University of Rijeka
FACULTY OF ENGINEERING

Doctoral Study in the area of Engineering Sciences, in the field of Computer Science

Study programme

University of Rijeka
FACULTY OF ENGINEERING

Basic information	
Title of study programme	Doctoral Study in the area of Engineering Sciences, in the field of Computer Science
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 proposed postgraduate study programme in the area of Technical Sciences, in the field of Computer Science, aims to provide Masters of Computer Science graduated at the Faculty of Engineering, and other related institutions in Croatia and abroad, the opportunity to continue the education and further scientific training in order to attain highly educated professionals in the related field. The initiation of this study will provide larger economic entities, both in local community and in the broader context, additional training of existing employees, but also employment opportunities for new PhDs. It is also expected that graduated students from the suggested study will further foster innovation and development of new technologies in a number of small and medium enterprises operating in the Computer Science activity spectre. Faculty of Engineering, as well as other departments of the University of Rijeka, have been lacking new researchers at PhD level in the field of Computer Science for many years, and it is expected that a part of the students of the proposed study programme will continue to work at the University of Rijeka.

The Computer Science field is a subsection of the Electrical Engineering and Computer Science CROQF sector, which is one of the top-ten sectors that have the greatest positive contribution to employment growth in the Republic of Croatia (Labour market future trends projections, CROQF, The Ministry of Science and Education; http://www.kvalifikacije.hr/fgs.axd?id=1074). Since 2012, the employment within the relevant key activities of the CROQF Computer Science subsector (e.g. Scientific research and development, Managing activities; consulting management, Computer programming, consultancy and related activities) has a constant growth (source: CROQF Portal). The constant demand for highly educated professionals in the field of Computer Science represents the current trend, both in Europe and in the world.

Upon completion of the study, students will have job opportunities in public and private sector, especially in industry entities with whom the Faculty has developed cooperation, but also elsewhere in Croatia and abroad.

When designing and developing the proposed study programme, the current trends in the development of science, research and technology in the CS field have been primarily taken into account. The programme proposition and the related curriculum draft are the result of collaborative efforts put in by both the Faculty members and the experts from the partner higher education institutions and industry entities (KTH Royal Institute of Technology, Sweden; Faculty of Electrical Engineering, University of Montenegro; University of Ljubljana, Slovenia; Ericsson Nikola Tesla Ltd.). The study programme has been designed by taking into account The ACM Curricula Recommendations in the field of computing, basic guidelines of the European Seventh Framework Programme (FP7), The European Charter for Researchers, The Code of Conduct for the Recruitment of Researchers, The Dublin Descriptors, Croatian Qualification Framework (CROQF), the capacity of the Faculty,

as well as the needs of the Faculty, University, and the Croatian society for CS-oriented scientific research resources in general.

The proposed study programme represents the highest level of formal education, enabling the acquisition of a doctoral degree, and therefore directly contributes to the professional and personal development of the individual – the programme participant. According to the Croatian Qualifications Framework Law (NN 22/2013), learning outcomes at the PhD level include knowledge acquisition in the context of the creation and evaluation of new facts, concepts, procedures, principles and theories in the field of scientific research, which extends the boundaries of the known. As such, the proposed study clearly encourages creativity and freedom of the individual. The proposed programme contributes to the independence of the individual because, according to the same learning outcomes descriptor set, it empowers expressing personal professional and ethical authority, managing the scientific research activities, and commitment to the development of new ideas and/or processes. Finally, the programme allows the development of cognitive and social skills, thus enabling the student an additional benefit and personal gain.

The learning outcomes of individual subjects are expressed through 4 categories:

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 programmes 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

Faculty of Engineering of the University of Rijeka presently implements the Postgraduate Doctoral Study in the area of Technical Sciences, in the fields of Electrical Engineering, Mechanical Engineering, Naval Architecture and Fundamental Technical Sciences. Studies in the field of Computer Science have been provided at the Faculty of Engineering since 2008 for undergraduate level, and since 2011 for graduate level. In addition to Computer

Science teaching activities at the undergraduate and graduate levels, which are carried out in accordance with the Bologna Declaration, the Department of Computer Science is also involved in research projects approved by the National Science Foundation, EU COST (European Cooperation in Science and Technology), University Support Programmes, and the Croatian Agency for SMEs, Innovation and Investments (HAMAG BICRO). The proposed study programme is based on the tradition of scientific postgraduate studies at the Faculty (since 1971), as well as on the teaching and research know-how in the field of Computer Science, and, as such, complements the educational and scientific potential within all areas encompassed in the Faculty's activity scope. The proposed study programme is aligned with the needs of inherent progress of the Faculty of Engineering and with the strategy of the University of Rijeka (Strategy 2014-2020, University of Rijeka, 2014), seeing that it directly strengthens the visibility of the University in a research context and broadens the base of scientists and researchers in the field of Computer Science. Finally, in accordance with the current advancement of the University of Rijeka, especially in existing IT infrastructure, the proposed programme increases competitiveness and enables following state-of-the-art trends.

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, the 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 field of Computer Science within the scientific area of Engineering Sciences. Subjects in the area of study cover the aforementioned scientific field and are organized through one field – Modul Computer Science.

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LIST OF MODULES/COURSES							
Year of study: 1.							
Semester: I.							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS[1]
Computer Science	Methodology of the Scientific-Research Work		15	0	0	6	C
	Mathematical Modelling 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
	Information Processing		15	0	0	6	E
	Applied Machine Learning		15	0	0	6	E
	Advanced Interactive Systems Design and Evaluation		15	0	0	6	E
	Selected Chapters from Communication Networks		15	0	0	6	E
	Computer Perception		15	0	0	6	E
	Data Mining		15	0	0	6	E
	Parallel Computing		15	0	0	6	E

LIST OF MODULES/COURSES							
Year of study: 1.							
Semester: II.							
MODULE	COURSE	COURSE INSTRUCTOR	L	E	S	ECTS	STATUS
Computer Science	Wearable Computing		15	0	0	6	E
	Intelligent Systems		15	0	0	6	E
	Service Robotics		15	0	0	6	E
	Applied Soft Computing		15	0	0	6	E
	Biomedical Image Analysis		15	0	0	6	E
	Cybersecurity		15	0	0	6	E
	Spatio-temporal statistical learning		15	0	0	6	E

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

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COURSE DESCRIPTION		
Course instructor		
Name of the course	**Biomedical Image Analysis**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	elective	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives

The aim of the course is to acquire knowledge about procedures for the analysis of biomedical images.

2. Course enrolment requirements

None.

3. Expected learning outcomes

Know the basic methods of image analysis.
Analyse the properties of the selected problem in biomedicine.
Apply appropriate techniques of image processing and predictive modeling to solve the chosen problem.
Critically evaluate developed solutions.

4. Course content

Basic terms. Biomedical image record formats. Data structures for image analysis. Image transformations. Morphological image processing. Retrieving image features and descriptors. Detection, localisation and segmentation.

5. Teaching methods	[ ] lectures [ ] seminars and workshops [ ] exercises [X] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
6. Comments		

7. Student responsibilities

Studying the relevant literature, conducting research and creating and documenting a project in the field of image analysis in biomedicine.

8. Monitoring of student work

Class attendance		Activity/Participation		Seminar paper		Experimental work	
Written exam		Oral exam		Essay		Research	3
Project	3	Continuous assessment		Report		Practical work	
Portfolio							

9. Procedure and examples of learning outcome assessment in class and at the final exam

Assessment and evaluation of students' work will be done based on the results of their project.

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

Image Processing, Analysis, and Machine Vision. Milan Sonka, Vaclav Hlavac, Roger Boyle. Cengage Learning; 4th edition, 2014.
Hands-On Image Processing with Python: Expert techniques for advanced image analysis and effective interpretation of image data. Sandipan Dey. Packt Publishing, 2018.

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

Digital Image Processing. Rafael C. Gonzalez, Richard E. Woods. Pearson; 4th edition, 2018.
Radiographic Image Analysis. Kathy McQuillen Martensen. Elsevier Inc; 5th edition, 2019.
Deep Learning with PyTorch: Build, train, and tune neural networks using Python tools. Eli Stevens, Luca Antiga, Thomas Viehmann. Manning Publications; 1st edition, 2020.

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

Title	*Number of copies*	*Number of students*
Image Processing, Analysis, and Machine Vision. Milan Sonka, Vaclav Hlavac, Roger Boyle. Cengage Learning; 4th edition, 2014.	2	3 – 5
Hands-On Image Processing with Python: Expert techniques for advanced image analysis and effective interpretation of image data. Sandipan Dey. Packt Publishing, 2018.	1	3 – 5

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

Through the institution's quality assurance system.

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COURSE DESCRIPTION		
Course instructor		
Name of the course	**Data Mining**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

14. Course objectives

The course objectives are to train students for application of data mining for solving problems in the field of data modelling, pattern recognition and knowledge discovery from data sets.

15. Course enrolment requirements

None.

16. Expected learning outcomes

Rationalize the appropriateness of using data mining for the given problem.
Perform preprocessing of high-dimensional data.
Create a program framework for the analysis of data sets based on data mining.
Discover new knowledge using data mining.

17. Course content

Definitions, goals and importance of data mining. Classification and clustering problem for multi-dimensional data. Fundamentals of statistical data analysis. Data preprocessing and cleaning. Multivariate techniques. Feature selection and extraction techniques. Cross-validation. Evaluation of results. Examples of data mining applications.

18. Teaching methods	[ ] lectures [X] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
19. Comments		

20. Student responsibilities

Participation in consultations, study of related literature, preparation of a seminar paper and project in the field of data mining.

21. Monitoring of student work

Class attendance		Activity/Participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	2
Project	2	Continuous assessment		Report		Practical work	
Portfolio							

22. Procedure and examples of learning outcome assessment in class and at the final exam
Assessment and evaluation of students' work will be done on the basis of the results of their seminar and project.
23. Mandatory literature (at the time of submission of study programme proposal)
Ian W. Witten, Eibe Frank, Mark A. Hall, Christopher J. Pall, Data Mining, Practical Machine Learning Tools and Techniques, 4th edition, Elsevier, 2017
24. Optional/additional literature (at the time of submission of the study programme proposal)
J. Han, M. Kamber, J. Pei, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2012 Barbara G. Tabachnick, Linda S. Fidell, Using Multivariate Statistics, 7th edition, Pearson, 2018
25. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
Ian W. Witten, Eibe Frank, Mark A. Hall, Christopher J. Pall, Data Mining, Practical Machine Learning Tools and Techniques, 4th edition, Elsevier, 2017	1	3 – 5

26. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
Through the institution’s quality assurance system.

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COURSE DESCRIPTION		
Course instructor		
Name of the course	**Intelligent Systems**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

27. Course objectives

Use of methods and procedures needed for development of intelligent systems.

28. Course enrolment requirements

None.

29. Expected learning outcomes

Analyse methods and procedures used for intelligent system development.
Describe the architecture of intelligent systems.
Use of software for intelligent system development.
Prepare and develop databases of learning examples used in intelligent system development.

30. 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 schemes. 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.

31. Teaching methods		
	[ ] lectures	[ ] individual assignment
	[X] seminars and workshops	[ ] multimedia and network
	[ ] exercises	[ ] laboratories
	[X] long distance education	[X] mentorship
	[ ] fieldwork	[ ] other _____

32. Comments

33. Student responsibilities

Students have to attend to all course activities and work on projects.

34. Monitoring of student work

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

35. Procedure and examples of learning outcome assessment in class and at the final exam
Assessment and evaluation of students' work will be done on the basis of the results of their seminar and project.
36. Mandatory literature (at the time of submission of study programme proposal)
N. Pavešić. Raspoznavanje vzorcev. ZAFER Ljubljana 1995. L. Gyergyek, N. Pavešić, S. Ribarić: Uvod u raspoznavanje uzoraka, Tehnička knjiga Zagreb, 1988. Russell, S., Norvig, P., Artificial Inteligence: A Modern Approach, Prentice Hall, Englewood Cliffs, 1995.
37. Optional/additional literature (at the time of submission of the study programme proposal)
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.
38. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
N. Pavešić. Raspoznavanje vzorcev. ZAFER Ljubljana 1995.	1	3 – 5
L. Gyergyek, N. Pavešić, S. Ribarić: Uvod u raspoznavanje uzoraka, Tehnička knjiga Zagreb, 1988.	0	3 – 5
Russell, S., Norvig, P., Artificial Inteligence: A Modern Approach, Prentice Hall, Englewood Cliffs, 1995.	1	3 – 5

39. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
Through the institution’s quality assurance system.

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COURSE DESCRIPTION		
Course instructor		
Name of the course	**Cybersecurity**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

40. Course objectives

The goal of the course is to enable students to master theoretical principles and acquire practical skills to use tools and methods for data protection and computer infrastructure security, and to develop solutions for real-world problems in the field of cybersecurity.

41. Course enrolment requirements

None.

42. Expected learning outcomes

Understand the theoretical concepts of cryptography, secure communication, and security protocols.
Identify cyber threats and vulnerabilities of computer systems and perform a risk assessment.
Design and implement security measures for monitoring, detecting, and mitigating cyber threats.
Acquire ethical hacking skills to identify vulnerabilities in systems.
Understand legal and ethical issues in the domain of cybersecurity, data protection, and privacy issues.

43. Course content

Ensuring data confidentiality, integrity, and authenticity. Secure communication. Security protocols. Advanced cryptographic procedures. Vulnerability of information systems. Threat models. Tools for monitoring, detection, and mitigating of cyber threats. Risk assessment. Implementation of security measures. Responses to security incidents. Ethical hacking. Legal and ethical issues in the domain of cybersecurity. Legal regulations for data protection and privacy issues.

44. Teaching methods	[ ] lectures [ ] seminars and workshops [ ] exercises [X] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
45. Comments		

46. Student responsibilities

Studying relevant literature, conducting research, and developing and documenting a project in the field of cybersecurity.

47. Monitoring of student work

Class attendance		Activity/Participation		Seminar paper		Experimental work	
Written exam		Oral exam		Essay		Research	3

Project	3	Continuous assessment		Report		Practical work	
Portfolio							

48. Procedure and examples of learning outcome assessment in class and at the final exam

The project that students develop during the semester is evaluated.

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

Cybersecurity Law. Jeff Kosseff, Wiley; 3rd edition, 2022.
Applying Artificial Intelligence in Cybersecurity Analytics and Cyber Threat Detection. Shilpa Mahajan, Mehak Khurana, Vania Vieira Estrela, Wiley; 1st edition, 2024.

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

Advanced Penetration Testing: Hacking the World's Most Secure Networks. Wil Allsopp. Wiley; 1st edition, 2017.
The Principles and Practice of Cryptography and Network Security. William Stallings. Pearson; 7th edition, 2016.
Applied Cryptography: Protocols, Algorithms and Source Code in C. Bruce Schneier. Wiley; 20th Anniversary edition, 2015.
Introduction to Modern Cryptography. Jonathan Katz, Yehuda Lindell. Chapman and Hall/CRC; 2nd edition, 2014.

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

Title	*Number of copies*	*Number of students*
Cybersecurity Law. Jeff Kosseff, Wiley; 3rd edition, 2022.	1	3 – 5
Applying Artificial Intelligence in Cybersecurity Analytics and Cyber Threat Detection. Shilpa Mahajan, Mehak Khurana, Vania Vieira Estrela, Wiley; 1st edition, 2024.		

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

Through the institution's quality assurance system.

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COURSE DESCRIPTION		
Course instructor		
Name of the course	**Mathematical Modelling and Numerical Methods**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives

Introduction to mathematical modelling problems based on ordinary and partial differential equations required to solve problems in engineering practice. The mathematical formulation of the considered problem, the model construction and determining its solution by using the appropriate methods and software.

2. Course enrolment requirements

None.

3. Expected learning outcomes

To connect some mathematical models with typical physical problems, to distinguish models based on ordinary and partial differential equations. To interpret correctly the key ideas and properties of numerical methods for solving the differential equation as well as understanding of their advantages and disadvantages. To define the typical mathematical models in engineering, to recognize them and to describe them in practical problems. To describe the mathematical model formulation, to analyze the model complexity and its solvability. To construct an appropriate numerical model of the considered model by using existing software and/or to develop new software. To compare different approaches, to validate and analyze the obtained results. To improve accuracy by using different approaches.

4. Course content

Models based on ordinary differential equations. Dynamical systems and chaos. Numerical methods based on finite differences. Runge-Kutta methods.
Models based on partial differential equations in fluid mechanics, thermodynamics and elasticity theory. The mass conservation law, momentum and energy conservation laws applied to fluid mechanics. Boundary value problems for Laplace and Poisson equations with applications. Heat diffusion equation and concentration flow equation. Wave equation. Sound propagation and the acoustic wave equation.
Numerical approaches for solving the partial differential equations based on the finite differences. The application to Laplace equation, equations of heat conduction and wave equation. Variational principles. Introduction to finite element and finite volume methods.

5. Teaching methods	[X] lectures [X] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____

6. Comments

7. Student responsibilities

Class attendance (individual consultations), solving the project assignments, preparation and presentation of seminar paper.							
8. Monitoring of student work							
Class attendance	0.5	Activity/Participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	4
Project		Continuous assessment		Report		Practical work	
Portfolio							
9. Procedure and examples of learning outcome assessment in class and at the final exam							
Course attendance, class activity, project assignments, seminar paper.							
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 Veselić K., Aganović I.: Mathematical methods and models, 2010 (in Croatian, script)							
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 Press, W.H., Taukolsky, S.A., Flannery, B.P., W.T.: Numerical recipes, Cambridge Press, 1986							

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	2	3 – 5
Chapra, S.C., Canale, R.P.: Numerical methods for engineers, McGraw Hill Book Co., 1989	2	3 – 5
Veselić K., Aganović I.: Mathematical methods and models, 2010 (in Croatian, script)	2	3 – 5

13. Quality monitoring methods that ensure the acquisition of exit knowledge, skills and competences
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COURSE DESCRIPTION		
Course instructor		
Name of the course	**Optimization Methods**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives

Knowledge of optimal control principles necessary for recognition of optimization problems in engineering practice. Mathematical definition of optimization problems and its solution through the application of appropriate methods and software.

2. Course enrolment requirements

None.

3. Expected learning outcomes

To classify optimization methods, to explain fundamental ideas in various methods, to compare methods by their properties and area of application. To connect engineering knowledge with mathematical optimization methods and to recognize and describe optimization problems in engineering practice. To give mathematical formulation of the optimization problems, to analyse effect of formulation variations, complexity and solvability of the problem. To analyse possibilities of application of various methods on optimization problems, to compare and to choose the most appropriate method. To explore possibilities of problem solution through application of software and/or development of new software. To compare different approaches. To analyse optimization results, to improve results through combination and variation of methods and approaches.

4. Course content

Optimal control problems in engineering. Optimal control problems in stationary phenomena. Optimal control problems in non-stationary phenomena. Optimal shape design. Optimization problems of permutation and optimal grouping type. Optimization methods. Powell methods. Steepest descent methods and conjugate gradient direction methods (CGD). Simulated annealing method. Simplex method. Integer programming. Dynamic programming. Genetic algorithms.

5. Teaching methods	[X] lectures [X] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____

6. Comments

7. Student responsibilities

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

8. Monitoring of student work

Class attendance	0.5	Activity/Participati		Seminar paper	1.5	Experimental	

		on				work	
Written exam		Oral exam		Essay		Research	4
Project		Continuous assessment		Report		Practical work	
Portfolio							

9. Procedure and examples of learning outcome assessment in class and at the final exam

Course attendance, class activity, project assignments, seminar paper

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.

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

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.	2	3 – 5
Press, W. H. <at al.>: Numerical Recipes in C, 2nd ed. University Press, Cambridge, 1990.	1	3 – 5
Goldberg, E. D.: Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley Publishing Company, New York, 1989.	2	3 – 5

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

Through the institution's quality assurance system.

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COURSE DESCRIPTION			
Course instructor			
Name of the course	**Methodology of the Scientific-Research Work**		
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**		
Status of the course	**compulsory**		
Year of study	1.		
ECTS credits and teaching	ECTS credits	6	
	Number of class hours (L+E+S)	15 + 0 + 0	

1. Course objectives

Getting acquainted with the meaning of science and the difference between the scientific and professional work. Becoming familiar with the scientific-research activities and fundamentals of the scientific-research work's methodology.

2. Course enrolment requirements

None.

3. Expected learning outcomes

Indicate the fundamentals of the theory of science as well as of the relationship between science and other relevant activities. Distinguish the scientific from professional work on the basis of knowledge of the features of the scientific work. Analyse the up-to-date development of science with the knowledge of the situation in the world as well as in the Republic of Croatia. Describe the organising of the scientific research. Distinguish the features of the research. Describe methodologies of the scientific research. Describe technologies of publishing the results of the scientific research.

4. Course content

Theory of science: notion, development, relationship between science and technology. Trends of the contemporary science` s development. Classification of science. Scientific categories. Scientific activity. Scientific investigation: experimental research, theoretical research, relations. Methodology of the scientific research: notion and structure of fundamental scientific methods. Technology of the scientific-research work. Processing and announcing the results of the scientific-research work: written works, types and significance. Scientific-research work in economy and industry. Scientific-research work at the university.

5. Teaching methods	[X] lectures [X] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
6. Comments		

7. Student responsibilities

Course attendance (tutorial), solving the project task and preparation and presentation of the seminar paper.

8. Monitoring of student work

Class attendance	0.5	Activity/Participation		Seminar paper	1	Experimental work	

Written exam		Oral exam		Essay		Research	3
Project	1.5	Continuous assessment		Report		Practical work	
Portfolio							

9. Procedure and examples of learning outcome assessment in class and at the final exam

Course attendance, activity in research, project tasks, seminar paper.

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

Zelenika, R.: Metodologija i tehnologija izrade znanstvenog I stručnog djela, Ekonomski fakultet, Rijeka, 2000

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

M. Žugaj, K. Dumičić, V. Dušak: Temelji znanstvenoistraživačkog rada, Fakultet organizacije i informatike, Varaždin, 2006
M. Marušić: Uvod u znanstveni rad, Medicinska naklada, Zagreb, 2008
T. Greenfield: Research methods, Arnold, London, 1996

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, Ekonomski fakultet, Rijeka, 2000	2	10

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	**Wearable Computing**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives

The students will get acquainted with physical, medical, technological, and social preconditions for implementations of wearable devices, including benefits, limitations. Moreover, current applications of wearable devices will be introduced through examples.

2. Course enrolment requirements

None.

3. Expected learning outcomes

Discuss variety of applications of body-worn devices, including the benefits and current limitations.
Explain applications of various sensors (bio, chemical, inertial, heat-flow sensors).
Describe characteristics and implementation of electronic textiles.
Present concepts of body-worn energy harvesting.
Discuss use of wearable algorithms, data mining techniques, and modelling of physical activity behaviour.
Explain traits of body-area network.
Discuss benefits of sensor usage for daily assisted activities and disease discovery.

4. Course content

Fundamentals of wearables. Social aspects of wearability. Wearable haptics. Wearable bio-, chemical- and inertial- sensors and their applications. Energy expenditure by body-worn heat-flow sensors. Electronic textiles. Energy harvesting by body-worn devices. Wearable algorithms and mining techniques for body sensor network data. Modelling of physical activity behavior. Body area wireless networks. Wearables assisting in daily activities and disease discovery.

5. Teaching methods	[ ] lectures [X] seminars and workshops [ ] exercises [X] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
6. Comments		

7. Student responsibilities

Literature Reading and Research. Assigned Topic Report Writing. Case Studies and Presentation.

8. Monitoring of student work

Class attendance	0.5	Activity/Participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	1

Project	1.5	Continuous assessment		Report	1	Practical work	
Portfolio							

9. Procedure and examples of learning outcome assessment in class and at the final exam

Assessment of student work will be done based on completeness and successfulness of student performance in the assigned tasks.

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

Wearable Sensors: Fundamentals, Implementation and Applications, ed. E. Sazonov and M.R. Neuman, Academic Press, 2014

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

Antennas and Propagation for Body-Centric Wireless Communications, 2nd ed., ed. Peter S. Hall and Yang Hao, Artech House, 2012
Fundamentals of Wearable Computers and Augmented Reality, 2nd ed., ed. Woodrow Barfield, CRC Press, 2015
Tony Olsson, Arduino Wearables (Technology in Action), 1st ed, Apress, 2012

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

Title	*Number of copies*	*Number of students*
Wearable Sensors: Fundamentals, Implementation and Applications, ed. E. Sazonov and M.R. Neuman, Academic Press, 2014	1	3 – 5

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	**Advanced Interactive Systems Design and Evaluation**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives

Acquiring fundamental knowledge about principles, methods and techniques used for interactive systems design and evaluation. Introduction to research methods relevant for the context of interactive systems empirical evaluation. Introduction to optimization and predictive modelling techniques used for interactive system design and evaluation.

2. Course enrolment requirements

None.

3. Expected learning outcomes

Upon a completion of the course, students will: have theoretical knowledge and practical skills dealing with interactive systems design and evaluation techniques; be able to conduct empirical research with the aim to evaluate and formally compare interactive systems; know how to apply optimization and predictive modelling techniques within the process of interactive system design and evaluation.

4. Course content

Interactive systems elements. Interaction design: descriptive and predictive models. Design, preparation and execution of interactive systems empirical evaluation. Optimization and predictive modelling within a process of interactive systems design and evaluation.

5. Teaching methods	[X] lectures [ ] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [X] laboratories [X] mentorship [ ] other _____
6. Comments		

7. Student responsibilities

Class attendance, project work, and seminar paper.

8. Monitoring of student work

Class attendance	0.5	Activity/Participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	4	Continuous assessment		Report		Practical work	
Portfolio							

9. Procedure and examples of learning outcome assessment in class and at the final exam
Class attendance, project work, and seminar paper.
10. Mandatory literature (at the time of submission of study programme proposal)
I. S. MacKenzie: Human-Computer Interaction: An Empirical Research Perspective, Morgan Kaufmann, 2013
11. Optional/additional literature (at the time of submission of the study programme proposal)
J. Sauro, J. R. Lewis: Quantifying the User Experience: Practical Statistics for User Research, Morgan Kaufmann, 2012 B. Albert, T. Tullis, D. Tedesco: Beyond the Usability Lab, Morgan Kaufmann, 2010 B. Kortum (ed.): HCI Beyond the GUI, Morgan Kaufmann, 2008
12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
I. S. MacKenzie: Human-Computer Interaction: An Empirical Research Perspective, Morgan Kaufmann, 2013	0	3 – 5

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	**Selected Chapters from Communication Networks**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives

The course objectives are to get students familiar with protocols used in modern wired and wireless communication networks. The students will learn how to analyze and implement potential communication solutions in different use cases.

2. Course enrolment requirements

None.

3. Expected learning outcomes

Describe communication networks architectures.
Select and apply chosen communication protocol on a specific use case.
Implement communication systems based on IP networks.
Use specialty operating systems adapted specifically to communication networks usage.

4. Course content

Network and protocol architectures. Communication models. Internet communication protocols. Routing protocols. Internet of things communication protocols. Operating systems for wireless sensor networks. Simulation environments for wireless sensor networks. Network protocol performances and new generation protocols. Software defined networking and network function virtualization.

5. Teaching methods	[X] lectures [ ] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [X] laboratories [X] mentorship [ ] other _____
6. Comments		

7. Student responsibilities

Students are required to attend classes, do their assignments and project, and take part in oral exam.

8. Monitoring of student work

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

9. Procedure and examples of learning outcome assessment in class and at the final exam
Assessment and evaluation of students' work will be based on the success in course assignments, project and oral exam.
10. Mandatory literature (at the time of submission of study programme proposal)
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11. Optional/additional literature (at the time of submission of the study programme proposal)
James F. Kurose, Keith W. Ross: Computer Networking: A Top-Down Approach, Pearson, 2012 D. E. Commer, D. L. Stevens: Internetworking with TCP/IP Vol. I, II, III, Prentice Hall, 2013 Jean-Philippe Vasseur, Adam Dunkels: Interconnecting Smart Objects with IP: The Next Internet, Morgan Kaufmann, 2010
12. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*

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	**Parallel Computing**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives

Knowledge of possibilities in the field of parallel computing. Independent design and implementation of a parallel algorithm. Implementation of ready-made parallel algorithms. Experimental and theoretical analysis of parallel algorithms.

2. Course enrolment requirements

None.

3. Expected learning outcomes

Classify architectures of parallel computers and computer networks, and the method of memory organization.
Evaluate a suitable parallel communication model for a given computer architecture.
Analyze the properties and performance of parallel algorithms.
Evaluate the method of load distribution by computer nodes.
Implement a parallel algorithm in solving a given problem.

4. Course content

Introduction to parallel computing with examples of standard computing problems. Communication protocols. Domain decomposition of numerical models. Balancing the computing effort. Implementation of a parallel algorithm for scientific problems. Analysis of properties and performance of parallel algorithms.

5. Teaching methods	[X] lectures [X] seminars and workshops [X] exercises [X] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [ ] mentorship [ ] other _____
6. Comments		

7. Student responsibilities

Attending classes, being active in classes, independent learning.

8. Monitoring of student work

Class attendance	2	Activity/Participation	0.5	Seminar paper	0.5	Experimental work	
Written exam		Oral exam		Essay		Research	1
Project	1	Continuous assessment	1	Report		Practical work	

Portfolio							

9. Procedure and examples of learning outcome assessment in class and at the final exam

Class attendance, class activity, continuous knowledge testing, seminar work, project assignment.

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

J. Dongarra, I. Foster, G. Fox, K. Kennedy, A. White, L. Torczon, W. Gropp, The Source book of Parallel Computing, Elsevier Science, 2003
A. Grama, A. Gupta, G. Karpypis, V. Kumar, Introduciton to Parallel Computing, Addison-Wesley, 2003
G. E. Karniadakis, R. M. Kirby, Parallel Scientific Computing in C++ and MPI, Cambridge University Press, 2003

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

P. S. Pacheco, Parallel Programming with MPI, Morgan Kauffman, 1996
B. Chapman, G. Jost, R. Van der Pas, Using OpenMP, MIT Press, 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*
J. Dongarra, I. Foster, G. Fox, K. Kennedy, A. White, L. Torczon, W. Gropp, The Source book of Parallel Computing, Elsevier Science, 2003	*1*	*3 – 5*
A. Grama, A. Gupta, G. Karpypis, V. Kumar, Introduciton to Parallel Computing, Addison-Wesley, 2003	*1*	*3 – 5*
G. E. Karniadakis, R. M. Kirby, Parallel Scientific Computing in C++ and MPI, Cambridge University Press, 2003	*1*	*3 – 5*

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	**Applied Soft Computing**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

14. Course objectives

The objectives of the course are to train students for application of fuzzy logic, neural network and genetic algorithms in solving problems from the fields of optimization, pattern recognition and decision support.

15. Course enrolment requirements

None.

16. Expected learning outcomes

Recognize data sets suitable for application of soft computing methods.
Apply soft computing methods for modelling the domain-specific processes.
Develop software solutions using the appropriate soft computing algorithm.
Analyse, evaluate and interpret the results obtained by the application of soft computing algorithm.

17. Course content

Definitions, goals of soft computing and importance of its application. Fuzzy computing. Graphical interpretations. Basic characteristics of fuzzy set and their operations. Neural computing. Neural networks and their biological model. Neural network architecture. Types of neural networks and learning rules. Genetic algorithms. Biological evolution. Definition of an individual, population, and gene. Recombination and mutation. Artificial evolution. Genetic algorithm components and parameters. Examples of soft computing applications.

18. Teaching methods	[ ] lectures [X] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
19. Comments		

20. Student responsibilities

Participation in consultations, study of study literature, preparation of a seminar paper and project in the field of soft computing.

21. Monitoring of student work

Class attendance		Activity/Participation		Seminar paper	2	Experimental work	
Written exam		Oral exam		Essay		Research	2
Project	2	Continuous assessment		Report		Practical work	

Portfolio							

22. Procedure and examples of learning outcome assessment in class and at the final exam

Assessment and evaluation of students' work will be done on the basis of the results of their seminar, project and oral exam.

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

V. Kecman, Learning and Soft Computing: Support Vector Machines, Neural Networks, and Fuzzy Logic Models (Complex Adaptive Systems), MIT Press, Cambridge, MA, 2001.
A. E. Eiben, J. E. Smith, Introduction to Evolutionary Computing, Springer, 2007.

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

N. Japkowicz, M. Shah, Evaluating Learning Algorithms, A Classification Perspective, Cambridge University Press, 2014
D. K. Chartuvedi, Soft computing: Techniques and its applications in Electrical Engineering, Springer, 2008
Neural Network, Fuzzy Logic, and Genetic Algorithms - Synthesis and Applications", by S. Rajasekaran and G.A. Vijayalaksmi Pai, (2005), Prentice Hall, Chapter 1-15, page 1-435

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

Title	*Number of copies*	*Number of students*
V. Kecman, Learning and Soft Computing: Support Vector Machines, Neural Networks, and Fuzzy Logic Models (Complex Adaptive Systems), MIT Press, Cambridge, MA, 2001	*0*	*3 – 5*
A. E. Eiben, J. E. Smith, Introduction to Evolutionary Computing, Springer, 2007.	*1*	*3 – 5*

26. 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	**Applied Machine Learning**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives		
Understanding of the concept of generalising from data. Application of basic machine-learning techniques for model learning. Understanding and application of inference methods. Results interpretation. Understanding and application of experiments and results evaluation in machine learning. Problem-solving skill development.		
2. Course enrolment requirements		
None.		
3. Expected learning outcomes		
Apply, understand and compare knowledge-representation models, applicable to a given problem. Apply, understand and compare adequate learning techniques for a given problem. Synthesise and analyse new knowledge-representation models and learning algorithms. Apply and understand applicable statistical comparison methods. Analyse and evaluate experimental results.		
4. Course content		
Basics. Knowledge-representation models. Techniques for learning from data. Experimental methods. Big-data analysis. Deep learning. Reinforced learning.		
5. Teaching methods	[X] lectures [ ] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[ ] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
6. Comments		
7. Student responsibilities		
Students are obligated to follow classes, inspect literature, perform scientific research for the given field under teacher supervision and give a report on the conducted research.		

8. Monitoring of student work

Class attendance	0.5	Activity/Participation		Seminar paper		Experimental work	1.5
Written exam		Oral exam	0.5	Essay		Research	3.5
Project		Continuous assessment		Report		Practical work	
Portfolio							

9. *Procedure and examples of learning outcome assessment in class and at the final exam*
Students will be enticed to research topics close to their research focus. Evaluation of certain learning outcomes will be conducted at the end of the semester, by estimating the quality of the submitted report concerning the conducted research, and through an oral exam.
10. *Mandatory literature (at the time of submission of study programme proposal)*
Hastie, Tibshirani: The Elements Of Statistical Learning: Data Mining, Inference And Prediction, 3rd ed., 2009
11. *Optional/additional literature (at the time of submission of the study programme proposal)*
Bishop: Pattern Recognition and Machine Learning, 2007 Duda, Hart, Stork: Pattern classification, 2nd ed., 2001 Goodfellow, Bengio, Courville: Deep Learning, 2016 Jackson: Social and Economic Networks, 2008
12. *Number of assigned reading copies in relation to the number of students currently attending the course*

Title	*Number of copies*	*Number of students*
Hastie, Tibshirani: The Elements Of Statistical Learning: Data Mining, Inference And Prediction, 3rd ed., 2009	freely available	3 – 5

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	**Spatio-temporal statistical learning**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives		
Understanding spatio-temporal processes and their descriptive variables. Mastering the concept of computer representation, analysis, and prediction of spatio-temporal processes. Applying the procedures of formal mathematical and computational representation, analysis, characterisation, planning, and prediction of spatio-temporal processes and the methods of statistical analysis and statistical learning to solve problems in technical, natural science, and socio-economic disciplines.		
2. Course enrolment requirements		
None.		
3. Expected learning outcomes		
Estimate the observational structures of spatio-temporal processes for the purposes of analysis, characterization and development of prognostic models. Apply and evaluate methods of spatio-temporal statistical learning for analysis, characterization, planning and forecasting of spatio-temporal processes and their characteristics and limitations. Analyze and interpret the results of models developed using spatio-temporal statistical learning methods in the context of targeted technical, natural science and socio-economic disciplines.		
4. Course content		
Spatio-temporal phenomena and processes. Observations of spatio-temporal phenomena and processes: methods (satellite navigation, remote sensing, etc.), structures and forms of data records. Spatial uncertainty quantification. Detection and characterization of anomalies in sets of spatio-temporal observations. Statistical tests. Methods for development and evaluation of prognostic models of spatio-temporal phenomena and processes, based on statistical learning. Occupancy models. Trajectory models, trajectory analysis and prediction. Applications of spatio-temporal statistical learning on problems of analysis, anomaly detection, and prediction of the behavior of spatio-temporal phenomena and processes in technical, natural science and socio-economic disciplines.		
5. Teaching methods	[X] lectures [ ] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
6. Comments		
7. Student responsibilities		
Students are required to attend classes, study the scientific literature, select and complete a research project, and document its results through a technical report.		

8. Monitoring of student work

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

9. Procedure and examples of learning outcome assessment in class and at the final exam

Assessment and evaluation of students' work is based on the results of experimental and research activities within the research project, presentation of the project results, and on the basis of an oral exam.

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

Wikkle, C K, Zammit-Mangion, A, Cressie, N. (2019). Spatio-Temporal Statistics with R. CRC Press. Boca Raton, FL. Available at: https://spacetimewithr.org
Ceja, E G. (2023). Behavior Analysis with Machine Learnig and R: A Sensor and Data Driven Approach. CRC Press. Boca Raton, FL. Available at: https://enriquegit.github.io/behvior-free
Pebesma, E, Bivand, R. (2023). Spatial Data Science: With Applications in R. CRC Press. Boca Raton, FL. Available at: https://r-spatial.org/book/
Sun, J. (2019). Open Aircraft Performance Modeling Based on an Analysis of Aircraft Surveillance Data. Delft University of Technology. Delft, The Netherlands. Available at: https:tinyurl.com/2p8deydr

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

Gimond, M. (2023). Intro to GIS and Spatial Analysis. Dostupno na: https://mgimond.github.io/Spatial/index.html
Souza de Cursi, E. (2023). Uncertainty Quantification using R. Springer Nature. Cham, Switzerland. ISBN 978-3-031-17784-2
Chiles, J-P, Delfiner, P. (2012). Geostatistics: Modelling Spatial Uncertainty (2nd ed). John Wiley & Sons. Chichester, UK. ISBN 978-0-470-18315-1,
Efron, B, and Hastie, T. (2021). Computer Age Statistical Algorithms, Evidence, and Data Science. Cambridge University Press. Cambridge, UK. Available at: https://web.stanford.edu/~hastie/CASI
Davey, S, Gordon, N, Holland, I, Rutten, M, Williams, J. (2016). Bayesian Methods in the Search for MH370. Springer Nature, Springer Science+Business Media Singapore Pte Ltd. Singapore, Singapore.
Mehdi Moradi, M, Pebesma, E, and Mateu, J. (2018). trajectories: Classes and Methods for Trajectory Data. J of Stat Software. Available at: https://cran.r-project.org/web/packages/trajectories/vignettes/article.pdf

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

Title	*Number of copies*	*Number of students*
Wikkle, C K, Zammit-Mangion, A, Cressie, N. (2019). Spatio-Temporal Statistics with R. CRC Press. Boca Raton, FL. Available at: https://spacetimewithr.org	freely available	3 – 5
Ceja, E G. (2023). Behavior Analysis with Machine Learnig and R: A Sensor and Data Driven Approach. CRC Press. Boca Raton, FL. Available at: https://enriquegit.github.io/behvior-free	freely available	3 – 5
Pebesma, E, Bivand, R. (2023). Spatial Data Science: With Applications in R. CRC Press. Boca Raton, FL. Available at: https://r-spatial.org/book/	freely available	3 – 5
Sun, J. (2019). Open Aircraft Performance Modeling Based on an Analysis of Aircraft Surveillance Data. Delft University of Technology. Delft, The Netherlands. Available at: https:tinyurl.com/2p8deydr	freely available	3 – 5

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	**Computer Perception**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

14. Course objectives

Familiarization with the basics as well as with advanced techniques of perception in computers and autonomous agents, and the preparation for independent application of those techniques in practical situations.

15. Course enrolment requirements

None.

16. Expected learning outcomes

Identify the current trends and most often used sensors and methods for computer perception.
Understand novel and advanced algorithms for perception.
Be able to apply the learned methods and algorithms in concrete practical examples.

17. Course content

Application of sensors for the detection of the environment and tracking of people in the space. Sensors and algorithms for visual, audio, tactile, and other modalities of perception. Detection and use of features in computer vision. Object recognition and scene understanding. Use of machine learning methods for advanced perception techniques. Modelling of people's activities and behaviour.

18. Teaching methods	[X] lectures [ ] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [X] laboratories [X] mentorship [ ] other _____
19. Comments		

20. Student responsibilities

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

21. Monitoring of student work

Class attendance	0.5	Activity/Participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	
Project	4	Continuous assessment		Report		Practical work	
Portfolio							

22. Procedure and examples of learning outcome assessment in class and at the final exam
Course attendance, class activity, project assignments, seminar paper.
23. Mandatory literature (at the time of submission of study programme proposal)
R. Szeliski, Computer Vision: Algorithms and Applications, Springer Science & Business Media, 2010
24. Optional/additional literature (at the time of submission of the study programme proposal)
D. Forsyth, J. Ponce, Computer Vision: a Modern Approach, Prentice Hall, 2011
25. Number of assigned reading copies in relation to the number of students currently attending the course

Title	*Number of copies*	*Number of students*
R. Szeliski, Computer Vision: Algorithms and Applications, Springer Science & Business Media, 2010	freely available	3 – 5

26. 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	**Statistical Methods and Stochastic Processes**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

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.

2. Course enrolment requirements

None.

3. Expected learning outcomes

To differentiate methods of statistical inference, to explain basic concepts of techniques of statistical inference. To define stochastic processes and Markov chains as a special type of stochastic processes, to define and explain in an appropriate way the basic concepts in stochastic processes. To identify and to describe practical engineering problems in which the statistical methods can be usefully applied as well as problems which can be modelled as stochastic processes. To define adequate problem formulation for applying the appropriate statistical method, or to model a problem as a stochastic process. To analyse the possibilities of applying different methods of statistical inference in the considered problem, to compare them and to choose an appropriate method. To summarize statistical data and to analyse them by using some typical statistical engineering software's. To analyse the results of statistical data processing, to interpret obtained results and make conclusions about the data, as well as to make possible predictions based on obtained conclusions.

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4. Course content

Elements of statistical inferences: Bayesian methods, sample based methods, statistical estimation, parametrical tests, analysis of variance, multidimensional random variables, regression and correlation analysis, mathematical bases of quality control methods. Statistical methods by using statistical software. Stochastic processes: Markov chains, stochastic matrix, optimal control of Markov chains. Stationary and regular Markov chains. Markov processes. Birth and death processes. Queuing systems. Stationary stochastic processes. Correlation theory. Some applications in engineering.

5.	*Teaching methods*	[X] lectures [X] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
6.	*Comments*		
7.	*Student responsibilities*		

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

8. Monitoring of student work

Class attendance	0.5	Activity/Participation		Seminar paper	1.5	Experimental work	
Written exam		Oral exam		Essay		Research	4
Project		Continuous assessment		Report		Practical work	
Portfolio							

9. Procedure and examples of learning outcome assessment in class and at the final exam

Course attendance, class activity, project assignments, seminar paper.

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
Winston, W. L.: Introduction to probability models: Operations Research, Volume II, Duxbury Press, 2003

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

McClave, J.T., Dietrich, F.: Statistics, Collier Macmillan Publishers, London, 1988
Elezović, N.: Statistika i procesi, FER, Element, Zagreb 2008. (in Croatian)

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	3 – 5
Devore, J.L.: Probability and Statistics for Engineering and the Sciences, Duxbury Press, 1995	1	3 – 5
Winston, W. L.: Introduction to probability models: Operations Research, Volume II, Duxbury Press, 2003	1	3 – 5

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	**Information Processing**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives

The objectives of the course are to enable students to understand and practically apply methods for information processing. Students will learn to apply advanced information processing methods across a wide range of engineering and physical systems.

2. Course enrolment requirements

None.

3. Expected learning outcomes

Implement methods for processing and manipulating information and digital signals.
Analyse data with advanced digital signal processing algorithms.
Apply information theory methods in data processing.
Analyse, propose, and implement new applications based on information theory.
Develop and apply advanced machine learning techniques in analysing big data.

4. Course content

Theoretical principles of information processing. Procedures for digital signal and data processing. Signal analysis methods in the signal and transformation domains. Application of information theory concepts in data processing and analysis. Optimization of algorithms for efficient processing of big data. Machine learning in digital signal processing.

5. Teaching methods	[ ] lectures [ ] seminars and workshops [ ] exercises [X] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
6. Comments		

7. Student responsibilities

Students are required to complete a project, write a seminar paper, and attend an oral exam. Both the seminar paper and the project should be carried out in consultation with the instructor.

8. Monitoring of student work

Class attendance		Activity/Participation		Seminar paper	1	Experimental work	
Written exam		Oral exam		Essay		Research	3
Project	2	Continuous assessment		Report		Practical work	

Portfolio							

9. Procedure and examples of learning outcome assessment in class and at the final exam

Assessment and evaluation of student's work will be done based on the results of their seminar paper, project, and oral exam.

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

Complexity, Entropy, and the Physics of Information: Volume I. Wojciech H. Zurek, Stuart A. Kauffman, Seth Lloyd, John Archibald Wheeler, Benjamin Schumacher, William K. Wootters, V. F. Mukhanov, P. C. W. Davies, Carlton M. Caves, Charles H. Bennett, SFI Press, 2023.
John G. Proakis, Dimitris G Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson; 5th edition, 2021.
Robert M. Gray, "Entropy and Information Theory", Springer-Verlag, New York, 1990, http://ee.stanford.edu/~gray/it.html.

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

Complexity, Entropy & the Physics of Information (Volume II). Wojciech H Zurek, Santa Fe Institute of Science, 2023.
S. Esakkirajan, T. Veerakumar, Badri N. Subudhi, "Digital Signal Processing: Illustration Using Python", Springer; 1st ed. 2024.
Igor S. Pandžić i drugi, "Uvod u teoriju informacije i kodiranje", Element, 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*
Complexity, Entropy, and the Physics of Information: Volume I. Wojciech H. Zurek, Stuart A. Kauffman, Seth Lloyd, John Archibald Wheeler, Benjamin Schumacher, William K. Wootters, V. F. Mukhanov, P. C. W. Davies, Carlton M. Caves, Charles H. Bennett, SFI Press, 2023.	1	3 – 5
John G. Proakis, Dimitris G Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson; 5th edition, 2021.	1	3 – 5
Robert M. Gray, "Entropy and Information Theory", Springer-Verlag, New York, 1990, http://ee.stanford.edu/~gray/it.html.	freely available	3 – 5

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	**Service Robotics**	
Study programme	**Doctoral Study in the Area of Engineering Sciences, in the Field of Computer Science**	
Status of the course	**elective**	
Year of study	1.	
ECTS credits and teaching	ECTS credits	6
	Number of class hours (L+E+S)	15 + 0 + 0

1. Course objectives

The objectives of this course are to teach students about service robotics through lectures and implementations of a robotic system; teach students how to program a robotic system; and teach students how to simulate a robotic system using a robotic simulation platform.
The goal is helping students to design, simulate, build and program a robot for effective solutions of selected problems in service robotics.

2. Course enrolment requirements

None.

3. Expected learning outcomes

Describe service robot designs and their usage in industry.
Identify service robot components, sensors and support systems.
Apply and practice basic principles of robotic design.
Use modular robot toolkit and service-oriented platform to simulate the robotics design.
Program a service robot using high level programming language.

4. Course content

Service robotics applications. Service robot components and subsystems. Methods of controlling and interfacing to robots. Robot programming. Robotic toolkit and simulation platform. Selected applications.

5. Teaching methods	[X] lectures [X] seminars and workshops [ ] exercises [ ] long distance education [ ] fieldwork	[X] individual assignment [ ] multimedia and network [ ] laboratories [X] mentorship [ ] other _____
6. Comments		

7. Student responsibilities

Students are required to attend classes, select or propose a project and present their work through formal presentation.

8. Monitoring of student work

Class attendance	0.5	Activity/Participation		Seminar paper		Experimental work	
Written exam		Oral exam	2	Essay		Research	
Project	3.5	Continuous assessment		Report		Practical work	

Portfolio							

9. Procedure and examples of learning outcome assessment in class and at the final exam

Assessment and evaluation of students' work will be done on the basis of the results of their project and oral exam.

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

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

R. Murphy, Introduction to AI Robotics, MIT Press, Cambridge, 2000

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

Title	*Number of copies*	*Number of students*

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

Through the institution’s quality assurance system.