Based on the resolution of the University of Rijeka Senate from July 2003, the Faculty is accredited for organising and carrying out postgraduate university scientific and vocational studies in the field of Other Fundamental Engineering Sciences, as well as for carrying out the acquisition of the degree of Doctor of Science within and outside the postgraduate study programme. In the same year, alongside six majors a new, seventh major was introduced: Ecological Engineering and Environmental Protection. Furthermore, in the 2003/2004 academic year, innovations were introduced into the curricula which were then adopted at the 20th session of the Faculty Council held on 28 May 2004 and approved by the University of Rijeka Senate on the 103rd session held on 17 June 2004. The aim of this programme is to educate capable researchers in research and supervision for working at research institutions or for working on research projects in companies, as well as for working at higher education institutions. In creating the curricula, student interests and science development tendencies in global and Croatian high-tech economy have been taken into account.

Since the 2003/2004 academic year, in accordance with the new Law on Science and Higher Education, the Faculty has been carrying out only the postgraduate scientific study programme for the acquisition of the degree of Doctor of Engineering Sciences. Since the 2011/2012 academic year, an innovated postgraduate doctoral study programme has been carried out. Changes to the programme were adopted at the 5th session of the Faculty Council held on 26 February 2011, and approved by the University of Rijeka Senate at the 29th session held on 19 July 2011. In the 2010/2011 academic year, the Faculty was, alongside postgraduate university study programmes in the scientific fields of Mechanical Engineering and Naval Architecture, accredited for organising and carrying out postgraduate scientific and vocational study programmes in the scientific fields of Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences.

Further Encouraged by the University of Rijeka Senate's decision on taking measures to improve postgraduate doctoral studies, from 19 January 2011 and respecting The European Charter for Researchers, The Code of Conduct for the Recruitment of Researchers, the Dublin Descriptors, the Croatian Qualification Framework (CROQF), the Faculty's capabilities and the needs of the Faculty and the Croatian society for scientific and research resources, the Council of the Faculty of Engineering, University of Rijeka, at its 8th session in the 2010/2011 academic year, held on 28 May 2011, decided to approve the proposal to amend the existing postgraduate doctoral programme and forward it to the Senate of the University of Rijeka for further evaluation. The University of Rijeka Senate approved the proposed changes and students enrolled in the study programme according to the new proposal, beginning with the 2013/2014 academic year. The proposed changes proved successful, as confirmed by the results of the new self-analysis and evaluation of the Committee for the Re-accreditation of Postgraduate Study Programmes (in June 2016). However, further improvements increase the quality of studies and strengthen the learning outcomes of prospective doctoral students.

The improved study programme has been approved for implementation by the decree of the Senate of the University of Rijeka in March 2020. It is aligned with the Strategy of Science Development, which was highlighted as a positive example by the Expert Committee in the Process of Re-accreditation of the Faculty of Engineering in Rijeka (August 2018). It is also aligned with the Strategy of the University of Rijeka (Strategy 2014-2020, University of Rijeka, 2014), primarily for the purpose of enhancing the University's visibility in the research context and expanding the pool of scientists and researchers in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences. Finally, with the goal to strengthen the research of the University of Rijeka, the programme increases competitiveness and enables the monitoring of current trends. It is also expected to contribute to an increase in the number of scientific papers published in high-ranking journals indexed in the most important scientific bases, which will further contribute to the Faculty's reputation, and the University of Rijeka will be ranked better in the world rankings of universities.

2. IMPLEMENTATION OF THE STUDY PROGRAMME

Due to the valid Regulations on Postgraduate University (Doctoral) Study Programmes, which are harmonised with the provisions of the University of Rijeka Study Regulations, the organisation of studies, the procedure and criteria for admission, the guidance through the programme, execution of the programme and programme obligations, doctoral dissertation and completion of the programme, as well as the student rights and responsibilities are determined.

3. PROGRAMME DESCRIPTION

The study is conducted in the scientific fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences within the scientific area of Engineering Sciences. Subjects in the area of study cover the aforementioned scientific fields and are organised by subject areas - modules. The modules are of advisory nature and have been formed for the purpose of a clearer overview of related subjects. The modules in the study are: Production Engineering, Thermal Power Engineering, Computational Mechanics, Design and Building of Ships, Mechanical Engineering Design, Quality Assurance and Engineering System Control as well as Ecological Engineering and Environmental Protection.

Common courses

LIST OF MODULES/COURSES

Year of study: 1.

Semester: 1.

MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
All modules	Methodology of scientific work and research		15	0	0	6	C
	Mathematical modeling and numerical methods		15	0	0	6	E
	Optimization methods		15	0	0	6	E
	Statistical methods and stochastic processes		15	0	0	6	E
	Freely selected course						E

Module 1: Production engineering

LIST OF MODULES/COURSES							
Year of study: 1							
Semester: 1							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Production engineering	CAM, CAP, CAD/NC-CIM		15	0	0	6	E
	Formability and modern forming technology		15	0	0	6	E
	Intelligent manufacturing systems		15	0	0	6	E
	Simulation methods in production		15	0	0	6	E
	Intelligent robots and manipulators		15	0	0	6	E
	Selected Chapters on Mechanical Behaviour and Fatigue of Materials		15	0	0	6	E
	Damage and fracture mechanics		15	0	0	6	E
	Corrosion and corrosion protection		15	0	0	6	E
	Sustainable manufacturing		15	0	0	6	E

LIST OF MODULES/COURSES							
Year of study: 1							
Semester: 2							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Production engineering	Selected chapters on flexible manufacturing systems		15	0	0	6	E
	Selected Chapters on Conventional Machining Processes		15	0	0	6	E
	Selected Chapters on Non-Conventional Machining Processes		15	0	0	6	E
	Processes plans optimization		15	0	0	6	E
	Production Planning and Control		15	0	0	6	E
	Development and operations management		15	0	0	6	E
	Heat treatment and surface engineering		15	0	0	6	E
	Materials testing		15	0	0	6	E

Module 2: Thermal power engineering

LIST OF MODULES/COURSES

Year of study: 1

Semester: 1

MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Thermal power engineering	Selected chapters on thermal sciences		15	0	0	6	E
	Numerical modelling of heat transfer		15	0	0	6	E
	Experimental methods in heating and energy engineering		15	0	0	6	E
	Selected chapters on refrigeration		15	0	0	6	E
	Selected chapters on heat exchangers		15	0	0	6	E
	Selected chapters on heating and air conditioning		15	0	0	6	E
	Implementation of energy efficiency measures		15	0	0	6	E
	Selected chapters on internal combustion engines		15	0	0	6	E
	Modern engine design		15	0	0	6	E
	Durability and reliability of thermal energy systems		15	0	0	6	E
	Selected chapters on marine energy systems		15	0	0	6	E

LIST OF MODULES/COURSES

Year of study: 1

Semester: 2

MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Thermal power engineering	Selected chapters on marine machinery systems		15	0	0	6	E
	Selected chapters on thermal turbomachines		15	0	0	6	E
	Thermodynamic analysis of processes		15	0	0	6	E
	Numerical modelling in refrigeration		15	0	0	6	E
	Selected chapters on renewable energy sources		15	0	0	6	E
	Numerical modelling of combustion processes		15	0	0	6	E
	Optimization of energy systems		15	0	0	6	E

Module 3: Computational mechanics

LIST OF MODULES/COURSES							
Year of study: 1							
Semester: 1							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Computational mechanics	Elastomechanics and plastomechanics		15	0	0	6	E
	Nonlinear structural analysis		15	0	0	6	E
	Selected chapters on thermomechanics		15	0	0	6	E
	Vibrations and durability of machines and structures		15	0	0	6	E
	Protection from noise and vibrations		15	0	0	6	E
	Free surface flow		15	0	0	6	E
	Turbulent flow		15	0	0	6	E

LIST OF MODULES/COURSES							
Year of study: 1							
Semester: 2							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Computational mechanics	Mechanics of composite structures		15	0	0	6	E
	Nanomechanics		15	0	0	6	E
	Dynamics of nonlinear mechanical systems		15	0	0	6	E
	Structural integrity		15	0	0	6	E
	Computational structural stability analysis		15	0	0	6	E
	Computational fluid mechanics		15	0	0	6	E
	Turbomachinery hydrodynamics		15	0	0	6	E
	Unsteady pipe flow modelling		15	0	0	6	E

Module 4: Design and building of ships

LIST OF MODULES/COURSES							
Year of study: 1.							
Semester: 1.							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Design and building of ships	Outfitting of marine vessels and offshore structures		15	0	0	6	E
	Ship's design methodology		15	0	0	6	E
	Seakeeping and maneuverability		15	0	0	6	E
	Selected chapters on ship resistance		15	0	0	6	E

LIST OF MODULES/COURSES							
Year of study: 1.							
Semester: 2.							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Design and building of ships	Selected chapters on shipbuilding methodology		15	0	0	6	E
	Selected chapters on ship propulsion		15	0	0	6	E
	Selected topics in marine dynamics		15	0	0	6	E
	Selected chapters on ship's design		15	0	0	6	E
	Selected chapters on marine structural design		15	0	0	6	E

Module 5: Mechanical engineering design

LIST OF MODULES/COURSES							
Year of study: 1.							
Semester: 1.							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Mechanical engineering design	Special mechanical transmissions		15	0	0	6	E
	Principles of High- and Ultra-high Precision Devices		15	0	0	6	E
	Damage modelling and load carrying capacity analysis of elements and components		15	0	0	6	E
	Selected Chapters on Design Science		15	0	0	6	E
	Design of advanced engineering constructions made of innovative materials		15	0	0	6	E
	Advanced control methods in precision engineering		15	0	0	6	E

LIST OF MODULES/COURSES							
Year of study: 1.							
Semester: 2.							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Mechanical engineering design	Selected chapters on industrial transport equipment and devices		15	0	0	6	E
	Compliant Elements and Mechanisms		15	0	0	6	E
	Selected chapters on machine elements design		15	0	0	6	E
	Multi-speed mechanical convertors		15	0	0	6	E
	Selected chapters on gear transmissions		15	0	0	6	E
	Selected chapter on fluid power		15	0	0	6	E

Module 6: Quality assurance and engineering system control

LIST OF MODULES/COURSES							
Year of study: 1							
Semester: 1							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Quality assur...	Total quality management		15	0	0	6	E
	Production planning and control		15	0	0	6	E

LIST OF MODULES/COURSES							
Year of study: 1							
Semester: 2							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Quality assurance and engineering system control	Statistical process control		15	0	0	6	E
	Design of data base		15	0	0	6	E
	Business decision making		15	0	0	6	E
	Project management in product and production systems development		15	0	0	6	E
	Reliability of technical systems		15	0	0	6	E
	Intelligent systems		15	0	0	6	E
	Strategic management and competitiveness		15	0	0	6	E
	Quality engineering		15	0	0	6	E
	Technical systems safety		15	0	0	6	E

Module 7: Ecological engineering and environmental protection

LIST OF MODULES/COURSES							
Year of study: 1.							
Semester: 1.							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Ecological engineering and environmental protection	Selected topics on environment protection		15	0	0	6	E
	Sustainable development management and environmental protection		15	0	0	6	E
	Protection of marine and coastal environments		15	0	0	6	E

LIST OF MODULES/COURSES							
Year of study: 1.							
Semester: 2.							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Ecological engineering and environmental protection	Materials testing		15	0	0	6	E
	Waste management		15	0	0	6	E
	Noise pollution		15	0	0	6	E
	Computational modelling of pollution dispersion		15	0	0	6	E
	Numerical modelling of environmental flow		15	0	0	6	E
	Environmental refrigeration		15	0	0	6	E
	Environment protection in energy and process industry		15	0	0	6	E
	Microbiological pollution of water		15	0	0	6	E

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Advanced control methods in precision engineering**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Understanding of basic and advanced control methodologies in precision engineering and mechatronics. Development of control algorithms using suitable programming environments and their application to mechatronics systems. Acquisition of skills and competences needed for independent scientific research. Ability to communicate and exchange the knowledge with other scientists and experts in the field.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Based on the scientific approach, develop suitable control algorithms and apply them to mechatronics systems with the aim of improving their performances. Independently conduct scientific research activities and establish scientific collaboration with scientists and experts in the field. Based on the scientific research results, publish and present achieved results in the form of scientific paper or project report.

1.4. Course content

Basic control methods in precision engineering and mechatronics. Nonlinear dynamical system modelling and identification via theoretical and experimental approach. Advanced data-driven modelling of nonlinear mechanical systems based on machine learning algorithms. Advanced control methods in precision engineering and mechatronics. Adaptive control in precision engineering and mechatronics. Examples of application of control algorithms to different systems.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Class attendance (consultations), work on project assignment and preparation and presentation of seminar and/or scientific paper.

1.8. Monitoring of student work[1]

[1] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	2
Written exam		Oral exam		Essay		Research	2
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class attendance, seminar and/or scientific paper, laboratory work, presentation of research results.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Levine, W. S. (Ed.). (2018). The Control Systems Handbook: Control System Advanced Methods. CRC press.
Mauroy, A., Mezić, I. & Susuki Y. (Eds.). (2020). The Koopman Operator in Systems and Control: Concepts, Methodologies and Applications. Springer International Publishing.
Schmidt, R. M., Schitter, G., & Rankers, A. (2014). The Design of High Performance Mechatronics: High-Tech Functionality by Multidisciplinary System Integration. Ios Press.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Zelenika, S., & Kamenar, E. (2015). Precizne konstrukcije i tehnologija mikro- i nanosustava I – Precizne konstrukcije (Precision Engineering and Micro- and Nanosystems' Technology I – Precision Engineering), University of Rijeka, Faculty of Engineering.
Nof, S. Y. (Ed.). (2009). Springer handbook of automation. Springer Science & Business Media.
Burns, R. (2001). Advanced control engineering. Elsevier.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Levine, W. S. (Ed.). (2018). The Control Systems Handbook: Control System Advanced Methods. CRC press.	1	1
Mauroy, A., Mezić, I. & Susuki Y. (Eds.). (2020). The Koopman Operator in Systems and Control: Concepts, Methodologies and Applications. Springer International Publishing.	1	1
Schmidt, R. M., Schitter, G., & Rankers, A. (2014). The Design of High Performance Mechatronics: High-Tech Functionality by Multidisciplinary System Integration. Ios Press.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Business decision making**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

The course objective is to provide students with knowledge and skills in elements of the business decision-making process. Through individual projects, students develop skills necessary for practical application of course topics.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Evaluate theoretical concepts of business decision-making and linking the legality of costs with long- and short-term aspects of business decision-making. Development of decision-making methods using economic and financial decision-making criteria and risk measurement techniques. Apply advanced multi-criteria decision-making concepts.

1.4. Course content

1. Basic concepts and decision theories. 2. Decision making based on cost concept - business leverage - benefit cost analysis. 3. Decision making based on financial concept - financial leverage - economic and financial investment criteria. 4. The concept of risk management and measurement. 5. Multi-criteria decision making. 6. Specific and alternative business decisions - unconventional optional approaches to capital budgeting.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

The students are required to attend the classes (consultations), prepare and present the project task - seminar and do written exam.

1.8. Monitoring of student work[2]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam	3,0	Oral exam	0,5	Essay		Research	0,5

[2] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their seminar (project) work and on final exam

1.10. Mandatory literature (at the time of submission of study programme proposal)

Orsag S., Poslovne financije, Avantis, Hufa, 2017.
Sikavica P., Hunjak T., Begicevic Redep N., Hernaus T., Poslovno odlučivanje, Školska knjiga, Zagreb, 2014.
Orsag S., Dedi L., Budžetiranje kapitala: Procjena investicijskih projekata, Masmedia, Zagreb, 2011.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Pranjić G., Decision Making Proces sin the Business Intelligence Context, 2018.
Damodaran A., Damodaran o valuaciji, Mate, Zagreb, 2010.
Hillson, D., Managing Risk in Projects, Gower, USA, 2009.
Pettit, J., Strategic Corporate Finance: Application in Valuation and Capital Structure, Wiley, USA, 2007.
Bierman H., Smidt S., The Capital Budgeting Decision, Economic Analysis of Investment Projects, Routledge, London, 2006.
Amenc N., Le Sourd V., Portfolio Theory and Performance Analysis, John Wiley&Sons, Ltd, USA, 2003.
Panian Ž., Klepac G., Poslovna inteligencija, Masmedia, Zagreb, 2003.
Santini I., Troškovi u poslovnom odlučivanju, HIBIS, d.o.o., Zagreb, 1999.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Orsag S., Poslovne financije, Avantis, Hufa, 2017.	1	1
Sikavica P., Hunjak T., Begicevic Redep N., Hernaus T., Poslovno odlučivanje, Školska knjiga, Zagreb, 2014.	1	1
Orsag S., Dedi L., Budžetiranje kapitala: Procjena investicijskih projekata, Masmedia, Zagreb, 2011.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

In accordance with established quality assurance system at the Faculty.

COURSE DESCRIPTION			
Course instructor			
Name of the course	**CAM, CAP, CAD/NC-CIM**		
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences		
Status of the course	elective		
Year of study	1		
ECTS credits and manner of instruction	ECTS credits	6	
	Number of class hours (L+E+S)	15+0+0	

1.1. Course objectives

Understanding the situation and tendencies in the development of computer application in the process planning and programming machines as essential elements of CIM.

1.2. Course enrolment requirements

No prerequisites.

1.3. Expected learning outcomes

Analyze the basic features of computer aided process planning (CAPP) and computer aided process assembly. Evaluate the assumptions for variant and generative approach of CAPP. Investigate and apply the capabilities of the CAM software packages in the preparation of the NC programs.

1.4. Course content

CIM concept. Elaboration of assumptions, solutions and tendencies in the development of automation. Variant and generative approach of computer aided process planning (CAPP). Computer aided planning (CAP). Computer aided programming of numerically controlled machines, examples of software systems. Linking CAD - databases and NC - programming systems. Problems with data transfer.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance of classes (consultations), work on project assignment as well as preparation and presentation of seminar.

1.8. Monitoring of student work[3]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3,0
Project		Continuous assessment		Report		Practical work	

[3] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Portfolio								

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of active participation in the class, evaluation of the project assignment. Presentation of seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Groover, M.P.: Automation, Production Systems and Computer Integrated Manufacturing, New York Pearson, 2019.
Framinan, J.M., Leisten, R., Garcia, R.R.: Manufacturing scheduling systems, Springer Verlag, London, 2014.
Halevi, G.: Process and Operation Planning, Kluwer Academic Publishers, London, 2003.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

G. Halevi & R.D. Weill: Principles of Process Planning, Chapman & Hall, London, 1995.
Fandel, G. & other.: Operations Research in Production Planning and Control, Springer Verlag, 1992.
Kusiak, A.: Inteligent Manufacturing Systems. Prentice Hall Inc., Englewood Cliffs, New Jersey. 1990.
El Wakil, S.D.: Processes and Design for Manufacturing. Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1989.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Groover, M.P.: Automation, Production Systems and Computer Integrated Manufacturing	1	-
Framinan, J.M., Leisten, R., Garcia, R.R.: Manufacturing scheduling systems	1	-
Halevi, G.: Process and Operation Planning	1	-

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

According to Institutional Quality Assurance System.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Compliant Elements and Mechanisms**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Systematic approach, critical analysis and assessment of most recent scientific information in the field of compliant elements and mechanisms. Acquisition of knowledge about the models of their behaviour and experimental validation of performances of this class of devices in the framework of complex project solutions. Acquisition of skills of scientific and research work as well as of synthesis of new and complex ideas. Capability of communication with experts and peers in the relevant research field.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

By applying the scientific methodology and based on the analysis and revision of current literature, critically assess the types, the characteristics as well as the methods of modelling of their behaviour and of the experimental validation of performances of complaint elements and mechanisms.
Set research hypotheses, organize and plan own research work (also in collaboration with researchers and on scientific projects) and synthetize the acquired knowledge as well as generate innovative design solutions, methods and theories, considering especially the industrial and societal implications and the usage of research results.
Publish and present the achieved results in a scientifically sound manner with development of skills of writing of original scientific and professional publications.

1.4. Course content

Advanced topics and principles of compliant elements as well as compliant translation and rotation mechanisms and comparison with sliding and rolling devices. Parasitic displacements.
Analytical and numerical approaches to the modelling of the behaviour with special emphasis on nonlinearities. Static and dynamic analyses. Optimisation of design configurations and fatigue behaviour. Compensated compliant mechanisms. Stability problems.
Materials used for the production of compliant mechanisms. Production and assembly approaches.
Experimental assessment of the behaviour of compliant mechanisms by using laser interferometric and other optical contactless measurement techniques.
Integration with actuators and measurement systems and usage of integrated mechatronics compliant devices on the macro-, micro- (MEMS) and nano- (NEMS) scales. Scaling effects.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other

1.6. Comments	-

1.7. Student responsibilities

Attendance of classes (consultations), work on project assignment as well as preparation and presentation of a seminar (and/or publishing and presentation of scientific work on an international conference).

1.8. Monitoring of student work[4]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	4.0
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance of classes, adoption of methodology of scientific work via research activity, project work, seminar (and/or scientific publication) work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

S. Zelenika and E. Kamenar: „Precizne konstrukcije i tehnologija mikro- i nanosustava I – Precizne konstrukcije (Precision Engineering and Micro- and Nanosystems' Technology I – Precision Engineering)“, University of Rijeka – Faculty of Engineering, Rijeka, Croatia, 2015.
L. L. Howell: „Compliant Mechanisms“, J. Wiley, New York (NY, USA), 2001.
S. T. Smith: „Flexures - Elements of Elastic Mechanisms“, Gordon & Breach, Amsterdam (NL), 2000.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

N. Lobontiu: „Compliant Mechanisms – Design of Flexure Hinges“, CRC, Boca Raton (FL, USA), 2003.
***: „Springer Handbook of Nanotechnology“ - 3rd ed., Springer Verlag, Berlin (D), 2010.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
S. Zelenika and E. Kamenar: Precision Engineering and Micro- and Nanosystems Technology I	10	1
L. L. Howell: Compliant Mechanisms	1	1
S. T. Smith: Flexures - Elements of Elastic Mechanisms	1	1
N. Lobontiu: Compliant Mechanisms – Design of Flexure Hinges	1	1
***: Springer Handbook of Nanotechnology	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Via the institutional quality assurance system of the Faculty of Engineering of the University of Rijeka.

[4] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Computational fluid mechanics**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Computational fluid mechanics required to solve problems in the engineering practice. Identification of problems in engineering practice solved by the use of computational fluid mechanics, setting up and solving the above problems using the acquired knowledge in computational fluid dynamics. Employing CFD models in solution of realistic engineering problems.

1.2. Course enrolment requirements

No requirements.

1.3. Expected learning outcomes

Apply the finite difference, finite element and finite volume models to solve the problems in the engineering practice and compare the methods. Apply the potential flow model. Apply the selected numerical models in solution of free surface flow problems. Apply the Navier-Stokes equations and k- ε turbulence model on the problem selected. Employ the CFD models in solution of realistic engineering problems.

1.4. Course content

Numerical models of pollution transport, diffusion and dispersion including water, air and groundwater fluid flow with the pollution propagation. Ability to employ models in original scientific research.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Consultations, studying of literature, solving the problem task, preparing and giving a presentation.

1.8. Monitoring of student work[5]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	4

[5] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attending consultations, activity and independence in studying, project task, seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Chaudry, M. H., Open-Channel Flow, Prentice-Hall, 1993.
Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012.
Bird, R. B., Stewart, W. E., Lightfoot, E. N.,Transport Phenomena, 2002.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Toro, E., Riemann Solvers and Numerical Methods for Fluid Dynamics, 2009.
Warner, T. T. Numerical Weather and Climate Prediction, 2011.
Lauritzen, Taylor, Jablonowski, Nair, Numerical techniques for Global Atmospheric Models, 2011.Leveque, J.R., Finite Volume Methods for Hyperbolic Problems, Cambridge Univ Press, 2002.
Software manuals for ALTAIR HYPERWORKS, OPENFOAM and FLUENT.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Chaudry, M. H., Open-Channel Flow, Prentice-Hall, 1993.	1	0
Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012.	1	0
Bird, R. B., Stewart, W. E., Lightfoot, E. N.,Transport Phenomena, 2002	1	0

1.13. Quality monitoring methods *that ensure the acquisition of exit knowledge, skills and competences*

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Computational modelling of pollution dispersion**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	**1.**	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

To set up and develop the environmental models of fluid flow with pollution propagation. Models include water, air and groundwater fluid flow with the pollution propagation. Ability to employ models in original scientific research.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyse environmental flow models with pollution propagation. Models include water, air and groundwater fluid flow with the pollution propagation. Apply models in original scientific research.

1.4. Course content

Numerical models of pollution transport, diffusion and dispersion including water, air and groundwater fluid flow with the pollution propagation. Ability to employ models in original scientific research.

1.5. Manner of instruction		
	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other

1.6. Comments	-

1.7. Student responsibilities

Consultations, studying of literature, solving the problem task, preparing and giving a presentation.

1.8. Monitoring of student work[6]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	4,0
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

[6] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Attending consultations, activity and independence in studying, project task, seminar paper.
1.10. Mandatory literature (at the time of submission of study programme proposal)
Chaudry, M. H., Open-Channel Flow, Prentice-Hall, 1993. Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012. Bird, R. B., Stewart, W. E., Lightfoot, E. N.,Transport Phenomena, 2002.
1.11. Optional/additional literature (at the time of submission of the study programme proposal)
Toro, E., Riemann Solvers and Numerical Methods for Fluid Dynamics, 2009. Warner, T. T. Numerical Weather and Climate Prediction, 2011. Lauritzen, Taylor, Jablonowski, Nair, Numerical techniques for Global Atmospheric Models, 2011.Leveque, J.R., Finite Volume Methods for Hyperbolic Problems, Cambridge Univ Press, 2002. Upute za softvere ALTAIR HYPERWORKS, OPENFOAM, FLUENT.
1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Chaudry, M. H., Open-Channel Flow, Prentice-Hall, 1993.	1	
Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012.	1	
Bird, R. B., Stewart, W. E., Lightfoot, E. N.,Transport Phenomena, 2002	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
Through the quality assurance system of the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Computational structural stability analysis**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Students will be qualified for autonomous assessing of structural instability load by computational methods.

1.2. Course enrolment requirements

Basic knowledge of structural stability.

1.3. Expected learning outcomes

Analyse stability of thin-walled structures. Analyse effects of large rotations on stability of spatial structures. Apply computational methods in buckling analysis of load-carrying structures. Develop finite element models for nonlinear structural stability analysis.

1.4. Course content

Geometric nonlinearity. Linearized structural stability analysis. Nonlinear structural stability analysis. Large displacements and large rotations. Global and local instabilities. Flexural, torsional and torsional-flexural buckling of compressed rods. Lateral-torsional buckling of beams. Stability of planar frames. Stability of space frames. Stability of arches and rings. Dynamic stability of rods under varying load. Stability of thin plates. Stability analysis of materially nonlinear structures. Application of computational methods in structural stability analysis. Geometrically nonlinear finite element formulations.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

1.8. Monitoring of student work[7]

Class attendance	0,5	Class participation		Seminar paper	3	Experimental work	
Written exam		Oral exam		Essay		Research	2,5

[7] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Relevant scientific journals.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Simitses, G. J., Hodges, D. H.: Fundamentals of Structural Stability, Elsevier, Amsterdam, 2006.
Perelmuter, A. V., Slivker, V.: Handbook of Mechanical Stability in Engineering, Vols. 1-3, World Scientific, Singapore, 2013.
Bažant, Z. P., Cedolin, L.: Stability of Structures, Dover Publication, Mineola, 2003.
Gambhir, M. L.: Stability Analysis and Design of Structures, Springer-Verlag, Berlin, 2004.
Xie, W. C.: Dynamic Stability of Structures, Cambridge University Press, Cambridge, 2006.
Chen, W. F., Atsuta, T.: Theory of Beam-Columns, J. Ross Publishing, Fort Lauderdale, 2008.
Olsson K. G., Dahlblom O.: Structural Mechanics: Modelling and Analysis of Frames and Trusses, Wiley, 2016.
McGuire, W., Gallagher, R. H., Ziemian, R. D.: Matrix Structural Analysis, John Wiley & Sons, New York, 2000.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Corrosion and corrosion protection**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	**1**	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Knowledge of corrosion mechanisms, causes of corrosion and methods of corrosion protection of metals and alloys.

1.2. Course enrolment requirements

No specific requirements.

1.3. Expected learning outcomes

Link the causes and mechanisms of corrosion. Analyse the factors affecting the corrosion rate and predict the form of corrosion damage. Set up the optimal corrosion protection method by selecting the optimal construction solution and manufacturing process. Analyse the results of corrosion rate tests.

1.4. Course content

Classification of corrosion processes. Chemical and electrochemical corrosion of metals and alloys. Thermodynamic aspects of corrosion. Faraday law. Nernst equation. Pourbaix diagram. Corrosion cells. Factors affecting the rate of corrosion. Determination of corrosion rate. Tafel equation. Various forms of corrosion damage. Corrosion under mechanical stress. Methods of corrosion protection.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance at lectures (consultation), preparation and presentation of seminar paper, oral exam.

1.8. Monitoring of student work[8]

Class attendance	0,5	Class participation		Seminar paper	4	Experimental work	
Written exam		Oral exam	1,5	Essay		Research	
Project		Continuous assessment		Report		Practical work	

[8] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance at lectures, quality of preparation and presentation of seminar paper, oral examination.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Esih, I., Dugi. Z.: Tehnologija zaštite od korozije, Sv. 1, Školska knjiga, Zagreb, 1990.
Ahmad, Z., Principles of Corrosion Engineering and Corrosion Control, Butterworth-Heinmann/IChemE series, Amsterdam, 2007.
Talbot, D. Talbot, J., Corrosion Science and Technology, Boca Raton : CRC Press, 2018.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

ASM Hanbook ,Vol. 13B Corrosion: Materials, 2005.
Handbook of Cathodic Corrosion Protection – Theory and Practice of Electrochemical Protection Processes, Third Edition, W. von Baeckmann, W. Schwenk, W. Prinz, Editors, USA, 1997.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Esih, I., Dugi. Z.: Tehnologija zaštite od korozije, Sv. 1, Školska knjiga, Zagreb, 1990.	1	0
Ahmad, Z., Principles of Corrosion Engineering and Corrosion Control, Butterworth-Heinmann/IChemE series, Amsterdam, 2007.	1	0
Talbot, D. Talbot, J., Corrosion Science and Technology, Boca Raton : CRC Press, 2018.	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Damage and fracture mechanics**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	Elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Familiarisation with and understanding of processes of damaging of materials subjected to various loading conditions and modelling of damage in the frame of continuum damage mechanics. Detailed analysis of mechanisms of crack initiation and growth, and of fracture as their consequence, under various loading conditions; acquiring knowledge on the application of fracture mechanics on their modelling and prediction, and familiarisation with methods of failure analysis.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyze the causes and mechanisms of different kinds of damage of materials, including crack initiation and growth.
Apply and, if necessary, further develop special constitutive models accounting for damage due to plastic yielding, creep, ageing, fatigue or creep-fatigue interaction.
Calculate or evaluate the loading capacity of components or structures containing a crack and assess their lifetime under variable loading.

1.4. Course content

Definition, phenomenology and kinds of damage, mechanisms of damaging of materials, damage variables, kinetic equation of evolution of damage, the principles of linear and non-linear accumulation of damage, special constitutive models accounting for damage due to plastic deformation, creep, fatigue and creep-fatigue interaction; failure modes and factors influencing them, determination of fracture toughness and other fracture relevant material properties, fractography in failure analysis, application of concepts and methods of fracture mechanics to a damage tolerant design of load bearing components and structures.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	The proportion of manners of instruction is adapted to student's needs and preferences.	

1.7. Student responsibilities							
Active participation in lectures and completion of various types of assignments: solution of specific problems, expositions, excerpts or reviews.							
1.8. Monitoring of student work[9]							
Class attendance	0,5	Class participation		Seminar paper	4	Experimental work	
Written exam		Oral exam	1,5	Essay		Research	
Project		Continuous assessment		Report		Practical work	
Portfolio							
1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)							
Assessment and evaluation of student's work is based on the participation in lectures, the quality of his or her assignments and expositions, and an oral exam.							
1.10. Mandatory literature (at the time of submission of study programme proposal)							
J. Lemaitre, R. Desmorat: Engineering Damage Mechanics : Ductile, Creep, Fatigue and Brittle Failures, Springer, Berlin, 2005. R. W. Hertzberg: Deformation and Fracture Mechanics of Engineering Materials, 4th ed., Wiley, New York, 1995. M. Janssen, J. Zuidema, R. J. H. Wanhill: Fracture Mechanics, 2nd ed., Spon Press, Abingdon, 2004.							
1.11. Optional/additional literature (at the time of submission of the study programme proposal)							
D. Rubeša: Lifetime Prediction and Constitutive Modelling for Creep-Fatigue Interaction, Gebrüder Borntraeger, Berlin, 1996. P. I. Kattan, G. Z. Voyiadjis: Damage Mechanics with Finite Elements : Practical Applications with Computer Tools, Springer, Berlin, 2001.							
1.12. Number of assigned reading copies in relation to the number of students currently attending the course							

Title	*Number of copies*	*Number of students*
Lemaitre/Desmorat: Engineering Damage Mechanics	0	
Hertzberg: Deformation and Fracture Mechanics...	1	
Janssen/Zuidema/Wanhill: Fracture Mechanics	0	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
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.

[9] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Damage modelling and load carrying capacity analysis of elements and components**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Investigation of load carrying capacity and durability of structural elements and components through the non-linear material behaviour modelling, based on chosen material damage criteria.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

Increase the accuracy of the load carrying capacity and durability of structural elements. Model and simulate the material behaviour of designed structural elements. Critically asses results of performed research on selected topic.

1.4. Course content

Assessment and modelling of the load spectrum for structural elements and components. Selection of materials for their production based on newly published research results. Examine and systematize available data of material response on loading or perform experimental procedures to determine material response. Material characterization and application of material models to simulation of the behaviour of structural elements and components in order to determine the damage initiation and to analyse the load carrying capacity of the elements and components.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Class attendance (individual consultations), solving the project assignments, preparation and presentation of the seminar paper.

1.8. Monitoring of student work[10]

Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	0,5
Written exam		Oral exam		Essay		Research	3

[10] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the research results they achieve and the seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Ottosen, N. S., Ristinmaa, M.: The Mechanics of Constitutive Modeling, Elsevier Science, 2005.
Lemaitre, J., Chaboche, J. L.: Mechanics of solid materials, Cambridge University Press, 1994.
Madenci, E., Guven, I.: The Finite Element Method and Applications in Engineering Using ANSYS, Springer, 2015.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Oluwole, O.: Finite Element Modeling for Materials Engineers Using MATLAB, Springer, 2011.
Stephens, R.I., Fatemi, A., Stephens, R. R., Fuchs, H.O.: Metal Fatigue in Engineering, Wiley-Interscience, 2000.
Mott, R. L., Vavrek, E. M., Wang, J.: Machine Elements in Mechanical Design, Pearson, 2018.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
The Mechanics of Constitutive Modeling	1	3
Mechanics of solid materials	1	3
The Finite Element Method and Applications in Engineering Using ANSYS	1	3

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

University of Rijeka
FACULTY OF ENGINEERING

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Design of advanced engineering constructions made of innovative materials**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Selection of the optimal structural solution of advanced engineering construction based on the systematization of innovative materials and methods of construction due to the durability and load carrying capacity of the structure. Development of a numerical model of the chosen structural solution and, if applicable, prototype construction.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

Analyze the impact of the application of innovative materials on the durability and load carrying capacity of advanced engineering constructions. Critically evaluate the results of the research conducted. Synthesize the acquired knowledge and generate an innovative solution of engineering construction from adequate material, and consequently the publication of the results of the research in the form of scientific or professional work.

1.4. Course content

Additive technologies. Innovative materials. Static and dynamic load carrying capacity of advanced engineering structures. Application of numerical methods in carrying capacity and durability research. Experimental measurements. Geometric features of the structure and their optimization.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other
1.6. Comments	Exceptionally, if practical work is not applicable in the design of the project, then part of the teaching will not be performed in the laboratory.	

1.7. Student responsibilities

Class attendance (individual consultations), solving the project assignments, preparation and presentation of the seminar paper.

1.8. Monitoring of student work[11]

Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	

[11] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam		Essay		Research	2,5
Project		Continuous assessment		Report		Practical work	1
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the research results they achieve, practical work (if applicable) and the seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Forrester, A., Sobester, A., Keane, A.: Engineering Design via Surrogate Modelling: A Practical Guide, Wiley, 2005.
Madenci, E., Guven, I.: The Finite Element Method and Applications in Engineering Using ANSYS, Springer, 2015.
Daniel, Isaac M.: Engineering Mechanics of Composite Materials 2nd Edition, Oxford University Press, 2005.
Zienkiewicz, O., Taylor, R.: The finite element method for solid and structural mechanics, Elsevier Butterworth-Heinemann, 2014.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Mott, R. L., Vavrek, E. M., Wang, J.: Machine Elements in Mechanical Design, Pearson, 2018.
Slocum, H.: Precision Machine Design, Society of Manufacturing Engineers, Dearborn, 1992.
Burchell, T. D.: Carbon Materials for Advanced Technologies, Elsevier Science, Oxford, 1999.
Rosato, Dominick V., Rosato, Donald V.: Plastics Engineered Product Design, Elsevier Science, Oxford, 2003.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Engineering Design via Surrogate Modelling: A Practical Guide	1	2
The Finite Element Method and Applications in Engineering Using ANSYS	1	2
Engineering Mechanics of Composite Materials	1	2
The finite element method for solid and structural mechanics	1	2

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Design of data base**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

The course is designed to provide the student with knowledge in data base design as well as application of developed skills in design and modelling of data base.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Develop a model for data modelling and ER method. Analyse and model data. Translate ER model to the relational data model. Define objective approach, safety and protection of data.

1.4. Course content

Types of data. Semantic, numeric and physical data units. Abstractions. Entity relationship method (ER method). Structure of ER method: entity, relationship, attribute aggregation. Limits of ER method: number of relationships and attributes types. Data analysis and modelling. Individual and group modelling. Data organization, file. Data bank. Data base. 4GL. Data dictionary. Relational model: relation, attribute, domain, candidate for key, relation key, outer key, limitations, relation operator, normalization. Transpose of ER model to relational model. Object approach, UML/OML. Data protection. Design and building of database. Data base modelling.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Students are required to attend the class (consultation), solving the project task, preparation and presentation of seminars and taking the oral exam.

1.8. Monitoring of student work[12]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam	0,5	Essay		Research	3,0

[12] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report	0,5	Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of student's work during classes, project exercises and final oral exam.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Pavlić, M., Oblikovanje baza podataka, Sveučilište u Rijeci, Rijeka, 2011.
Kalpić, D., Fertalj, K., Projektiranje informacijskih sustava, FER, Zagreb, 1999.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Barker, R., CASE*Method Entity Relationship Modelling, Addison-Wesley, Wokingham, England, 1990
Rumbaugh, J., et al., The Unified Modeling Language, Addison-Wesley, Wokingham, England, 1999.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Pavlić, M., Oblikovanje baza podataka, Sveučilište u Rijeci, Rijeka, 2011.	1	1
Kalpić, D., Fertalj, K., Projektiranje informacijskih sustava, FER, Zagreb, 1999.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

In accordance with established quality assurance system at the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Development and operations management**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Introducing strategies, methods and principles of the development and planning of production programs and the development of production systems. Ability to analyse influential factors in managing of production. Ability to analyse the effects of business with the introduction of new or innovative products in the production program.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analysis of the fundamental ideas of product marketing for the global market. Evaluation of management role and procedures in the development of production systems and operational management in managing the production process. Analysis of the business results with the combination and variation of new organizational concepts within operational management.

1.4. Course content

Development management: goals and objectives. Operation strategies. Management in the development of production systems and operational management in the running of the production process. Construction production manager / strategic perspective. Shaping the company's strategy. Strategic management. The process of strategic management. Components of strategic management. Factors organizations. Board of Directors. Executive Management - Administration. Styles strategic manager. Crisis Management. Ethics strategic managers. Strategic planning. Strategic Planning Model – The method of forced choice. The model of strategic planning of production / operations. Systems design. Strategy, process and methods of introducing a new product. Robust design. Analysis values.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☐ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attendance of classes (consultations), preparation and presentation of seminar.

1.8. Monitoring of student work[13]

[13] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Class attendance	0,5	Class participation		Seminar paper	4,5	Experimental work	
Written exam		Oral exam	1,0	Essay		Research	
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Presentation and defence of seminar work. Final exam is oral.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Mikac, T., Ikonić, M.: *Operations Management*, Faculty of Engineering University in Rijeka, Rijeka, 2010.
Polajnar, A.: *Operations Management*, Faculty of Mechanical Engineering, Maribor, 1998.
Buble, M. et al.: *Strategic Management*, Faculty of Economics, University of Split, Split, 1997.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Stevenson, W. J.: *Production / Operations Management*, Richard D. Irwin, Inc., Boston, 1993.
Kuzmanovic, S.: *Management products*, University of Novi Sad, Faculty of Technical Sciences, Novi Sad 2007.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Mikac, T., Ikonić, M.: Operations Management, Faculty of Engineering University in Rijeka, Rijeka, 2010.	10	-
Polajnar, A.: Operations Management, Faculty of Mechanical Engineering, Maribor, 1998.	1	-
Buble, M. et al.: Strategic Management, Faculty of Economics, University of Split, Split, 1997.	1	-

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the established quality assurance system of the Faculty of Engineering, University of Rijeka.

COURSE DESCRIPTION			
Course instructor			
Name of the course	**Durability and reliability of thermal energy systems**		
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences		
Status of the course	elective		
Year of study	1		
ECTS credits and manner of instruction	ECTS credits	6	
	Number of class hours (L+E+S)	15+0+0	

1.1. Course objectives

The ability of mathematical modelling and optimization of thermal energy systems. Ability to determine cost-effectiveness of plant aging. Ability of lifetime budget estimates for thermal energy systems. Knowledge of technical and economic problems regarding reliability and optimization of thermal power plants.

1.2. Course enrolment requirements

There are no conditions

1.3. Expected learning outcomes

Analyse thermal power systems from the efficiency and operation economy point of view with special reference to the ageing of parts. Define the life expectancy of thermal power systems parts. Apply the scientific method to improve the efficiency of thermal power plants. Perform technical and economic analysis and optimization regarding the reliability of thermal power systems. Present and popularize the results of your scientific research to the general public.

1.4. Course content

State of the art trends in the field of thermal energy systems. Mathematical modelling and optimization of thermal energy systems. Optimization of parameters, elements and loads. Aging of the elements in thermal energy systems. Estimation of elements life assessment in thermal systems. Technical and economic problems of reliability in thermal energy systems. Reliability optimization of thermal energy systems.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attending classes (consultation), addressing the terms of reference and the preparation and presentation of seminars.

1.8. Monitoring of student work[14]

Class attendance	0.5	Class participation		Seminar paper	2	Experimental	

[14] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

						work	
Written exam		Oral exam		Essay		Research	1.5
Project	2	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class attendance, project assignments, presentation of the results of own research to the general public.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Bejan, A., Tsatsaronis, G., Moran, M.: Thermal Design and Optimization, Wiley, New York, 1996.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Schroder, K.: Grosse Dampfkraftwerke, Springer Verlag, Berlin, 1968.
Kam, W.L., Priddy, A.P.: Power Plant System Desing, John Wiley & Sons Inc., New York, 1985.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Nag, P. K.: Power Plant Engineering, Mc Graw Hill, 2014.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the established system of quality assurance at the Faculty of Engineering.

Course description		
Course instructor		
Name of the course	**Dynamics of nonlinear mechanical systems**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Deepening theoretical knowledge in the field of nonlinear dynamics of mechanical systems. Acquiring skills to identify problems in the aforementioned field in engineering practice and to formulate and solve them mathematically using the adopted knowledge. Adopting the necessary knowledge to analyze and correctly interpret the obtained results.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Qualitatively analyse the nonlinear mechanical system as well as explain the basic nonlinear phenomena in its response. Develop the adequate approximate analytical method to solve it. Analyse and interpret the obtained solution in terms of the influence of nonlinear effects on its free, forced and parametric excited response as well as determine and analyse its stability. Present the results of scientific research, and, if possible, publish a paper in scientific journal or at an international scientific conference.

1.4. Course content

Introduction to nonlinear dynamics of mechanical systems. Qualitative analysis of conservative systems, phase portraits, equilibrium points, saddle-point, cusp point. Commonly observed nonlinear phenomena: multiple response, bifurcations, jump phenomena... Derivation of nonlinear equations of motion. D' Alembert's Principle for Continuous System. Extended Hamilton's Principle. Lagrange Principle. Galerkin's method for continuous system. Commonly used nonlinear equations. Approximate analytical solution methods. Lienstedt-Poincare' method. Modified Lindstedt-Poincare' Technique. Method of multiple scales (MMS). Harmonic balancing method (HBM). Method of Averaging. Generalized Method of Averaging. Method of normal form. Incremental HBM. Higher order MMS. Stability and bifurcation analysis. Limit cycles and Bifurcation of Periodic response. Quasi – periodic and Chaotic response. Examples from technical praxis of Free Vibrations of nonlinear systems (cubic and quadratic nonlinearities, nonconservative systems, quadratic damping), forced nonlinear vibrations (Primary resonance, Non-resonant hard excitation, Cubic and quadratic nonlinearities of systems with one or multi-degrees of freedom) and parametrically excited systems (One or multi-degrees of freedom as well as continuous systems, systems with Internal resonances).

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☐ individual assignments ☐ multimedia and network ☐ laboratories ☐ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities
The students are required to attend the classes (consultations), perform research assignments, prepare and present the seminar work.
1.8. Monitoring of student work[15]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)
Class attendance, drafting and defending a seminar work and presentation of research results.
1.10. Mandatory literature (at the time of submission of study programme proposal)
Nayfeh A.H., Balachandran, B.: Applied nonlinear dynamics – Analytical, Computational and Experimental methods, John Willey and Sons, 1995. Nayfeh A.H., Mook, D.T.: Nonlinear oscillations, John Willey and Sons, 1995. Ishida, Y., Yamamoto T.: Linear and Nonlinear Rotordynamics: A Modern Treatment with Applications, 2. ed., John Willey and Sons, 2012.
1.11. Optional/additional literature (at the time of submission of the study programme proposal)
Strogatz, S.H.: Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry and Engineering, CRC Press, 2015. Lynch, S.: Dynamical Systems with Applications using Mathematica, Birkhauser, Boston, 2007. Enns, R.H., McGuire, G.C.: Nonlinear Physics with Mathematica for Scientists and Engineers, Birkhauser, Boston, 2001.
1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Nayfeh A.H., Balachandran, B.: Applied nonlinear dynamics	1	1
Nayfeh A.H., Mook, D.T.: Nonlinear oscillations	1	1
Ishida, Y., Yamamoto T.: Linear and Nonlinear Rotordynamics	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
Through the Institution's quality assurance system.

[15] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Elastomechanics and plastomechanics**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

To enable students to independently perform analysis of structure response in the elastic / plastic / elastoplastic area.

1.2. Course enrolment requirements

There are no conditions.

1.3. Expected learning outcomes

Analyze different states of strain and stress. Solve construction problems of different shapes and loads. Apply yield criteria in structural analysis. Apply analytical and numerical methods in structural analysis. Apply and analyze idealized and realistic models of response, solidification and modeling of structures.

1.4. Course content

Stress and strain: definition, types, components and their transformation, small strain tensor (spherical tensor and deviator), principal stresses / principal strains and their invariants, strain measurement. Strain-displacement equations. Finite strain tensor. Different types of problems in theory of elasticity. Constitutive laws. Stress space. Constitutive equations in the field of plasticity. Mechanical testing of material behavior of engineering elements. Yield criteria. Rheological models of material response. Creep, relaxation and fracture of structural elements. Analytical and numerical approach to problem solving of structures.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	-

1.7. Student responsibilities

Lectures (consultations), solving problems (tasks), and presentation of the solutions at the seminar.

1.8. Monitoring of student work[16]

Class attendance	0,5	Class participation		Seminar paper	3	Experimental work	
Written exam		Oral exam		Essay		Research	2,5

[16] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Lectures (consultations), seminar.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Brnić, J.: Elastomehanika i plastomehanika, Školska knjiga, Zagreb, 1996. (Elastomechanics and Plastomechanics).
Alfirević, I.: Linearna analiza konstrukcija, Sveučilište u Zagrebu, Fakultet strojarstva i brodogradnje, Zagreb, 1999. (Linear Structural Analysis, Faculty of Mechanical Engineering and Naval Architecture).
Brnić, J.: Analysis of Engineering Structures and Material Behavior, John Wiley & Sons, Chichester, UK, 2018.
Boresi, A. P., Chong, K.P., Lee, J.D.: Elasticity in Engineering Mechanics, New Jersey, USA, 2011.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Solecki, R., Conant, R. J: Advanced Mechanics of Materials, Oxford University Press, New York, 2003.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Brnić, J.: Elastomehanika i plastomehanika, Školska knjiga, Zagreb, 1996. (Elastomechanics and Plastomechanics).	1	*1*
Alfirević, I.: Linearna analiza konstrukcija, Sveučilište u Zagrebu, Fakultet strojarstva i brodogradnje, Zagreb, 1999. (Linear Structural Analysis, Faculty of Mechanical Engineering and Naval Architecture).	*1*	*1*
Brnić, J.: Analysis of Engineering Structures and Material Behavior, John Wiley & Sons, Chichester, UK, 2018.	*1*	*1*
Boresi, A. P., Chong, K.P., Lee, J.D.: Elasticity in Engineering Mechanics, New Jersey, USA, 2011.	*1*	*1*

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the established quality assurance system of the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Environment protection in energy and process industry**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Introduction to the sources of pollution and problems of environment protection in energy and production plants. Study of methods and technological process that enable economically feasible and environmentally sustainable production in production and energy production plants. Determining and finding solutions of environment pollution problems using a scientific approach with regard to the use of the best available technology, low carbon energy production and sustainable development principles.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Defining a hypothesis for applying possible solutions to avoid or to decrease environmental pollution in the production process. Analysing and defining possible technical solutions and methods using scientific approach to solve various pollution problems. Produce models and methods for a techno-economical analysis of environment protection projects using synthesis, analysis and interpretation of results deriving of studies concerning environmental protection.

1.4. Course content

Emissions to atmosphere. Sources of emissions pollutants. Process and techniques to decrease emissions to the atmosphere. Low-carbon energy production. Pollutions by the process waste water. Typical water pollutants. Parameters of water pollution. Technologies for waste water treatment in process and power plants (primary, secondary, advanced). Technologies for sludge and mud treatment. Hazardous waste generation and treatment in process and energy plants. Technical and technological proceedings for the environment protection in process and energy plants, Costs of environment protection.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance on consultations, research work according to project task, written seminar paper, report of seminar paper.

1.8. Monitoring of student work[17]							
Class attendance	0,5	Class participation		Seminar paper	3,0	Experimental work	
Written exam		Oral exam		Essay		Research	2,5
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Research activity, proceeding of seminar, report of seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Prelec, Z.: Energetika u procesnoj industriji, Školska knjiga, Zagreb, 1994.
Kiely, G.: Environmental Engineering, Mc Graw-Hill, International Editions, 1998.
Nemerow, N., Agardy, F.: Strategies of Industrial and Hazardous Waste Managment, Van Nostrand Reinhold, 2002.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Klass, D.: Biomass for Renewable Energy, Fuels and Chemicals, Academic Press, 2003.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Prelec, Z.: Energetika u procesnoj industriji, Školska knjiga, Zagreb, 1994.		
Kiely, G.: Environmental Engineering, Mc Graw-Hill, International Editions, 1998.		
Nemerow, N., Agardy, F.: Strategies of Industrial and Hazardous Waste Managment, Van Nostrand Reinhold, 2002.		

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the quality assurance system of the Faculty.

[17] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Environmental refrigeration**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Capability for analysis and synthesis. Enhancement and widening of theoretical knowledge basis in the field of environmental refrigeration and developing of knowledge necessary for the choice of environmentally friendly refrigeration systems. Developing of specific skills necessary for scientific research in environmental refrigeration.

1.2. Course enrolment requirements Postgraduate doctoral study

None.

1.3. Expected learning outcomes

Describe the properties and classification of refrigerants, interpret their ozone depletion potential and their impact on global warming. Critically interpret the implications of environmental regulation on refrigeration systems.
Conduct a review and critical analysis of the literature, synthesize knowledge about the complex influence of refrigerants on the environment and properties of refrigeration systems and apply them in the conception and optimization of refrigeration systems.
Analyze, create models and optimize refrigeration processes with natural refrigerants by their properties and environmental impact.
Present research results in the form of research work.

1.4. Course content

Refrigeration technology processes and their environmental impact. Classification of refrigerants. Environmental Impact of refrigerants, ozone depletion potential (ODP) and global warming potential (GWP). Ozone Depleting Substances (ODS) and greenhouse gasses in the atmosphere. Ozone depletion and global warming processes and Implications. Regulations for the restriction of production and release to the atmosphere of ozone depleting substances and substances affecting global warming. Natural and alternative refrigerants in refrigeration processes. Refrigeration technology processes with reduced environmental impact. The overall impact of the plant on global warming.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance to lectures (consultation), research project, preparation and presentation of seminar paper.

1.8. Monitoring of student work[18]							
Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	2,0
Project	2,0	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Consultation, seminar work and project, publication of research results

1.10. Mandatory literature (at the time of submission of study programme proposal)

IPCC – The intergovernmental Panel on Climate Change: CLIMATE CHANGE The IPCC Scientific Assessment, https://www.ipcc.ch/
World Meteorological Organization: Scientific Assessment of Ozone Depletion: 2018, Global Ozone Research and Monitoring Project – Report No 58, http://ozone.unep.org
Von Cube, H. L. et al.: Lehrbuch der Kältetechnik, 4 Aufl., Bd. 1-2, C.F.Müller Verlag, Heidelberg 1997.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Granryd, E. et al.: Refrigerating Engineering, Part 1 -2, Dept. of Energy Technology, Royal Institute of Technology, KTH, Stockholm 2003.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
IPCC – The intergovernmental Panel on Climate Change: CLIMATE CHANGE The IPCC Scientific Assessment, https://www.ipcc.ch/	unlimited	
World Meteorological Organization: Scientific Assessment of Ozone Depletion: 2018, Global Ozone Research and Monitoring Project – Report No 58, http://ozone.unep.org	unlimited	
Von Cube, H. L. et al.: Lehrbuch der Kältetechnik, 4 Aufl., Bd. 1-2, C.F.Müller Verlag, Heidelberg 1997.	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the quality assurance system of the Faculty.

[18] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Experimental methods in heating and energy engineering**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

The ability of analysis and synthesis. The ability of organizing and planning. Information management skills. Enhancing the theoretical knowledge in fields of experimental methods and training of skills for solving practical problems in the field of measuring, data acquisition and experimental data presentation. Training of particular skills necessary for performing of scientific-research experimental work.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Design, organize and perform experimental research in the field of thermal energy engineering.
Analyse the results of measurements and measurement error.
Apply statistical methods for processing the measurement results.
Critically interpret measurement results.

1.4. Course content

Basic principles of measurements. Setting up and calibrating the sensor. Transient phenomena in the measurement. Planning of experiments. Measurements of pressure. Measuring the flow rate using direct and indirect methods. Temperature measurement. Thermal measurements and measurements in the field of heat and mass transfer. Measurements in the boundary layer. Humidity measuring. Determining the heat of combustion of solid, liquid and gaseous fuels and solid waste. Data acquisition systems. Analysis of results and measurement error. Data processing, statistical methods. Presentation of measurement results.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attending the classes (consultations), project solving, seminar paper preparing and presenting.

1.8. Monitoring of student work[19]							
Class attendance	0.5	Class participation		Seminar paper	1	Experimental work	2.5
Written exam		Oral exam		Essay		Research	
Project	2	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class activity, project and seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Montgomery, D. C.: Design and Analysis of Experiments, J. Wiley & Sons, NY, 2013.
Holman, J.P., Gajda, W.J.: Experimental Methods for Engineers, Mc Graw-Hill, NY 1989.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Figliola, R. S.,Beasley, D. E.: Theory and Design for Mechanical Measurements, John Wiley & Sons, NY, 2000.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Montgomery, D. C.: Design and Analysis of Experiments, J. Wiley & Sons, NY, 2013.	1	1
Holman, J.P., Gajda, W.J.: Experimental Methods for Engineers, Mc Graw-Hill, NY 1989.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[19] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION

Course instructor		
Name of the course	**Formability and modern forming technology**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Familiarisation and application of modern methodologies for formability testing and evaluation and modern forming technology. Acquiring new skills of the forming processes planning with using available software's. Application of artificial intelligence in modern forming processes.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyzing of material formability methods. Apply scientific methodology in evaluation of influencing of keys process parameters and their optimization. Develop own models of modern forming processes. Compare and critically evaluate the obtained results.

1.4. Course content

Formability of materials. Methods of material formability. Formability tests. Technological methods of testing. Modern sheet-metal forming processes: punching, blanking, bending, deep drawing, spinning, stretch forming. Modern of bulk forming processes: upsetting, extrusion, hobbing, forging, rolling, drawing, flow forming. Nonconventional forming processes: hydroforming, hydromechanical, ultrasound, laser, high-speed forming. Incremental forming. Net-shape forming and near-net shape forming. Modelling, simulation, optimization and experimental research of modern forming technologies. Application of commercial software's in forming technology. Artificial intelligence in modern forming technology.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance at classes (consultations), literature study, research of the subject area under course instructor's mentorship, as well as seminar paper preparation and presentation.

1.8. Monitoring of student work[20]

Class attendance	0,5	Class participation		Seminar paper	2	Experimental	

[20] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

						work	
Written exam		Oral exam	1	Essay		Research	2,5
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of learning outcomes is based on the quality the seminar paper, presentation and oral exam or published scientific paper in the subject area.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Yanwu, X.: Modern Formability, Hanser Gardner, ISBN-13:978-1-56990-392-6, 2006.
Wagoner, R. H.; Chenot, J. L.: Metal Forming Analysis, Cambridge University Press, ISBN 0-521-64267-1, 2001.
Duplančić, I.: Obrada deformiranjem, Fakultet strojarstva i brodogradnje Split, ISBN 978-953-6114-96-2, 2007.
Mandić, V.: Fizičko i numeričko modeliranje procesa obrade deformisanjem, Fakultet inženjerskih nauka u Kragujevcu, ISBN 978-86-86663-88-7, 2012.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Erman Tekkaya, A.; Homberg, W.; Brosius, A.: 60 Excellent Inventions in Metal Forming, Publisher: Springer Vieweg, 10.1007/978-3-662-46312-3, 2015.
Klocke, F.: Manufacturing Processes 4: Forming, Publisher: Springer-Verlag, 10.1007/978-3-642-36772-4, 2013.
Lange, K.: Handbook of Metal Forming, Publisher: McGraw Hill Book Company, ISBN 0-07-036285-8, 1985.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Yanwu, X.: Modern Formability	1	1
Wagoner, R. H., Chenot, J. L.: Metal Forming Analysis	1	1
Duplančić, I.: Obrada deformiranjem	3	1
Mandić, V.: Fizičko i numeričko modeliranje procesa obrade deformisanjem	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Free surface flow**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Competence in physics and modelling of free surface flows. Capability for employing free surface flow models in original scientific research.

1.2. Course enrolment requirements

No requirements.

1.3. Expected learning outcomes

Analyzing free surface flow for the purposes of scientific research. Applying 1D, 2D and 3D numerical models of free surface flow for the purpose of confirming or rejecting a hypothesis. Producing new theories, methods, procedures and models for free surface flows.

1.4. Course content

Open channel flow. Coastal flow. Flow in estuaries and seas. Shallow water models. Multiphase flow models. Numerical techniques for free surface modelling.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other
1.6. Comments		

1.7. Student responsibilities

Consultations, studying of literature, solving the problem task, preparing and giving a presentation.

1.8. Monitoring of student work[21]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	4
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

[21] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Attending consultations, activity and independence in studying, project task, seminar paper.
1.10. Mandatory literature (at the time of submission of study programme proposal)
Chaudry, M. H., Open-Channel Flow, Prentice-Hall, 1993. French, R. H., Open-Channel Hydraulics, McGraw-Hill, 1987. Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012.
1.11. Optional/additional literature (at the time of submission of the study programme proposal)
Leveque, J.R., Finite Volume Methods for Hyperbolic Problems, Cambridge Univ Press, 2002. Godlewski, E., Raviart, P.-A., Numerical Approximation of Hyperbolic Systems of Conversation Laws, 1996.
1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Chaudry, M. H., Open-Channel Flow, Prentice-Hall, 1993.	1	0
French, R. H., Open-Channel Hydraulics, McGraw-Hill, 1987.	1	0
Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012.	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Heat treatment and surface engineering**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Gaining knowledge of heat treatment and surface engineering. Mastering the methods of design and modelling of heat treatment and surface engineering.

1.2. Course enrolment requirements

There are no requirements.

1.3. Expected learning outcomes

Analyse the possibilities of heat treatment and surface engineering of metals. Select the optimal heat treatment and surface engineering process of metals. Predict and evaluate the results of heat treatment and surface engineering of metals. Analyse methods of testing of results of heat treatment and surface engineering of metals.

1.4. Course content

The theory of heat treatment of metals (hardening mechanisms, phase transformation, heating, cooling). Heat treatment and properties of metals. Processes and equipment of heat treatment and surface engineering. Unconventional methods of heat treatment and surface engineering. The combined processes of modification of metal. Modelling of heat treatment and surface engineering. The energy aspect of heat treatment and surface engineering. Optimization of thermal processing and surface engineering.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Course attendance (consultation), preparation and presentation of seminar paper, written and oral exam.

1.8. Monitoring of student work[22]

Class attendance	0,5	Class participation		Seminar paper	4	Experimental work	
Written exam	0,5	Oral exam	1	Essay		Research	

[22] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance at lectures, quality of preparation and presentation of seminar paper, written and oral examination.

1.10. Mandatory literature (at the time of submission of study programme proposal)

ASM Handbook Vol. 4: Heat Treating, ASM, Metals Park, Ohio, 2006.
ASM Handbook Vol. 5: Surface Engineering, ASM, Metals Park, Ohio, 1999.
Prabhudev, T., Handbook of Heat Treatment of Steels, McGraw-Hill, New York, 1988.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Kraus, G., Principles of Heat Treatment of Steel, ASM Metals Park, Ohio, 1980.
ASM Handbook Vol. 4: Heat Treating, ASM, Metals Park, Ohio, 1991.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
ASM Handbook Vol. 4: Heat Treating, ASM, Metals Park, Ohio, 2006.	1	2
ASM Handbook Vol. 5: Surface Engineering, ASM, Metals Park, Ohio, 1999.	1	2
rabhudev, T., Handbook of Heat Treatment of Steels, McGraw-Hill, New York, 1988.	1	2

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Implementation of energy efficiency measures**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Over the duration of the course, the students will develop advanced skills and the research methods needed for the analysis, evaluation and improvement of energy efficiency measures, and their implementation in the sectors of buildings, transportation, industry and energy generation. The students will acquire the necessary knowledge for the use of theoretical, experimental and numerical tools, which are a prerequisite for the correct analysis and optimization of the performance of energy efficiency measures. Furthermore, students will develop critical thinking skills by reading and analyzing the existing body of literature and the regulations concerning the implementation of energy efficiency measures. The students will use the existing research methods but also develop new theoretical, experimental and numerical procedures for the analysis and improvement of existing energy efficiency measures, as well as will design and assess new or improved technologies to be implemented in the field energy efficiency.

1.2. Course enrolment requirements

No requirements.

1.3. Expected learning outcomes

Analyze and optimize the performance of energy efficiency measures that are applied in the buildings, transport, industry and energy generation sectors. Evaluate and design new low-carbon technologies for the application in the field of energy efficiency taking into account the return of investment period, the environmental impact and the waste generation potential.

1.4. Course content

The student critically analyze the relevant literature, the existing national and international regulations on energy efficiency with the goal to learn the necessary scientific theories and methods, to understand the practical applications and to become acquainted with the legal framework. In the buildings sector, the students will learn and develop the analytical and numerical methods for the optimization of the performance of energy efficiency measures: thermal insulation, multilayered windows, airtight envelope, mechanical ventilation system with heat recovery, heating and cooling systems using renewable energy sources and heat pumps, energy-efficient lighting, smart systems for management of control of low-energy buildings and nearly zero energy buildings. In the industry and energy generation sectors, the students will develop advanced skills and learn methods for the analysis of the relevant energy intensity indicators and the consumption of primary forms of energy and materials, for the analysis and comparison of emerging processes and low carbon technologies, for the analysis and evaluation of different directions of industrial and energy generation development, with a view on the mitigation of environmental and climate impacts. In the transport sector, the student critically evaluates new concepts of smart urban and interurban transport, optimizes the transport structure, compares different vehicle types with respect to fuel and materials consumption, proposes new technologies for the reduction of harmful emissions and waste generation, and conversely to stimulate material reuse at the end of the vehicle lifespan.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Students are expected to attend course lectures and workshops, design and write the seminar work and the project assignment, to prepare and present the research results.

1.8. Monitoring of student work[23]

Class attendance	0.5	Class participation		Seminar paper	2.5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	3	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance of course lectures, class activity, project assignments and seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

B. Pavković, V. Zanki (ur.): Priručnik za Energetsko Certificiranje Zgrada, Program Ujedinjenih naroda za razvoj (UNDP), Zagreb, Hrvatska, 2010.
F. Asdrubali, U. Desideri: Handbook of Energy Efficiency in Builings, A Life Cycle Approach, Elsevier, 2019.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Z. Morvaj (ur.): Energy Efficiency – A Bridge to Low Carbon Economy, InTech, Rijeka, Hrvatska 2012.
Z. Morvaj, D. Gvozdenac: Applied Industrial Energy and Environmental Management, JohnWiley & Sons Ltd, West Sussex, Ujedinjeno Kraljevstvo, 2008.
V. Zanki (ur.): Tipske Mjere za Povećanje Energetske Efikasnosti u Kućanstvima, Program Ujedinjenih naroda za razvoj (UNDP), Zagreb, Hrvatska, 2010.
B. Pavković, V. Zanki (ur.): Priručnik za Energetsko Certificiranje Zgrada – 2. dio, Program Ujedinjenih naroda za razvoj (UNDP), Zagreb, Hrvatska, 2012.
D. Y. Goswami, F. Kreith: Energy Efficiency and Renewable Energy Handbook, 2nd. ed., CRC Press, 2016.
D. Martinez, B. Ebenhack, T. Wagner: Energy Efficiency: Concepts and Calculations, Elsevier, 2019.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
B. Pavković, V. Zanki (ur.): Priručnik za Energetsko Certificiranje Zgrada, Program Ujedinjenih naroda za razvoj (UNDP), Zagreb, Hrvatska, 2010.	1	1
F. Asdrubali, U. Desideri: *Handbook of Energy Efficiency in Builings, A Life Cycle Approach*, Elsevier, 2019.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the established quality assurance system of the Faculty.

[23] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Intelligent manufacturing systems**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

The student will acquire theoretical and practical knowledge of modelling, simulation and analysis of intelligent complex systems, which is based on the study of specific structures and methods of application of modern architectures of production systems.

1.2. Course enrolment requirements

There are no conditions.

1.3. Expected learning outcomes

Identify trends in the modern production environment, and define system intelligence according to the individual concepts of modern production systems. Analyze and describe the application of reconfiguration and modularity methodology, with reference to the application of artificial intelligence methods to the optimization of production systems. Implement modern scientific methods for the implementation of virtual reality in the process of design and reconfiguration of the production system, and the relationship between man and production systems. Implement the modeling of complex systems using ready-made software packages.

1.4. Course content

Trend analysis in a modern production environment. CIM production analysis; defining the disadvantages of classic CIM production in a modern manufacturing environment. Multi-agent based intelligent manufacturing. Introducing new concepts to address deficiencies in the organization, sharing of information, and running classic CIM production systems; fractal, holonic and biological concept. Fractal Production Systems; Holon Production Systems; definition, Biological Production Systems; definition, basic individuals, problems, application. Introducing the concepts of mass customization and active reconfiguration of production systems. Production systems optimization methods based on artificial intelligence methods. Application of evolutionary computation and advanced machine learning methods in modelling and running modern production systems in real time. Object modelling of production systems. Software for modelling and control of modern production systems.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attendance at lectures (consultations), project assignment and preparation and presentation of seminars.

1.8. Monitoring of student work[24]							
Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance at lectures (consultations), project assignment and preparation and presentation of seminars.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Lamb, F., 2013, ,Industrial Automation: Hands-on, McGraw-Hill Education,
Bonaccorso, G.; Fandango, A; Rajalingappaa S.: Python: Advanced Guide to Artificial Intelligence 2018.
Ueda, K., 1994, Biological Manufacturing Systems, Kogyochosakai Pub. Comp. Tokyo.
Bangsow S., 2010, Manufacturing Simulation with Plant Simulation and Simtalk: Usage and Programming with Examples and Solutions, Springer
LaRoux K. Gillespie, 2017., Design for Advanced Manufacturing: Technologies, and Processes, McGraw Hill Professional
William B. Bonvillian, William Bonvillian, Peter L. Singer, 2017, Advanced Manufacturing: The New American Innovation Policies, MIT Press

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Kovacs, G.L. & Haidegger, G., 1992, Integration in manufacturing: From FMS and FMC to CIM, Computer integrated manufacturing, Vol. 2, New York
Langton, C.G., editor, 1994, "Artificial Life III", Addison-Wesley.
Banks J., Carson S.J., Nelson L.B., Nicol M.D., 2009, Discrete-Event System Simulation (5th Edition), Prentice Hall

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Lamb, F., 2013, ,Industrial Automation: Hands-on, McGraw-Hill Education,	1	2
Bonaccorso, G.; Fandango, A; Rajalingappaa S.: Python: Advanced Guide to Artificial Intelligence 2018.	1	2
Ueda, K., 1994, Biological Manufacturing Systems, Kogyochosakai Pub. Comp. Tokyo.	1	2
Bangsow S., 2010, Manufacturing Simulation with Plant Simulation and Simtalk: Usage and Programming with Examples and Solutions, Springer.	1	2
Banks J., Carson S.J., Nelson L.B., Nicol M.D., 2009, Discrete-Event System Simulation (5th Edition), Prentice Hall	1	2

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[24] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Intelligent robots and manipulators**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

The student will gain insight into the current state of robotics, an overview of development trends, applications and directions of development and barriers along the way. Analyse trends in modern robotics. Define the laws of robotics. Position and importance of robotics in modern philosophy of technology. Analyse the construction of industrial robots. Define the operating mode of the robot. Analyse robot management strategies and algorithms. Define the integration of robots into production systems. Analyse robot application, current state and development trends.

1.2. Course enrolment requirements

There are no conditions.

1.3. Expected learning outcomes

Define and recognize the population, terminology, standardization and norms in robotics. Analyse the structure of industrial robots, with associated kinematics and dynamics. Define and describe robot intelligence, and implement advanced robot management strategies and algorithms. Using artificial methods to apply artificial intelligence to human-robot interaction and the interaction of biological and technical systems. Critically analyse the concepts of biorobotics, microbotics, and biologically inspired ideas and solutions in robotics.

1.4. Course content

Foundations of robotics: history, definitions, population, terminology, standardization and norms. The laws of robotics. Position and importance of robotics in modern philosophy of technology. Construction of industrial robots. Robotics kinematics and dynamics. Robot design (design, construction, simulation and calculation). Robot motions. Robot Workplace Organization. Robot Operating Mode: Pose-to-pose, continuous path. Robot end effectors and receivers (material, drives, sensors, flexibility, intelligence). Robot guidance strategy and algorithms. Artificial intelligence in path planning. Optimization of manipulator operations using evolutionary computation. Human-robot interaction. Interaction of biological and technical systems. Robot Programming and Learning. Robot Installation. Integration of robots into production systems. Application of the robot current state and development trends. Bio robotics. Micro robotics. Biologically inspired ideas and solutions in robotics. Generations of industrial robots. Robots in flexible manufacturing / assembly systems. Robotics as part of the CIM system.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities							
Attendance at lectures (consultations), project assignment and preparation and presentation of seminars.							
1.8. Monitoring of student work[25]							
Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3
Project		Continuous assessment		Report		Practical work	
Portfolio							
1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)							
Attendance at lectures (consultations), project assignment and preparation and presentation of seminars.							
1.10. Mandatory literature (at the time of submission of study programme proposal)							
Francis X. Govers , 2018., Artificial Intelligence for Robotics: Build intelligent robots that perform human tasks using AI techniques, Packt Publishing Arkapravo Bhaumik, 2018., From AI to Robotics: Mobile, Social, and Sentient Robots, CRC Press Bonaccorso, G.; Fandango, A; Rajalingappaa S.: Python: Advanced Guide to Artificial Intelligence 2018. Nikolic, G.; Katalinic, B.; Rogale, D.; Jerbic, B, & Cubric, G.: Roboti & Primjena u industriji tekstila i odjece, ISBN 978-953- 7105-22-8, Sveucilisni udzbenik, Tekstilno Tehnoloski Fakultet, Sveuciliste u Zagrebu, Zagreb, 2008; 336 pages Robin R. Murphy, 2000, Introduction to AI Robotics, Massachusetts Institute of technology							
1.11. Optional/additional literature (at the time of submission of the study programme proposal)							
Nof, S.Y., Handbook of Industrial Robotics, 2nd Edition, 1999. Bishop, R.H., The Mechatronics Handbook, 2002. Thomas R. Kurfess, Robotics and Automation Handbook,London, 2005.							
1.12. Number of assigned reading copies in relation to the number of students currently attending the course							

Title	*Number of copies*	*Number of students*
Bonaccorso, G.; Fandango, A; Rajalingappaa S.: Python: Advanced Guide to Artificial Intelligence 2018.	1	
Nikolic, G.; Katalinic, B.; Rogale, D.; Jerbic, B, & Cubric, G.: Roboti & Primjena u industriji tekstila i odjece, ISBN 978-953-7105-22-8, Sveucilisni udzbenik, Tekstilno Tehnoloski Fakultet, Sveuciliste u Zagrebu, Zagreb, 2008; 336 pages	1	
Robin R. Murphy, 2000, Introduction to AI Robotics, Massachusetts Institute of technology	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
Through the Institution's quality assurance system.

[25] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Intelligent systems**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Intelligent systems try to imitate human actions like communication, learning, planning and decision making. The course objective is to present the use of methods and procedures needed for development of intelligent systems.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

To detect the possible fields of implementation of intelligent agents and to get an overview of concepts and formalisms for knowledge presentation. Analyse, compare and detect deficiencies in various techniques for problem solving in state space search. Evaluate efficiency of methods and procedures of intelligent systems. Write a report on the selected field of applications.

1.4. Course content

Introduction to intelligent systems, definitions, functions and features. Problem-solving as a search procedure: state space search, graph theory, search strategies: forward and backward-chaining, backtracking. Intelligent agents. Expert systems. Knowledge presentation schemas. Planning. Automatic learning and reasoning. Symbolic algorithms: decision-tree, version space, clustering procedures. Connectionist algorithms: characteristics of neural networks. Semantic analysis. Spoken dialog systems. Dialog modelling.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☒ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

It is the student's obligation to acquire fundamental knowledge regarding intelligent system development. It is expected that students conduct research project in order to solve several problems implementing models and algorithms, and at the end present their project results. Partial student work evaluation is made on the base of several seminars and workshops.

1.8. Monitoring of student work[26]

[26] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Class attendance	*0.5*	Class participation		Seminar paper	1	Experimental work	1
Written exam		Oral exam		Essay		Research	2
Project	*1.5*	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

The learning outcomes will be evaluated through a research paper that is prepared based on scientific research conducted in the context of the course.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Russell, S., Norvig, P., Artificial Inteligence: A Modern Approach, Prentice Hall, Englewood Cliffs, 2009.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

N. Pavešić. Raspoznavanje vzorcev. ZAFER Ljubljana 2000.
L. Gyergyek, N. Pavešić, S. Ribarić: Uvod u raspoznavanje uzoraka, Tehnička knjiga, Zagreb, 1988.

Huang, X. D., A. Acero and H. W. Hon (2000). Spoken Language Processing: A Guide to theory, Algorithm and System Development, Prentice Hall, New Jersey, USA.

Jurafsky, D., and J. Martin (2000). Speech and Language Processing, An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. Upper Saddle River, New Jersey: Prentice Hall.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Russell, S., Norvig, P., Artificial Inteligence: A Modern Approach, Prentice Hall, Englewood Cliffs, 2009.	1	10

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

In accordance with established quality assurance system at the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Materials testing**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Gaining knowledge of the theory, practice and issues of mechanical testing and non-destructive testing of materials during material development, production and during product exploitation.
Obtaining a higher level of environmental awareness in the field of material testing.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyse basic properties of engineering materials and selection criteria for materials testing methods.
Establish a material testing program to evaluate the state of the material.
Evaluate and analyse the results of mechanical testing and non-destructive testing of materials.
Estimate the influence of materials structure and properties on the product function in exploitation, with regard to environmental protection.

1.4. Course content

Connection of the nano-, micro- and macrostructure of engineering materials and the resulting properties and behaviour of materials in exploitation. Application of mechanical testing and non-destructive testing methods in various fields of engineering and environmental protection. Environmental aspects of materials testing methods.
Mechanical testing methods: static short-term and long-term testing, dynamic short-term and long-term testing. Testing tribological and technological properties. Optical and electron microscopy. Non-destructive testing methods: penetrant testing, magnetic particle testing, eddy current testing, ultrasonic testing, radiographic testing, acoustic emission testing. Influence of defect parameters on product function in exploitation. Specificity of testing different materials: metals and alloys, polymers, ceramics and composites.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Class attendance (consultations), preparation and presentation of seminar paper, oral exam.

1.8. Monitoring of student work[27]

Class attendance	0,5	Class participation		Seminar paper	4,0	Experimental work	
Written exam		Oral exam	1,5	Essay		Research	
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class participation, quality of seminar paper and presentation, oral exam.

1.10. Mandatory literature (at the time of submission of study programme proposal)

ASM Handbook Volume 8: Mechanical Testing and Evaluation, ASM International
ASM Handbook Volume 9: Metallography and Microstructures, ASM International
ASM Handbook Volume 17: Nondestructive Evaluation and Quality Control, ASM International

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

ASM Handbook Volume 10: Materials Characterization, ASM International

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
ASM Handbook Volume 8: Mechanical Testing and Evaluation, ASM International	1	
ASM Handbook Volume 9: Metallography and Microstructures, ASM International	1	
ASM Handbook Volume 17: Nondestructive Evaluation and Quality Control, ASM International	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the quality assurance system of the Faculty.

[27] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

<table>
<tr><th colspan="3">COURSE DESCRIPTION</th></tr>
<tr><td>Course instructor</td><td colspan="2"></td></tr>
<tr><td>Name of the course</td><td colspan="2">Mathematical modeling and numerical methods</td></tr>
<tr><td>Study programme</td><td colspan="2">Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences</td></tr>
<tr><td>Status of the course</td><td colspan="2">elective</td></tr>
<tr><td>Year of study</td><td colspan="2">1</td></tr>
<tr><td rowspan="2">ECTS credits and manner of instruction</td><td>ECTS credits</td><td>6</td></tr>
<tr><td>Number of class hours (L+E+S)</td><td>15+0+0</td></tr>
</table>

1.1. Course objectives

Knowledge of the mathematical modeling based on the ordinary and partial differential equations and/or on the metamodel, necessary for solving problems in engineering. Knowledge of the chosen numerical methods for data analysis and the use of data-driven methods. Mathematical formulation of the problem, definition of the model and its solving with the aid of appropriate methods and software.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Set up a mathematical formulation of the observed problem that is based on differential equations and/or on metamodel, justify the choice of the formulation, analyze the complexity and solvability of the problem.
Propose an appropriate numerical model and solve it with the aid of the existing software and/or by writing new software, or build the metamodel using the data-driven algorithms.
Critically evaluate and compare the obtained results and independently investigate the possible improvements.

1.4. Course content

Models based on ordinary differential equations. System dynamics and chaos. Numerical solution with the finite difference method. Runge-Kutta methods.
Models based on partial differential equation in fluid mechanics, thermodynamics and elasticity theory. Variational principle. Conservation laws for mass, momentum and energy applied to continuum mechanics. The concept of metamodels.
The chosen numerical methods for solving parabolic, hyperbolic and eliptic differential equations.
The chosen numerical methods for data analysis. Data-driven methods for building the metamodels.

<table>
<tr><td rowspan="5">1.5. Manner of instruction</td><td>☒ lectures</td><td>☒ individual assignments</td></tr>
<tr><td>☒ seminars and workshops</td><td>☐ multimedia and network</td></tr>
<tr><td>☐ exercises</td><td>☐ laboratories</td></tr>
<tr><td>☐ distance learning</td><td>☒ mentorship</td></tr>
<tr><td>☐ fieldwork</td><td>☐ other</td></tr>
<tr><td>1.6. Comments</td><td colspan="2"></td></tr>
</table>

1.7. Student responsibilities

Course attendance (consultations), solving project assignment, preparing and presenting the seminar.

1.8. Monitoring of student work[28]							
Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	4	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Course attendance, project, seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Strang, G.: Introduction to applied mathematics, Wellesley-Cambridge Press, Cambridge, 1986.
Chapra, S.C., Canale, R.P.: Numerical methods for engineers, McGraw Hill Book Co., 1989.
Press, W.H., Taukolsky, S.A., Flannery, B.P., W.T.: Numerical recipes, Cambridge Press, 1986.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

LeVeque, J.R., Finite Volume Methods for Hyperbolic Problems, Cambridge Univ. Press, 2002.
Cheney, W., Kincaid, D.: Numerical mathematics and computing, Thomson Brooks/Cole, 2004.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Strang, G.: Introduction to applied mathematics, Wellesley-Cambridge Press, Cambridge, 1986.	1	1
Chapra, S.C., Canale, R.P.: Numerical methods for engineers, McGraw Hill Book Co., 1989.	1	1
Press, W.H., Taukolsky, S.A., Flannery, B.P., W.T.: Numerical recipes, Cambridge Press, 1986..	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[28] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Mechanics of composite structures**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

To introduce students to theoretical bases, numerical formulations and adequate techniques suitable for composite structure analysis. Setting up mathematical models and numerically simulate behavior of various composite materials structural applications. Development of own codes and application of existing advanced numerical algorithms for composite structures simulations. Validation of simulations based on appropriate numerical approach.

1.2. Course enrolment requirements

Basic knowledge of elastomechanics.

1.3. Expected learning outcomes

Identify and formulate the problem, research the literature, set up an appropriate mathematical model.
Assess opportunities and independently choose a suitable numerical formulation.
Develop own algorithms and adapt the existing ones.

1.4. Course content

Continuum mechanics of non-isotropic materials. Analysis of laminated structures. Application of numerical methods in composite structural analysis. Composite damage mechanisms and their affect on structural integrity. Buckling simulations of thin-walled composite beams. Modelling of response of functionally graded and sandwich structures.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

1.8. Monitoring of student work[29]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3

[29] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Appropriate journal paper references.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Agarwal, D. B.; Broutman, J.L.; Chandrashekhara, K.:"Analysis and performance of fiber composites", John Wiley & Sons, New Jersey, 2006.
Barbero, E. J.: "Finite element analysis of composite materials", CRC Press, Boca Raton, 2008.
Carrera, E.; Fazzolari, F.A.; Cinefra, M.:"Thermal stress analysis of Composite beams, plates and shells", Academic press, 2015.
Christensen, R. M.: "Mechanics of composite materials", Dover Publications inc., New York, 2005.
Jones, R. M.: "Mechanics of composite materials", Taylor & Francis, Philadelphia, 1999.
Kollar, L. P., Springer, G. S.: "Mechanics of composite structures", Cambrige University Press, Cambridge, 2003.
Reddy, J. N.: "Mechanics of laminated composite plates and shells", CRC Press, Boca Raton, 2004.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION	
Course instructor	
Name of the course	**Methodology of the scientific-research work**
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences
Status of the course	compulsory
Year of study	1
ECTS credits and manner of instruction	ECTS credits: 6 Number of class hours (L+E+S): 15+0+0

1.1. Course objectives

To familiarize student with the scientific method. To learn how to write and peer review scholarly works and research proposals. To understand organizational aspects of science as well as ethics in science. To learn basic skills required for a scientists..

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

To organize research. Critically evaluate methods used in science. To write a scientific paper and a research proposal. To conduct a peer review of a scholarly work.

1.4. Course content

Research and other elements of the scientific method. Critical thinking. Analysis and synthesis. Deduction and induction. Scientific communication. Elements of a scientific paper. Peer review. Open science. Preparing the research proposal. Writing and organizing a bibliography. Citations and References. Ph.D. thesis. Science and research in the Republic of Croatia and the world. Software tools for scientists. Ethics in science.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	-

1.7. Student responsibilities

Students are required to attend the classes/consultations. Each student will be given a project task. Students should write and present the seminar paper.

1.8. Monitoring of student work[30]

Class attendance	0,5	Class participation		Seminar paper	4	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	1,5	Continuous		Report		Practical work	

[30] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

		assessment					
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in solving their project task, seminar paper and the presentation of the seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Zelenika, R.: Metodologija i tehnologija izrade znanstvenog i stručnog djela,4. izd., Ekonomski fakultet u Rijeci, Rijeka, 2000.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Churchill, H., Sanders, T. Getting Your Ph.D., SAGE Publications, Los Angeles, 2007.
Schimel, J.: Writing Science, Oxford University Press, Oxford, 2012.
Turabian, K.L.: A Manual for Writers of Research Papers, Theses, and Dissertations, 8th Ed., The University of Chicago Press, Chicago and London, 2010.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Zelenika, R.: Metodologija i tehnologija izrade znanstvenog i stručnog djela,4. izd., Ekonomski fakultet u Rijeci, Rijeka, 2000.	20	20

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Microbiological pollution of water**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Microbiological contamination of water from the point of view of water quality control in urban water supply systems, water supply pipe systems of buildings, ships, settlements, tourist facilities, coastal marine areas, rivers, lakes and other aquatic areas under anthropogenic influence. Identification of problems in the engineering practice. Understanding the sampling procedures, regimes and obtained database analysis. Understanding the protection procedures and protocols.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyse microbiological contamination of water from the point of view of water quality control in urban water supply systems, water supply pipe systems of buildings, ships, settlements, tourist facilities, coastal marine areas, rivers, lakes and other aquatic areas under anthropogenic influence. Apply knowledge to problems in engineering practice. Implement sampling procedure and define sampling regimes. Analyse obtained database by statistical methods. Apply protection procedures and protocols.

1.4. Course content

Water quality control in urban water supply systems, water supply pipe systems of buildings, ships, settlements, tourist facilities, coastal marine areas, rivers, lakes and other aquatic areas under anthropogenic influence. Application of protection procedures to a real problem in engineering practice, sampling procedures and protocols and methods of database processing regarding the problem selected.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Consultations, studying of literature, solving the problem task, preparing and giving a presentation.

1.8. Monitoring of student work[31]							
Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	4,0
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attending consultations, activity and independence in studying, project task, seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Edwin E. Geldreich, Gordon A. McFeters Brock/Springer Series in Contemporary Bioscience
Drinking Water Microbiology: Progress and Recent Developments, Springer-Verlag New York, 1990
Duncan Mara, Nigel J. Horan, Handbook of Water and Wastewater Microbiology, Academic Press, 2003
Tarmo Soomere, Tarmo Soomere, Ewald Quak, Preventive Methods for Coastal Protection: Towards the Use of Ocean Dynamics for Pollution Control Springer International Publishing, 2013

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Jean J. Fried, Groundwater Pollution Theory Methodology Modelling and Practical Rules, Elsevier Science Ltd, 2003
Yung-Tse Hung, Yung-Tse Hung, Nazih K Shammas, Lawrence K Wang Handbook of Environment and Waste Management: Volume 2: Land and Groundwater Pollution Control, World Scientific Publishing Company, 2013

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Edwin E. Geldreich, Gordon A. McFeters Brock/Springer Series in Contemporary Bioscience Drinking Water Microbiology: Progress and Recent Developments, Springer-Verlag New York, 1990	1	
Duncan Mara, Nigel J. Horan, Handbook of Water and Wastewater Microbiology, Academic Press, 2003	1	
Tarmo Soomere, Tarmo Soomere, Ewald Quak, Preventive Methods for Coastal Protection: Towards the Use of Ocean Dynamics for Pollution Control Springer International Publishing, 2013	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the quality assurance system of the Faculty.

[31] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Modern engine design**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Adoption of theoretical and experimental knowledge and skills in scientific research in the field of internal combustion engines and their applications.

1.2. Course enrolment requirements

There are no conditions.

1.3. Expected learning outcomes

Analyze and revise existing literature in the field of engines with the aim of collecting the necessary data to conduct their own research.
Apply the scientific method (theoretical, experimental, analytical, numerical) for the purpose of analyzing and optimizing processes in the engine.
Present your own work in a lecture or scientific article.

1.4. Course content

Modern engine design trends: turbocharging, downsizing, hybridization, innovative combustion concepts, alternative fuels, exhaust gas treatment systems.

1.5. Manner of instruction	☐ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attending classes (consultation), addressing the terms of reference and the preparation and presentation of seminars

1.8. Monitoring of student work[32]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	

[32] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project	4.0	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance, class participation, projects, seminars.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Grljušić, M.: Motori s unutarnjim izgaranjem, FESB, Split, 2000.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Heywood, J.B. Internal Combustion Engines Fundamentals, McGrow Hill Book Co., New York, 1988.
Ferrari, G.: Motori a combustione interna, Il capitello, Torino, 1992.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Grljušić, M.: Motori s unutarnjim izgaranjem, FESB, Split, 2000.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Multi-speed mechanical convertors**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

To develop a scientific approach to the problems of simple and complex mechanical convertor and to prepare students for creating new gear train arrangements applicable in the industry.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

To establish existing gaps in the knowledge that impedes the development of converting mechanisms.
To create analytical and numerical models of insufficiently explored structures, systematic analysis of the influence of the convertor arrangement and its main parameters on the transforming and geometric characteristics as well as synthesizing new mechanical convertor solutions.
To present research results in the form of research work and publish them in scientific communication resources.

1.4. Course content

Simple and complex multi-speed mechanisms for the mechanical energy parameters converting and motion transmitting. System operation modes such as reduction, multiplication, reversibility, working with one or more degrees of freedom of movement. Classical and alternative methods for analysis and synthesis of converting mechanisms with fixed and movable axes. Determination of the function of kinematic and energy transmission ratio, power flows through the mechanism, function of the efficiency and function of the load in parts of the mechanism. Determining dimensions of mechanism elements. Insufficiently investigated phenomena of energy parameters conversion (energy flow division, parasite energy flows). Creating an algorithm and software for analysis, synthesis and optimal selection of the mechanism and its parameters. Modeling, calculation, synthesis and analysis of complex converting mechanism using available software systems (KISSSOFT, KISSSYS). Designing a system for experimental determination of the efficiency of a converting mechanism.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the achievement.

1.8. Monitoring of student work[33]

Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	3,5
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of student’s work during classes and on final exam.
The attendance and activity during classes/consultations, the achieved research results.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Arnaudov, K.; Karaivanov, D.: Planetary Gear Trains, CRC Press, 2019
Linke, H.; Börner, J. ; Heß, R.: Cylindrical Gears, Carl Hanser Verlag, Munich, 2016
Jelaska, D.: Gears and Gear Drives, Wiley, 2012
Looman, J.: Zahnradgetriebe, Springer Verlag Berlin Heidelberg, 2009
Nieman, G.; Winter, H.: Meschinenelemente, Band 2, 2. Auflage, Springer 2003

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Arnaudov, K.; Karaivanov, D.; Torque Method for Analysis of Compound Planetary Gear Trains, Lambert, 2017
Kudrjavcev, V.N.; Kirdjašev, L. N.: Planetarnie peredači, Mašinostrojenije, Lenjingrad, 1977

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Arnaudov, K.; Karaivanov, D.: Planetary Gear Trains, CRC Press, 2019	1	1
Linke, H.; Börner, J. ; Heß, R.: Cylindrical Gears, Carl Hanser Verlag, Munich, 2016	1	1
Jelaska, D.: Gears and Gear Drives, Wiley, 2012	1	1
Looman, J.: Zahnradgetriebe, Springer Verlag Berlin Heidelberg, 2009	1	1
Nieman, G.; Winter, H.: Meschinenelemente, Band 2, 2. Auflage, Springer 2003	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

[33] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Nanomechanics**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Acquire knowledge of numerical and analytical modelling of mechanical behaviour of nanostructures. Predict the material mechanical properties at the micro- and macro-levels. Apply nonlocal mechanics to nanostructures.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyze and revise existing literature on nanomechanics to gather the necessary data to conduct own research. Apply molecular structural mechanics method and molecular dynamics to the modelling of nanostructures. Implement existing and develop new nonlocal models of nanorods, nanobeams and nanoplates.

1.4. Course content

Potentials, distances and forces at the atomic and molecular levels. Molecular structural mechanics method. Introduction to molecular dynamics. Multiscale methods. Small size effects and their influence on the mechanical behaviour of structures. Nonlocal models of rods, beam and plate nanostructures. Influence of defects in the structure on material mechanical properties. Application to modelling of carbon nanotubes, graphene, carbon nanotube-reinforced composite materials.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Students are required to attend the classes/consultations. Each student will be given a research assignment. Student should solve the problem, write a seminar paper and present the results.

1.8. Monitoring of student work[34]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	

[34] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam		Essay		Research	3
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class attendance, class activity, project assignments, seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Tadmor, E. B., Miller, R.E.: Modeling Materials - Continuum, Atomistic and Multiscale Techniques, Cambridge University Press, Cambridge, 2011.
Liu, W. K., Karpov, G. K., Park, H. S.: Nano Mechnanics and Materials, Wiley, 2006.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Marotti de Sciarra, F., Russo, P.: Experimental Characterization, Predictive Mechanical and Thermal Modeling of Nanostructures and their Polymer Composites, Elsevier, Amsterdam, 2018.
Ramesh, K. T.: Nanomaterial – Mechanics and Mechanisms, Springer, New York, 2009.
Cherkaoui, M., Capolungo, L.: Atomistic and Continuum Modeling of Nanocrystalline Materials, Springer series in materials science 112, Springer, 2009.
Li, S., Wang, G:. Introduction to Micromechanics and Nanomechanics, World Scientific, New Jersey, 2011.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Tadmor, E. B., Miller, R.E.: Modeling Materials - Continuum, Atomistic and Multiscale Techniques	1	0
Liu, W. K., Karpov, G. K., Park, H. S. Nano Mechnanics and Materials	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

University of Rijeka
FACULTY OF ENGINEERING

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Noise pollution**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives		
Understanding and evaluating environmental noise pollution. Evaluating possible health risk from exposure to noise. Solving case studies in noise abatement.		
1.2. Course enrolment requirements		
None.		
1.3. Expected learning outcomes		
Assess the current state of environmental noise pollution using measurement equipment and reference standards. Theoretically explain possible causes of noise pollution. Apply analytical or numerical scientific method to reduce noise pollution with experimental confirmation of results.		
1.4. Course content		
Principles of noise pollution (Sound as a wave, Sound levels in decibel scale, A-weighting, Measuring noise, Noise control, Outdoor and indoor sound propagation). Noise impact on health (Relationship of noise and stress, hearing loss, annoyance, sleep disturbance, cardiovascular diseases, tinnitus, other physiological and psychological effects of noise). Strategic Noise Mapping (EU noise policy and legislation). Transportation Noise (Road traffic noise, Railway noise, Aircraft noise). Industrial Noise (Airports and Sea Ports as industrial sources, Wind farm noise). Construction Noise. Noise Mitigation Approaches (Strategic noise mitigation, Source-based abatement, Propagation measures).		
1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☐ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other
1.6. Comments	-	
1.7. Student responsibilities		
The students are required to attend the classes (consultations), do their project, prepare and present the seminar.		
1.8. Monitoring of student work[35]		

[35] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Class attendance	0,5	Class participation		Seminar paper	2,0	Experimental work	1,5
Written exam		Oral exam		Essay		Research	2,0
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on their engagement during lecture and the results they achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Saenz, A.L., Stephens, R.W.B. , Noise pollution : effects and control, John Wiley & Sons, New York, 1986.
Fahy, F., Walker, J.: Advanced Applications in Acoustics, Noise and Vibration, Spon Press, London, 2004.
Kim, Y.-H., Sound propagation : an impedance based approach, Singapore : John Wiley & Sons, 2010.
Warring, R.H., Handbook of Noise and Vibration Control, Trade & Tehnical Press Ltd., 1979.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Crocker, M.J., Handbook of acoustics, New York : John Wiley & Sons, 1998.
Acoustics, ISO Standard Handbook, Second edition, ISO 1995.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Saenz, A.L., Stephens, R.W.B., Noise pollution : effects and control	1	
Fahy, F.: Advanced Applications in Acoustics, Noise and Vibration	1	
Kim, Y.-H., Sound propagation : an impedance based approach	1	
Warring, R.H., Handbook of Noise and Vibration Control	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the quality assurance system of the Faculty.

COURSE DESCRIPTION							
Course instructor							
Name of the course	**Nonlinear structural analysis**						
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences						
Status of the course	elective						
Year of study	1						
ECTS credits and manner of instruction	ECTS credits			6			
	Number of class hours (L+E+S)			15+0+0			
1.1. Course objectives							
Students will be qualified for autonomous nonlinear stress and strain analyses of load-carrying structures.							
1.2. Course enrolment requirements							
Basic knowledge of structural mechanics.							
1.3. Expected learning outcomes							
Determine nonlinear displacement field of a structural element. Derive tangent stiffness matrix of a structural element. Develop incremental equilibrium equations. Apply incremental-iterative solving schemes. Computationally model material nonlinear responses of load-carrying structures.							
1.4. Course content							
Geometrical and material nonlinearities. Stress tensors, strain tensors and constitutive equations for nonlinear problems. Virtual work principles. Lagrangian (total & updated) and Eulerian approaches in nonlinear structural analysis. Numerical approaches for nonlinear problems solving. Finite element method (FEM) applications. Tangential stiffness matrix of finite elements. Incremental-iterative solving schemes. Non-commutative character of large space rotations. Nonlinear field of a beam cross-section. Conservative and non-conservative external moments. Correction stiffness matrices for quasitangential, tangential and axial moments, respectively. Analysis of elastic-plastic structures: plastic zone and plastic hinge methods. Yielding function. Prandtl's flow rule. Plastic reduction matrix of a finite element.							
1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork			☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other			
1.6. Comments	-						
1.7. Student responsibilities							
The students are required to attend the classes (consultations), do their project, prepare and present the seminar.							
1.8. Monitoring of student work[36]							
Class attendance	0,5	Class participation		Seminar paper	3	Experimental work	

[36] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam		Essay		Research	2,5
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Relevant scientific journals.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Chen, W. F., Han, D. J.: Plasticity for Structural Engineers, J. Ross Publish., Fort Lauderdale, 2007.
Kojić, M., Bathe, K. J.: Inelastic Analysis of Solids and Structures, Springer, Berlin, 2005.
Doyle, J. F.: Nonlinear Analysis of Thin-Walled Structures, Springer, New York, 2001.
Chan, S. L., Chui, P. P. T.: Non-Linear Static and Cylic Analysis of Steel Frames with Semi-Rigid Connections, Elsevier, Amsterdam, 2000.
Belytschko, T., Liu, W. K., Moran B.: Nonlinear Finite Elements for Continua and Structures, John Wiley & Sons, Chichester, 2000.
Basar, Y., Weicherter, D.: Nonlinear Continuum Mechanics of Solids, Springer-Verlag, 2000.
Yang, Y. B., Kuo, S. R.: Theory and Analysis of Nonlinear Framed Structures, Prentice Hall, N.Y., 1994.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Numerical modelling in refrigeration**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Expanding theoretical knowledge for solving practical problems in the field of refrigeration engineering and developing the knowledge required for numerical modelling of refrigeration devices and systems. Developing skills for performing scientific research in the field of technical sciences.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Conduct a critical analysis of the available literature in the field of modelling elements of vapor compression refrigeration systems with an emphasis on the convenience of model application. Apply expert and theoretical knowledge on modelling problems in refrigeration (different system concepts, application of appropriate system components and method of automation and control). Develop numerical models of different refrigeration units. Analyse obtained results and draw concrete conclusions and explanations based on the combination of expertise and the results obtained.
Present research results in the form of research work.

1.4. Course content

Numerical analysis of heat and mass transfer in refrigeration systems. Equations and correlations for determining the properties of working substances and heat transfer substances. System dynamics. Numerical models of compression refrigeration units and heat pumps and their components (compressors, heat exchangers, throttle valves, automation and control subsystems). Black box models, models with concentrated and distributed parameters. Numerical modelling of dynamic working conditions in refrigeration applications.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attendance at lectures (consultations), project assignment and preparation, presentation of seminar work.

1.8. Monitoring of student work[37]							
Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	2,0
Project	2,0	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Consultation, project, seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Bourdouxhe, J. P.: Reference Guide for Dynamic Models of HVAC Equipment, ASHRAE, Atlanta, 1998.
Dhar, P. L.: Thermal system design and simulation, Elsevier, Oxford, 2017
VDI Heat Atlas, Second edition, Springer-Verlag Berlin Heidelberg 2010.
Bejan, A., Kraus, A. D.: Heat Transfer Handbook, John Wiley & Sons, Inc., New Jersey, 2003.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Bejan, A.: Thermal Design and Optimization, John Wiley & Sons, Inc., New York, 1996.
Bejan, A.: Advanced Engineering Thermodynamics, John Wiley & Sons, Inc., New Jersey, 2016.
Chhabra, R. P.: The CRC Handbook of Thermal Engineering, CRC Press, LLC, Boca Raton USA, 2018.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
VDI Heat Atlas, Second edition, Springer-Verlag Berlin Heidelberg 2010.	1	1
Dhar, P. L.: Thermal system design and simulation, Elsevier, Oxford, 2017	1	1
Bejan, A., Kraus, A. D.: Heat Transfer Handbook, John Wiley & Sons, Inc., New Jersey, 2003.	1	1
Bourdouxhe, J. P.: Reference Guide for Dynamic Models of HVAC Equipment, ASHRAE, Atlanta, 1998.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[37] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

University of Rijeka
FACULTY OF ENGINEERING

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Numerical modeling of combustion processes**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Adoption of theoretical and experimental knowledge and skills in scientific research in the field of combustion and application of the combustion processes.

1.2. Course enrolment requirements

There are no conditions

1.3. Expected learning outcomes

Associate expert knowledge and numerical simulation models to identify and to select appropriate models for analysing problems in the profession. Set up a mathematical model formulation for the numerical simulations, choose the most suitable methods of integration and appropriate models for certain combustion processes. To analyze the possible application of some models in the definition and for the analysis of specific problems in combustion. To investigate the influence of various parameters on combustion processes in selected terms.

1.4. Course content

Introduction to the combustion. Conservation equations for fluid flow with chemical reactions. Thermodynamics of chemical reactions. Chemical equilibrium. The kinetics of chemical reactions. Chemistry of combustion. The premixed combustion. Diffusion combustion processes controlled by mass transfer. Flames. Detonation. Ignition and quenching the flame. The combustion of liquid fuels. The combustion of solid fuel. Flame stabilization. The formation of pollutants and its control. Environmental issues in combustion. Numerical modelling of the combustion processes. Domain discretization methods. Methods for solving systems of equations for flow problems with chemical reactions. Special methods for solving systems of equations. Modern methods of experimental validation of numerical models.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attending classes (consultation), addressing the terms of reference and the preparation and presentation of seminars.

1.8. Monitoring of student work[38]							
Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	4	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance, class participation, projects, seminar.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Warnatz, J., Maas, U., Dibble, R.W.: Combustion, Springer Verlag, Berlin, 1996.
Annamalai, K., Puri, I. K.: Combustion Science and Engineering, CRC Press, Boca Raton, 2007.
Turns, S. R.: An Introduction to Combustion, McGraw Hill, Boston, 2000.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Strehlov, R.A.: Combustion Fundamentals, McGraw Hill Book Co., New York, 1988.
Glassman, I.: Combustion, 3rd edition, Academic Press, San Diego, 1996.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Warnatz, J., Maas, U., Dibble, R.W.: Combustion, Springer Verlag, Berlin, 1996.	1	1
Annamalai, K., Puri, I. K.: Combustion Science and Engineering, CRC Press, Boca Raton, 2007.	1	1
Turns, S. R.: An Introduction to Combustion, McGraw Hill, Boston, 2000.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[38] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Numerical modelling of environmental flow**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	**1**	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Competence in physics and modelling of environmental flows. Capability for employing numerical models in original scientific research.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyse environmental flow physics for the purposes of scientific research. Apply 1D, 2D and 3D numerical models of environmental flow for the purpose of confirming or rejecting a hypothesis. Produce new theories, methods, procedures and models for environmental flows.

1.4. Course content

Numerical models of transport, diffusion and dispersion. Level-set methods. Flow in estuaries and seas and open channels. Free surface flow models. Atmospheric flow models. Numerical treatment of atmospheric boundary layer.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	-

1.7. Student responsibilities

Consultations, studying of literature, solving the problem task, preparing and giving a presentation.

1.8. Monitoring of student work[39]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	4,0
Project		Continuous assessment		Report		Practical work	
Portfolio							

[39] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)
Attending consultations, activity and independence in studying, project task, seminar paper.
1.10. Mandatory literature (at the time of submission of study programme proposal)
Chaudry, M. H., Open-Channel Flow, Prentice-Hall, 1993. Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012. Bird, R. B., Stewart, W. E., Lightfoot, E. N.,Transport Phenomena, 2002.
1.11. Optional/additional literature (at the time of submission of the study programme proposal)
Deen, Wiham M., Analysis of transport phenomena, 1998. Toro, E., Riemann Solvers and Numerical Methods for Fluid Dynamics, 2009. De Visscher, A., Air dispersion modeling : foundations and applications, 2014. Fischer, H. G. et al., Mixing in Inland and Coastal Waters, 1979. Osher, S., Fedkiw, R., Level Set Methods and Dynamic Implicit Surfaces, 2003.
1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Chaudry, M. H., Open-Channel Flow, Prentice-Hall, 1993.	1	
Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012.	1	
Bird, R. B., Stewart, W. E., Lightfoot, E. N.,Transport Phenomena, 2002	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
Through the quality assurance system of the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Numerical modelling of heat transfer**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Enhancing the theoretical knowledge in fields of mathematical modelling and numerical solving, as well as training of skills for solving practical numerical problems in fields of heat transfer processes. Training of skills necessary for performing of scientific-research work in field of technical sciences.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Apply the relevant physical laws on the mathematical formulation of the specific problems of heat transfer.
Investigate possibilities of numerical solving of the problem, select and implement the appropriate numerical method as well as perform numerical calculations using a self-written computer code or using a commercial software for numerical simulations of heat transfer.
Critically interpret and analyse the results as well as perform specific conclusions and explanations based on the linking of expertise with the results obtained.
Present research results in the form of research work.

1.4. Course content

Mathematical description of physical processes. Mass, momentum and energy conservation laws. Vector and differential form of fluid flow and heat transfer equations. Initial and boundary conditions. Differential and integral forms of the general transport equation. Main types of heat transfer processes and appropriate numerical methods. Control volume method for conduction problems. Discretisation equations. Control volume method for calculation of fluid velocity and temperature distributions in forced convection problems. Discretisation equations and discretisation schemes for convection-diffusion problems. Solution algorithms for pressure-velocity coupling. Control volume method for calculation of fluid velocity and temperature distributions in natural convection problems. Discretisation equations. Solution of discretised equation systems. Control volume method for unsteady conduction and convection problems. Explicit, Crank-Nicolson and fully implicit schemes. Control volume method for heat transfer in phase change processes. Conservation laws and discretisation equations. Computer codes for numerical simulations of heat transfer processes.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	

1.7. Student responsibilities

Attending the classes (consultations), project solving, seminar paper preparing and presenting.

1.8. Monitoring of student work[40]

Class attendance	0.5	Class participation		Seminar paper	1	Experimental work	
Written exam		Oral exam		Essay		Research	2.5
Project	2	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class activity, project and seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Incropera, F.P., Dewitt, D.P., Bergman, T.L., Lavine, A.S.: Principles of Heat and Mass Transfer, John Wiley & Sons, Singapore, 2013.
Rathore, M.M., Kapuno, R.R.A.: Engineering Heat Transfer, Jones & Bartlett Learning, MA, 2011.
Versteeg, H.K.,Malalasekera,W.: An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical, Essex, 1995.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Welty, J.R.,Wicks, C.E.,Wilson, R.E.: Fundamentals of Momentum, Heat & Mass Transfer, J. Wiley & Sons Inc, NY, 1984.
Patankar, S. W.: Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corp., NY, 1980.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Incropera, F.P., Dewitt, D.P., Bergman, T.L., Lavine, A.S.: Principles of Heat and Mass Transfer, John Wiley & Sons, Singapore, 2013.	1	1
Rathore, M.M., Kapuno, R.R.A.: Engineering Heat Transfer, Jones & Bartlett Learning, MA, 2011.	1	1
Versteeg, H.K.,Malalasekera,W.: An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Longman Scientific & Technical, Essex, 1995.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[40] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Optimization methods**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Identification of optimization problems in engineering practice and scientific research. Mathematically set optimization problems and solve them using appropriate methods and software.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Set up a mathematical formulation of an optimization problem, analyze and evaluate the complexity and solvability of the problem based on the formulation.
Investigate the possibilities of applying particular methods to a given optimization problem and choose the appropriate method.
Build a computer code that represents the implementation of the goals and constraints of the optimization problem (goal function).
Explore problem-solving capabilities by using ready-made software and / or writing your own implementation of the optimization method.
Solve the optimization problem and analyze the results of optimization, identify the causes of possible handicaps in implementation and formulation, improve the accuracy of the results with combination and variation of methods and approaches.

1.4. Course content

Optimization problems in technology. Optimization problem formulation: optimization variables, objectives, and constraints. Problems of optimal management of stationary phenomena. Problems of optimal management of non-stationary phenomena. Optimal design problems. Model parameter calibration problems. Optimization problems of permutation type and optimal clustering. Treatment of restrictions.
Optimization methods and the notion of a black box. Methods based on the objective function gradient. Methods of direct search and sample search. Combinatorial methods. Heuristic methods. Evolutionary optimization methods. Swarm intelligence based methods. Software for solving optimization problems.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Course attendance (consultations), solving project assignment, preparing and presenting the seminar.
1.8. Monitoring of student work[41]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	4	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)
Course attendance, project, seminar paper.
1.10. Mandatory literature (at the time of submission of study programme proposal)
Winston, W. L.: Operations Research Application and Algorithms, Duxbury Press, Belmont, 1993 Press, W. H. at al.: Numerical Recipes in C, 2nd ed. University Press, Cambridge, 1990 Goldberg, E. D.: Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley Publishing Company, New York, 1989
1.11. Optional/additional literature (at the time of submission of the study programme proposal)
1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Winston, W. L.: Operations Research Application and Algorithms, Duxbury Press, Belmont, 1993	1	1
Press, W. H. at al.: Numerical Recipes in C, 2nd ed. University Press, Cambridge, 1990.	1	1
Goldberg, E. D.: Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley Publishing Company, New York, 1989.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
Through the Institution's quality assurance system.

[41] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Optimization of energy systems**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Ability to analyse energy systems and critically evaluate state of the art optimization methods applicable in thermal power engineering. Application of the selected optimization method to the set energy system. Synthesis of acquired results and their presentation.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

Analyse energy systems from the efficiency, the economic operation and reduction of their negative impact on the environment point of view. Identify possible causes of energy losses and choose appropriate modes to improve the efficiency of the energy system operation. Select and apply the scientific method and set up a mathematical interpretation of the optimization problem. Present the results obtained by solving the optimization problem to the other scientists.

1.4. Course content

Analysis of energy systems (steam systems, gas systems, cogeneration systems, combined systems, hybrid energy systems). Mathematical modelling and optimization of operating parameters, configuration and capacity of energy systems. Criteria for analysis and comparison. Analysis of operating and investment costs and environmental impact assessment. Optimization of energy systems in the design and exploitation phase. Analysis and evaluation of losses, energy recovery, ways of increasing energy and exergy efficiency, reduction of their negative environmental impact. Energy, exergy and economic analysis of energy systems. Economic analysis of investments for the rational use of energy. Techno-economic optimization. Feasibility studies.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

The students are required to attend consultations, to prepare and to present their seminar work.

1.8. Monitoring of student work[42]

[42] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Class attendance	0.5	Class participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	1.5
Project	2	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class attendance, project assignments, presentation of the results of own research to the general public.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Nag, P. K.: Power Plant Engineering, Mc Graw Hill, 2014.
Zhu, F.: Energy and Process Optimization for the Process Industries, Wiley, 2014.
Jaluria, Y.: Design and Optimization of Thermal Systems with MATLAB Applications, CRC Press, 2019.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Bejan, A., Tsatsaronis, G., Moran, M.: Thermal Design and Optimization, John Wiley and Sons Inc., New York, 1996.
Sahoo, U.: A Polygeneration Process Concept for Hybrid Solar and Biomass Power Plant: Simulation, Modelling, and Optimization, John Wiley and Sons Inc., New York, 2018.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Zhu, F.: Energy and Process Optimization for the Process Industries, Wiley, 2014.	1	1
Jaluria, Y.: Design and Optimization of Thermal Systems with MATLAB Applications, CRC Press, 2019.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the institution’s quality assurance system.

University of Rijeka
FACULTY OF ENGINEERING

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Outfitting of marine vessels and offshore structures**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Introducing the theoretical and practical knowledge about integrating outfitting design and outfitting of marine vessels and offshore structures within selected shipyard. Solving the posted problems by using appropriate methods, techniques and tools.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Integrate the core outfitting processes in shipbuilding.
Apply the methodology of operational research in shipbuilding.
Analyse and optimize the outfitting technology of marine vessels and offshore structures.
Analyse and optimize shipyards layout design based on outfitting improvement.

1.4. Course content

The basic processes of shipbuilding. Modern concepts in shipbuilding production, outfitting and repair process. Operations research methodology in shipbuilding. Automation and integration of production technology of various marine vessels and offshore structures. Planning and management processes. Ship repair and equipment maintenance based on reliability. Modern methods and tools for shipyards layout design. The spatial distribution of the means of production. Means of transport.

1.5. Manner of instruction	☐ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	The publication of seminar work in scientific journal is expected.	

1.7. Student responsibilities

Regular attendance at consultations, solving project assignments and presenting seminar work.

1.8. Monitoring of student work[43]

Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	3,5

[43] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their research aktivitries, project accuracy and the final seminar work presentation.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Richard Lee Storch et al.: Ship Production, SNAME, 2007.
Internat. group of authorities, T. Lamb–editor: Ship Design and Construction. SNAME. Jersey City, 2003.
Winston, W. L.: Operations research - Applications and Algorithms. Cengage Learning; 4th ed., 2003.
Frederick Hiller: Introduction to Optimization in Operation Research. McGraw-Hill Education; 10th ed., 2014.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Roland L. Rardin: Optimization in Operation Research. Pearson; 2nd ed., 2016.
Saaty, L. T.: The Analitic Hierarchy Process. RWS Publications, Pittsburg, 1996.
Mohamed A. El-Reedy: Offshore Structures: Design, Construction and Maintenance. Gulf Professional Publishing; 1 ed., 2012.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Richard Lee Storch et al.: Ship Production, SNAME, 2007.	1	
Internat. group of authorities, T. Lamb–editor: Ship Design and Construction. SNAME. Jersey City, 2003.	1	
Winston, W. L.: Operations research - Applications and Algorithms. Cengage Learning; 4th ed., 2003.	1	
Frederick Hiller: Introduction to Optimization in Operation Research. McGraw-Hill Education; 10th ed., 2014.	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Principles of High- and Ultra-high Precision Devices**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Systematic approach as well as critical analysis and assessment of most recent scientific information about components and assemblies of high- and ultra-high precision devices. Acquisition of knowledge about high-precision design principles in the framework of complex project solutions. Acquisition of skills of scientific and research work as well as of synthesis of new and complex ideas. Capability of communication with experts and peers in the considered research field.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

By applying the scientific methodology and based on the analysis and revision of current literature, critically assess the components and assemblies of high- and ultra-high precision devices.
Set research hypotheses, organize and plan own research work (also in collaboration with researchers and on scientific projects) and synthetize the acquired knowledge as well as generate innovative design solutions, methods and theories, considering especially the industrial and societal implications and the usage of research results.
Publish and present the achieved results in a scientifically sound manner with development of skills of writing of original scientific and professional publications.

1.4. Course content

Advanced topics and principles of high- and ultra-high precision devices. Principles, ways of achieving and of enhancing precision, accuracy and resolution.
Elements of high- and ultra-high precision devices. Kinematic mounts and Hertz theory of contact stresses. Elastic averaging. Principles of structural and metrological loops. Friction and tribology.
Choice and characteristics of materials for high- and ultra-high precision devices. Scaling of mechanical properties.
Design of high-precision devices. Measurement systems, their principles and characteristics in high-precision devices. High-precision actuators. Error compensation via advanced control typologies.
Integration of high-precision mechanisms into mechatronics devices. Autonomous systems and assuring their powering. Application of high-precision devices (in machine tools, in micro- and nanotechnologies, in scientific instrumentation, in robotics, in aerospace and astrophysics, in medicine etc.).

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other

1.6. Comments	-

1.7. Student responsibilities

Attendance of classes (consultations), work on project assignment as well as preparation and presentation of a seminar (and/or publishing and presentation of scientific work on an international conference).

1.8. Monitoring of student work[44]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	4.0
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance of classes, adoption of methodology of scientific work via research activity, project work, seminar (and/or scientific publication) work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

S. Zelenika and E. Kamenar: „Precizne konstrukcije i tehnologija mikro- i nanosustava I – Precizne konstrukcije (Precision Engineering and Micro- and Nanosystems' Technology I – Precision Engineering)“, University of Rijeka – Faculty of Engineering, Rijeka, Croatia, 2015.
H. Slocum: „Precision Machine Design“, Society of Manufacturing Engineers, Dearborn (MI, USA), 1992.
S. Mekid (ed.): „Introduction to Precision Machine Design and Error Assessment“, CRC Press, Boca Raton (FL, USA), 2009.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

***: „Springer Handbook of Nanotechnology“ - 3rd ed., Springer Verlag, Berlin (D), 2010.
C. W. de Silva: "Mechatronics – An Integrated Approach", CRC Press, Boca Raton (FL, USA), 2005.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
S. Zelenika and E. Kamenar: Precision Engineering and Micro- and Nanosystems Technology I	10	1
H. Slocum: Precision Machine Design	1	1
S. Mekid (ed.): Introduction to Precision Machine Design and Error Assessment	1	1
***: Springer Handbook of Nanotechnology	1	1
C. W. de Silva: Mechatronics – An Integrated Approach	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Via the institutional quality assurance system of the Faculty of Engineering of the University of Rijeka.

[44] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Processes plans optimization**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Knowing the start points, methods and techniques for optimization of plans processes and production systems. Mathematical modelling and solving a problem by applying appropriate methods and software.

1.2. Course enrolment requirements

No prerequisites.

1.3. Expected learning outcomes

Analyze the optimization methods and evaluate basic ideas of methods. Evaluate professional knowledge and mathematical methods of processes optimization. Investigate possibilities of solving optimization problems by using artificial intelligence (AI) methods. Investigate the possibility of solving the problem of multicriteria optimization. Critically evaluate the possibilities of solving the problem by applying the ready-made software and / or developing one of own program.

1.4. Course content

Theoretical basis of processes plans optimization. Identification of variables and process factor selection. Mathematical modeling of process. Operation research. Linear programming. Alternative plans of process and methods of selection optimal combination. Methods of tabutechnic search, genetic algorithms, and artificial neural networks for solving problems of processes plans selection. Application of software for optimization of process plans. Optimization of process plans and production systems based on productivity, costs and quality. Multidimensional optimization. Exploitation value of system.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	-

1.7. Student responsibilities

Attendance of classes (consultations), work on project assignment as well as preparation and presentation of seminar.

1.8. Monitoring of student work[45]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	

[45] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam		Essay		Research	3,0
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of active participation in the class, evaluation of the project assignment. Presentation of seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Ramya, R., Rajendran, C., Ziegler, H., Mohapatra, S., Ganesh, K.: Capacitated Lot Sizing Problems in Process Industries, Springer, 2019.
Pinedo, M.L.: Scheduling: Theory, algorithms and systems, Springer, New York, 2016
Deb, K.: Multy-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, New York, 2004.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Framinan, J.M., Leisten, R., Garcia, R.R.: Manufacturing scheduling systems, Springer Verlag, London, 2014.
Emmons, Hamilton, Vairaktarakis, George: Flow Shop Scheduling, Theoretical Results, Algorithms, and Applications, Springer, 2013.
Gen, M., Cheng, R.: Genetic Algorithms and Engineering Design, John Wiley & Sons, New York, 1997.
Perinić, M.: Optimizacija ciklusa izrade na FPS-u primjenom genetskih algoritama, disertacija, Tehnički fakultet u Rijeci, 2004.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Ramya, R., Rajendran, C., Ziegler, H., Mohapatra, S., Ganesh, K.: Capacitated Lot Sizing Problems in Process Industries	1	8
Pinedo, M.L.: Scheduling: Theory, algorithms and systems	1	8
Deb, K.: Multy-Objective Optimization using Evolutionary Algorithms	1	8

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

According to Institutional Quality Assurance System.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Production planning and control**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Being able to analyse and synthesize influencing factors in production planning. Master the modern principles of production planning and control. To acquire knowledge and skills of scientific research work and communication with experts.

1.2. Course enrolment requirements

No prerequisites.

1.3. Expected learning outcomes

Evaluate known approaches to planning and control of production processes. Create a model for planning and control of production with respect to specific influential variables. Critically analyse and manage elements of investment and operating costs. Compare model results with known production planning and control approaches.

1.4. Course content

Definition of operations and production process. The concept and influent factors of production planning and control. Basic models and logic of production planning and control process. The integral concept of production resources planning and control. The structure of an integrated information system. Databases for automatic information processing. Theoretical aspects of scheduling. Types and contents of production schedules. Master production schedule. Definition and structure of a makespan. Operative schedules of production resources. Methods of scheduling. Launching and observation of production process. Optimization of resources. The structure of production order costs. Planning calculations. CAPPC – system of production planning and control in frame of CIM. Basic characteristics of MRP II concept. ERP. OPT and KANBAN plan strategies. JIT – just in time production. Characteristics of CAPPC software for production control.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance of classes (consultations), work on project assignment as well as preparation and presentation of seminar.

1.8. Monitoring of student work[46]							
Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	4.0
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of active participation in the class, evaluation of the project assignment. Presentation of seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Vollmann, T.E.; Berry, W.L.; Whybark, D.C.; Jakobs F.R.: „Manufacturing planning and control systems for Supply Chain Management“, McGraw-Hill, 2005.
Sheikh, K.: „Manufacturing Resource Planning (MRP II) with Introduction to ERP, SCM, and CRM“, McGraw-Hill Professional, Chicago, 2002.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Higgins, P.: Manufacturing Planning and Control: Beyond MRP II, Kluwer Academic Publishers, 1996.
Halevi, G.: Handbook of Production Management Methods“, Reed Educational and Professional Publishing Ltd 2001.
Kumar, S.A.: „Operations Management“, New Age International Publishers, New Delhi, 2009.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Vollmann, T.E.; Berry, W.L.; Whybark, D.C.; Jakobs F.R.: „Manufacturing planning and control systems for Supply Chain Management“, McGraw-Hill, 2005.	1	2
Sheikh, K.: Manufacturing Resource Planning (MRP II) with Introduction to ERP, SCM, and CRM, McGraw-Hill Professional, Chicago, 2002.	1	2

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the institutionalised system of quality assurance in the Faculty of Engineering.

[46] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

University of Rijeka
FACULTY OF ENGINEERING

COURSE DESCRIPTION			
Course instructor			
Name of the course	**Project management in product and production systems development**		
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences		
Status of the course	Elective		
Year of study	1		
ECTS credits and manner of instruction	ECTS credits	6	
	Number of class hours (L+E+S)	15+0+0	

1. Course objectives		
Knowledge of project management principles in product and production systems development. Knowledge of project planning methods. Knowledge of project management software.		
2. Course enrolment requirements		
None.		
3. Expected learning outcomes		
Analyze vision, strategy and goals when designing new products or production systems. Determine the optimal model for project planning and monitoring considering all influencing factors. Plan the project and critically analyze the investment and operating costs of the project activities.		
4. Course content		
Introduction and basic concepts of project management. Projects - vision, strategy, goals. Project management and organizational structures. Project management models. HBS model. Project phases: project definitions and organization, project planning and project monitoring and management. Project Planning Techniques for Time and / or Capacity Planning - Gantt Charts, Network Planning Techniques - PERT, CPM. Cost Management Project Planning Methods - Target Costing. View MS Project project management software.		
5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☐ mentorship ☐ other
6. Comments	-	
7. Student responsibilities		
Attendance at classes (consultations), preparation and presentation of seminars.		
*8. Monitoring of student work*47		

Class attendance	0.5	Class participation		Seminar paper	0.5	Experimental work	
Written exam		Oral exam	0.5	Essay		Research	1.5

[47] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project	3.0	Continuous assessment		Report		Practical work	
Portfolio							

9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Presentation and defence of seminar work. Final exam is oral.

10. Mandatory literature (at the time of submission of study programme proposal)

Vanchoucke M.: Integrated Project Management Sourcebook, Springer International Publishing Switzerland, 2016.
Tonchia A.: Industrial Project Management - Planning, Design, and Construction, Springer-Verlag Berlin Heidelberg, 2008.

11. Optional/additional literature (at the time of submission of the study programme proposal)

M. Ikonić; A. Vuković: *Projektni management,* Tehnički fakultet Sveučilišta u Rijeci, Rijeka, 2011.
Hrvatski nacionalni vodič za temeljne sposobnosti upravljanja projektima, Hrvatska verzija 3.0, HUUP, Zagreb, 2008.
M. A. Omazić; S. Baljkas: Projektni menadžment, Sinergija-nakladništvo, Zagreb, 2005.
Hauc, A.: „Projektni menadžment i projektno poslovanje“, M.E.P. Consult, Zagreb 2007.

12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Vanchoucke M.: Integrated Project Management Sourcebook, Springer International Publishing Switzerland, 2016.	1	1
Tonchia A.: Industrial Project Management - Planning, Design, and Construction, Springer-Verlag Berlin Heidelberg, 2008.	1	1

13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the established quality assurance system of the Faculty of Engineering, University of Rijeka.

COURSE DESCRIPTION		
Course instructor		
Name of the course	Protection from noise and vibrations	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

14. Course objectives

Student gains the ability to conduct scientific research in the field of noise and vibration and how to protect the subject system from their negative impact. Numerical simulation and experimental verification of the effect of isolation and / or absorption. Understanding of the active approach to noise and vibration control.

15. Course enrolment requirements

None

16. Expected learning outcomes

Numerically analysis of given noise and vibration problem in FEM software with the aim of proposing optimal intervention to the machine or structure in order to reduce vibration and / or noise. Propose and preferably perform experimental verification of the proposed measures or intervention of construction / machinery in order to reduce vibration and / or noise.

Present and popularize the results of your own scientific research to the general public and, if possible, publish a scientific paper in a significant international journal or international scientific conference

17. Course content

Fundamentals of noise and vibration. Signal processing methods. Vibration and sound based condition monitoring. Sources of noise and vibrations in machines and structures (for example: rotating machinery unbalance, noise of traffic vehicles, ventilation, etc.). Generation of airborne and structure-borne sound. Simulation of vehicle interior noise and vibrations of different sources with finite element method. Harmful effects of noise and vibrations on workers, passengers and human being. Ways and means for noise and vibrations isolation and absorption. Active noise and vibration control.

18. Manner of instruction		
	☒ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☒ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

19. Comments	-

20. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

21. Monitoring of student work[48]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	1
Written exam		Oral exam		Essay		Research	3
Project		Continuous assessment		Report		Practical work	
Portfolio							

22. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on their engagement during lecture and the results they achieve in their project and the seminar work.

23. Mandatory literature (at the time of submission of study programme proposal)

Genta, G.: Vibration Dynamics and Control, Springer, New York, 2009.
Fahy, F., Gardonio, P.: Sound and structural vibration, Academic Press, 2007.
Randall, R.B., Vibration-based Condition Monitoring, Wiley, Chichester, 2011.

24. Optional/additional literature (at the time of submission of the study programme proposal)

Fahy, F., Walker, J.: Advanced Applications in Acoustics, Noise and Vibration, Spon Press, London, 2004.
Harrison, M.: Vehicle Refinement; Controlling Noise and Vibration in Road Vehicles, Elsevier Butterworth-Heinemann, Oxford, 2004.
Gawronski, W.K.: Advanced Structural Dynamics and Active Control of Structures, Springer, New York, 2004.

25. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Genta, G.: Vibration Dynamics and Control	1	1
Fahy, F., Gardonio, P.: Sound and structural vibration	1	1
Randall, R.B., Vibration-based Condition Monitoring	1	1

26. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

[48] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Protection of marine and coastal environments**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

To introduce the students to the concepts and current issues related to the protection of the marine and coastal environments. Fundamental aspects of marine science – chemistry, physics, biology and geology.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyse the Management Strategy of the marine and coastal environment of the Republic of Croatia. Estimate the activities and the expected outcomes within the Strategy. Rank the goals based on their complexity and reformulate them if needed. Suggest a plan of implementation of activities regarding the chosen example.

1.4. Course content

Fundamental concepts of chemical, physical, biological and geological oceanography. Ecology of living resources and habitats in the sea. The ecosystems of the Adriatic Sea. Sources and types of pollution in marine and coastal areas. Action plans for pollution accidents in the sea. Integrated coastal zone management. Protection of marine and coastal environments – issues of biodiversity, environmental risk assessment and monitoring strategies. Croatian legislation related to EIA. 4MAT model of learning and presenting.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Write and submit a seminar related to the assigned or chosen topic of the dissertation. Present the research orally to the group and mentor.

1.8. Monitoring of student work[49]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	

[49] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam	3,0	Essay		Research	
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment *of learning outcomes in class and at the final exam (procedure and examples)*

Class attendance monitoring. Regular consultations regarding the seminar paper, which is expected to be at a technical and linguistic level matching the doctoral study. The exam consists of an oral and visual presentation of the work. Within the presentation the student needs to give a clear argumentation of the research based on the 4MAT model, or similar.

1.10. Mandatory literature *(at the time of submission of study programme proposal)*

Clark, R.B. (2002) Marine pollution, 5th edition, Oxford University Press, Oxford.
Strategija upravljanja morskim okolišem i obalnim područjem, Ministarstvo zaštite okoliša i energetike (website).

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Handbook on Marine Environment Protection Science, Impacts and Sustainable Management, 2018. Editors: Salomon, Markus, Markus.
Resources on the web and other literature, depending on the scope of the project/seminar (approved by course coordinator).

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Clark, R.B. (2002) Marine pollution, 5th edition, Oxford University Press, Oxford.	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the quality assurance system of the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Quality engineering**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Detail understanding of the methods and applications of design of experiments and quality improvement methodology. Application of acquired knowledge and skills in design of experiments and quality improvement projects management for a given process.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Design experiments and analyze the results obtained using a full and fraction factorial design. Plan and manage the quality improvement projects in a given business environment. Design robust processes.

1.4. Course content

Quality engineering definition. Design of measurements and experiments. Single factor experiments. Multiple factors experiments. Randomisation. Clustering of experiments and measurements. Design and analysis of full and fraction factorial experiments. Measurement system design and analysis. Sampling. Sampling based on the monitoring of attributes properties and variables. Acquisition and processing of data, probability, correlation. Analysis of the variability of results and input-output dependencies. Taguchi methods. Robust process design. Response surface methodology. Simulation modelling and analysis. Tools, methods and models of quality improvement. Defects analysis. Expert systems in quality engineering. Quality information systems.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance at lectures (consultations), topic research, preparation and defence of seminar work, oral exam.

1.8. Monitoring of student work[50]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	

[50] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam	0,5	Essay		Research	3,0
Project		Continuous assessment		Report	0,5	Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of active participation in the class, evaluation of the project assignment. Oral exam.
For example, a proposal for a plan to establish total quality management given on the basis of an analysis of the default business environment will be evaluated.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Phadke, M. S., Quality Engineering Using Robust Design, Prentice Hall, New Jersey, 1989.
Montgomery, D. C., Design and Analysis of Experiments, 8th ed., John Wiley & Sons, Hoboken, 2013.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Breyfogle III, F. W., Implementing Six Sigma: Smarter Solutions Using Statistical Methods,2nd ed., John Wiley & Sons, Hoboken, 2003.
Tennant, G., Design For Six Sigma, Gower Publishing, Hampshire, 2002.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Phadke, M. S., Quality Engineering Using Robust Design, Prentice Hall, New Jersey, 1989.	0	1
Montgomery, D. C., Design and Analysis of Experiments, 8th ed., John Wiley & Sons, Hoboken, 2013	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION			
Course instructor			
Name of the course	**Reliability of technical systems**		
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences		
Status of the course	elective		
Year of study	1		
ECTS credits and manner of instruction	ECTS credits	6	
	Number of class hours (L+E+S)	15+0+0	

1.1. Course objectives

A thorough knowledge of content related to the reliability of technical systems. Developing a student's ability to independently analyze and evaluate the reliability of a technical system.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Creating and evaluating new concepts, facts and principles in reliability theory and developing an experimental method for determining reliability. Using advanced knowledge and skills in modelling the reliability of systems with independent components and analyzing the reliability of systems with dependent components. Development of new ideas through the analysis of safety and risk of technical systems, the parameter of reliability as well as the design of fault trees of complex technical systems.

1.4. Course content

Basic concepts of reliability theory: component reliability, failure probability density functions, and failure rates. Reliability modelling of systems with independent components. (Serial, parallel and combined configuration). Mathematical models for calculating the reliability and availability of complex systems. Reliability of systems with dependent components. Backup system. Markov models. System with repairable components. Safety and risk analysis of technical systems. Concept of technical system efficiency, definition of efficiency parameters. Reliability analysis and failure tree analysis of complex technical systems. Experimental methods for determining reliability.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance in class (consultations), project assignment, preparation and presentation of seminars, and oral examination.

1.8. Monitoring of student work[51]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental	

[51] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

						work	
Written exam		Oral exam	0,5	Essay		Research	3,0
Project		Continuous assessment		Report	0,5	Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of active participation in the class, evaluation of the project assignment. Oral exam.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Mangey Ran, Reliability Engineering – Methods and Application, CRC Press, Boca Raton, 2019
Briolini, A., Reliability Engineering – Theory and Practice, 8th Edition, Springer, Berlin, 2017.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Vujanović, N., Teorija pouzdanosti tehničkih sistema, Beograd, 1987
Hrvatska norma HRN 61730, „Matematički izrazi za pouzdanost, raspoloživost, sposobnosti održavanja i održavanje“, 2008.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Mangey Ran, Reliability Engineering – Methods and Application, CRC Press, Boca Raton, 2019	1	2
Briolini, A., Reliability Engineering – Theory and Practice, 8th Edition, Springer, Berlin, 2017.	1	2

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the established quality assurance system of the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Seakeeping and maneuverability**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Introducing the research field of seakeeping and maneuverability. Mathematical formulation of problems related to the seakeeping and maneuverability and solving of those problems by means of appropriate methods and computer programs.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

To relate the expert knowledge and stochastic approach, and to identify and describe problems in the research and professional fields related to the seakeeping or manoeuvrability. To set up a mathematical formulation of the vessel motion equations, to analyse the effect of the coefficient variation, as well as the complexity and solvability of the problem. To analyse the application possibilities of certain methods in order to solve the problems related to the seakeeping and manoeuvrability, to compare and choose the most appropriate one. To investigate the possibility of solving the problem by applying an existing software solution and/or by creating the appropriate computer program on his/her own, and to discuss and disseminate obtained results.

1.4. Course content

Wave mechanics. Wave theories. Boundary conditions. Sea environment. Wave-structure interaction. Application of numerical methods. Second order non-linear problems. Ship response on sea waves. Time domain computation. Hydrodynamics of slender body.
Kinematics and dynamics of vessel motion in 6DOF. Nonlinear and linearized manoeuvring equations. Manoeuvring models. Autopilot models. Dynamic positioning. Thrust allocation. Path-following and trajectory-tracking. Advance motion control methods. Analysis and criteria of stability.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Students are required to attend the classes (consultations), to undertake and complete their project, and to prepare and present a seminar.

1.8. Monitoring of student work[52]							
Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of progress in student research work through mentoring. Assessment of mathematical formulation and computational solution of the problem posed through a successfully completed project assignment. Evaluating analytical thinking and dissemination skills through discussion during presentation and defence of seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Faltinsen, O. M.: Hydrodynamics of High-speed Vessels, Cambridge University Press, New York, US, 2006.

Faltinsen, O. M.: Sea Loads on Ships and Offshore Structures, Cambridge University Press, Cambridge, UK, 1993.

Fossen, T. I.: Handbook of Marine Craft Hydrodynamics and Motion Control, John Wiley & Sons Ltd., Chichester, UK, 2011.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Newman, J. N.: Marine Hydrodynamics, 40th Anniversary Edition, The MIT Press, Cambridge, Massachusetts, UK, 2017.

Perez, T.: Ship Motion Control: Course Keeping and Roll Stabilisation Using Rudder and Fins, Springer, Heidelberg, Germany, 2005.

Do, K. D., Pan, J.: Control of Ships and Underwater Vehicles: Design for Underactuated and Nonlinear Marine Systems, Springer, Heidelberg, Germany, 2009.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Faltinsen, O. M.: Hydrodynamics of High-speed Vessels, Cambridge University Press, New York, US, 2006.	1	1
Faltinsen, O. M.: Sea Loads on Ships and Offshore Structures, Cambridge University Press, Cambridge, UK, 1993.	1	1
Fossen, T. I.: Handbook of Marine Craft Hydrodynamics and Motion Control, John Wiley & Sons Ltd., Chichester, UK, 2011.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[52] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapter on fluid power**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Knowledge with complex hydrostatic and pneumatic systems for transmission power and information's. Development of mathematical models for simulation of hydrostatic and pneumatic systems and verification of theoretical results in the laboratory.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

Analysing the literatures and databases with the aim of gathering information for solving project task. Create specialist knowledge based on the scientific approach for solving project task. Presenting the results of the project task.

1.4. Course content

Mathematical and numerical modelling of hydrostatic and pneumatic components and systems. Hydrostatic and pneumatic servo systems. Hydrostatic hybrid technology. Power plants with hydrostatic transmissions. Design and optimization of the pneumatic artificial muscles.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Presence at lectures (consultation), solving the project task and presentation of seminar.

1.8. Monitoring of student work[53]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	2
Written exam		Oral exam		Essay		Research	2
Project		Continuous assessment		Report		Practical work	

[53] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Portfolio								

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance of lectures, activity in laboratory, preparation and presentation of a seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Jelali, M., Kroll.: Hydraulic Servo-systems, Modelling, Identification and Control, Springer-Verlag, London, 2003.
Costa, G. K., Sepehri, N.: Hydrostatic Transmissions and Actuators, Operation, Modelling and Applications, John Wiley & Sons, West Sussex, 2015.
Beater, P.: Pneumatic Drives, System Design, Modelling and Control, Springer-Verlag, Berlin, 2007.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Barber, A.: Pneumatic Handbook, Elsevier, Oxford, 1997.
Merritt, H. E.: Hydraulic Control Systems, John Wiley & Sons, West Sussex, 1967.
Findeisen, D., Findeisen, F.: Ol-Hydraulik, Springer-Verlag, berlin, 2000.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Jelali, M., Kroll.: Hydraulic Servo-systems, Modelling, Identification and Control, Springer-Verlag, London, 2003.	1	0
Costa, G. K., Sepehri, N.: Hydrostatic Transmissions and Actuators, Operation, Modelling and Applications, John Wiley & Sons, West Sussex, 2015.	1	0
Beater, P.: Pneumatic Drives, System Design, Modelling and Control, Springer-Verlag, Berlin, 2007.	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected Chapters on Conventional Machining Processes**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Acquisition of actual and developing the new scientific knowledge in the subject area. Application of acquainted knowledge to real machining process examples with emphasis on their optimization and minimization of expenses to achieve competition of machining technologies. Ability to implement the methods of modelling and optimization of machining process.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Independently analyze the economic aspects of machining processes, evaluate the influencing factors and set up an appropriate mathematical formulation of the optimization problem of production efficiency. Apply basic methods of machining process modelling. Critically evaluate the results of existing and own researches – compare approaches.

1.4. Course content

Current state and trends in machining. High speed machining. Hard machining. Modelling and simulation of machining process. Methods of machining process optimization. Estimation of production cost and optimization of cutting parameters.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☐ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	-

1.7. Student responsibilities

Attendance at classes (consultations) and solving a project assignment.

1.8. Monitoring of student work[54]

Class attendance	0.5	Class participation		Seminar paper		Experimental work	
Written exam		Oral exam		Essay		Research	4

[54] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project	1.5	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of activity in class and of the solution of project assignment, or published scientific paper in the subject area.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Gupta, K. (Ed.), Davim, J.P. (Ed.): High-Speed Machining, 1st edition, Academic Press, 2020.
Cukor, G.: Obrada metala rezanjem, Tehnički fakultet Sveučilišta u Rijeci, 2017.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Montgomery, D.C.: Design and Analysis of Experiments, 8th edition, John Wiley & Sons, Inc., 2013.
Shaw, M.C.: Metal Cutting Principles, 2nd edition, Oxford University Press, 2004.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Gupta, K. (Ed.), Davim, J.P. (Ed.): High-Speed Machining	1	1
Cukor, G.: Obrada metala rezanjem	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	Selected Chapters on Design Science	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Understanding and adopting terms and concepts of the design science research framework and advanced principles in methodical product design and development. Ability to methodically approach the selection and application of methods for finding design solutions. Defining evaluation criteria and criteria-based selection of the optimal technical solution or method. Applying the right design approaches. Acquiring knowledge on the application of conventional and unconventional design approaches and modern computer aided and machine learning-based product development methods.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Apply design science research principles and concepts in the analysis of existing and development of new technical solutions.
Evaluate and select methods for finding design solutions.
Develop solutions realized with selected design approaches and product development methods.

1.4. Course content

Introduction to the design science. Framework for research in design science and associated activity cycles - relevance cycle, development/design cycle, evaluation cycle. Advanced principles in methodical design and product development. General and special (unconventional) methods for finding design solutions. Criteria for evaluating and selecting solutions in the product development process. Design approaches for specific goals and technologies (Design for X) and with different materials (Design with X). Unconventional approaches to design - design inspired by biological systems. Modern and computer-aided approaches and methods for product development and design solutions (machine learning, topology optimization, generative design).

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attendance of classes/consultations, literature study, research defined topic under course instructor’s mentorship, preparation and presentation of seminar.

1.8. Monitoring of student work[55]							
Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam	0,5	Essay		Research	3,5
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of learning outcomes will be performed at the end of the semester and will be based on the quality the seminar work and oral exam.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Pahl, B. ; Beitz, W.: Engineering Design - A Systematic Approach. Springer Verlag, 1996.
Hubka, V. ; Eder, W.E.: Theory of technical systems - a total concept theory for engineering design. Springer Verlag, 1988.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Myrup Andreasen, M.; Hein, L.: Integrated Product Development. Institute for Product Development TU Denmark, 2000.
Haykin, S.: Neural Networks and Learning Machines. 3rd ed. Pearson, 2009.
Russel, S.; Norvig, P.: Artificial Intelligence: A Modern Approach. 3rd ed. Pearson, 2014.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Pahl, B.; Beitz, W.: Engineering Design - A Systematic Approach. Springer Verlag, 1996.	1	1-3
Hubka, V.; Eder, W.E.: Theory of technical systems - a total concept theory for engineering design. Springer Verlag, 1988.	1	1-3

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[55] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on flexible manufacturing systems**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Acquire theoretical and practical knowledge in the field of development of flexible and reconfigurable production systems.

1.2. Course enrolment requirements

No prerequisites.

1.3. Expected learning outcomes

Design the concept of a complex manufacturing system with respect to known external and internal variables. Compare the degrees of flexibility and productivity of such a concept. Evaluate optimization concepts and methods when designing a manufacturing system. Simulate the workflow of a flexible manufacturing system.

1.4. Course content

Manufacturing paradigms. Manufacturing integration and automation. Flexible Manufacturing Systems (FMS) and Reconfigurable Manufacturing Systems (RMS) – a definition. Evolution and development of FMS and RMS. Degrees of flexibility and productivity of the system and their correlation. Manufacturing equipment for flexible and reconfigurable systems. Interdependence of production program, manufacturing system and transportation system. FMS and RMS configurations and layouts. Fully and partially automated flexible manufacturing systems. Optimization methods for system selection. Simulation of FMS and RMS operation. Scope, advantages and disadvantages of FMS and RMS over traditional manufacturing systems. Simulation software.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance of classes (consultations), work on project assignment as well as preparation and presentation of seminar.

1.8. Monitoring of student work[56]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental	

[56] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

						work	
Written exam		Oral exam		Essay		Research	4.0
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of active participation in the class, evaluation of the project assignment. Presentation of seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Koren, Y.: „Global Manufacturing Revolution“, John Wiley & Sons, 2010.
Tolio, T.: „Design of Flexible Production Systems“, Springer-Verlag Berlin Heidelberg 2009.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

ElMaraghy, H.(ur.): „Changeable and Reconfigurable Manufacturing Systems“, Springer-Verlag London Limited, 2009.
Raouf, A.; Ben-Daya, M.: „Flexible Manufacturing Systems: Recent Developments“, Elsevier Health Sciences, 1995.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Koren, Y.: „Global Manufacturing Revolution“, John Wiley & Sons, 2010.	1	2
Tolio, T.: „Design of Flexible Production Systems“, Springer-Verlag Berlin Heidelberg 2009.	1	2

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on gear transmissions**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Determination of the actual gear tooth loading capacity by application of analytical, numerical and experimental methods. Creation of gear tooth stress model hypotheses based on the analysis of stress measurement.

1.2. Course enrolment requirements

No specific requirements.

1.3. Expected learning outcomes

Investigate the loading capacity of geared transmissions by applying analytical methods and numerical and experimental analysis. Evaluate experimental data and evaluate the adherence of the numerical model with analytical and experimental data. Presentation and popularisation of research results in the broader scientific and professional community.

1.4. Course content

Influence of the basic geometrical parameters on mesh kinematics and gear load capacity. Influence of the geometrical parameters of gear wheels on gearing load capacity. Analytical and experimental procedures for the determination of gear load capacity. Vibrations and noise during the operation of geared transmissions. Forms and causes of gear wear and damage.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☐ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	

1.7. Student responsibilities

Class attendance (consultations), writing a seminar paper, public presentation of research results

1.8. Monitoring of student work[57]

Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	2,5

[57] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio						Public presentation	1

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class attendance, class participation, seminar paper, public presentation of research results

1.10. Mandatory literature (at the time of submission of study programme proposal)

Abersek, B.; Flašker, J.: How gears break, WIT Press, Southampton, 2004.
Oberšmit, E.: Ozubljenja i zupčanici, SNL, Zagreb, 1982.
Opalić, M.: Prijenosnici snage i gibanja, Sveučilište u Zagrebu, Zagreb, 1998.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Colbourne,J.R.: The Geometry of Involute Gears, Springer-Verlag, New York, 1987.
Flašker, J., Glodež, S., Ren, Z.: Zobniška gonila, Založba Pasadena, Maribor, 2010.
Dudley, D. W.: Gear handbook, McGraw – Hill, New York, 1992.
Litvin, F., Fuentes, A.: Gear geometry and Applied Theory, Cambridge University Press, New York, 2004.
Looman, J.: Zahnradgetriebe; Springer-Verlag, Berlin, 1996.
Niemann G., Winter H., Hoehn, B. R.: Maschinenelemente, Springer-Verlag, Berlin 2001.
Radzevich, S. P.: Theory of Gearing, CRC Press, New York, 2013.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Abersek, B.; Flašker, J.: How gears break, WIT Press, Southampton, 2004.	2	1
Oberšmit, E.: Ozubljenja i zupčanici, SNL, Zagreb, 1982.	6	1
Opalić, M.: Prijenosnici snage i gibanja, Sveučilište u Zagrebu, Zagreb, 1998.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on heat exchangers**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Enhancing the theoretical knowledge and training of skills for solving practical problems in field of heat exchangers as parts of thermal and energy systems, as well as training of skills necessary for performing of scientific-research work in field of technical sciences.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Associate professional knowledge and apply the relevant physical laws on the formulation of the specific problems of heat transfer within the heat exchanger.
Investigate the possibility of solving the problem using analytical and numerical approach as well as select and implement the appropriate method.
Analyse the results and perform specific conclusions and explanations based on the linking of expertise with the results obtained.
Present research results in the form of research work.

1.4. Course content

Heat exchangers. Recuperative, regenerative and direct heat exchangers. Heat and mass transfer. Heat conduction. Forced convection. Pipe fluid flow. Cylinders and pipe bundles in cross - flow. Natural convection. Heat transfer through fins. Heat transfer in phase change processes. Parallel-flow, counter-flow and cross - flow heat exchangers. Shell-and-tube and plate heat exchangers. Design and thermal analysis. Temperature distribution and heat exchange. Reversal and rotary regenerators. Dry and wet regenerator’s theory. Methods for thermal analysis. Temperature distribution and heat exchange. Heat storages. Sensible heat storages. Latent heat storages. Temperature distribution and heat exchange.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attending the classes (consultations), project solving, seminar paper preparing and presenting.

1.8. Monitoring of student work[58]

Class attendance	0.5	Class participation		Seminar paper	1	Experimental work	
Written exam		Oral exam		Essay		Research	2.5
Project	2	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class activity, project and seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Kakac, S., Liu, H., Pramuanjaroenkij, A.: Heat Exchangers: Selection, Rating and Thermal Design, CRC Press, Taylor & Francis Group, NY, 2012.
Hausen,H.: Heat Transfer in Counterflow, Parallel Flow and Cross Flow, McGraw-Hill Book Co, NY, 1983.
Cabeza, L.F.: Advances in Thermal Energy Storage Systems, Methods and Applications, Elsevier, Cambridge, 2015.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Smith, E.M.: Thermal Design of Heat Exchangers, John Wiley & Sons Inc., NY, 1997.
Dincer,I.,Rosen,M.A.: Thermal Energy Storage: Systems and Application, John Wiley & Sons Inc., NY, 2002.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Kakac, S., Liu, H., Pramuanjaroenkij, A.: Heat Exchangers: Selection, Rating and Thermal Design, CRC Press, Taylor & Francis Group, NY, 2012.	1	1
Hausen,H.: Heat Transfer in Counterflow, Parallel Flow and Cross Flow,McGraw-Hill Book Co, NY, 1983.	1	1
Cabeza, L.F.: Advances in Thermal Energy Storage Systems, Methods and Applications, Elsevier, Cambridge, 2015.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[58] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on heating and air conditioning**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

The development of theoretical knowledge and the skills needed to solve practical problems related to the design, optimization and automatic control and monitoring of heating, ventilation and air conditioning. Developing the skills necessary to perform scientific research in the field of technical sciences.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Apply specialist knowledge based on the scientific approach for solving engineering problems on the design and optimization (from techno-economical and ecological point of view) of HVAC components and systems. Efficiently choose and apply appropriate modern modeling and simulation tools and methods to assess energy performance of buildings and their energy systems.

1.4. Course content

Thermal comfort and indoor air quality in enclosed spaces. Comfort indices. Analysis of local climate factors and their influence on designing and constructing buildings. Building physics. Heat and mass transfer processes in buildings. Energy performance of buildings. Heating and cooling systems. Ventilation and air-conditioning systems. Domestic water heating (DHW) systems. HVAC and DHW systems elements. Building management systems. Intelligent buildings. Building information modeling (BIM). Heating, cooling and DHW demand calculations. Building energy modeling. Economics of HVAC systems. HVAC systems optimization.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

1.8. Monitoring of student work[59]							
Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	3.0	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Lectures (consultations) attendance and activity, research project and seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Awbi, H.B.: Ventilation of Buildings, Spon Press, Taylor and Francis Group, London, 2003.
Jones, W.P.: Air Conditioning Engineering, Elsevier, 2001.
Kreider, J.F.: Handbook of Heating, Ventilation and Air Conditioning, CRC Press, 2001.
Oughton, D.R., Hodkinson S.: Heating and Air Conditioning of Buildings, Elsevier, 2002.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

ASHRAE Handbook (SI), ASHRAE, Atlanta.
Recknagel, Sprenger, Schramek: Heitzung und Klimatechnik, Springer Verlag, München
Baturin, V. V.: Fundamentals of Industrial Ventilation, Pergamon Press Ltd, Oxford, 1972.
Fanger, P. O.: Thermal Comfort Analysis and Applications in Environmental Engineering, McGraw-Hill Book Company, New York, 1972.
Rajaratnam, N.: Turbulent Jets, Elsevier Scientific Publishing Company, Amsterdam, Netherland, 1976.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Awbi, H.B.: Ventilation of Buildings, Spon Press, Taylor and Francis Group, London, 2003.	1	1
Jones, W.P.: Air conditioning engineering, Elsevier, 2001.	1	1
Kreider, J.F.: Handbook of heating, ventilation and air conditioning, CRC Press, 2001.	1	1
Oughton, D.R., Hodkinson S.: Heating and air conditioning of buildings, Elsevier, 2002	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[59] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected Chapters on Industrial Transport Equipment and Devices**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Analysis of the application of industrial transport equipment and devices in industrial practice. Acquisition of knowledge and skills in the application, calculation, analysis and design of industrial transport equipment using modern materials and respecting the requirements of safety, ergonomics, ecology, engineering ethics and other requirements. Development of knowledge and skills of scientific research work.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyse design, real workloads and calculation methods of industrial transport equipment and devices. Research and analysis of the importance and application of transport ecology, green transportation logistics and automation of industrial transport equipment and devices. Present and popularize the results of own scientific research to the general scientific and professional public.

1.4. Course content

Introduction. Transport of materials and people. Historical development. The importance and place of transport in the industry. Basic concepts, application, divisions and characteristics of industrial transport equipment and devices. Application of transport logistics, green transport logistics, transportation ecology and engineering ethics in industrial transport equipment and devices. Occasional transport, continuous transport, vertical transport. Design and calculation of industrial transport equipment and devices. Hand and motor driven industrial vehicles. Small transport devices. Lifts and ropeways. Forklifts and pallets. Application of expert systems and computers for the calculation of industrial transport equipment and devices. Automation of work, an integrated and flexible transportation systems. Directions for further development of industrial transport equipment and devices.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☐ seminars and workshops	☐ multimedia and network
	☐ exercises	☒ laboratories
	☐ distance learning	☒ mentorship
	☒ fieldwork	☐ other

1.6. Comments	-

1.7. Student responsibilities

The students are required to attend the classes (consultations), study relevant literature, complete assigned project work, prepare and publicly present the seminar.

1.8. Monitoring of student work[60]							
Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	2,5
Project		Continuous assessment		Report		Practical work	
Portfolio						Public presentation	1

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve doing independently their seminar work and on the public presentation of their results.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Spivakovsky, A., Dyachkov, V.: Conveying Machines, Mir Publishers, Moscow, 1985.
Trešćec, I.: Teorija, proračun i primjena transportera s gumenom trakom, Zavod za produktivnost, Zagreb, 1983.
Ščap, D.: Transportni uređaji, Fakultet strojarstva i brodogradnje, Zagreb, 2004.
Fayed, M., E., Skocir, S., T.: Mechanical Conveyors, CRC Press, New York, 2009.
Stroh, M., B.: A Practical Guide to Transportation and Logistics, Logistics Network Inc., 2006.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Herold, Z., Ščap, D., Hoić, M.: Prenosila i dizala, Fakultet strojarstva i brodogradnje, Zagreb, 2019.
Dundović, Č., Hess, S.: Unutarnji transport i skladištenje, Pomorski fakultet, Rijeka, 2007.
Fleddermann, C. B.: Engineering Ethics, Pearson Education Limited, Harlow, 2014.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Spivakovsky, A., Dyachkov, V.: Conveying Machines, Mir Publishers, Moscow, 1985.	1	-
Trešćec, I.: Teorija, proračun i primjena transportera s gumenom trakom, Zavod za produktivnost, Zagreb, 1983.	1	-
Ščap, D.: Transportni uređaji, Fakultet strojarstva i brodogradnje, Zagreb, 2004.	1	-
Fayed, M., E., Skocir, S., T.: Mechanical Conveyors, CRC Press, New York, 2009.	1	-
Stroh, M., B.: A Practical Guide to Transportation and Logistics, Logistics Network Inc., 2006.	1	-

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[60] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on internal combustion engines**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Adoption of theoretical and experimental knowledge and skills in scientific research in the field of internal combustion engines and their applications.

1.2. Course enrolment requirements

There are no conditions

1.3. Expected learning outcomes

Analyze and revise existing literature in the field of engines with the aim of collecting the necessary data to conduct their own research.
Apply the scientific method (theoretical, experimental, analytical, numerical) for the purpose of analyzing and optimizing processes in the engine.
Present your own work in a lecture or scientific article.

1.4. Course content

Fuel injection and combustion theory. Important fuel properties for engine processes. Different engine model categories: 0D, QD and 3D models. Engine process modeling focused on harmful products generation reduction.

1.5. Manner of instruction		
	☐ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments

1.7. Student responsibilities

Attending classes (consultation), addressing the terms of reference and the preparation and presentation of seminars.

1.8. Monitoring of student work[61]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	4.0	Continuous assessment		Report		Practical work	

[61] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Portfolio								

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attendance, class participation, projects, seminars.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Grljušić, M.: Motori s unutarnjim izgaranjem, FESB, Split, 2000.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Heywood, J.B. Internal Combustion Engines Fundamentals, McGrow Hill Book Co., New York, 1988.
Stesch, G: Modeling Engine Spray and Combustion Processes, Springer-Verlag Berlin Heidelberg, 2003.
Baumgarten, C: Mixture Formation in Internal Combustion Engines, Springer-Verlag Berlin Heidelberg 2006

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Grljušić, M.: Motori s unutarnjim izgaranjem, FESB, Split, 2000.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on machine elements design**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Numerical and analytical calculation of carrying capacity and durability of machine elements and structural components, optimisation of their design with application of appropriate methods and software solutions.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

Explore possibilities of load carrying capacity and durability increase of machine elements. Optimize geometrical properties of machine elements. Critically asses results of performed research on selected topic.

1.4. Course content

Static and dynamic loading carrying capacity of referred machine elements and components. Application of numerical methods in research of their loading capacity and durability. Optimization of their design. Geometrical properties of elements. Numerical structural analysis of elements. Material fatigue of elements. Stress concentration.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Class attendance (individual consultations), solving the project assignments, preparation and presentation of the seminar paper.

1.8. Monitoring of student work[62]

Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	3,5
Project		Continuous assessment		Report		Practical work	

[62] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the research results they achieve and the seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Mott, R. L., Vavrek, E. M., Wang, J.: Machine Elements in Mechanical Design, Pearson, 2018.
Madenci, E., Guven, I.: The Finite Element Method and Applications in Engineering Using ANSYS, Springer, 2015.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Ottosen, N. S., Ristinmaa, M.: The Mechanics of Constitutive Modeling, Elsevier Science, 2005.
Stephens, R.I., Fatemi, A., Stephens, R. R., Fuchs, H.O.: Metal Fatigue in Engineering, Wiley-Interscience, 2000.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Machine Elements in Mechanical Design	1	3
The Finite Element Method and Applications in Engineering Using ANSYS	1	3

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION			
Course instructor			
Name of the course	**Selected chapters on marine energy systems**		
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences		
Status of the course	elective		
Year of study	1		
ECTS credits and manner of instruction	ECTS credits	6	
	Number of class hours (L+E+S)	15+0+0	

1.1. Course objectives		
Within the course students acquire the advanced knowledge and skills that are required to find optimal technical solution for given conditions during exploitation of marine energy system.		
1.2. Course enrolment requirements		
None.		
1.3. Expected learning outcomes		
Classify types of marine energy systems, compare according to advantages, disadvantages and field of applicability. Connect practical and theoretical knowledge and identify and describe problems in design and exploitation of marine energy systems. Analyze possibilities of application of numerical methods on applicable example, compare and select numerical method. Investigate possibilities of problem solving by commercial software and/or by own program code. Analyze obtained results and evaluate their accuracy and applicability on specific example of marine energy system.		
1.4. Course content		
Analysis of ship demand for different kinds of energy. Statistical analysis of machinery system loads during ship exploitation. Choice of energy source size and other characteristics in marine machinery system. Ship energy sources. Choice of kind and capacity of energy sources. Energy balances (electric energy, steam, compressed air, water, fuel, gas). Energy analysis of system. Control and management of marine propulsion plants. Equipment and installation of marine energy systems. Marine energy systems.		
1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		
1.7. Student responsibilities		
The students are required to attend the classes (consultations), do their project, prepare and present the seminar.		
1.8. Monitoring of student work[63]		

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental	

[63] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

						work	
Written exam		Oral exam		Essay		Research	
Project	4	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Lectures (consultations) attendance and activity, projects and seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Clark G.H.: Industrial and Marine Fuels, Butterworths, London, 1988.
Roy, L. Harrington: Marine Engineering, The Society of Naval Architects and Marine Engineers, New Jersey, 1992.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

McGeorge H.D.: Marine Auxiliary Machinery, 7th Edition, Butterworth Heinemann, Oxford, 2002.
Rawson K.J., Tupper E.C.: Basic Ship Theory, 5th Edition, Vol. 2 Ship Dynamics and Design, Butterworth Heinemann, Oxford, 2001.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Clark G.H.: Industrial and Marine Fuels, Butterworths, London, 1988.	1	1
Roy, L. Harrington: Marine Engineering, The Society of Naval Architects and Marine Engineers, New Jersey, 1992.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on marine machinery systems**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Within the course students acquire the advanced knowledge and skills that are required to find optimal technical solution for given conditions during exploitation of marine machinery system.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Classify types of marine machinery systems, compare according to advantages, disadvantages and field of applicability. Connect practical and theoretical knowledge and identify and describe problems in design and exploitation of marine machinery systems. Analyze possibilities of application of numerical methods on applicable example, compare and select method. Investigate possibilities of problem solving by commercial software and/or by own program code. Analyse obtained results and evaluate their accuracy and applicability on specific example of marine machinery system.

1.4. Course content

Basis in design of marine machinery systems. Concept of marine machinery system. Characteristics of marine machinery systems functioning. Analysis and selection of machinery and equipment. Complex marine machinery systems with combined propulsion plants. Energy analysis of marine machinery system. Analysis and optimization of marine machinery system expenses. Analysis of different energy transmission systems for marine propulsion. Remote transmissions (mechanical, hydraulic, pneumatic, electric). Numerical modelling of marine machinery systems. Selected chapters on automation of marine machinery systems.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

1.8. Monitoring of student work[64]							
Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	4	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Lectures (consultations) attendance and activity, projects and seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Gallin, Hiersig, Heidrich: Ship and their propulson sistem, Lohmann, 1989.
Roy, L. Harrington: Marine Engineering, The Society of Naval Architects and Marine Engineers, New Jersey, 1992.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Smith, D. W.: Marine Auxiliary Machinery, Butterworths, London, 1988.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Gallin, Hiersig, Heidrich: Ship and their propulson sistem, Lohmann, 1989.	1	1
Roy, L. Harrington: Marine Engineering, The Society of Naval Architects and Marine Engineers, New Jersey, 1992.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[64] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

University of Rijeka
FACULTY OF ENGINEERING

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on marine structural design**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Within the course students will acquire the advanced knowledge about marine structural design as well as possibilities of practical application to ship structure through design methodology and specialized software.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Apply the principles of designing marine structures and the use of composite materials.
To set theoretical and numerical method of calculation of wave load of linear model, and to analyse nonlinear effects in wave load.
Apply different methods of structural analysis: (a) response (linear or nonlinear FEM), (b) adequacy (damage, collapse) (c) material (isotropic, anisotropic).
Apply theoretical and numerical procedure to calculate the hull ultimate strength and fatigue strength of structural details.

1.4. Course content

Marine structural design principles. Marine composite materials and structure. Structural design loads. Different aspects of hydrodynamic loadings and structural responses. Linear and nonlinear wave load model. Application of finite element method in structural analysis. Structural analysis in the plastic area and nonlinear FEM in the analysis of marine structures. Ultimate strength of panel and stiffened panel. Hull ultimate strength calculation. Fatigue strength in ship structure analysis and design. Basics of ship collisions and groundings, dynamics, internal mechanics, modeling. Uncertainty assessment and risk analysis in ship structural design.

1.5. Manner of instruction	☐ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

The students are required to attend the consultations, do their project, prepare and present the seminar.

1.8. Monitoring of student work[65]							
Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	
Written exam		Oral exam	0,5	Essay		Research	3
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Hughes, O.F., Paik, J. K.: *Ship Structural Analysis and Design,* SNAME, 2010.
Bai, Y, Jin, W.L..: *Marine Structural Design*, Butterworth-Heinemann, 2015.
Okumoto, Y., Takeda, Y., Mano, M., Okada T.: *Design of Ship Hull Structures*, Springer, 2009.
Mansour, A., Liu, D.: *Strength of Ships and Offshore Structures*, SNAME, 2008.
Belytscko, T., Liu, W.K., Moran, B.; *Nonlinear Finite Elements for Continua and Structures*,John Wiley & Sons, 2001.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

ISSC Proceedings, Reports of Technical Committees, TC II-1, TC IV-2, TC V.3, 2012, 2015, 2018
Jensen, J. J.: *Load and global response of the ships*, Elsevier 2001.
Paik, J. K., Thayamballi, A. K.: *Ultimate Limit State Design of Steel-Plated Structures*, John Wiley & Sons, 2006.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Hughes, O.F., Paik, J. K.: *Ship Structural Analysis and Design*	2	
Okumoto, Y., Takeda, Y., Mano, M., Okada T.: *Design of Ship Hull Structures*	1	
Paik, J. K., Thayamballi, A. K.: *Ultimate Limit State Design of Steel-Plated Structures*	1	
Belytscko, T., Liu, W.K., Moran, B.; *Nonlinear Finite Elements for Continua and Structures*	1	
ISSC Proceedings, Reports of Technical Committees	2	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

[65] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on mechanical behaviour and fatigue of materials**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Familiarisation with and understanding of processes and mechanisms of mechanical behaviour, stress-strain response and fatigue of materials subjected to various loading conditions. Analysis and selection of methodologies of experimental characterisation and modeling of material's response. Understanding of processes of crack initiation and growth and fatigue material damage under low-cycle and high-cycle fatigue. Evaluation and selection of crack initiation criteria and fatigue damage parameters and models for determination of fatigue lifetime. Acquiring knowledge on analytical and numerical determination of response and lifetime assesment of materials and components subjected to variable cyclic loading and material fatigue.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyze and explain processes and mechanisms of mechanical behaviour and fatigue of materials on various scales.
Evaluate and select methodologies for characterisation and modeling of mechanical behaviour and fatigue of materials.
Develop and apply calculational models for determination and assesment of load capacity and durability of materials and components subjected to variable cyclic loading and fatigue.

1.4. Course content

Structure of materials at various scales. Irregularities in materials' crystal structure. Mechanisms, processes and models related to elastic and plastic deformation and stregthening/hardening of materials. Mechanical behaviour of materials subjected to monotonic and cyclic loading. High-cyclic and low-cyclic fatigue mechanisms and processes in materials. Stress- and strain-based approaches to fatigue. Advanced determination and estimation of cyclic and fatigue material parameters. Constant and variable amplitude loading fatigue and multiaxial fatigue. Fatigue crack initiation theories and criteria. Methods and software tools for assesment of lifetime of materials and components subjected to cyclic loading and fatigue.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attendance and participation in lectures, literature study, research of defined topics under course instructor's mentorship, seminar paper preparation and presentation.

1.8. Monitoring of student work[66]

Class attendance	0,5	Class participation		Seminar paper	4	Experimental work	
Written exam		Oral exam	1,5	Essay		Research	
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of learning outcomes is based on the quality the seminar paper and presentation and oral exam.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Dowling, N. E.: Mechanical Behavior of Materials : Engineering Methods for Deformation, Fracture, and Fatigue, 3rd ed., Pearson Education, Upper Saddle River, 2007.
Roesler, J. ; Harders, H. ; Baeker, M.: Mechanical Behaviour of Engineering Materials - Metals, Ceramics, Polymers and Composites. Springer Verlag, Berlin, 2007.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Hertzberg, R. W.: Deformation and Fracture Mechanics of Engineering Materials, 4th ed., Wiley, New York, 1995.
Meyers, M. A. ; Chawla, K. K.: Mechanical Behavior of Materials. Cambridge University Press, 2009.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Dowling, N. E.: Mechanical Behavior of Materials : Engineering Methods for Deformation, Fracture, and Fatigue, 3rd ed., Pearson Education, Upper Saddle River, 2007.	1	1-3
Roesler, J. ; Harders, H. ; Baeker, M.: Mechanical Behaviour of Engineering Materials - Metals, Ceramics, Polymers and Composites. Springer Verlag, Berlin Hedelberg 2007.	1	1-3

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[66] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on non-conventional machining processes**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Acquisition of actual and developing the new scientific knowledge in the subject area. Application of acquainted knowledge on real non-conventional machining process examples. Ability to implement the methods of modelling and optimization of non-conventional machining processes.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Independently evaluate the influencing factors and set up an appropriate mathematical formulation of the optimization problem of production efficiency. Apply basic methods of machining process modelling. Critically evaluate the results of existing and own researches – compare approaches.

1.4. Course content

Current status, achievements and areas of application of non-conventional machining processes. Required requirements for the introduction of non-conventional technology, advantages and disadvantages. Development trends: hybrid (combined) machining processes, micro and nano machining, additive manufacturing. Modelling and optimization of non-conventional machining processes.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance at classes (consultations) and solving a project assignment.

1.8. Monitoring of student work[67]

Class attendance	0.5	Class participation		Seminar paper		Experimental work	
Written exam		Oral exam		Essay		Research	4
Project	1.5	Continuous assessment		Report		Practical work	

[67] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of activity in class and of the solution of project assignment, or published scientific paper in the subject area.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Cukor, G.: Nekonvencionalni postupci obrade odvajanjem čestica, Tehnički fakultet Sveučilišta u Rijeci, 2017.
El-Hofy, H.: Advanced Machining Processes: Nontraditional and Hybrid Machining Processes, McGraw-Hill, 2005.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Montgomery, D.C.: Design and Analysis of Experiments, 8th edition, John Wiley & Sons, Inc., 2013.
Rao, R.V.: Advanced Modeling and Optimization of Manufacturing Processes, Springer, 2011.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Cukor, G.: Nekonvencionalni postupci obrade odvajanjem čestica	1	1
El-Hofy, H.: Advanced Machining Processes: Nontraditional and Hybrid Machining Processes	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	Selected chapters on refrigeration	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Capability for analysis and synthesis. Problem solving. Enhancement and widening of theoretical and practical knowledge basis in the field of refrigeration and developing of knowledge and skills necessary for solving the problems of optimization of refrigeration systems. Developing of specific skills necessary for scientific research in refrigeration.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

Conduct a critical analysis of the available literature in the field of refrigeration processes with an emphasis on the suitability of application in different conditions of consumption, energy efficiency, optimal construction, application of environmentally friendly working substances and establish a research hypothesis.
Critically interpret different system concepts, application of appropriate system components, and method of regulation.
Integrate expertise and mathematical optimization methods and apply to optimization problems in refrigeration. Perform analysis of features and performance for different refrigeration systems.
Present research results in the form of research work.

1.4. Course content

Compression refrigeration cycles. Primary refrigerants and secondary coolants. Influence of refrigerant properties on the refrigeration systems' concept. Heat exchangers in refrigeration. Analysis of fluid flow and heat transfer. Refrigeration compressors. Absorption and adsorption refrigeration processes. Alternative refrigeration cycles. Dynamics of refrigeration processes. Applications of refrigeration in food production, air-conditioning and process industry. Control of refrigeration systems. Simulation and analysis of refrigeration systems and their components. Optimization problems in refrigeration. Low- and extremely low – temperature processes.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance to lectures (consultation), research project, preparation and presentation of seminar paper.

1.8. Monitoring of student work[68]							
Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	2,0
Project	2,0	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Consultation, seminar work and project, publication of research results

1.10. Mandatory literature (at the time of submission of study programme proposal)

Von Cube, H. L. et al.: Lehrbuch der Kältetechnik, 4 Aufl., Bd. 1-2, C.F.Müller Verlag, Heidelberg 1997.
Hausen, H., Linde, H.: Tieftemperaturtechnik, Springer Verlag, 1985.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Dincer, I., Ratwamwala, T.A.H.: Integrated Absorption Refrigeration Systems – Comparative Energy and Exergy Analyses, Springer International publishing, Switzerland 2016.
Gu, J., Wang, S., Gan, Z.: Two-Phase Flow in Refrigeration Systems, Springer Verlag, 2014.
Grazzini, G., Milazzo, A., Mazzelli, F.: Ejectors for Efficient Refrigeration, Springer Verlag 2018.
Kitanovski, A. et al.: Magnetocaloric Energy Conversion, Springer Verlag 2015.
Kagawa, N.: Regenerative Thermal Machines for Heating and Cooling, IIR Paris, 2000.
ASHRAE, The 4 -Volume ASHRAE Handbook, Atlanta, ASHRAE, Atlanta, 2016 - 2019.
Stoecker, W. F.: Industrial Refrigeration Handbook, Mc Graw Hill, New York, 1998.
Granryd, E. et al.: Refrigerating Engineering, Part 1 -2, Dept. of Energy Technology, Royal Institute of Technology KTH, Stockholm 2003.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Von Cube, H. L. et al.: Lehrbuch der Kältetechnik, 4 Aufl., Bd. 1-2, C.F.Müller Verlag, Heidelberg 1997.	1	1
Hausen, H., Linde, H.: Tieftemperaturtechnik, Springer Verlag, 1985.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[68] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on renewable energy sources**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Enhancing the theoretical knowledge in the field of renewable energy sources and training of skills for solving practical problems on the design, optimization and application of renewable energy components and systems. Training of skills necessary for performing scientific-research work in the field of technical sciences.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Apply specialist knowledge based on the scientific approach for solving engineering problems on the design and optimization (from techno-economical and ecological point of view) of renewable energy sources components and systems. Efficiently choose and apply appropriate modern modeling and simulation tools and methods to assess energy performance of renewable energy systems.

1.4. Course content

Earth's ecosystems. Ecological footprint. Ozone depletion. Global warming. Measures and actions for pollution reduction and environmental protection. Energy potential of renewable energy use. Solar energy. Conversion of solar energy into heat. Solar thermal systems. Heating, cooling, domestic hot water and desalinization solar systems. Conversion of solar energy into electricity. Solar concentrators. Solar power plants. Photovoltaic systems. Passive solar architecture. Energy storage systems. Geothermal energy. Geothermal power plants. Heat pumps. Wind energy. Wind power plants. Biomass. Biofuels. Biogas facilities. Hydrogen technologies. Fuel cells. Hydrogen and fuel cells energy systems. Hydro energy. Energy potential of municipal and special waste. Ecological and energy prerequisites of usage. Calculations and sizing of renewable energy systems. Modeling and simulation of renewable energy sources systems and components. Techno-economic analyses and systems optimization.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

1.8. Monitoring of student work[69]							
Class attendance	0.5	Class participation		Seminar paper	1.0	Experimental work	
Written exam		Oral exam		Essay		Research	2.5
Project	2.0	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Lectures (consultations) attendance and activity, research project and seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Schmid, J.: Photovoltaik – Strom aus der Sonne, Hüthig, Heidelberg, 1999.
Williams, P.T.: Waste Treatment and Disposal, J. Wiley & Sons Inc., New York, 1998.
Pregizer, D.: Grundlagen und Bau eines Passivhauses, Promotor Verlag, Karlsruhe, 2002.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Energy for tommorrow's world, WEC (World Energy Council), London, 2000.
Feist, W.: Das Niedrig-energiehaus, Verlag C.F. Müller, Karlsruhe, 2002.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Schmid, J.: Photovoltaik – Strom aus der Sonne, Hüthig, Heidelberg, 1999.	1	1
Williams, P.T.: Waste Treatment and Disposal, J. Wiley & Sons Inc., New York, 1998.	1	1
Pregizer, D.: Grundlagen und Bau eines Passivhauses, Promotor Verlag, Karlsruhe, 2002.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[69] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	Selected chapters on ship propulsion	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

General knowledge of the ship propulsion and ship propulsion devices. Understanding the relationship between the engine and the propeller as well as the connection between the ship resistance and ship propulsion. Introduction to methods for propeller design. Solving the problem of ship propulsion using appropriate methods.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

To analyze the theories of work of marine propellers and to apply them to different types of propellers. To analyze the interaction between ship's hulls and propellers and to evaluate devices to improve ship's propulsion efficiency. To research the possibilities of determining the hydrodynamic characteristics of a propeller by commercial and / or in-house made software. To apply a computer model to determine the propeller hydrodynamic characteristics and to analyze the possibility of optimizing the ship's propulsion characteristics.

1.4. Course content

Propulsion of ships. Ship propulsion devices: sail, ship screw propeller, waterjet propulsion, vertical-axis propellers, and azimuthing thruster. Special types of propellers: controllable pitch propeller, ducted propeller, contrarotating propellers. Theory of propeller action. Propeller cavitation. Types of propeller cavitation. Criteria for prevention of cavitation. Propeller model tests. Interaction between ship hull and propeller. Devices to improve ship propulsion. Dynamic effects of propellers. Operational problems of propellers. Propeller design theories. Analysis of propeller hydrodynamics characteristics. Application of computational models for propeller design and analysis. Optimization of ship propulsion characteristics. Ship trial. Analysis of ship trial results.

1.5. Manner of instruction	☐ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	None.	

1.7. Student responsibilities

Regular consultations, collecting and studying of a literature, drafting a seminar work with a presentation.

1.8. Monitoring of student work[70]							
Class attendance	0,5	Class participation	0,5	Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	3,5
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class participation (consultations), research, preparation and presentation of seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Carlton, J.S., Marine Propellers and Propulsion, Butterworth-Heinemann, Oxford, 2007.
Breslin, J.P., Andersen, P., Hydrodynamics of Ship Propellers, Cambridge Univ. Press, Cambridge, 1994.
Perez Gomez, G., Gonzales-Adalid, J., Detailed Design of Ship Propellers, Fondo Editorial De Ingenieria Naval Del Colegio Oficial De Ingenieros Navales Y Oceanicos, Madrid, 1998.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Harvald, Sv.Aa., Resistance and Propulsion of Ships, John Wiley & Sons, New York, 1983.
Saunders, H.E., Hydrodynamics in Ship Design, Volume I-II, SNAME, Jersey City, 1957.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Carlton, J.S., Marine Propellers and Propulsion, Butterworth-Heinemann, Oxford, 2007.	1	0
Breslin, J.P., Andersen, P., Hydrodynamics of Ship Propellers, Cambridge Univ. Press, Cambridge, 1994.	1	0
Perez Gomez, G., Gonzales-Adalid, J., Detailed Design of Ship Propellers, Fondo Editorial De Ingenieria Naval Del Colegio Oficial De Ingenieros Navales Y Oceanicos, Madrid, 1998.	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

[70] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on ship resistance**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

General knowledge of factors influencing the motion of ship in calm water. Introduction to the problem of flow around a ship. Understanding the problem of ship resistance and solving the resistance problem by appropriate methods.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

To analyze the components of the ship's resistance on calm water and the influence of hull and appendage shapes. To analyze the local and overall hydrodynamic characteristics of the ship's hull. To research the possibilities of using computer models to determine the hydrodynamic characteristics of a ship's hull by using commercial and / or in-house made software. To analyze the possibility of optimizing the ship hull from a hydrodynamic standpoint.

1.4. Course content

Ship resistance on calm water. The breakdown of resistance components. Frictional resistance. Viscous resistance. The wave resistance. Other resistance components. Ship resistance in shallow water. Methods for determining the resistance of the ship: analytical, experimental, and numerical. Added resistance. Effects of hull form to ship resistance. Effects of appendages form to ship resistance. The interaction of the hull and appendages. Local and overall hydrodynamic characteristics of the hull form. Preliminary determination of the hydrodynamic characteristics. The application of computational methods for determining the hydrodynamic characteristics of hull form. Ship hull form optimization from a hydrodynamic point of view.

1.5. Manner of instruction	☐ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	None.	

1.7. Student responsibilities

Regular consultations, collecting and studying of a literature, drafting a seminar work with a presentation.

1.8. Monitoring of student work[71]

[71] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Class attendance	0,5	Class participation	0,5	Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	3,5
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class participation (consultations), research, preparation and presentation of seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Birk, L., Fundamentals of Ship Hydrodynamics: Fluid Mechanics, Ship Resistance and Propulsion, John Willey & Sons, New Orleans, 2019.
Doctors, L.J., Hidrodynamics of High-Performaance Marine Vessels, Volime 1 / 2, CreateSpace Independent Publishing Platform, Charleston, 2015.
Marc, P., Ceccio, S., Mitigation of Hydrodynamic Resistance, World Scientific, Singapore, 2015.
Bertram, V., Practical Ship Hydrodynamics, Butterworth-Heinemann, Oxford, 2000.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Ferziger, J.H., Peric, M., Computational Methods for Fluid Dynamics, Springer Verlag, 2001.
Harvald, Sv.Aa., Resistance and Propulsion of Ships, John Wiley & Sons, New York, 1983.
Saunders, H.E., Hydrodynamics in Ship Design, Volume I-II, SNAME, Jersey City, 1957.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Birk, L., Fundamentals of Ship Hydrodynamics: Fluid Mechanics, Ship Resistance and Propulsion, John Willey & Sons, New Orleans, 2019.	1	0
Doctors, L.J., Hidrodynamics of High-Performaance Marine Vessels, Volume 1 / 2, CreateSpace Independent Publishing Platform, Charleston, 2015.	1	0
Marc, P., Ceccio, S., Mitigation of Hydrodynamic Resistance, World Scientific, Singapore, 2015.	1	0
Bertram, V., Practical Ship Hydrodynamics, Butterworth-Heinemann, Oxford, 2000.	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on shipbulding methodology**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	**1**	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Understanding of theoretical and practical knowledge on selected topics in shipbuilding methodology and especially on modern shipbuilding concepts. Solving the problems posed by using appropriate methods, techniques and tools.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Production and product technological parameters analysis and definition.
Synthesize and analyze concepts and procedures of marine vessels construction methodology.
Analysis and synthesis for design of project and production technology for the marine vessels construction and building.
Marine vessels construction and building methodology improvement using scientific methods, techniques and tools.

1.4. Course content

Technological features of products and processes. Design of technology for marine vessels construction. Modern concepts of the marine vessels construction methodology for the purpose of hull technological breakdown, defining technological structural solutions, defining and production of interim products. The integration of design, construction, outfitting and product exploitation. Environmental sustainability of production. Standardization, unification, network/ virtual shipyard. Scientific methods for improving the marine vessels construction methodology. Modern collaborative computer PLM platforms. Simulation modeling of the design and production scenarios.

1.5. Manner of instruction	☐ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

The students are required to attend consultations, resolve research assignments, prepare and present the seminar.

1.8. Monitoring of student work[72]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their activity on research assignments, seminar work, consultations, scientific contribution and presentation.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Internat. group of authorities, T. Lamb–editor: Ship Design and Construction. SNAME. Jersey City, 2003.
Storch, R. L. et al.: Ship Production, ISBN-10: 0939773570, SNAME, New Jersey, 2007.
Frederick Hillier: Introduction to operation research, ISBN-10: 1259162982, 2014.
Jingshan, Li; Semyon M.Meerkov; Production Systems Engineering; Springer, 2009.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Design for Production Manual, 2nd edition, National Shipbuilding Research Program, U.S.Department of the Navy Carderock Division, Vol. 1-3, 1999.
Banks, J. : Handbook of Simulation: Principles, Methodology, Advances, Applications and Practice. John Wiley & Sons, Inc. 1998.
Winston, W.L.: Operations research - Applications and Algorithms. Duxbury Press, Belmont, 1994.
Winston, W.L.: Introduction to Probability Models: Operations Research, Vol. 2, 4th edition, Duxbury Press, 2003.
Chang, Y. R., Kelly, K. P.: Improving through Benchmarking, Kogan Page Ltd., London, 1995.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Internat. group of authorities, T. Lamb–editor: Ship Design and Construction. SNAME. Jersey City, 2003.	1	1
Frederick Hillier: Introduction to operation research, ISBN-10: 1259162982, 2014.	1	1
Jingshan, Li; Semyon M.Meerkov; Production Systems Engineering; Springer, 2009.	1	1
Storch, R. L. et al.: Ship Production, ISBN-10: 0939773570, SNAME, New Jersey, 2007.	1	1
Internat. group of authorities, T. Lamb–editor: Ship Design and Construction. SNAME. Jersey City, 2003.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[72] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on ship's design**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Within the course students acquire the advanced knowledge and skills that are required to be carried out in small ship's design method, special ship's design method and off-shore structures design methods. Additional basic knowledge related to fixed off-shore structures design methods, and definition and/or application of special additional technical requirements.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyse the criteria for the design of the floating objects.
Apply modern procedures for the design of the floating objects.
Synthesize and evaluate the project..

1.4. Course content

The vessel design field systematisation. Review of regulatory standards. Methodologies of the vessel`s design. Procedures and transfer of information between various stages of the project. Computer aided tools applied in ship design. System architecture of selected tools specifically used in ship design.

1.5. Manner of instruction	☐ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

The students are required to attend the consultations, do their project, prepare and present the seminar.

1.8. Monitoring of student work[73]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3
Project		Continuous assessment		Report		Practical work	

[73] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Portfolio								

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Papanikolaou, A.: Ship design : methodologies of preliminary design, Springer, 2014
Principles of Naval Architecture, Second Revision, Volume I,II, The Society of Naval Architects and Marine Engineers, Jersey City, NJ, 1988.
Schneekluth, H.: Ship Design for Efficiency and Economy, Butterworth & Co. Ltd,1987.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Barrass, C.B.: Ship design and performance for masters and mates, Elsevier, 2004
Watson, D. G. M.: Practical ship design, Elsevier, 1998
PRAVILA HRVATSKOG REGISTRA BRODOVA, srpanj 2015.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Ship design : methodologies of preliminary design	1	1
Principles of Naval Architecture, Second Revision, Volume I,II	1	1
Ship Design for Efficiency and Economy	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on thermal sciences**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Mastering of theoretical knowledge in the field of numerical modelling for heat transfer problems.
Mastering of skills required to carry out scientific research in the field of technical sciences.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Associate professional knowledge and apply the relevant physical laws on the formulation of the specific problem of heat and mass transfer.
Investigate the possibility of solving the problem using analytical and numerical approach as well as select and implement the appropriate method.
Analyse the results and perform specific conclusions and explanations based on the linking of expertise with the results obtained.
Present research results in the form of research work.

1.4. Course content

Heat conduction. Basic laws of heat transfer. Temperature distribution within solids having cylindrical or spherical shapes. Linear and nonlinearity boundary condition. Heat sources and heat sinks, non-stationary systems, phase change. Convective heat transfer and the boundary layer problem. Mathematical model of the boundary layer. Nusselt similarity. Natural convection. Heat transfer in turbulent flow. Radiative heat transfer. Black body radiation and properties of grey bodies. Radiative heat transfer between general surfaces. Combined heat transfer by conduction, convection and radiation. Fundamentals of mass transfer. Definition of concentration, velocity and mass flow. Molecular mass transfer. Diffusion coefficients. Convection mass transfer. Fick's law of diffusion. Special forms of differential equations for mass transfer and boundary conditions. Steady-state molecular diffusion. Unsteady molecular diffusion. Mass transfer at interfaces. Heat and mass transfer in porous bodies. Examples of numerical methods.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Attending the classes (consultations), project solving, seminar paper preparing and presenting.

1.8. Monitoring of student work[74]

Class attendance	0.5	Class participation		Seminar paper	1	Experimental work	
Written exam		Oral exam		Essay		Research	2.5
Project	2	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Class activity, project and seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Incropera, F. P., DeWitt, D. P., Bergman, T. L., Lavine, A. S.: Principles of heat and mass transfer, John Wiley & Sons, NY, 2013.
Wang, Q., Chen, Y., Sunden, B.: Emerging topics in heat transfer : enhancement and heat exchangers, WIT Press, Southampton, 2014.
Rathore, M. M., Kapuno, R. R. A.: Engineering heat transfer, Jones & Bartlett Learning, Sudbury, 2011.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Incropera, F. P., DeWitt, D. P.: Fundamentals of heat and mass transfer, John Wiley & Sons, NY, 1996.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Incropera, F. P., DeWitt, D. P., Bergman, T. L., Lavine, A. S.: Principles of heat and mass transfer, John Wiley & Sons, NY, 2013.	1	1
Wang, Q., Chen, Y., Sunden, B.: Emerging topics in heat transfer : enhancement and heat exchangers, WIT Press, Southampton, 2014.	1	1
Rathore, M. M., Kapuno, R. R. A.: Engineering heat transfer, Jones & Bartlett Learning, Sudbury, 2011.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[74] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters on thermal turbomachines**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Capability of two-phase flow analysis in thermal turbomachinery. Two-phase flow modelling. Experimental analysis of two-phase flows. Experimental analysis of erosion and erosion-corrosion process in laboratory and running environment.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Experimentally analyse the erosion and erosion-corrosion process in laboratory and running environment. Carry out the standard and improved energy and exergy analysis of heat turbomachine. Perform a complex calculation of heat turbomachine. Optimize heat turbomachine operation by using artificial intelligence methods.

1.4. Course content

Two-phase flow in thermal turbomachinery. Current state of the two-phase fluid flow research in thermal turbomachinery. Two-phase flow modelling. Wet vapour characteristics and flow in turbine stages. Solid particles flow with the working fluid in thermal turbomachines. Experimental research on two-phase flow. Erosion and erosion-corrosion of turbomachinery components due to two-phase flow. Erosion and erosion-corrosion prediction methods. Erosion and erosion-corrosion prevention. Standard and improved energy and exergy analysis of heat turbomachine. Complex calculation of heat turbomachine. Heat turbomachine optimization by using artificial intelligence methods.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

1.8. Monitoring of student work[75]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental	

[75] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

						work	
Written exam		Oral exam		Essay		Research	
Project	4	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Miler, J.: Parne i plinske turbine I i II dio, Tehnička knjiga, Zagreb 1955. i 1965.
Kostjuk, A. G., Frolov, V. V.: Steam and Gas Turbines, Mir Publishers, Moscow, 1988.
Shlyakhin, P.: Steam Turbines – Theory and Design, University Press of the Pacific,Honolulu, Hawaii, 2005.
Kanoglu, M., Cengel, Y. A., Dincer, I.: Efficiency Evaluation of Energy Systems, SpringerBriefs in Energy, Springer, 2012.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Leyzerovich , A. S.: Steam Turbines for Modern Fossil-Fuel Power Plants, The Fairmont Press ,2008.
Bloch, H. P., Singh, M. P.: Steam Turbines - Design, Applications, and Rerating, The McGraw-Hill Companies, Inc. 2009.
Elčić, Z.: Parne Turbine, Nacionalna i sveučilišna biblioteka, Zagreb, 1995.
Kitto, J. B., Stultz, S. C.: Steam/its generation and use, 41st edition, The Babcock & Wilcox Company, Ohio, 2005.
Woodruff, E. B., Lammers, H. B., Lammers, T. F.: Steam plant operation, The McGraw-Hill Companies, Inc., 2005.
Sutton, I.: Plant Design and Operations, Elsevier Inc., 2015.
Sarkar, D. K.: Thermal Power Plant - Design and Operation, Elsevier Inc., 2015.
Tanuma , T.: Advances in Steam Turbines for Modern Power Plants, Woodhead Publishing, Elsevier, 2017.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Miler, J.: Parne i plinske turbine I i II dio, Tehnička knjiga, Zagreb 1955. i 1965.	2	2
Kostjuk, A. G., Frolov, V. V.: Steam and Gas Turbines, Mir Publishers, Moscow, 1988.	1	2
Shlyakhin, P.: Steam Turbines – Theory and Design, University Press of the Pacific,Honolulu, Hawaii, 2005.	1	2
Kanoglu, M., Cengel, Y. A., Dincer, I.: Efficiency Evaluation of Energy Systems, SpringerBriefs in Energy, Springer, 2012.	1	2

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected chapters of thermomechanics**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Introduction to balance laws of continuum mechanics and constitutive material models with emphasis on elevated temperatures. To acquire knowledge about analytical and numerical solution procedures of coupled thermomechanical problems.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

Analyze and revise existing literature on thermomechanics of solids and structures for the purpose of gathering the necessary data to conduct own research. Apply analytical method on thermoelastic structural problems. Apply finite element method to nonlinear thermomechanics of solids.

1.4. Course content

Introduction. Balance laws of continuum mechanics. Constitutive equations for elastic and inelastic materials in thermomechanics. Time dependent and time independent problems. Coupled problems in thermomechanics. Analytical solutions in thermomechanical structural analysis: trusses, beams, plates, shells. Computational methods in thermomechanics. Finite element method in thermoplasticity. Modelling of thermomechanical damage. Creep and fatigue under simultaneous mechanical loading and temperature. Non-local problems.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Students are required to attend the classes/consultations. Each student will be given a research assignment. Student should solve the problem, write a seminar paper and present the results.

1.8. Monitoring of student work[76]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3

[76] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in solving their assignment.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Boley, B. A., Weiner, J. H.: Theory of Thermal Stresses, John Wiley & Sons, New York, 1967.
Noda, N. et al.: Thermal Stresses, Taylor & Francis, New York, 2003.
Lemiatre, J., Chaboche, J.-L.: Mechanics of Solid Materials, Cambridge University Press, Cambridge, 2000.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Holzapfel, G. A.: Nonlinear Solid Mechanics – A Continuum Approach for Engineering, Wiley, Chichester, 2000.
Kleiber, M., Kowalczyk, P.: Introduction to Nonlinear Thermomechanics of Solids, Springer, 2016.
Maugin, G.: Thermomechanics of Plasticity and Fracture, Cambridge University Press, Cambridge, 1992.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Boley, B. A., Weiner, J. H.: Theory of Thermal Stresses	1	3
Noda, N. et al.: Thermal Stresses	1	3
Lemiatre, J., Chaboche, J.-L.: Mechanics of Solid Materials	1	3

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	Selected topics in marine dynamics	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Within the course students acquire the advanced knowledge and skills that are required to carry out dynamic analysis of marine objects.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

Connect expertise and stochastic approach and identify and describe problems in the field related to marine dynamics. Set a mathematical formulation of the vessel dynamics; analyze the effect of the coefficients variation, complexity and solvability of the problem. Analyze the possible application of certain methods to problems in the field of marine dynamics, compare and choose the appropriate method. Investigate the possibility of solving the problem by applying the existing software and / or write own program, and to discuss and disseminate obtained results.

1.4. Course content

Design sea state. Short-term and long-term prediction. All sea state and design sea state approach. Return period and encounter probability. Wave data sources. Statistics of currents and wind. Wave forces on small structures. Wave forces on large structures. Structure response statistics. Nonlinear dynamics of marine vehicles. Time domain analysis of motion.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Students are required to attend the classes (consultations), to undertake and complete their project, and to prepare and present a seminar.

1.8. Monitoring of student work[77]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3

[77] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of progress in student research work through mentoring. Assessment of mathematical formulation and computational solution of the problem posed through a successfully completed project assignment. Evaluating analytical thinking and dissemination skills through discussion during presentation and defence of seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Faltinsen, O. M.: Sea Loads on Ships and Offshore Structures, University Press, Cambridge, 1998.
Goda, Y.: Random Seas and Design of Maritime Structures, World Scientific, London 2000.
Wilson, J. F. Dynamics of Offshore Structures, John Wiley & Sons, New Jersey, 2003.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Sarkapaya T., Isaacson M.: Mechanics of Wave Forces on Offshore Structures, Van Nostrand Reinhold Co., Melbourne, 1981.
Jensen, J. J.: Load and Global Response of Ships, Elsevier Ocean Eng. Book Series, Oxford, 2001.
Carlton, J., Jukes, P., Choo, Y: Encyclopedia of Maritime and Offshore Engineering, Wiley, 2018.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Faltinsen, O. M.: Sea Loads on Ships and Offshore Structures, University Press, Cambridge, 1998.	1	1
Goda, Y.: Random Seas and Design of Maritime Structures, World Scientific, London 2000.	1	1
Wilson, J. F. Dynamics of Offshore Structures, John Wiley & Sons, New Jersey, 2003.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Selected topics on environment protection**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Disseminate information about the importance of environmental protection in technical and other activities. To inform about the situation in the area, as well as about the legislative system. Therefore, ensure a higher level of knowledge about the importance of sustainable development and the rational use of energy and the exploitation of natural resources.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Apply specialist knowledge based on the scientific approach for solving engineering problems.
Critically asses the influence of characteristic parameters on the results of procedures and/or processes.
Recommend system integration and information processing based on an interdisciplinary approach.

1.4. Course content

Introduction: environment, environmental system, distinguish factors. Environmental pollution: sources of pollution. Pollution of air, soil, water and sea. Influence of different technologies on environment: chemical technology, energy engineering, marine technology. Interaction between environment and marine technology structures: corrosion, biological influence, protection. Monitoring: measuring methods, sampling, limits. International conventions, law and regulation in the Republic of Croatia. Environmental protection: subjects, factors. Ecological engineering.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

1.8. Monitoring of student work[78]

Class attendance	0,5	Class participation		Seminar paper	1,0	Experimental work	

[78] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam		Essay		Research	3,0
Project	1,5	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work be based on the results their achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Prelec Z: Energetika u procesnoj industriji, Školska knjiga, Zagreb, 1994.
Richter L. A., Volkov E. P., Pokrovski V. N.: Thermal Power Plants and Environmental Control, Mir Publishers, Moskva, 1984.
Theodore L., Buonicore J.A.: Energy and Environment Interactions, CRS Press Inc., Boca Raton, 1980.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Pandey G. N., Carney G. C.: Environmental engineering, Tata McGraw-Hill Publiching Company Limited, New Delhi, 1989.
Nicoll E. H.: Small Water Pollution Control Works- Design and Practice, Ellis Horwood Limited, John Wiley&Sons, New-York, 1988.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Prelec Z: Energetika u procesnoj industriji, Školska knjiga, Zagreb, 1994.	4	
Richter L. A., Volkov E. P., Pokrovski V. N.: Thermal Power Plants and Environmental Control, Mir Publishers, Moskva, 1984.	1	
Theodore L., Buonicore J.A.: Energy and Environment Interactions, CRS Press Inc., Boca Raton, 1980.	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the quality assurance system of the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Ship's design methodology**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Within the course students acquire the advanced knowledge and skills that are required to be carried out in ship's design methods. Teaching relates to up to date floating and off-shore objects design procedures. Students have to understand fundamental design knowledge to be implemented in complex floating objects and off-shore structures, including own knowledge and responsible managing of design procedure.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Choose the criteria to perform the concept, preliminary, contract and detail design.
Apply modern procedures for the assessments of the ship's characteristics. Evaluate conceptual solutions for the designing project.

1.4. Course content

Modern methods and methodology of vessels design. Project phases – concept, preliminary, contract and detail design. Influence of a vessel project on its characteristics. Assessments of the ship's characteristics. Optimisation of the vessels project. Safety of the ship.

1.5. Manner of instruction	☐ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

The students are required to attend the consultations, do their project, prepare and present the seminar.

1.8. Monitoring of student work[79]

Class attendance	0,5	Class participation		Seminar paper	2,5	Experimental work	
Written exam		Oral exam		Essay		Research	3

[79] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Papanikolaou, A.: Ship design : methodologies of preliminary design, Springer, 2014
Principles of Naval Architecture, Second Revision, Volume I,II, The Society of Naval Architects and Marine Engineers, Jersey City, NJ, 1988.
Yasuhisa. O et al.: Design of ship hull structures : a practical guide for engineers, Springer, 2009

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

The Maritime Engineering Reference Book: A Guide to Ship Design, Construction and Operation, Elsevier, 2008.
Barrass, C.B.: Ship design and performance for masters and mates, Elsevier, 2004.
Watson, D. G. M.: Practical ship design, Elsevier, 1998.
PRAVILA HRVATSKOG REGISTRA BRODOVA, srpanj 2015.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Ship design : methodologies of preliminary design	1	1
Principles of Naval Architecture, Second Revision, Volume I,II	1	1
Design of ship hull structures : a practical guide for engineers	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Simulation methods in production**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Introduction to simulation modeling and methodology of simulation model building. Verification of simulation model then validation and analysis of the obtained results of the simulation experiment and comparison with the real production system.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Critically explaining of simulation principle and recognizing needs of simulation modelling of production system. Create simulation models of different types and solve them using appropriate methods and software. Evaluate and analyse the obtained simulation models.

1.4. Course content

The role and significance of simulation modeling of production systems. Discrete event processes simulation. Continuous processes simulation. Stochastic characteristics of the production processes. Random variables. Probability distributions. Random number generation and analysis of goodness generators. The theory of queues: entities of the queue, discipline and priorities. Optimization of production systems by queues. Simulation software's.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance at classes (consultations), literature study, research of the subject area under course instructor's mentorship, as well as seminar paper preparation and presentation.

1.8. Monitoring of student work[80]

Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	
Written exam		Oral exam	1	Essay		Research	2,5

[80] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of learning outcomes is based on the quality the seminar paper, presentation and oral exam or published scientific paper in the subject area.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Banks, J., Carson, J. S., Nelson B. L., Nicol, D. M.: Discrete event system simulation, 5th Ed., Pearson Education International Series, 2013.
Kelton, W. D., Sadowski, R. P., Swets, N. B.: Simulation with Arena, 5th Ed., McGraw-Hill, 2010.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Seila, A., Ceric, V., Tadikamalla, P.: Applied simulation modeling, Duxbury Press, 2003.
Rossetti, M. D.: Simulation modeling and Arena, John Wiley & Sons Inc., 2009.
Altiok, T., Melamed, B.: Simulation modeling and analysis with Arena, Academic Press, 2007.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Banks, J., Carson, J. S., Nelson B. L., Nicol, D. M.: Discrete event system simulation	1	1
Kelton, W. D., Sadowski, R. P., Swets, N. B.: Simulation with Arena	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	Special Mechanical Transmissions	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Acquisition of knowledge and skills in the application, calculation, analysis and design of special mechanical transmissions using modern materials and respecting the requirements of safety, ergonomics, ecology, engineering ethics and other requirements. Development of knowledge and skills of scientific research work.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Critically evaluate application conditions, design options and methods of gear, belt and friction drive calculations. Apply numerical and experimental analysis and determine the optimal load capacity of gear, belt and friction drives. Present and popularize the results of own scientific research to the general scientific and professional public.

1.4. Course content

Fundamentals of special mechanical transmissions. Design criteria: compaction, minimisation of the power losses, durability and reliability, maintenance. Marine high-power gearing, marine planetary (epicyclic) gearing, shaft generator gearing, turbine gearing, planetary gear-boxes. Analysis of forces and torques. Power branching. Planetary differential gearing. Transmissions with elastic gears. Frictional and belt transmissions. Continuously variable transmissions. Automatic gear-boxes. Orbit gearing. Cycloidal planetary gearing. Robot gearing. High transverse contact ratio gearing. Special non-involute gearing. Application of ecology and engineering ethics in special mechanical transmissions. Application of expert systems and computers for the calculation of special mechanical transmissions.

1.5. Manner of instruction	☒ lectures	☒ individual assignments
	☐ seminars and workshops	☐ multimedia and network
	☐ exercises	☒ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other
1.6. Comments	-	

1.7. Student responsibilities

The students are required to attend the classes (consultations), study relevant literature, complete assigned project work, prepare and publicly present the seminar.

1.8. Monitoring of student work[81]							
Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	2,5
Project		Continuous assessment		Report		Practical work	
Portfolio						Public presentation	1

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve doing independently their seminar work and on the public presentation of their results.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Lechner, G., Naunheimer, H.: Automotive Transmissions, Springer-Verlag Berlin Heidelberg, 1999.
Orlić, Ž., Orlić, G.: Planetni prijenosi, Zigo, Rijeka, 2006.
Opalić, M.: Prijenosnici snage i gibanja, HDESK, Zagreb, 1998.
Dudas, I.: The Theory and Practice of Worm Gear Drives, Penton Press, London, 2000.
Litvin, L., F., Fuentes-Aznar, A., Gonzales-Perez, I., Hayasaka, K.: Noncircular Gears, Cambridge University Press, New York, 2009.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Lovrin, N.: Load Capacity Analysis of the High Transverse Contact Ratio Involute Gearing, Thesis (in Croatian), University of Rijeka, Rijeka (Croatia), 2001.
Baura, D., G.: Engineering Ethics: An Industrial Perspective, Elsevier Academic Press, London, 2006.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Lechner, G., Naunheimer, H.: Automotive Transmissions, Springer-Verlag Berlin Heidelberg, 1999.	1	-
Orlić, Ž., Orlić, G.: Planetni prijenosi, Zigo, Rijeka, 2006.	1	-
Opalić, M.: Prijenosnici snage i gibanja, HDESK, Zagreb, 1998.	1	-
Dudas, I.: The Theory and Practice of Worm Gear Drives, Penton Press, London, 2000.	1	-
Litvin, L., F., Fuentes-Aznar, A., Gonzales-Perez, I., Hayasaka, K.: Noncircular Gears, Cambridge University Press, New York, 2009.	1	-

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution’s quality assurance system.

[81] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Statistical methods and stochastic processes**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Knowledge about basic principles in statistical methods needed for the analysis of data obtained from different engineering problems. Introduction to stochastic processes. Data manipulation and the analysis of statistical data by applying acquired methods within statistical engineering software's, modeling of engineering problems as stochastic processes.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Independently explore the possibilities of applying different statistical methods or stochastic processes in the observed problem.
Set up a problem formulation for the application of the selected methods, implement the methods, critically evaluate and compare the obtained results.
Review the behavior of the system by applying theoretical knowledge and independently investigate possible improvements of the system.

1.4. Course content

Elements of statistical inferences: Bayesian methods, sample based methods, statistical estimation, parametric and nonparametric tests, analysis of variance, multidimensional random variables, regression and correlation analysis. Matrix methods in statistics. Statistical methods by using statistical software.
Stochastic processes. Markov processes and Markov chains. Birth and death processes. Queuing systems. Stationary stochastic processes. Correlation theory. Some applications in engineering.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

Course attendance (consultations), solving project assignment, preparing and presenting the seminar.

1.8. Monitoring of student work[82]

[82] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	4	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Course attendance, project, seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Montgomery, D.C., Runger, G.C.: Applied Statistics and Probability for Engineers, Wiley, New York, 2003.
Devore, J.L.: Probability and Statistics for Engineering and the Sciences, Duxbury Press, 1995.
Yates, Goodman, Probability and Stochastic Processes: a friendly intorduction for electrical and computer engineers, Wiley, 2005.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Leon-Garcia, Alberto: Probability, statistics, and random processes for electrical engineering, Pearson Education, Inc., 2008.
Elezović, N.: Statistika i procesi, FER, Element, Zagreb 2008.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Montgomery, D.C., Runger, G.C.: Applied Statistics and Probability for Engineers, Wiley, New York, 2003.	1	1
Devore, J.L.: Probability and Statistics for Engineering and the Sciences, Duxbury Press, 1995.	1	1
Yates, Goodman, Probability and Stochastic Processes: a friendly intorduction for electrical and computer engineers, Wiley, 2005.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION			
Course instructor			
Name of the course	**Statistical process control**		
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences		
Status of the course	elective		
Year of study	1		
ECTS credits and manner of instruction	ECTS credits	6	
	Number of class hours (L+E+S)	15+0+0	

1.1. Course objectives

Detail understanding the content in the field of statistical process control. Application of acquired knowledge and skills through individual project assignments for given environment.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Design statistical process control for given environment. Perform critical analysis of statistical process control results. Make conclusions from a particular case and extrapolate them to a general rule.

1.4. Course content

Statistical methods for process control. Statistics of samples and processes. Common and special causes of process variability. Sampling. The frequency and size of the samples. Assumption plans and probability of acceptance. Empirical distribution of events or patterns. Estimation and confidence interval of the process. Probability function. Analysis and calculation of parameters of process capability and process harmonization. Estimating of natural process limits. Statistical tolerance. Control charts for monitoring the attribute properties and process variables. Group control charts. Control and warning limits. Deming's approach to process quality control. Demerit methods. Optimizing the quality of the process. The probability of noncompliance. Statistical analysis and interpretation. Automation of statistical process control. Application of statistical process control methods and problem solving

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Solving individual assignment and project, preparation and presentation of seminar and oral exam.

1.8. Monitoring of student work[83]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	

[83] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam	0,5	Essay		Research	3,0
Project		Continuous assessment		Report	0,5	Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Evaluation of students' project work. Oral exam.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Montgomery, D. C.: Introduction to Statistical Quality Control, 6th ed., John Wiley & Sons, New York, 2009.
Montgomery, D. C.: Runger, G. C., Applied statistics and probability for engineers, 6th ed., John Wiley & Sons, New York, 2014.
Vardeman, S. B., Jobe, J. M.: Statistical Quality Assurance Methods for Engineers, John Wiley & Sons, New York, 1999.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Gitlow, H., et al.: Tools and Methods for the Improvement of Quality, Irwin, Boston, 1989.
Betteley, G., Mettrick, N., Sweeney, E., Wilson, D.: Using Statistics in Industry – Quality Improvement Through Total Process Control, Prentice Hall, New York, 1994.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Montgomery, D. C.: Introduction to Statistical Quality Control, 6th ed., John Wiley & Sons, New York, 2009.	0	1
Montgomery, D. C.: Runger, G. C., Applied statistics and probability for engineers, 6th ed., John Wiley & Sons, New York, 2014.	0	1
Vardeman, S. B., Jobe, J. M.: Statistical Quality Assurance Methods for Engineers, John Wiley & Sons, New York, 1999.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

In accordance with established quality assurance system at the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Strategic management and competitiveness**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

The objective is to understand paradigm of strategic management with the special emphasis on the competitive advantage.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

Critical analysis of competitive advantage on which the firm has been created strategy.

Write strategic analysis of the company.

1.4. Course content

Historical development of strategy. Benefits and tasks of strategic management. Types of strategic thinking. Schools of strategic management. Process of strategic management, classical approach to formulation, implementation and control, and more contemporary views. Mission. Vision. Goals. Identification and analysis of the environment (PESTLE analysis). SWOT analysis. Successes and failures in implementing strategy. Sources of sustainable competitive advantage, resource based view, core competences and dynamic capabilities. Quality as source of competitive advantage. Porter's contribution to strategy. Strategic analysis of the firm.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☐ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Create strategic analysis of the firm with the special emphasis on the competitive advantage.

1.8. Monitoring of student work[84]

Class attendance	0,5	Class participation		Seminar paper		Experimental work	
Written exam		Oral exam	0,5	Essay		Research	5

[84] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Research implies writing a strategic analysis of the selected firm and its oral presentation. Research is the individual written work based on the practical elaboration of all theoretical elements mentioned during the lecture.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Vrdoljak Raguž I., Podrug N., Jelenc L., Neostrategic Management An International Perspective on Trends and Challenges, Springer, Heidelberg ,(odabrana poglavlja), 2016.
Vrdoljak Raguž I., Jelenc L., Podrug N., Izvori konkurentske prednosti u XXI. Stoljeću, Sveučilište u Dubrovniku, Dubrovnik, 2013.
Grant R., Jordan J., Foundations of Strategy, treće izdanje, Wiley (odabrana poglavlja), 2016.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Tovstiga G., Strategy in Practice: A Practitioner's Guide to Strategic Thinking, 3rd Edition, Chichester: John Wiley & Sons, 2015.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Vrdoljak Raguž I., Podrug N., Jelenc L., Neostrategic Management An International Perspective on Trends and Challenges, Springer, Heidelberg, (odabrana poglavlja), 2016.	1	2
Vrdoljak Raguž I., Jelenc L., Podrug N., Izvori konkurentske prednosti u XXI. Stoljeću, Sveučilište u Dubrovniku, Dubrovnik, 2013.	1	2
Grant R., Jordan J., Foundations of Strategy, treće izdanje, Wiley (odabrana poglavlja), 2016.	1	2

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

In accordance with established quality assurance system at the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Structural integrity**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Training the students to independently perform numerical and experimental analysis of structural mechanics problem at limit state conditions.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Develop and apply complex theories and concepts of structural mechanics at limit state conditions. To apply advanced theories and to apply the theory of elastomechanics and plastomechanics and the laws of fracture mechanics in the design and analysis of structural elements. Apply the theory of elastomechanics and plastomechanics to estimate the service life of structures and structural elements. Conduct nonlinear numerical analysis of material behaviour at elevated temperatures, based on experimental data from creep, relaxation, low-cycle fatigue and fracture toughness processes.

1.4. Course content

Fatigue and fracture of material. Material life expectancy diagrams. Linear elastic fracture mechanics. Elasto-plastic fracture mechanics. Experimental and theoretical nonlinear material behaviour at elevated and low temperatures; creep, relaxation, low-cycle fatigue, fracture toughness. Numerical modelling of nonlinear coupled problems related to material behaviour, load and parameters at fracture of structures.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☐ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

The students are required to attend the classes, prepare and present the seminar.

1.8. Monitoring of student work[85]

Class attendance	0,5	Class participation		Seminar paper	2	Experimental work	1
Written exam		Oral exam		Essay		Research	2,5

[85] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on the results they achieve through class attendance and their seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Brnić, J.: Analysis of Engineering Structures and Material Behavior, John Wiley & Sons Ltd, 2018.
Schijve, J.: Fatigue of Structures and Materials, 2nd ed., Springer Science+Bussines Media, B.V., 2009.
Liebowitz, H.: Fracture: An Advanced Treatise, Vol. I, II & III, Academic Press Inc., New York, 1968.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Zhender, A.T.: Fracture mechanics, Springer Science+Bussines Media, B.V., 2012.
Gross, D.; Seelig, T.: Fracture mechanics With an Introduction to Micromechanics, 2nd ed., Springer-Verlag, Berlin Heidelberg, 2011.
Shukla, A.: Practical Fracture Mechanics in Design, 2nd ed., Marcel Dekker, New York, 2005.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Brnić, J.: Analysis of Engineering Structures and Material Behavior, John Wiley & Sons Ltd, 2018.	1	0
Schijve, J.: Fatigue of Structures and Materials, 2nd ed., Springer Science+Bussines Media, B.V., 2009.	1	0
Liebowitz, H.: Fracture: An Advanced Treatise, Vol. I, II & III, Academic Press Inc., New York, 1968.	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

University of Rijeka

FACULTY OF ENGINEERING

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Sustainable development management and environmental protection**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

The aim of the course is to provide students with knowledge about possible ways of achieving sustainable development by applying various tools such as technical and technological approach to industrial development and with other scientific and professional methods of environmental impact assessment through theoretical and practical examples.
Gaining a higher level of environmental awareness in the area of sustainable development and environmental protection.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

To analyse the elements of sustainable development and evaluate the environmental impact of pollutants.
To evaluate and analyse the level of potential impact by using one-dimensional and multidimensional analysis. To evaluate the qualitative and quantitative indicators of the environmental impact of each intervention.
Based on the assessment, define a program of measures and procedures for environmental protection for the specific intervention and for each environmental component.

1.4. Course content

Basic principles, goals and strategies of sustainable development; sustainable development stakeholders (producers, consumers, the legislative system) and regulatory and governance mechanisms; standardization of environmental policy in the function of sustainable development; the impact of technologies on environmental components - air, climate, soil, water, resources; best available techniques (BAT) for sustainable development; waste management in the service of the circular economy; waste treatment techniques and the elimination of waste status for sustainable development; environmental impact assessment; techniques for predicting environmental impacts - one-dimensional and multidimensional analyses; defining qualitative and quantitative indicators for impact assessment; cost-benefit analysis; environmental pollution prevention measures; life cycle assessment(LCA); cleaner production and sustainable processes; environmental monitoring.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☒ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities							
Attendance (consultation), preparation and presentation of seminar work, oral exam.							
1.8. Monitoring of student work[86]							
Class attendance	0,5	Class participation		Seminar paper	4,0	Experimental work	
Written exam		Oral exam	1,5	Essay		Research	
Project		Continuous assessment		Report		Practical work	
Portfolio							
1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)							
Activity in class, quality of completed seminar work and presentation, oral exam.							
1.10. Mandatory literature (at the time of submission of study programme proposal)							
John Glasson, Riki Therivel and Andrew Chadwick: Introduction to environmental impact assessment, 3rd ed., Routledge, Canada, first published 2005, reprinted 2006. Peter Morris and Riki Therivel, Methods of Environmental impact assessment 2nd ed, Spon Press, Canada, first edd: 2000, reprinted 2007. Hendrickson, C.T.: Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach, Routledge, 2006. Tchobanoglous, G., Kreith, F.: Handbook of solid waste management, 2nd ed., New York, McGraw-Hill, 2002							
1.11. Optional/additional literature (at the time of submission of the study programme proposal)							
Circular economy package, https://ec.europa.eu/environment/circular-economy/index_en.htm Best reference documents for Best available techniques, https://eippcb.jrc.ec.europa.eu/reference/							
1.12. Number of assigned reading copies in relation to the number of students currently attending the course							

Title	*Number of copies*	*Number of students*
John Glasson, Riki Therivel and Andrew Chadwick: Introduction to environmental impact assessment, 3rd ed., Routledge, Canada, first published 2005, reprinted 2006.	1	
Peter Morris and Riki Therivel, Methods of Environmental impact assessment 2nd ed, Spon Press, Canada, first edd: 2000, reprinted 2007.	1	
Hendrickson, C.T.: Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach, Routledge, 2006.	1	
Tchobanoglous, G., Kreith, F.: Handbook of solid waste management, 2nd ed., New York, McGraw-Hill, 2002	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
Through the Institution's quality assurance system.

[86] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Sustainable manufacturing**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Acquisition of actual and developing the new scientific knowledge about sustainable manufacturing using non-polluting machining systems. Application of acquired knowledge to real machining process examples. Ability to develop and propose the type and set-up of economically viable sustainable machining systems that conserve energy and natural resources, and ensure safety and health for workers.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Independently analyze alternative cooling and/or lubrication techniques in machining processes. Judge and recommend techniques suitable for machining different materials. Design and develop sustainable manufacturing solutions. Critically evaluate the results of existing and own researches – compare approaches.

1.4. Course content

Green production. Environmental, health and economic aspects of conventional manufacturnig. Minimum quantity lubrication and cooling lubrication. Cooling with Vortex tube. Cryogenic machining. Dry machining. Economics of environmentally friendly machining.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☐ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	-

1.7. Student responsibilities

Attendance at classes (consultations) and solving a project assignment.

1.8. Monitoring of student work[87]

Class attendance	0.5	Class participation		Seminar paper		Experimental work	
Written exam		Oral exam		Essay		Research	4

[87] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project	1.5	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of activity in class and of the solution of project assignment, or published scientific paper in the subject area.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Gupta, K.: Innovations in Manufacturing for Sustainability, 1st edition, Springer, 2019.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Dixit, U.S., Sarma, D.K., Davim, J.P.: Environmentally Friendly Machining, Springer, 2012.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Gupta, K.: Innovations in Manufacturing for Sustainability	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION	
Course instructor	
Name of the course	**Technical systems safety**
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences
Status of the course	elective
Year of study	1
ECTS credits and manner of instruction	ECTS credits: 6 Number of class hours (L+E+S): 15+0+0

1.1. Course objectives

A thorough knowledge of content related to the security of technical systems. Developing a student's ability to independently analyze and evaluate the safety of a technical system.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Create and evaluate new concepts, facts and principles in the theory of reliability and security. Develop the concept of security of technical systems. Develop new ideas through safety and risk analysis, with the aim of designing the safety of a technical automatic system.

1.4. Course content

Components of an automated technical system. Static and dynamic properties of components. Monitoring and control of the automated technical system. Relationship between functionality, reliability, availability and security of the technical system. The resilience, toughness and safety of the technical system. Safety standards for technical systems. System sensitivity to parameter change. Incidence of system failures and failures. Fault detection / localization and diagnostics. Impact of failure on failure. Risk analysis and safety design of the technical system. Run and manage a fault tolerant automated process. Multi-criteria optimization of automated process management.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance in class (consultations), project assignment, preparation and presentation of seminars and oral examination.

1.8. Monitoring of student work[88]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam	0,5	Essay		Research	3,0

[88] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report	0,5	Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of active participation in the class, evaluation of the project assignment. Oral exam.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Verma, A.K., Ajit, A., Karanka, D.R., Reliability and Safety Engineering, 2nd Edition, Springer, London, 2016.
Blanke, M., Kinneart, M., Lunze J., Staroswiecki, M., Diagnosis and Fault-Tolerant Control, Springer, Heidelberg, 2016.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Nise, N., Control Systems Engineering, John Wiley & Sons, Eight Edition, New York, 2019.
Kuljača, Lj., Vukić, Z., Automatsko upravljanje - analiza linearnih sustava, Kigen, Zagreb, 2004.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Verma, A.K., Ajit, A., Karanka, D.R., Reliability and Safety Engineering, 2nd Edition, Springer, London, 2016.	1	1
Blanke, M., Kinneart, M., Lunze J., Staroswiecki, M., Diagnosis and Fault-Tolerant Control, Springer, Heidelberg, 2016.	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the established quality assurance system of the Faculty.

University of Rijeka
FACULTY OF ENGINEERING

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Thermodynamic analysis of processes**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Enhancing the theoretical knowledge in fields of mathematical modelling and numerical solving, as well as training of skills for solving practical numerical problems in fields of heat transfer processes. Training of skills necessary for performing of scientific-research work in field of technical sciences.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyse existing professional literature in the field and apply the appropriate physical laws in the formulation of concrete problems of thermodynamic processes.
Set and describe the mathematical formulation for solving a given thermodynamic problems.
Investigate the possibility of solving the problem by analytical and numerical approach using existing commercial software or by creating custom software.
Interpret the results and perform specific conclusions and explanations based on the linking of expertise and the results obtained.
Present research results in the form of research work.

1.4. Course content

Structural analysis. Modelling of thermal processes. Irreversible processes. Treatment of classical thermodynamics through irreversible processes. Entropy. Work losses. Exergy. Efficiency of thermal processes. Nernst theorem or 3rd law of thermodynamics. Treatment of classical thermodynamics using statistical methods.

1.5. Manner of instruction		
	☒ lectures	☒ individual assignments
	☒ seminars and workshops	☐ multimedia and network
	☐ exercises	☐ laboratories
	☐ distance learning	☒ mentorship
	☐ fieldwork	☐ other

1.6. Comments	

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

1.8. Monitoring of student work[89]

[89] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Class attendance	0,5	Class participation		Seminar paper	1	Experimental work	
Written exam		Oral exam		Essay		Research	2,5
Project	2	Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Lectures (consultations) attendance and activity, projects and seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Bošnjaković, F.: Nauka o toplini, Zagreb: Graphis, 2012.
Balmer, R. T.: Modern engineering thermodynamics, Hoboken: John Wiley and Sons, Inc., 2008.
Turns, S. R.: Thermodynamics concepts and applications, New York: Cambridge University Press. 2006.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Ahern, J.E.: The Exergy Method of Energy Systems Analysis, Wiley, New York, 1980.
Bejan, A.: Entropy Generation through Heat and Mass Fluid Flow, Wiley Interscience, New York, 1982.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Bošnjaković, F.: Nauka o toplini, Zagreb : Graphis, 2012.	19	1
Balmer, R. T.: Modern engineering thermodynamics, Hoboken : John Wiley and Sons, Inc., 2008.	1	1
Turns, S. R.: Thermodynamics concepts and applications, New York : Cambridge University Press. 2006.	2	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Total quality management**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Detail understanding of approaches in total quality management topics. Application of acquired knowledge and skills for planning and designing total quality management system in defined environment.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Compare different approaches and concepts of quality management.
Plan and design total quality management system in defined environment.
Management of projects related to quality improvement.
Analyse quality cost structure.

1.4. Course content

Concepts and methods of total quality management. Strategy, approach and concept of quality management system. Model of excellence. Decision-making methods, criteria and models. Risk management. Methods of quality planning. Approaches to process, product and services quality assurance. Program and methods of quality improvement. International quality management standards. Assessment of quality management system. Quality costs.

1.5. Manner of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance at lectures (consultations), topic research, preparation and defending of seminar work, oral exam.

1.8. Monitoring of student work[90]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	
Written exam		Oral exam	0,5	Essay		Research	3,0

[90] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report	0,5	Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment of active participation in the class, evaluation of the project assignment. Oral exam.
For example, a proposal for a plan to establish total quality management given on the basis of an analysis of the default business environment will be evaluated.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Hoyle, D., ISO 9000 Quality System Handbook, Butterworth – Heinmann, Oxford, 2009.
Rao, A., et al., Total Quality Management: A Cross Functional Perspective, John Wiley & Sons, New York, 1996.
De Feo, J.A., Juran's quality handbook : the complete guide to performance excellence, McGraw-Hill, New York, 2017.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Pyzdek, T., Quality Engineering Handbook, Taylor & Francis, New York, 2003.
Yang, K., El-Haik, B. S., Design for Six Sigma, McGraw Hill, New York, 2009.
Ishikawa, K., Guide to Quality Control, Quality Resources, New York, 1996.
Banks, J., Principles of Quality Control, J. Wiley & Sons, New York, 1989.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Hoyle, D., ISO 9000 Quality System Handbook, Butterworth – Heinmann, Oxford, 2009.	0	2
Rao, A., et al., Total Quality Management: A Cross Functional Perspective, John Wiley & Sons, New York, 1996	1	2
De Feo, J.A., Juran's quality handbook : the complete guide to performance excellence, McGraw-Hill, New York, 2017.	1	2

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

In accordance with established quality assurance system at the Faculty.

COURSE DESCRIPTION		
Course instructor		
Name of the course	Turbomachinery hydrodynamics	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Students will be qualified to use a specific computer environment to design the geometry of turbomachines, create a specific 2D and 3D numerical grids and advanced use of commercial and open-source software to simulate fluid flow.

1.2. Course enrolment requirements

No requirements.

1.3. Expected learning outcomes

Analyze turbo machines using a 2D fluid flow simulation. Develop tools for effective blade design for turbomachines. Apply the developed tools to create the geometry of wicket gate, stay vanes and runner blades. Apply computational methods for 3D fluid flow simulations in axial and radial turbomachines. Numerically analyze and determine the machine performance of the turbomachine. Define geometric parameters for shape optimization and perform an optimization based on fluid flow simulation results.

1.4. Course content

Problem formulation. 2D numerical fluid flow analysis of axial and radial turbines. Development of tools for designing the geometry of turbomachines. Blade shape design using NACA profile, pressure and suction side curves and camber and thickness curve distribution. Applications for creation of geometry of stay vanes, wicket gate and rotor blades. Advanced domain discretization. 3D fluid flow simulation in the axial and radial turbomachines. Machine performance assessment. Definition of geometric parameters for blade shape optimization.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Consultations, studying of literature, solving the problem task, preparing and giving a presentation.

1.8. Monitoring of student work[91]

Class attendance	0,5	Class participation		Seminar paper	1,5	Experimental work	

[91] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam		Essay		Research	4
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attending consultations, activity and independence in studying, project task, seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Krivchenko, G., Hydraulic Machines: Turbines and Pumps, ISBN 1-56670-001-9, CRC Press, 1994.
Raabe, J. Hydro Power: The design, Use, ..., VDI-Verlag, 1985
Tuzson, J., Centrifugal Pump Design, ISBN 0-471-36100-3, John Wiley & Sons, 2000.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012.
Horvat, D., Vodne turbine, Tehnička knjiga, 1955
W.Press et al: Numerical Recipes for C/C++/Pascal/fortran, Cambridge University Press, 1992.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Krivchenko, G., Hydraulic Machines: Turbines and Pumps, 1994.	1	0
Raabe, J. Hydro Power: The design, Use, ..., VDI-Verlag, 1985	1	0
Tuzson, J., Centrifugal Pump Design, John Wiley & Sons, 2000.	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Turbulent flow**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Numerical analysis of turbulent fluid flow in engineering practice. Understanding and application of a computing environment and software to simulate turbulent fluid flow.

1.2. Course enrolment requirements

No requirements.

1.3. Expected learning outcomes

Analyze the nature of the turbulent flow, equations, statistical description of turbulent flow, and equation averaging methods. Analyze the basic types of turbulent flows: free jets, flow over backward facing step and homogeneous turbulence. Analyze Kolmogorov's hypothesis, the cascade of energy, energy spectrum. Apply turbulence modeling using large-eddy simulation (LES) and phenomenological models of turbulent viscosity (algebraic models, k - ε model, K - ω model, Spalart - Allmaras, Reynolds stress models).

1.4. Course content

The nature of the turbulent flow. Randomness of turbulence. Statistical description of turbulent flow. Reynolds-averaged Navier–Stokes equations. Reynolds stresses. Kolmogorov's hypothesis. Energy cascade and energy spectrum. Calculation and modeling of turbulence flow. Direct numerical simulation. Large Eddy Simulation. Reynolds stress model. Turbulent viscosity models: algebraic models, k - ε, k - ω, Spalart - Allmaras model.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Consultations, studying of literature, solving the problem task, preparing and giving a presentation.

1.8. Monitoring of student work[92]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	4

[92] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attending consultations, activity and independence in studying, project task, seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Pope, B. S. Turbulent flows, Cambridge University press, 2000.
Durbin, P. A. Statistical Theory and Modeling for Turbulent Flows, John Willey & Sons, 2000.
Wilcox, D. C. Turbulence modeling of CFD. La Canada, CA; DCW Industries, 1993.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Sagant, P. Large Eddy Simulation for Incompressible Flows, Springer – Verlag, 1998
Ferziger, J. H., Perić, M., Computational methods for fluid dynamics, Springer, 2012.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Pope, B. S. Turbulent flows, Cambridge University press, 2000.	1	0
Durbin, P. A. Statistical Theory and Modeling for Turbulent Flows, John Willey & Sons, 2000.	1	0
Wilcox, D. C. Turbulence modeling of CFD., DCW Industries, 1993.	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Unsteady pipe flow modelling**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Understanding of mathematical models necessary for solving typical engineering problems. Numerical solutions for such models and application on specific problems in engineering practice.

1.2. Course enrolment requirements

No requirements.

1.3. Expected learning outcomes

Analyze physical phenomena underlying unsteady flow of liquids in pipelines: water hammer, cavitation etc. Apply the models of nonstationary flows: initial condition - boundary value problems for Euler equations, Allievi equations, Kranenburg equations. Simulate with the aid of computer nonstationary flow phenomena, i.e. to chose model, boundary conditions, software, to prepare input data and to post process and interpret results. Apply all the above to pipelines in hydroelectric power plants, water conduits, cooling water systems, long oil pipelines, etc.

1.4. Course content

Unsteady gas flow in pipes – Euler equations. Nonstationary liquid flow in pipes and water hammer – Allijevi equations. Nonstationary flow of liquid-gas mixture in pipes, water hammer and cavitation – Kranenburg equations. Other parts of a pipeline as boundary conditions in the mathematical model. Numerical methods – method of characteristics, upwind schemes of first and second order, ENO/WENO scheme. Computer simulations. Applications to pipelines in hydroelectric power plants, water conduits etc.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☐ laboratories ☒ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Consultations, studying of literature, solving the problem task, preparing and giving a presentation.

1.8. Monitoring of student work[93]

Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	

[93] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

Written exam		Oral exam		Essay		Research	4
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Attending consultations, activity and independence in studying, project task, seminar paper.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Chaudhry M. H., Applied Hydraulic Transients, 2014.
Toro, E., Riemann Solvers and Numerical Methods for Fluid Dynamics, 2009.
LeVeque R. J., Finite-Volume Methods for Hyperbolic Problems, 2004

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Chorin A. J., Marsden J. E., A Mathematical Introduction to Fluid Mechanics, Springer-Verlag, New York, 1993.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Chaudhry M. H., Applied Hydraulic Transients, 2014.	1	0
Toro, E., Riemann Solvers and Numerical Methods for Fluid Dynamics, 2009.	1	0
LeVeque R. J., Finite-Volume Methods for Hyperbolic Problems, 2004	1	0

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Vibrations and durability of machines and structures**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

Students acquire the advanced knowledge in the field of vibration and durability of machines and structures. Mathematical modeling and finding solution of problems related to vibration and durability using appropriate methods and software. Experimental verification of simulation results.

1.2. Course enrolment requirements

None

1.3. Expected learning outcomes

To propose and develop their own procedures and methods as improvements to existing ones or as a completely new solution to numerical and experimental vibration analysis of structure or machine.
For the given environmental conditions, loading history and mechanical properties of the material, propose an appropriate method of fatigue life assessment.
Present and popularize the results of your own scientific research to the general public and, if possible, publish a scientific paper in a significant international journal or international scientific conference.

1.4. Course content

Nonlinear vibration. Turbomachinery self excited vibration. Transient vibration. Modal parameters. The types of transfer functions displacement - force, velocity – force, acceleration - force. Balancing of the rotor. Flexible rotors and balancing theory in two and more plains. Mechanisms unbalance. Crank mechanism balancing. Dynamics of the rigid and flexible rotor.
Aging and wear processes. Creep and crack progression at creep. Low and high cyclic fatigue and fracture. Crack propagation at low cyclic fatigue. Influence of stress concentration. Crack propagation at corrosion. Effects of complex stress. Miner's rule. Erosion and corrosion. Tribological wear. Life estimation of machines and structures. Safety consideration in time domain, stress domain, strain domain and wear domain

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☒ individual assignments ☐ multimedia and network ☒ laboratories ☒ mentorship ☐ other
1.6. Comments		

1.7. Student responsibilities

The students are required to attend the classes (consultations), do their project, prepare and present the seminar.

1.8. Monitoring of student work[94]							
Class attendance	0.5	Class participation		Seminar paper	1.5	Experimental work	1
Written exam		Oral exam		Essay		Research	3
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

Assessment and evaluation of students' work will be based on their engagement during lecture/consultation and the results they achieve in their project and the seminar work.

1.10. Mandatory literature (at the time of submission of study programme proposal)

Genta, G.: Vibration Dynamics and Control, Springer, New York, 2009.
Rao, S.S., Mechanical vibrations, Prentice Hall, Upper Saddle River, 2011.
Lee, Y.L., Barkey, M.E., Kang, H.T.: Metal Fatigue Analysis Handbook, Butterworth-Heinemann, 2012.

1.11. Optional/additional literature (at the time of submission of the study programme proposal)

Harris, C.M., Piersol, A.G.: Harris' Shock and Vibration Handbook, Mc Graw Hill, New York, 2002
ASM Handbook, Volume 19: Fatigue and Fracture, ASM International, Materials Park, OH, 1996.
Manson, S.S., Halford, G.R., Fatigue and Durability of Structural Materials, ASM International, 2006

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Genta, G.: Vibration Dynamics and Control	1	1
Rao, S.S., Mechanical vibrations	1	1
Lee, Y.L., Barkey, M.E., Kang, H.T.: Metal Fatigue Analysis Handbook	1	1

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the Institution's quality assurance system.

[94] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.

University of Rijeka
FACULTY OF ENGINEERING

COURSE DESCRIPTION		
Course instructor		
Name of the course	**Waste management**	
Study programme	Postgraduate University Doctoral Study in the area of Engineering Sciences, in the fields of Mechanical Engineering, Naval Architecture, Fundamental Engineering Sciences and Interdisciplinary Engineering Sciences	
Status of the course	elective	
Year of study	1	
ECTS credits and manner of instruction	ECTS credits	6
	Number of class hours (L+E+S)	15+0+0

1.1. Course objectives

The objective of the course is to acquaint the student with waste characterization and classification methods, waste collection methods, waste treatment and disposal methods, health and environmental risk involved in waste management practices as well as risk environmental and health minimisation methods during waste management.

1.2. Course enrolment requirements

None.

1.3. Expected learning outcomes

Analyse the generation of solid waste including its physical, biochemical, and mechanical characteristics.
Propose a waste management plan based on the waste management hierarchy.
Analyse and propose housekeeping and technological measures for waste reduction including the reduction of its toxicity.
Differentiate and apply waste treatment options including mechanical, biological and waste to energy approaches.
Estimate the methanogenic potential of solid waste.
Perform environmental and health risk characterisation related to waste management practices and propose adequate risk mitigation measures.
Analyse and propose waste management practices compliant with the Croatian legislation and EU directives.

1.4. Course content

Definition of waste. Hazardous and non-hazardous waste. Municipal solid waste (MSW) and industrial waste. Waste management hierarchy. Environmental and health risks of waste management activities. Risk mitigation approaches. Waste collection. Waste prevention and minimisation. Reuse. Recycling. Biological treatment. Composting. Anaerobic digestion. Waste to energy. Landfilling. Estimating the methanogenic potential of discards. Estimating landfill requirements. Waste management plans.

1.5. Manner of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ distance learning ☐ fieldwork	☐ individual assignments ☐ multimedia and network ☐ laboratories ☐ mentorship ☐ other
1.6. Comments	-	

1.7. Student responsibilities

Attendance at lectures.

1.8. Monitoring of student work[95]							
Class attendance	0,5	Class participation		Seminar paper	2,0	Experimental work	
Written exam	3,5	Oral exam		Essay		Research	
Project		Continuous assessment		Report		Practical work	
Portfolio							

1.9. Assessment of learning outcomes in class and at the final exam (procedure and examples)

The students will be graded based on the attendance and activity during the lectures, seminars and a written final exam.

1.10. Mandatory literature (at the time of submission of study programme proposal)

William A. Worrell, P. Aarne Vesilind. Solid Waste Engineering. CL Engineering; 2 edition.

1.11. Optional/additional literature (at the time of submission of the study programme proposal

L Traven. Circular economy and the waste management hierarchy: Friends or foes of sustainable economic growth? A critical appraisal illustrated by the case of the Republic of Croatia. Waste Management & Research 37 (1), 1-2.
L Traven, I Kegalj, I Šebelja. Management of municipal solid waste in Croatia: Analysis of current practices with performance benchmarking against other European Union member states. Waste Management & Research 36 (8), 663-669)
Peer-reviewed papers on waste management. Legislative documents on waste management.

1.12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
William A. Worrell, P. Aarne Vesilind. Solid Waste Engineering. CL Engineering; 2 edition.	1	

1.13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences

Through the quality assurance system of the Faculty.

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[95] IMPORTANT: Enter the appropriate proportion of ECTS credits for each activity so that the total number of credits equals the ECTS value of the course. Use empty fields for additional activities.