LIST OF COURSES [17]						
Year of study: 1						
Semester: 1						
COURSE	LEAD INSTRUCTOR	L	P	S	ECTS	STATUS[18]
Computational Mathematics	Slaven Lulić	30	45	0	6	C
Embedded Computer Systems	Vedran Vyroubal	30	45	0	6	C
Robotic Systems	Denis Kotarski	30	45	0	6	C
Computer-Aided Design	Denis Kotarski	30	45	0	6	C
Non-metallic and Composite Materials	Tihana Kostadin	30	45	0	6	C

LIST OF COURSES						
Year of study: 1						
Semester: 2						
COURSE	LEAD INSTRUCTOR	L	P	S	ECTS	STATUS
Introduction to Data Science	Anamarija Kirin	30	45	0	6	C
Modelling and Simulation of Mechatronic System	Anamarija Kirin	30	45	0	6	C
Sensors and Actuators in Mechatronics and Robotics	Damir Kralj	30	45	0	6	C
Energy Storage Systems	Filip Žugčić	30	45	0	6	C
Additive Manufacturing	Denis Kotarski	30	45	0	6	C

[17] Please copy the table for each year of study.

[18] **IMPORTANT:** Add C for compulsory courses and E for elective courses.

LIST OF COURSES						
Year of study: 2						
Semester: 3						
COURSE	LEAD INSTRUCTOR	L	P	S	ECTS	STATUS
Project		10	0	0	7	C
Machine Learning	Adam Stančić	30	30	0	5	C
Linux Operating System	Vedran Vyroubal	30	30	0	5	C
Control Systems and Automation	Denis Kotarski	30	30	0	5	C
Object Oriented Programming	Vedran Vyroubal	30	30	0	4	E
Automotive Mechatronic Systems	Filip Žugčić	30	30	0	4	E
Programmable Logic Controllers (PLC)	Filip Žugčić	30	30	0	4	E
Renewable Energy Sources	Nenad Mustapić	30	30	0	4	E
Digital Systems Development	Vedran Vyroubal	30	30	0	4	E

LIST OF COURSES						
Year of study: 2						
Semester: 4						
COURSE	LEAD INSTRUCTOR	L	P	S	ECTS	STATUS
Final Thesis					12	C
Professional Internship	Anamarija Kirin				12	C
Foreign Language	Mirjana Cibulka / Sonja Eterović	15	15	0	2	C
Internet of things (IoT)	Adam Stančić	30	30	0	4	E
Robot Programming (ROS)	Vedran Vyroubal	30	30	0	4	E
Machine and System Maintenance	Nikola Šimunić	30	30	0	4	E

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Slaven Lulić, prof.**	
Course name	**Computational Mathematics**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

Students will develop skills in solving problems from numerical mathematics and computational algebra, and will gain an understanding of the fundamentals of mathematical modeling and analysis using computers.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Assess the suitability of different data types in MATLAB (vectors, matrices, arrays, strings) for solving specific problems.

LO2: Justify the use of commands and loops (for, if, while) for program control in MATLAB, with respect to specific programming requirements.

LO3: Determine the optimal way to define and implement functions in MATLAB according to programming requirements, and the most efficient way to create graphical representations (2D and 3D) in MATLAB for data analysis and interpretation.

LO4: Predict methods for solving problems in linear algebra (systems of linear equations, vector and matrix norms, eigenvalues, singular values, matrix rank) using MATLAB.

LO5: Select the appropriate algorithm for numerical differentiation, integration, and optimization based on the characteristics of the problem.

1.4. *Course content*

1. Course Objectives: Introduction to the Course; Overview of Mathematical Tools, Advantages and Disadvantages

2. Understanding data types, defining matrices, vectors, arrays, and other objects. The relationship between data types and algorithms for solving mathematical problems.

3. Understanding Program Structure: Conditionals and Loops; Functions and objects.

4. Definition and Calling of Functions: Formal and Actual Arguments. Functions with a variable number of arguments. Recursion.
5. Graphics. Creation of 2D and 3D computer graphics.
6. Systems of Linear Equations, Matrix Rank, Vector and Matrix Norms, Determinants and Trace of a Matrix
7. Systems of linear equations, Gaussian elimination, LU decomposition.
8. Eigenvalues and Eigenvectors, Singular Values
9. Accuracy and Precision; Sources of Errors in Numerical Algorithms; Condition Number of Problems; Error Estimation and Stopping Criteria for Algorithms
10. Polynomial Interpolation and Data Approximation; Spline
11. Lagrange and Newton Methods
12. Numerical Solution of Differential Equations
13. Numerical Stability of Dynamic Systems
14. Monte Carlo Method
15. Fourier Analysis and Its Application in Computational Mathematics

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper		Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project	X	Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio							

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course. The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

Continuous verification:

Outcome	Colloquium 1	Project assignment	Colloquium 2	Project assignment	Total	Passing the exam
LO1	20%				20%	10%
LO2	10%	10%			20%	10%
LO3		10%	10%	10%	30%	15%
LO4			15%		15%	7,5%
LO5			5%	10%		7,5%
%	30%	20%	30%	20%	100	50
Share of ECTS	1,8	1,2	1,8	1,2	6	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	20%		20%	10%
LO2	20%		20%	10%
LO3	20%	10%	30%	15%

LO4	5%	10%	15%	7,5%
LO5	5%	10%	15%	7,5%
%	70%	30%	100	50
Share of ECTS	4,2	1,8	6	

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
Todd Young, Martin J. Mohlenkamp: "Introduction to Numerical Methods and Matlab Programming for Engineers"	https://www.ohiouniversityfaculty.com/youngt/IntNumMeth/	25
Dmitri V. Fedorov: "Yet Another Introduction to Numerical Methods"	https://phys.au.dk/~fedorov/Numeric/Book/book.pdf	25
Jeffrey R. Chasnov: "Numerical Methods"	https://www.math.hkust.edu.hk/~machas/numerical-methods.pdf	25

1.10. Supplementary readings

1. Numerička matematika (Scitovski, R.)

2. Primjena programskog sustva MATLAB za rješavanje tehničkih problema (Ban Ž.)

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**mr. sc. Vedran Vyroubal**	
Course name	**Embedded systems**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of the course is to enable students to acquire advanced knowledge and practical skills necessary for the development, analysis, implementation, and optimization of embedded computer systems. Through the course, students will learn to design embedded systems with a focus on microprocessors, device drivers, real-time operating systems, and security aspects.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Select the architecture and fundamental components of embedded computer systems, including microprocessors, memory systems, and input-output peripherals.
LO2: Recommend an embedded computer system using microprocessors and sensors based on specific project requirements.
LO3: Anticipate software for embedded systems, including device drivers and hardware interfaces.
LO4: Measure the efficiency of embedded systems using profiling tools and timing analysis.
LO5: Compare real-time operating systems (RTOS).
LO6: Evaluate security aspects in the design of embedded systems, including encryption, authentication, and protection against external threats.

1.4. *Course content*

Weekly Plan:

1. Definition and application of embedded systems; Basic concepts of embedded systems; Differences between embedded and general-purpose computer systems
2. Microprocessors and microcontrollers (ARM, AVR, ESP); Memory in embedded systems (RAM, ROM, Flash); Bus architectures and input-output peripherals
3. Sensors, actuators, and their integration; Basic communication methods (I2C, SPI, UART); Analog-to-digital conversion (ADC) and digital-to-analog conversion (DAC)
4. Introduction to signal processing; Signal filtering and sensor technologies; Applications in embedded systems (IoT)
5. Development tools and environments (Arduino, STM32, ESP-IDF); Debugging and simulation tools; Development using Integrated Development Environments (IDE)

6. Basics of low-level programming (C/C++); Managing input-output interfaces; Handling interrupts and timers
7. Introduction to RTOS: definition and features; Task scheduling and resource management in RTOS; Using FreeRTOS and other RTOSs in projects
8. Process synchronization and inter-process communication; Managing semaphores, mutexes, and queues; Interrupt-driven and time-driven scheduling
9. Power saving in embedded systems; Power and energy consumption management; Designing energy-efficient IoT devices
10. Security challenges in embedded systems; Encryption and authentication in IoT environments; Protection against cyber attacks and integration of security solutions
11. Connecting embedded systems to networks (Wi-Fi, Bluetooth, Zigbee); Basics of network communication (TCP/IP, MQTT)
12. Performance measurement tools; Profiling timing constraints and latency; Optimization of memory space and processing power
13. Concepts of containerization and differences from virtualization; Installation and configuration of Docker tools; Container management
14. Applications of embedded systems in the automotive industry, medical electronics, automation; Use of embedded systems in industrial projects

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfill obligations in accordance with the course delivery plan, as stipulated by the Study Regulations. Absences during the semester must not exceed 20% of the total lecture and exercise hours for full-time students, and 40% for part-time students. A student who misses more than 50% of the total hours (regardless of the reason) must re-enroll in the course in the following academic year. Class attendance is an obligation, while taking the exam is a student's right and is subject to prerequisite conditions. These conditions include course enrollment requirements and exam eligibility. At the beginning of the semester, the instructor announces the conditions under which the course will be delivered: the required percentage of attendance and participation, as well as the number and method of knowledge assessments during the semester, including their evaluation (eligibility for course signature, exemption from parts or the entirety of the final exam, etc.).

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	X

Portfolio		Home Assignment					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Oral	Total	Passing the exam
LO1	14%		*2%*	15%	8%
LO2	14%		2%	20%	8%
LO3	*14%*		*3%*	15%	8,5%
LO4		14%	*3%*	15%	8,5%
LO5		14%	3%	20%	8,5%
LO6		14%	3%	15%	8,5%
%	42%	42%	16%	100	50
Share of ECTS	2,52	2,52	0,96	6	*3*

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	14%	*2%*	15%	7,5%
LO2	14%	*2%*	20%	10%
LO3	*14%*	3%	15%	7,5%
LO4	14%	*3%*	15%	7,5%
LO5	14%	*3%*	20%	10%
LO6	14%	3%%	15%	7,5%
%	84%	16%	100	50
Share of ECTS	5,04	0,96	6	*3*

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
P. Marwedel: Embedded System DesignEmbedded Systems Foundations Of Cyber-Physical Systems, and the Internet of Things	https://library.oapen.org/bitstream/handle/20.500.12657/46817/2021_Book_EmbeddedSystemDesign.pdf	25
T. D. Ngo: Open-Source Electronics Platforms Development and Applications	https://mdpi-res.com/bookfiles/book/1299/OpenSource_Electronics_Platforms.pdf	25

1.10. *Supplementary readings*

J. Ganssle: The Art of Designing Embedded Systems, Newnes, 2008.

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Denis Kotarski, s. lecturer**	
Course name	**Robotic Systems**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

The course program enables students to acquire knowledge about the classification, functions of robotic systems, and their key components, as well as skills for solving tasks in the field of robotics. Students will learn to design robotic mechanisms and solve kinematic and dynamic models of industrial robots. They will also be trained to program control systems and plan tasks in both virtual and real robotic environments.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Compare robotic systems, their components, and functions.
LO2: Select standard components for designing robotic mechanisms.
LO3: Determine the kinematic and dynamic model of a given industrial robot configuration.
LO4: Evaluate the control program and justify its use for a specific robotic task.
LO5: Assess the functional tasks of virtual and physical robotic systems.

1.4. *Course content*

1) Fundamentals of Robotic Systems: Introduction to basic concepts, classification, types, and applications of robotic systems in industry and research.
2) Components and Functions: Overview of key elements of robotic systems, such as mechanical components, tools, and end-effectors.
3) Design of Robotic Mechanisms: Selection criteria, segment geometry, and degrees of freedom required for the construction of robotic mechanisms.
4) Kinematic and Dynamic Modeling: Application of kinematic principles and solving direct and inverse kinematic problems, modeling the dynamics of robotic systems.
5) Control of Industrial Robots: Development of control programs for different configurations of industrial robots and manipulators.
6) Virtual and Physical Robotic Systems: Planning and controlling robotic systems in virtual and physical environments, including feedback analysis.
7) Simulation and Automation: Creating simulations of robotic processes and implementing and testing physical robotic systems.

8) Trends and Future Development: The role of robotic systems in automation and an overview of new trends in the robotics industry.		
1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Home Assignment	X				

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Home Assignment	Colloquium 2	Seminar Paper	Total	Passing the exam
LO1	20%				20%	10%
LO2	10%	10%			20%	10%

LO3		10%	10%	10%	30%	15%
LO4			15%		15%	7,5%
LO5			5%	10%	15%	7,5%
%	30%	20%	30%	20%	100	50
Share of ECTS	1,8	1,2	1,8	1,2	6	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	20%		20%	10%
LO2	20%		20%	10%
LO3	20%	10%	30%	15%
LO4	5%	10%	15%	7,5%
LO5	5%	10%	15%	7,5%
%	70%	30%	100	50
Share of ECTS	4,2	1,8	6	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
Z. Kovačić, i drugi: Osnove robotike	5	25

Robot Dynamics Lecture Notes, Robotic Systems Lab	https://ethz.ch/content/dam/ethz/special-interest/mavt/robotics-n-intelligent-systems/rsl-dam/documents/RobotDynamics2017/RD_HS2017script.pdf	25
K. M. Lynch, et al: Modern Robotics Mechanics, Planning, And Control	https://hades.mech.northwestern.edu/images/7/7f/MR.pdf	25

1.10. Supplementary readings

Introduction to Robotics; https://ocw.mit.edu/courses/2-12-introduction-to-robotics-fall-2005/download/

T. Šurina, i drugi: Industrijski roboti

Wilson, M.: Implementation of robot systems

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Denis Kotarski, s. lecturer**	
Course name	**Computer-Aided Design (CAD)**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

The course program enables students to acquire knowledge and master tools for independently and collaboratively solving project tasks in the field of computer-aided design. Students will become familiar with the design process, which includes the stages of creating 2D drawings, designing parts (3D models), assembling components, conducting simulations, and producing technical documentation.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Identify tools and techniques for creating computer models of mechatronic systems.
LO2: Select appropriate methods for constructing 3D models of functional parts and assemblies for different feature categories.
LO3: Recommend parametric approaches for modeling modular parts and assemblies.
LO4: Evaluate the results of computer simulations for complex geometries of parts and assemblies.
LO5: Assess the compliance of technical documentation with the technological and functional requirements of the mechatronic system.

1.4. *Course content*

1) Introduction to 3D Design and Virtual Engineering: Overview of basic concepts, tools, and steps in the product development process, and the role of 2D and 3D modeling in the design of mechatronic systems.
2) Creating 2D Drawings and Transition to 3D Models: Using tools for creating sketches, defining planes, and building CAD models using techniques of addition and subtraction of volumes for different geometric shapes.
3) Feature-Based Modeling: Applying techniques for creating parts based on features, organizing CAD data, and surface design for complex components.
4) Parametric Modeling and Modular Assemblies: Creating parametric 3D models of parts and assemblies, and using techniques to combine models into functional assemblies.
5) Computer Simulations of Parts and Assemblies: Using tools for simulating mechanical loads (FEM analysis) and fluid flow (CFD analysis) to assess the performance of mechatronic systems.

6) Creating Technical and Technological Documentation: Preparing technical documentation for the manufacturing of mechatronic systems according to industry standards and technological requirements.
7) Prototyping and Manufacturing Processes: Introduction to technologies for producing parts and material processing.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio							

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Seminar Paper	Total	Passing the exam

LO1	15%			15%	7,5%
LO2	15%		15%	30%	10%
LO3		10%	5%	15%	15%
LO4		10%	10%	20%	7,5%
LO5		10%	10%	20%	7,5%
%	30%	30%	40%	100	50
Share of ECTS	1,8	1,8	2,4	6	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	15%		15%	7,5%
LO2	30%		30%	15%
LO3	5%	10%	15%	7,5%
LO4	10%	10%	20%	10%
LO5	10%	10%	20%	10%
%	70%	30%	100	50
Share of ECTS	4,2	1,8	6	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*

R. Cozzens: Catia V5 Workbook	5	25
S. Baksa: Konstrukcijske metode računalnog 3D modeliranja	https://www.mev.hr/wp-content/uploads/2019/01/Konstrukcijske-metode-računalnog-3D-modeliranja.pdf	25

1.10. Supplementary readings

Onshape Basic and Onshape Fundamentals; Learn.onshape.com

Onshape Tutorials: Part Modeling, Assemblies, and Drawings, Paperback

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Tihana Kostadin, prof.**	
Course name	**Non-metallic and composite materials**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of this course is to introduce students—both theoretically and practically—to various classes of non-metallic and composite materials. Through the course program, students will acquire fundamental knowledge and competencies for the optimal selection and application of non-metallic and composite materials in mechanical engineering.

1.2. *Course enrolment requirements*

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1.3. *Intended course learning outcomes*

LO1: Identify the properties and classification of non-metallic materials within various categories.
LO2: Recommend appropriate ceramic, polymers, and composite materials for specific industrial applications.
LO3: Evaluate the use of ceramics, polymers, composites, wood, concrete, and other advanced materials in mechanical engineering.
LO4: Select material selection procedures and processing techniques in accordance with industrial requirements.
LO5: Compare properties and applications of modern materials and formulate recommendations for their use.
LO6: Analyze the influence of material structure on the properties of new materials under industrial conditions.

1.4. *Course content*

1) Introduction to Non-Metallic and Composite Materials: Basic definitions, properties, and applications of non-metallic and composite materials.
2) Classification, Nomenclature, and Microstructure: Understanding the classification of non-metallic materials and analyzing their microstructure through micrographs.
3) Structure and Properties of Ceramics and Hard Metals: Key characteristics and industrial applications of ceramics and hard metals.
4) Structure and Properties of Polymers & Mechanical Testing: Overview of polymer materials and procedures for evaluating their mechanical properties.

5) Composite Materials – Types, Properties, and Testing: In-depth study of composite materials and testing of their additional critical properties.
6) Industrial Applications of Polymers and Composites: Practical use of polymers and composite materials across various industry sectors.
7) Wood, Concrete, and Other Technical Non-Metallics: Properties and applications of wood, concrete, and other technical non-metallic materials in construction.
8) Manufacturing Processes & Mechanical Damage: Production methods for non-metallic materials and assessment of damage under mechanical loads.
9) Structural Influence & Combined-Load Damage: Analysis of how material structure affects properties and damage under combined loading.
10) Overview of Non-Metallic Properties & Wood as a Technical Material: Comprehensive review of non-metallic material properties with a focus on wood.
11) Damage Mechanisms in Non-Metallic and Composite Materials: Understanding failure modes under mechanical and combined stresses.
12) Advanced & Biomimetic Materials: Exploration of new materials, including biomimetic materials, and their industrial applications.
13) Nanomaterials in Engineering: Properties and applications of nanomaterials in technology and mechanical engineering.
14) Material Selection for Industrial Applications: Processes for selecting non-metallic and composite materials for specific industrial uses.
15) Applications of Non-Metallics and Composites in Mechanical Engineering: Use of non-metallic and composite materials in mechanical engineering, emphasizing modern materials.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☐ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper		Experimental work	X
Written exam	X	Oral exam	X	Essay		Research	

Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Home Assignment					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Oral	Total	Passing the exam
LO1	10%		5%	15%	7,5%
LO2	15%		5%	20%	10%
LO3	10%		5%	15%	7,5%
LO4		10%	5%	15%	7,5%
LO5		15%	5%	20%	10%
LO6		10%	5%	15%	7,5%
%	35%	35%	30%	100	50
Share of ECTS	1,4	1,4	1,2	4	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	10%	5%	15%	7,5%
LO2	15%	5%	20%	10%
LO3	10%	5%	15%	7,5%
LO4	10%	5%	15%	7,5%
LO5	15%	5%	20%	10%
LO6	10%	5%	15%	7,5%
%	70%	30%	100	50
Share of ECTS	2,8	1,2	4	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
T. Filetin, i drugi: Suvremeni materijali i postupci	5	
T. Kostadin: Nemetalni i kompozitni materijali –internal teaching material for lectures and exercises	link	

1.10. Supplementary readings

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1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Anamarija Kirin, s. lecturer**	
Course name	**Introduction to Data Science**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

This course aims to introduce students to the fundamental processes involved in data collection, preparation, analysis, and visualization within real-world contexts. Through the use of contemporary software tools, students will perform analyses of the statistical and mathematical properties of datasets to enhance their understanding of existing classification and predictive models. Additionally, the course places particular emphasis on the ethical considerations of data processing practices and the evaluation of model performance in the domains of image and text analysis.

1.2. *Course enrolment requirements*

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1.3. *Intended course learning outcomes*

LO1: Identify the characteristics and properties of data sets.
LO2: Evaluate the necessary transformations of collected data.
LO3: Justify the use of statistical and mathematical data analysis methods.
LO4: Critically assess supervised and unsupervised learning methods in data set analysis.
LO5: Recommend an appropriate model for image or text analysis.
LO6: Evaluate proposed models in terms of accuracy and ethical considerations.

1.4. *Course content*

1) Introduction and Basic Concepts: Overview of fundamental concepts, the data lifecycle, and software tools.
2) Data Manipulation: Data collection, preparation, processing, analysis, and visualization.
3) Data Structures: Scalar, vector, matrix, tensor, data formats, and databases.
4) Statistical Features: Descriptive statistics, deviations, and probability.
5) Machine Learning: Machine learning algorithms, regression, and classification.
6) Model Evaluation: Confusion matrix and error metrics.
7) Unstructured Data: Image processing and text analysis.
8) Data Security and Privacy: Ensuring data authenticity, reliability, and integrity.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures	☒ independent work

	☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio							

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course. The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C

50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Seminar paper	Total	Passing the exam
LO1	13,33%		3,33%	16,66%	8,33%
LO2	13,33%		3,33%	16,66%	8,33%
LO3	13,33%		3,33%	16,66%	8,33%
LO4		13,33%	3,33%	16,66%	8,33%
LO5		13,33%	3,33%	16,66%	8,33%
LO6		13,33%	3,33%	16,66%	8,33%
%	40%	40%	20%	100	50
Share of ECTS	2,4	2,4	1,2	6	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	11,66%	5%	16,66%	8,33%
LO2	11,66%	5%	16,66%	8,33%
LO3	11,66%	5%	16,66%	8,33%
LO4	11,66%	5%	16,66%	8,33%
LO5	11,66%	5%	16,66%	8,33%
LO6	11,66%	5%	16,66%	8,33%
%	70%	30%	100	50
Share of ECTS	4,2	1,8	6	

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
C. Shah: A Hands-On Introduction to Data Science	https://assets.cambridge.org/97811084/72449/frontmatter/9781108472449_frontmatter.pdf	25
M. Gagolewski: Minimalist Data Wrangling with Python	https://arxiv.org/pdf/2211.04630	25

1.10. Supplementary readings

A. Zheng, A. Casari: Feature Engineering for Machine Learning, O'Reilly Media, Inc.

J. T. Vanderplas, J. VanderPlas: Python Data Science Handbook, O'Reilly Media

M. Harrison, T. Petrou: Pandas 1.x Cookbook, Packt Publishing Ltd

F. Chollet: Deep Learning with Python, Second Edition, Simon and Schuster

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Anamarija Kirin, s. lecturer**	
Course name	**Modeling and Simulation of Mechatronic Systems**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

The objective of the course is to equip students with the knowledge and skills necessary for mathematical modeling of mechatronic systems and to enable them to proficiently use modern software tools for simulation purposes. Through structured laboratory exercises, students will develop the ability to address practical problems related to the modeling of mechatronic systems by applying both simulation techniques and experimental methods.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Assess the suitability of a state-space mathematical model for representing a continuous-time, linear time-invariant mechatronic system.
LO2: Predict the effects of linearizing a nonlinear system model near an operating point.
LO3: Determine a mathematical model of a multivariable mechatronic system through computer-based simulation.
LO4: Justify the validity of a state estimator for a mechatronic system using dedicated software tools.
LO5: Support the implementation of a simulation-based model on a physical system through experimental validation.

1.4. *Course content*

1) Fundamentals of mechatronic system modeling: Introduction to basic concepts of modeling and development of mechatronic systems, including methods and physical laws for modeling electrical and mechanical systems.
2) State-space systems: Representation of models in the state-space domain with the selection of variables based on the physical quantities of the system.
3) Nonlinear systems and linearization: Development of models for nonlinear elements in mechanical systems, and linearization of these models near the operating point.
4) Modeling of the mechanical system of a multirotor unmanned aerial vehicle: Introduction to modeling the kinematics and dynamics of UAVs, propulsion configuration, and allocation of control variables.

5) Computer simulation of mechatronic systems: Application of models for conducting computer simulations aimed at analyzing the behavior of mechatronic systems.
6) Modeling of digital control systems: Development of models for digital control systems and implementation of algorithms for controlling complex multivariable systems.
7) Experimental model validation: Experimental confirmation of simulation accuracy and assessment of model performance under real-world conditions.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper		Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	X
Portfolio							

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course. The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment.

Continuous verification:

Learning Outcome	Colloquium 1	Homework	Colloquium 1	Practical work	Total	Passing Threshold
LO1	15 %	10 %			25 %	12,5 %
LO2	15 %				15 %	7,5 %
LO3		10 %	20 %		30 %	15 %
LO4			5 %	10 %	15 %	7,5 %
LO5			5 %	10 %	15 %	7,5 %
%	30%	20 %	30 %	20%	100	50
ECTS contribution	1,8	1,2	1,8	1,2	6	

Exam period:

Learning Outcome	Written exam	Oral Exam	Total	Passing Threshold
LO1	20 %	5 %	25%	12,5 %
LO2	15 %		15%	7,5 %
LO3	20 %	10 %	30%	15 %
LO4	10 %	5 %	15%	7,5 %
LO5	5 %	10 %	15 %	7,5 %
%	70%	30%	100	50
ECTS contribution	4,2	1,8	6	

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
S. Lee: Mathematical Modeling and Simulation with MATLAB	https://scholarworks.alaska.edu/bitstream/handle/11122/12246/MathModelingWithMatlab.pdf	*25*
C. de Freitas: Introduction to MATLAB for First-Year Engineering Students	https://oercommons.s3.amazonaws.com/media/courseware/relatedresource/file/MATLAB_Textbook_by_deFreitas_2025.pdf	25

1.10. *Supplementary readings*

T. Bjažić: Modeliranje i simuliranje sustava - e-knjiga - radni materijali, TVZ, Zagreb, 2024.

Ž. Ban i drugi: Primjena Matlaba za rješavanje tehničkih problema, Graphis, Zagreb, 2010.

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Damir Kralj, prof.**	
Course name	**Sensors and Actuators in Mechatronics and Robotics**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

The course aims to introduce students to the fundamentals and applications of sensor and actuator systems in mechatronics and robotics. Students will develop the ability to identify and select appropriate sensors and master signal processing techniques. They will also gain an understanding of the operating principles of electromagnetic actuators and acquire the knowledge required for controlling electric drives and applying them in mechatronic and robotic systems.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Determine the characteristics of typical sensor systems used in mechatronic and robotic applications.
LO2: Select appropriate sensor systems for control and diagnostic tasks in mechatronic and robotic systems.
LO3: Evaluate methods for conditioning and processing signals from sensor circuitry.
LO4: Rank different types of electromagnetic actuators according to their performance attributes.
LO5: Specify the power-electronics hardware and sensors required for applications in electromagnetic actuators.
LO6: Assess the principles of vector control applied to electric drive systems.

1.4. *Course content*

1) *Sensor Systems in Mechatronics and Robotics: Basic concepts, sensor classification and historical evolution, overview of physical sensing principles (optical, thermal, piezoelectric, etc.), and the role of sensors in industrial automation.*
2) *Sensor Elements: Detailed review of various sensing elements and transducers used in automation, including associated electronic circuitry and signal-processing algorithms.*
3) Robotic Sensor Systems: Proprioceptive sensors (encoders, gyroscopes, accelerometers), perceptual sensors (cameras, LiDAR, ultrasonic), and their application in mapping, localization, and SLAM (Simultaneous Localization and Mapping).
4) State Estimation and Sensor Data Processing: MEMS-based inertial sensors, their configuration and calibration, and an introduction to signal-filtering techniques such as the Kalman filter and Bayesian approaches for orientation and position prediction.

5) Fundamentals of Actuator Systems in Mechatronics and Robotics: Overview of actuator types and applications, and their interaction with sensor systems.
6) Electromechanical Actuator Systems: In-depth study of electric drive units—DC motors, servomotors, stepper motors—along with speed control circuits and feedback techniques in servo control systems.
7) Advanced Actuator Control Approaches: Introduction to vector control of electric drives (Field-Oriented Control, FOC).
8) Practical Applications of Sensor and Actuator Systems: Case studies on the integration of sensors and actuators in robotic and industrial environments..

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Home Assignment	X				

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Home Assignment	Colloquium 2	Seminar Paper	Total	Passing the exam
LO1	15%				15%	7,5%
LO2	10%			10%	20%	10%
LO3		10%	5%		15%	7,5%
LO4		10%	5%		15%	7,5%
LO5			10%	10%	20%	10%
LO6			15%		15%	7,5%
%	25%	20%	35%	20%	100	50
Share of ECTS	1,5	1,2	2,1	1,2	6	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	15%		15%	7,5%
LO2	20%		20%	10%
LO3		15%	15%	7,5%
LO4	15%		15%	7,5%
LO5	20%		20%	10%
LO6		15%	15%	7,5%
%	70%	30%	100	50
Share of ECTS	4,2	1,8	6	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D

0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
Introduction to Robot Sensors	*https://stanfordasl.github.io/PoRA-l/aa274a_aut2223/pdfs/notes/lecture7.pdf*	25
D. Žarko, i drugi Elektromotorni pogoni s istosmjernim motorima, podloge iz kolegija, Osnove elektromotornih pogona, Fakultet elektrotehnike i računarstva	https://www.fer.unizg.hr/_download/repository/OEMP_P3-4_2020.pdf	25
N. Mohan: Advanced Electric Drives: Analysis, Control, and Modeling Using MATLAB / Simulink	https://www.perlego.com/book/993807/advanced-electric-drives-analysis-control-and-modeling-using-matlab-simulink-pdf	25

1.10. Supplementary readings

B. Skalicki,i drugi: Električni strojevi i pogoni

J. Fraden: Handbook of Modern Sensors: Physics, Designs, and Applications

J. G. Webster: Measurement and Instrumentation Sensors Handbook

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**Filip Žugčić, s. lecturer**	
Course name	**Energy storage systems**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

The course's objective is to familiarize students with a variety of energy storage technologies, including their design, economics, applications, and operating principles. Students will learn to classify and select an energy storage system for a particular application area.

1.2. *Course enrolment requirements*

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1.3. *Intended course learning outcomes*

LO1: Identify the basic concepts of energy storage systems.
LO2: Compare different electrical energy storage systems.
LO3: Select systems for electrical energy storage.
LO4: Examine various energy management systems (EMS).

1.4. *Course content*

1) Basic concepts of energy: Introduction to basic concepts of energy and energy storage, types and conversion of energy.
2) Basic features of mechanical energy storage systems: Overview of key elements of mechanical energy storage systems, pumped storage hydroelectric power plants, flywheels, energy storage based on the principle of gravitational energy and compressed air.
3) Basic features of electrochemical energy storage systems: Analyze the principle of energy conversion in battery energy storage systems (BES) and flow battery systems (FBES), and their applications in practice.
4) Basic features of chemical energy storage systems: Application of electrical energy storage in the form of hydrogen and synthetic natural gas.
5) Basic features of electrical energy storage systems: Ultracapacitor and superconducting magnetic coil technology.
6) Comparison of existing electrical energy storage technologies: Selection of electrical energy storage system technology depending on the application.
7) Energy management systems: Describe systems for data collection, control and monitoring.
8) Trends and future developments: Role and new technologies of electrical energy storage systems in the power industry, robotics and automotive industries.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper		Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio			X				

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course. The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Continuous verification:

Outcome	Colloquium 1	Homework	Colloquium 2	Seminar paper	Total	Passing the exam
LO1		5%		10%	15%	7,5%
LO2	35%				35%	17,5%
LO3			35%		35%	17,5%

LO4		5%		10%	15%	7,5%
%	35%	10%	35%	20%	100	50
Share of ECTS	2,1	0,6	2,1	1,2	6	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1		15%	15%	7,5%
LO2	35%		35%	17,5%
LO3	35%		35%	17,5%
LO4		15%	15%	7,5%
%	70%	30%	100	50
Share of ECTS	4,2	1,8	6	

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
A. M. Sadeq: Energy Storage Systems: A Comprehensive Guide, Research gate	https://www.researchgate.net/publication/374133294_Energy_Storage_Systems_A_Comprehensive_Guide	25

1.10. Supplementary readings

Lj. Majdančić: Solarni sustavi, Graphis d.o.o., 2010

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems.

Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Denis Kotarski, s. lecturer**	
Course name	**Additive Manufacturing**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	1.	
Number of credits and mode of delivery	ECTS student workload coefficient	6
	Number of hours (L+P+S)	30+45+0

COURSE DESCRIPTION

1.1. *Course aims*

TheThe course enables students to acquire knowledge of the key steps and industrial applications of additive manufacturing (AM) technologies. Students will learn to select appropriate AM technologies and materials based on process and design requirements, and to configure parameters in software tools for production preparation. Through hands-on practice, they will master the operation of additive manufacturing equipment.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Evaluate the justification for applying additive manufacturing and describe its fundamental process steps.
LO2: Select appropriate additive manufacturing technologies and materials based on product or prototype design and process requirements.
LO3: Determine additive manufacturing parameters in software packages (slicers) for various technologies and generate the corresponding G-code.
LO4: Assess the effectiveness of additive manufacturing technologies through practical examples.

1.4. *Course content*

1. Fundamentals and Applications of Additive Manufacturing: Introduction to AM technologies and their role in modern production, emphasizing the advantages and key process steps for producing parts and prototypes.
2. Polymer-Based AM Technologies: Working principles of extrusion-based AM (PLA, PETG, TPU, ASA) using Fused Deposition Modeling (FDM).
3. Parameter Configuration and G-Code Generation: Introduction to software tools for setting AM parameters (e.g., slicers) and the workflow for generating G-code for various 3D printing technologies.
4. Composite Materials in AM: Continuous Fibre Fabrication (CFF) technology and the impact of composite materials on the structural integrity of final parts.
5. Hands-On 3D Printer Operation: Demonstrations of Selective Laser Sintering (SLS) and Stereolithography (SLA) technologies, plus operation of both low-cost and industrial 3D printers.

6. Advancements and Future of AM: Production of composite components, metal and tooling AM technologies, synergies of AM with industrial processes, and emerging trends and innovations.		
1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio							

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Seminar Paper	Total	Passing the exam
LO1	15%			15%	7,5%
LO2	20%		10%	30%	15%

LO3		15%	10%	25%	12,5%
LO4		10%	20%	30%	15%
%	35%	25%	40%	100	50
Share of ECTS	2,1	1,5	2,4	6	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	15%		15%	7,5%
LO2	20%	10%	30%	15%
LO3	15%	10%	25%	12,5%
LO4	10%	20%	30%	15%
%	60%	40%	100	50
Share of ECTS	3,6	2,4	6	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
D. Godec, i drugi: Aditivna proizvodnja	5	25
Additive Manufacturing Essentials	https://openstax.org/books/additive-manufacturing-essentials/pages/1-summary	25

R. Wysk: Additive Manufacturing (AM)	https://oercommons.org/courseware/lesson/76708/overview	25

1.10. Supplementary readings

J. Pou, et al: Additive Manufacturing

I. Gibson, et al: Additive Manufacturing Technologies

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

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COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Adam Stančić, prof.**	
Course name	**Machine learning**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	5
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of the course is to introduce students to the application of basic machine learning algorithms to various practical problems. In addition to acquiring theoretical knowledge in the field of machine learning, students would solve practical examples of regression and data classification procedures using the Python programming language and appropriate libraries.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Compare different machine learning algorithms
LO 2: Recommend data preparation approaches
LO 3: Critically evaluate selected machine learning methods
LO 4: Defend the position on the choice of the appropriate machine learning method for a specific problem
LO 5: Evaluate the efficiency and accuracy of machine learning models
LO 6: Conclude on the reliability and generalizability of machine learning models

1.4. *Course content*

1) Introduction and basics: basic concepts, types of machine learning and development environments.
2) Data preparation: retrieval, missing data, data preparation.
3) Regression models: definition and formulation of linear regression.
4) Classification models: definition and formulation of logistic regression.
5) Model rating: rating reg. model (MAE, MSE, R2...) and class. model (confusion matrix).
6) Neural networks: neural model, activation function, cost functions, learning.
7) Convolutional neural networks: architecture, network layers, activation function, image processing.
8) Solving practical problems: solving practical examples using prog. of the Python language.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals	☒ independent work ☐ multimedia and network ☒ laboratory

	☐ remote learning ☐ field work	☐ supervision ☐ other _____

1.6. *Student obligations*

The student is obliged to attend classes regularly and fulfill the obligations according to the teaching plan in accordance with the Study Regulations. Absences from classes during the semester may not exceed 20% of the lecture and exercise hours of the course for full-time students, or 40% for part-time students. A student who has missed more than 50% of the class hours (regardless of the reasons for the absence) is obliged to re-enroll in the course in the following academic year.

Attendance is mandatory, and taking exams is the student's right and is carried out according to the continuity conditions. The continuity conditions include the prerequisites for enrolling in a course and taking exams.

At the beginning of the semester, the teacher announces the conditions under which classes are conducted: the percentage of mandatory attendance and participation in classes, and the number and method of knowledge assessment during the semester, including their evaluation (the right to sign, exemption from part or all of the exam, etc.).

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Homework					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Seminar paper	Total	Passing the exam
LO1	13,33%		3,33%	16,66%	8,33%
LO2	13,33%		3,33%	16,66%	8,33%
LO3	13,33%		3,33%	16,66%	8,33%
LO4		13,33%	3,33%	16,66%	8,33%
LO5		13,33%	3,33%	16,66%	8,33%
LO6		13,33%	3,33%	16,66%	8,33%

%	40,00%	40,00%	20,00%	100,00%	50,00%
Share of ECTS	2,00	2,00	1,00	5,00	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	11,66%	5,00%	16,66%	8,33%
LO2	11,66%	5,00%	16,66%	8,33%
LO3	11,66%	5,00%	16,66%	8,33%
LO4	11,66%	5,00%	16,66%	8,33%
LO5	11,66%	5,00%	16,66%	8,33%
LO6	11,66%	5,00%	16,66%	8,33%
%	70,00%	30,00%	100,00%	50,00%
Share of ECTS	3,50	1,50	5,00	

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
Ethem Alpaydin, Introduction to Machine Learning, The MIT Press, 2014	https://mitpress.mit.edu/9780262043793/introduction-to-machine-learning/	25
Machine Learning for Absolute Beginners, Scatterplot Press, 2017	https://mrce.in/ebooks/Machine%20Learning%20for%20Absolute%20Beginners.pdf	25

1.10. Supplementary readings *Python Machine Learning Workbook for Beginners: 10 Machine Learning Projects Explained from Scratch, AI Publishing, 2020*
1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.
Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**mr. sc. Vedran Vyroubal, s. lecturer**	
Course name	**Linux operating system**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	5
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of the course is to equip students with advanced understanding, installation, administration, and optimization of the Linux operating system, as well as the application of advanced concepts such as virtualization and containerization. Through this course, students will develop the ability to analyse, synthesize, and evaluate operating systems with a particular focus on Linux.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO 1: Identify key components of the Linux operating system, including the kernel, file system, and networking functions.
LO 2: Anticipate the procedures for installing and configuring a Linux system.
LO 3: Recommend advanced administrative procedures, including security settings, user privileges, and task automation using scripting.
LO 4: Re-examine networking functions and security settings of the Linux system, identifying key components for data and system protection.
LO 5: Compare virtualization and containerization using KVM and Docker, with an emphasis on resource optimization and security.
LO 6: Justify the integration of virtualized and containerized environments into existing infrastructures and apply orchestration techniques for scalable solutions.

1.4. *Course content*

Weekly Plan:
1. (LO 1) • History and development of the Linux operating system • Basic concepts of operating systems • Differences between Linux and other OSes (Windows, macOS)
2. (LO 1) • Kernel, shell, file systems • Processes and process management • Memory and resource management
3. (LO 1) • Installation prerequisites (hardware requirements, distributions) • Installing Linux distributions (Debian, Ubuntu, CentOS) • Basic system configuration
4. (LO 2) • File system structure and hierarchy • Partition and file system management • Mounting and unmounting file systems
5. (LO 2) • Package managers (APT, YUM, DNF) • Installing, upgrading, and removing software • Repositories and dependency management

6. (LO 2) • User and group management • Setting permissions and access rights • Security aspects of user management
7. (LO 2) • Basics of Bash scripting • Task automation • Using cron and systemd for task scheduling
8. (LO 3) • System security settings • Firewall management (iptables, firewalld) • Backups and data recovery
9. (LO 4) • Configuring network settings • Managing network interfaces • Network diagnostics and troubleshooting
10. (LO 3, LO 4) • Process management using tools (top, ps, kill) • Service management using systemd • System performance monitoring
11. (LO 5) • Fundamentals of virtualization • Types of virtualization (full, para-virtualization) • Installing and configuring KVM (Kernel-based Virtual Machine)
12. (LO 5) • Managing virtual machines • Resource optimization in virtualized environments • KVM and Libvirt management tools
13. (LO 5, LO 6) • Concepts of containerization and differences from virtualization • Installing and configuring Docker • Managing containers
14. (LO 5, LO 6) • Integrating virtualized and containerized environments • Case study: Application of Linux, virtualization, and containerization in industry • Final evaluation and project presentations
15. (LO 1, LO 2, LO 3, LO 4, LO 5, LO 6) • Review session

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is obliged to attend classes regularly and fulfill the obligations according to the teaching plan in accordance with the Study Regulations. Absences from classes during the semester may not exceed 20% of the lecture and exercise hours of the course for full-time students, or 40% for part-time students. A student who has missed more than 50% of the class hours (regardless of the reasons for the absence) is obliged to re-enroll in the course in the following academic year.

Attendance is mandatory, and taking exams is the student's right and is carried out according to the continuity conditions. The continuity conditions include the prerequisites for enrolling in a course and taking exams.

At the beginning of the semester, the teacher announces the conditions under which classes are conducted: the percentage of mandatory attendance and participation in classes, and the number and method of knowledge assessment during the semester, including their evaluation (the right to sign, exemption from part or all of the exam, etc.).

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper		Experimental work	

Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	X
Portfolio		Home Assignment					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Oral	Total	Passing the exam
LO1	14%		2%	15%	8%
LO2	14%		2%	20%	8%
LO3	14%		3%	15%	8,5%
LO4		14%	3%	15%	8,5%
LO5		14%	3%	20%	8,5%
LO6		14%	3%	15%	8,5%
%	42%	42%	16%	100	50
Share of ECTS	2,1	2,1	0,8	5	2,5

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	14%	2%	15%	7,5%
LO2	14%	2%	20%	10%
LO3	14%	3%	15%	7,5%
LO4	14%	3%	15%	7,5%
LO5	14%	3%	20%	10%
LO6	14%	3%%	15%	7,5%
%	84%	16%	100	50

Share of ECTS	4,2	0,8	5	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
W. Shotts: The Linux Command Line	https://linuxcommand.org/tlcl.php	25
P. Cobbaut, et al. : Linux Introduction	https://hogenttin.github.io/linux-training-hogent/introlinux.pdf	25
P. Cobbaut, et al. : Linux for Operations	https://hogenttin.github.io/linux-training-hogent/opslinux.pdf	25

1.10. *Supplementary readings*

Stallings, W. (2018) Operating systems internals and Design Principles, 190 High Holborn, London WC1V 7BH, UK, Pearson

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Denis Kotarski, s. lecturer**	
Course name	**Control Systems and Automation**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	5
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of the course is to introduce students to the fundamental principles and methods of controlling dynamic systems. Throughout the course, students will master the analysis of system stability, calculation of transfer functions, and tuning of controller parameters, as well as the application of algorithms for controlling complex multivariable systems.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Determine the block diagram of a control system in order to define the transfer function of both the open and closed-loop systems.
LO2: Evaluate the stability of dynamic systems with a controller and calculate amplitude and phase margins.
LO3: Recommend controller parameters using analytical and graph-analytical tuning methods.
LO4: Compare the structure of control algorithms for multivariable dynamic systems.

1.4. *Course content*

1) Introduction to Control Systems: Basic concepts, structure of a control system, methods of dynamic analysis.
2) Transfer Function: Modeling of elements in automatic control and representation of dynamic characteristics, block algebra, and determination of the transfer function.
3) Frequency Characteristics of Elements: Representation of control system element characteristics using Bode and Nyquist diagrams.
4) Stability Analysis: Methods for determining stability – direct methods (root finding), analytical methods, and graph-analytical methods.
5) Determination of Control Quality: Calculation of steady-state errors, assessment of overshoot, and maximum response time.
6) Controller Parameter Calculation: Analytical and graphical (Bode) methods for calculating conventional controller parameters, practical tuning using the Ziegler-Nichols method.
7) Control Algorithms: Overview of continuous and digital control system synthesis methods, cascade control of multivariable dynamic systems.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper		Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Home Assignment	X				

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Home Assignment	Colloquium 2	Total	Passing the exam
LO1	15%	10%		25%	12,5%
LO2	25%			25%	12,5%
LO3		10%	20%	30%	15%

LO4			20%	20%	10%
%	40%	20%	40%	100	50
Share of ECTS	2	1	2	5	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	15%	10%	25%	12,5%
LO2	25%		25%	12,5%
LO3	20%	10%	30%	15%
LO4	10%	10%	20%	10%
%	70%	30%	100	50
Share of ECTS	3,5	1,5	5	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
P. Crnošija, i drugi: Osnove automatike, I. Dio: Analiza i sinteza kontinuiranih sustava - teorija i primjena	5	25
Control Systems	https://upload.wikimedia.org/wikipedia/commons/e/e4/Control_Systems.pdf	25

1.10. Supplementary readings

D. Majetić, i drugi: Zbirka zadataka iz teorije automatskog upravljanja - jednovarijabilni sustavi D. Majetić, i drugi: Zbirka zadataka iz teorije automatskog upravljanja - viševarijabilni sustavi
1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.
Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

General information		
Lead instructor	**Mirjana Cibulka, s. lecturer**	
Course name	**English language**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	2
	Number of hours **(L+P+S)**	15+15+0

Course description

1.1. *Course aims*

Development of productive and receptive language skills (listening, speaking, reading and writing) with expansion of language structures (vocabulary, communication patterns, phonological and orthographic features), and acquisition of vocabulary and phraseology of business communication. Acquisition of competences necessary for lifelong learning, i.e. training for communication in conditions of increased international mobility and a changing labour market, encouragement of autonomous learning and sensitisation for intercultural aspects.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Select key information from written and/or heard texts in the field of business communication in English

LO2: Formulate professional texts in the native language and professional English

LO3: Translate expressions, phrases, sentences, short texts in the field of professional language

LO4: Distinguish and determine the basic elements of the text and apply them in written expression, consider different positions in the texts read and discuss them.

LO5: Design a dialogue / solution to a problem in a business situation in oral and written form (essay)

1.4. *Course content*

1 Social customs, cultural intelligence and intercultural communication competences in a globalised environment (introduction, introduction, greeting, apology, expressing gratitude, acceptance/rejection, small talk, formal conversation)
2 My profession and job, networking
3 Translation tools in a business environment
4 Business telephone communication and arranging meetings (with strangers and acquaintances)
5 Expressions for gaining more time to think
6 How to hold a top-notch meeting (meeting preparation, organisation, leadership, execution)
7 Recruitment process
8 Job application, CV
9 Job interview

10 Guidelines for business correspondence
11 Oral presentation (what makes a good and bad presentation)
10 Negotiation skills
13 Problem solving
14 Business travel
15 Repetition

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☐ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper		Experimental work	
Written exam	X	Oral exam	X	Essay	X	Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Participation in class					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus.

Continuous assessment:

LO	Term paper 1	Term paper 2	Total	Pass
LO 1	10%	10%	20%	10%
LO 2	10%	10%	20%	10%
LO 3	10%	10%	20%	10%
LO 4	10%	10%	20%	10%

LO 5	10%	10%	20%	10%
%	50%	50%	100	50
ECTS share	1	1	2	

Exam period:

LO	Written exam	Oral exam	Total	Pass
LO 1	10%	15%	25%	12.5%
LO 2	15%		15%	7.5%
LO 3	10%	15%	25%	12.5%
LO 4	20%		20%	10%
LO 5	15%		15%	7.5%
%	70%	30%	100	50

Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continuously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course. The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
Materials compiled for lectures organised by unit and current professional texts and publications with language content with exercises		

1.10 Supplementary readings

D. Cotton et al.: Language Leader Advanced, Pearson Longman, 2010.
P. Emmerson: Business Vocabulary Builder, Macmillan, I edition, 2009.
M. Ibbotson: Cambridge English for Engineering, Cambridge University Press, 2008.
M. Duckworth, R. Turner Business Result, Upper-intermediate, Oxford, 2008

1.11 Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completion of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continuously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

General information		
Lead instructor	**Sonja Eterović, s. lecturer**	
Course name	**German Language**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	2
	Number of hours (L+P+S)	15+15+0

Course description

1.1. *Course aims*

Development of productive and receptive language skills (listening, speaking, reading, and writing) alongside the expansion of language structures (vocabulary, communication patterns, phonological and orthographic features), as well as the acquisition of vocabulary and phraseology related to business communication. Gaining competences necessary for lifelong learning, i.e., acquiring the ability to communicate in conditions of increased international mobility and a changing labor market, encouraging autonomous learning, and raising awareness of intercultural aspects.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Select relevant information from written and/or spoken texts in the field of business communication in the German language
LO2: Formulate professional texts in the native language and in German
LO3: Apply vocabulary related to business communication in the German language
LO4: Compose a text on a given topic in the field of business communication in the German language
LO5: Create a dialogue/solution to a problem in a business situation

1.4. *Course content*

1. A New Conference Room in the Hotel
2. The Inquiry to Hotel Ost; Trade Fair Events in Germany
3. Types of Letters, Parts of a Letter, German Abbreviations in Emails
4. A Workday of Mr. Mobili
5. A Workday of Mr. Mobili
6. Hotel Ost Has a Problem
7. Telephone Communication
8. A Telephone Conversation;
9. The Inquiry to the Company Herzog
10. The Meeting; Taking Minutes of Meetings and Conferences (Contents of Minutes)
11. The Email to the Subsidiary in Poland
12. Office Conversation

13. The Email from the Subsidiary in Poland 14. Good News 15. Revision		
1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☐ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	x	Seminar paper		Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio							

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Total	Passing the exam
LO1	10%	10%	20%	10%
LO2	10%	10%	20%	10%
LO3	*10%*	10%	20%	10%
LO4	*10%*	10%	20%	10%

LO5	*10%*	10%	20%	10%
%	50%	50%	100%	50%
Share of ECTS	1	1	2	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	10%	*10%*	20%	10%
LO2	10%	*10%*	20%	10%
LO3	10%	10%	20%	10%
LO4	10%	10%	20%	10%
LO5	10%	10%	20%	10%
%	50%	50%	100%	50%
Share of ECTS	1	1	2	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
1. K. Sobo, S. Eterović; Deutsch in der Geschäftskommunikation ; Veleučilište u Karlovcu, 2024. (selected chapters)	*https://www.vuka.hr/images/50013954/Deutsch_in_der_Geschaftskommunikation.pdf*	

1.10. Supplementary readings

2. H.-H. Rohrer, C. Schmidt; Kommunizieren im Beruf; Langenscheidt, 2008. (selected chapters)

3. M. Čičin-Šain Buljan, J. Kosanović, A. Štampalija; Mikrorad d..o.o., Zagreb, Ekonomski fakultet Zagreb, 2001. (selected chapters)
1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.
Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Anamarija Kirin, s. lecturer**	
Course name	**Professional Internship**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Compulsory	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	12
	Number of hours (L+P+S)	0+240+0

COURSE DESCRIPTION

1.1. *Course aims*

Students will acquire practical knowledge and skills in the fields of electrical engineering, mechanical engineering, and/or computing.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Identify specific work tasks and responsibilities within the organization where the internship is carried out.
LO2: Anticipate potential challenges and obstacles when applying acquired knowledge in a real working environment.
LO3: Assess the effectiveness of the methods and tools used during the internship.
LO4: Evaluate personal contribution to business activities during the internship.

1.4. *Course content*

-

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☐ lectures ☐ seminars and workshops ☐ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

Students are required to attend the internship according to the agreed schedule and adhere to the working hours set by the employer.

During the internship, students must comply with the internal rules of the company or institution, including safety and organizational guidelines.

Students are expected to actively participate in assigned tasks, show initiative, and apply theoretical knowledge in practical situations.

Students must keep a record of the tasks they performed, the tools and technologies they used, and the competencies they gained during the internship.

Upon completion of the internship, students must prepare a final report detailing the course of the internship, tasks performed, skills acquired, and a self-evaluation of their experience and satisfaction with the internship.

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper		Experimental work	
Written exam		Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge		Student report	X	Practical work	
Portfolio							

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course. The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment.

Learning Outcome	Mentor's Evaluation Form	Internship Report	Oral Exam	Total	Passing Threshold
LO1	5	15	5	25%	12,5%
LO2	5	15	5	25%	12,5%
LO3	5	15	5	25%	12,5%
LO4	5	15	5	25%	12,5%
%	20%	60%	20%	100	50
ECTS contribution	2,4	7,2	2,4	12	

Percent	Grade description	Numeric grade	ECTS grade

90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
Group of Authors: Handbook for Organization and Implementation of Professional Internship in Higher Education, Polytechnic of Karlovac,	https://www.vuka.hr/images/50013954/Prirucnik%20za%20provodjenje%20istrazivanja%20stavova%20posjetitelja%20manifestacija.pdf	*25*

1.10. *Supplementary readings*

Relevant professional and scientific literature in the fields of mechanical engineering, electrical engineering, and computing.

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**mr. sc. Vedran Vyroubal, s. lecturer**	
Course name	**Object oriented programming**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Elective	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	4
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of the course is to equip students with advanced understanding and application of object-oriented programming (OOP) principles in software development. Students will learn how to use key OOP concepts such as inheritance, polymorphism, abstraction, and encapsulation, and how to develop complex systems using modern programming languages like Java or C++. Emphasis will be placed on good software design and the application of design patterns.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO 1: Examine the fundamental concepts of object-oriented programming (OOP) in the development of software solutions.
LO 2: Select key OOP principles, including encapsulation, inheritance, and polymorphism.
LO 3: Recommend design patterns in the development of scalable, adaptable, and modular software applications.
LO 4: Validate the correctness and efficiency of software code using unit tests and debugging techniques.
LO 5: Measure the performance of object-oriented systems with a focus on memory efficiency and execution time.
LO 6: Compare software solutions that implement advanced OOP techniques such as abstract classes, interfaces, generic types, and multiple inheritance.

1.4. *Course content*

Weekly Plan:
1. (LO 1) History and motivation for OOP. Comparison of procedural and object-oriented approaches. Basic OOP concepts: object, class, method, attribute
2. (LO 1) Encapsulation: data protection and access methods. Abstraction: hiding implementation and working with abstract types. Practical examples: abstraction models in real-world projects
3. (LO 1) Concept of inheritance and types of inheritance (single and multiple). Superclasses and subclasses Method overriding and use of keywords (e.g., super, override)
4. (LO 2) Static and dynamic polymorphism. Using abstract classes and interfaces to achieve polymorphism Implementation of polymorphism in different OOP languages

5. (LO 2) UML class, object, and sequence diagrams. Application of UML in software system design. Modeling tools (e.g., Visual Paradigm, StarUML)
6. (LO 2) Difference between abstract classes and interfaces. Application of interfaces in modular software development. Practical examples: use of abstract classes and interfaces in application design
7. (LO 2) Generic types in OOP languages (Java, C++). Using generics to develop flexible and type-safe data structures. Examples of working with collections (List, Set, Map)
8. (LO 3) Templates in C++
9. (LO 4) Introduction to exception handling mechanisms (try, catch, throw). Using custom exceptions. Best practices for designing systems with exception handling
10. (LO 3, LO 4) File operations (reading, writing, serialization). Managing data streams and working with binary and text files. Examples of implementing simple file-handling applications
11. (LO 5) Advantages and disadvantages of inheritance. Difference between inheritance and composition. Introduction to design patterns
12. (LO 5) Using design patterns such as Strategy and Decorator. Application of fundamental patterns: Singleton, Factory, Observer, Adapter Implementation of patterns in practical examples
13. (LO 5, LO 6) Unit testing. Debugging techniques and troubleshooting OOP applications. Test automation (Continuous Integration, CI)
14. (LO 5, LO 6) Introduction to multithreading and parallelism. Synchronization and inter-process communication in OOP languages. Thread safety in multithreaded applications
15. (LO 1, LO 2, LO 3, LO 4, LO 5, LO 6) Review session

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper	X	Experimental work	

Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	X
Portfolio		Home Assignment					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Oral	Total	Passing the exam
LO1	14%		2%	15%	8%
LO2	14%		2%	20%	8%
LO3	14%		3%	15%	8,5%
LO4		14%	3%	15%	8,5%
LO5		14%	3%	20%	8,5%
LO6		14%	3%	15%	8,5%
%	42%	42%	16%	100	50
Share of ECTS	1,68	1.68	0.64	4	2

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	14%	2%	15%	7,5%
LO2	14%	2%	20%	10%
LO3	14%	3%	15%	7,5%
LO4	14%	3%	15%	7,5%
LO5	14%	3%	20%	10%
LO6	14%	3%%	15%	7,5%
%	84%	16%	100	50

Share of ECTS	3,36	0,64	4	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
B. Stroustrup: Principles and Practice Using C++ (3rd Edition)	https://www.stroustrup.com/programming.html	25
K. L. Busbee: Programming Fundamentals: A Modular Structured Approach using C++	https://open.umn.edu/opentextbooks/textbooks/144	25

1.10. Supplementary readings

E. Gamma, et al.: Design Patterns: Elements of Reusable Object-Oriented Software, Addison-Wesley, 1994.
B. Motik i drugi: Demistificirani C++

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**Filip Žugčić, s. lecturer**	
Course name	**Automotive mechatronic systems**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Elective	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	4
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

Students will learn about the essential components and working assemblies of mechatronic systems in automobiles, as well as how to analyze, design, and simulate these systems. The emphasis is on drive, energy, sensor and control modules and their application in modern vehicles.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Compare the elements and functional assemblies of automotive mechatronic systems and classify different vehicle drive systems.

LO2: Recommend automotive mechatronic systems including drive, energy, sensor and control modules, with an emphasis on autonomous vehicle functions.

LO3: Choose an option and implement dynamic models of elements and systems in a programming language for simulation and behavior analysis.

LO4: Critically assess different levels of vehicle autonomy (SAE 0–5) and their technical, safety, and regulatory challenges.

1.4. *Course content*

1) Introduction to automotive mechatronics and classification of drive systems - Basic elements of mechatronic systems and classification of drives: conventional (diesel, gasoline), hybrid (parallel, series) and electric. Advantages and challenges of different solutions.

2) Dynamic models of automotive drives and vehicle drive systems - Modeling the dynamics of drive systems. Differences between front, rear and all-wheel drive (4x4) and their impact on driving dynamics.

3) Modeling and simulation of vehicle dynamics - Mathematical vehicle models, analysis of drive, batteries, suspension and tires. Simulation of dynamics in different driving conditions.

4) Drive systems of electric and hybrid vehicles - Structure of electric drives, battery management, energy regeneration. Comparison of series and parallel hybrid systems.

5) Control systems in vehicles - Electronic stability control (ESP), ABS, traction control. Torque vectoring for active torque distribution and stability improvement.

6) Autonomous driving and driver assistance systems (ADAS) - SAE levels of autonomy, key sensors (lidar, radar, cameras), decision-making algorithms. CAN bus as a communication infrastructure for connecting systems.

7) The future of automotive mechatronic systems - Trends in digitalization, connected vehicles, AI in cars, sustainability and energy efficiency of new drives.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☒ field work	☒ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Homework					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course. The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Seminar paper	Total	Passing the exam
LO1	20%		5%	25%	12,5%
LO2	20%		5%	25%	12,5%
LO3		20%	5%	25%	12,5%
LO4		20%	5%	25%	12,5%
%	40%	40%	20%	100	50
Share of ECTS	1,6	1,6	0,8	4	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	20%	5%	25%	12,5%
LO2	20%	5%	25%	12,5%
LO3	20%	5%	25%	12,5%
LO4	20%	5%	25%	12,5%
%	80%	20%	100	50
Share of ECTS	3,2	0,8	4	

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*

A. K. Darwins, et al.: Mechatronics in Automotive Engineering: Concepts and Techniques, DeltaBox Publishing House, 2024.	https://books.google.hr/books?id=538pEQAAQBAJ&printsec=frontcover&hl=hr#v=onepage&q&f=false	

1.10. Supplementary readings

M. Grubišić: Automobilski mehatronički sustavi, Sveučilište u Mostaru, Fakultet strojarstva i računarstva, 2013.

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**Filip Žugčić, s. lecturer**	
Course name	**Programmable logic controller (PLC)**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Elective	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	4
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of the course is to introduce students to the principles of operation of programmable logic controllers (PLC), their application in industrial systems, programming methods and integration with other systems.

1.2. *Course enrolment requirements*

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1.3. *Intended course learning outcomes*

LO1: Determine the operating principle of a PLC system.
LO2: Compare input and output modules, and data addressing in a PLC.
LO3: Recommend basic functions in LAD and STL languages when programming.
LO4: Justify procedures for identifying and eliminating errors in PLC systems.
LO5: Evaluate PLC programs for industrial process control.

1.4. *Course content*

1) Introduction to PLC Systems: Historical development, basic components and advantages of PLCs in industrial processes.
2) PLC Hardware Architecture: Overview of CPUs, memory units, and input/output modules that enable communication with the process.
3) PLC Operating Principle: Program execution cycle, processing of input data, and decision making based on program logic.
4) PLC Programming Languages: Basics of Ladder Diagram (LAD) and Statement List (STL), comparison and application in industrial applications.
5) PLC Programming and Testing: Program creation, simulation and debugging before implementation in real systems.
6) Signal Management and Operations: Working with digital and analog inputs and outputs, using counters and timers for process control.
7) PLC Communication with Other Systems: Connecting PLCs to supervisory systems, industrial networks and other control devices.
8) Application of PLC systems in industry: Analysis of specific practical examples, such as automation of production lines and processes.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Homework					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course. The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Seminar paper	Total	Pass
LO1			20%	20%	10%
LO2	20%			20%	10%
LO3	20%			20%	10%

LO4		20%		20%	10%
LO5		20%		20%	10%
%	40%	40%	20%	100	50
Share in ECTS	1,6	1,6	0,8	4	

Knowledge evaluation on exams:

Outcome	Written exam	Oral exam	Total	Pass
LO1		15%	15%	7,5%
LO2	23,33%		23,33%	11,665%
LO3	23,33%		23,33%	11,665%
LO4	23,33%		23,33%	11,665%
LO5		15%	15%	7,5%
%	70%	30%	100	50
Share in ECTS	2,8	1,2	4	

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
G. Malčić, D. Maršić: Simatic S7 Programirljivi logički kontroleri, TVZ, 2020. g., Zagreb.	https://www.bib.irb.hr:8443/1098629/download/1098629.S7_Simatic_Programirljivi_Logicki_Kontroleri_TVZ.pdf	

1.10. Supplementary readings

N. Clark: PLC Programming Using RSLogix 500, Independently Published, 2018
1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.
Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Nenad Mustapić, prof.**	
Course name	**Renewable Energy Sources**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Elective	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	4
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The primary aim of this course is to familiarize students with the various types of renewable energy sources. For each source, the fundamental characteristics relevant to potential applications are covered, and existing technologies for the production of electricity and heat (and, where applicable, fuel) are analyzed. Current trends in the utilization of each renewable energy source are also examined.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Evaluate the fundamental characteristics of individual renewable energy sources and explain the operating principles of technologies for electricity and heat generation.
LO2: Describe the operating mechanisms of key components in renewable energy conversion systems.
LO3: Assess the advantages, disadvantages, and limitations of renewable energy sources compared to conventional energy sources.
LO4: Rank the energy potential of various renewable energy sources.
LO5: Identify the main performance parameters of system components and evaluate their impact on the overall conversion efficiency of renewable energy systems.
LO6: Recommend measures to enhance the technological and economic performance of renewable energy conversion systems.

1.4. *Course content*

1. Introduction to Energy and Hydropower: Definitions of energy, work, and power; overview of conventional and renewable energy sources. Students will learn the International System of Units (SI) and apply basic concepts to energy, work, and power calculations.
2. Hydropower Potential: Characteristics of watercourses and hydropower plants; calculation of available head and flow rate; estimation of extractable energy and power. Overview of hydropower plant types and major components.
3. Small Hydropower Systems and Economic Aspects: Technical and economic analysis of small hydropower plants, including net power and annual electricity production calculations; discussion of deployment trends for small hydropower.

4. Wind Turbine Fundamentals: Electricity generation from wind; analysis of wind speed, energy, and power; overview of main components and operating characteristics of wind turbines.
5. Wind Power Output Estimation: Use of the Weibull distribution to calculate wind-generated electricity and study how turbine parameters affect energy yield.
6. Solar Thermal and Photothermal Systems: Principles and characteristics of solar thermal collectors and converters; determination of available solar energy flux and analysis of thermal system efficiency.
7. Photovoltaic Systems: Operation and components of PV systems; technical and economic characteristics; sizing and performance calculations for PV arrays.
8. Hydrogen as a Fuel: Production, transport, and storage of hydrogen; comparison of hydrogen's physical properties with conventional fuels; analysis of hydrogen production cost trends.
9. Fuel Cells and Hydrogen Engines: Types and operating principles of fuel cells and hydrogen-fueled engines; simulation and efficiency analysis of solid oxide fuel cells (SOFC).
10. Biomass Energy: Types of biomass and conversion technologies; heating value calculations; comparison with conventional fuels; impact of moisture and ash content.
11. Biomass Conversion Technologies: Overview of biomass-to-energy technologies and sizing principles for biomass power plants, with design calculations for different feedstocks.
12. Geothermal Energy and Applications: Types of geothermal resources and their utilization; ORC geothermal power plant performance calculations.
13. Geothermal Plant Design: Key design features of geothermal plants; sizing calculations for geothermal heat pumps.
14. Heat Pumps: Types and operating principles of heat pumps; economic performance; sizing and efficiency analysis of heat pump systems.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☒ seminars and workshops ☒ practicals ☐ remote learning ☒ field work	☒ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	

Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Home Assignment	X				

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Home Assignment	Seminar Paper	Total	Passing the exam
LO1	6%	10%	16%	8%
LO2	6%	10%	16%	8%
LO3	6%	10%	16%	8%
LO4	6%	10%	16%	8%
LO5	5%	15%	20%	10%
LO6	6%	10%	16%	8%
%	35%	65%	100	50
Share of ECTS	1,4	2,6	4	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	8%	8%	16%	8%
LO2	8%	8%	16%	8%
LO3	8%	8%	16%	8%
LO4	8%	8%	16%	8%
LO5	5%	15%	20%	10%
LO6	8%	8%	16%	8%
%	50%	50%	100	50
Share of ECTS	2	2	4	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
N. Mustapić i drugi: Energetski strojevi i sustavi, VUK, elektronsko izdanje.	https://korana.vuka.hr/fileadmin/user_upload/knjiznica/on_line_izdanja/Energetski_strojevi_i_sustavi.pdf	
Lj. Majdandžić, Obnovljivi izvori energije, Graphis d.o.o., Zagreb, 2008.	5	

1.10. Supplementary readings

D. Šljivac, Z. Šimić.: Obnovljivi izvori energije s osvrtom na gospodarenje, Knjiga, Osijek

B. Labudović: Obnovljivi izvori energije, Knjiga, EM, Zagreb

H. Požar „Osnove energetike I i II dio“ Školska knjiga

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**mr. sc. Vedran Vyroubal, s. lecturer**	
Course name	**Digital Systems Development**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Elective	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	4
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of the course is to equip students with advanced understanding, design, development, and optimization of digital systems using modern methods and tools. The course focuses on the use of hardware description languages (HDL), digital circuit design, the application of programmable logic devices (FPGA), and the integration of digital systems in real-world applications.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO 1: Select the basic components of digital systems.
LO 2: Validate complex combinational and sequential logic circuits using hardware description languages (HDL).
LO 3: Compare digital systems on programmable logic devices such as FPGA and CPLD using modern development tools.
LO 4: Evaluate digital system design using simulation tools and testing techniques to ensure functionality and reliability.
LO 5: Measure the performance and efficiency of digital systems.
LO 6: Recommend design methodologies for the development of specific digital systems with a focus on adaptability, modularity, and security.

1.4. *Course content*

Weekly Plan:

1) Differences between analog and digital systems; Basic concepts of digital logic: logic functions, Boolean algebra, Karnaugh maps; Application examples of digital systems
2) Design and analysis of combinational circuits; Multiplexers, demultiplexers, encoders, decoders; Use of design tools (Altera Quartus, Xilinx ISE)
3) Flip-flops (SR, D, JK, T); Registers and counters; Analysis and design of sequential circuits
4) Introduction to VHDL and Verilog; Syntax and basic constructs; Writing basic modules in VHDL and Verilog
5) Combinational design in VHDL and Verilog; Modeling of sequential circuits; Circuit synthesis from HDL

6) Simulation tools (ModelSim, Vivado Simulator); Verification of combinational and sequential modules; Test automation and result analysis
7) Introduction to FPGA and CPLD architectures; FPGA development tools (Xilinx Vivado, Intel Quartus Prime); Mapping designs to FPGA and CPLD devices
8) Programmable logic and FPGA configuration; Project examples: ALU, serial communication modules; Resource optimization within FPGA
9) Timing analysis of digital circuits; Signal delay, setup and hold time; Clock signal management and synchronization
10) Finite State Machines (FSM); Mealy and Moore automaton models; FSM design implementation in HDL
11) Hierarchical design; Use of modules and component libraries; Design approaches for large-scale systems
12) Spatial and temporal optimization (area vs. speed trade-offs); Power consumption optimization in digital circuits; Optimization of a simple processor
13) Security challenges in digital systems; Hardware-level cryptography; Implementation of security protocols in digital system design
14) Applications in specific domains: automotive, telecommunications, industrial automation; FPGA as a hardware accelerator; Case study: Digital signal processing systems

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfill obligations in accordance with the course delivery plan, as stipulated by the Study Regulations. Absences during the semester must not exceed 20% of the total lecture and exercise hours for full-time students, and 40% for part-time students. A student who misses more than 50% of the total hours (regardless of the reason) must re-enroll in the course in the following academic year. Class attendance is an obligation, while taking the exam is a student's right and is subject to prerequisite conditions. These conditions include course enrollment requirements and exam eligibility. At the beginning of the semester, the instructor announces the conditions under which the course will be delivered: the required percentage of attendance and participation, as well as the number and method of knowledge assessments during the semester, including their evaluation (eligibility for course signature, exemption from parts or the entirety of the final exam, etc.).

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	

Project		Continuous assessment of knowledge	X	Student report		Practical work	X
Portfolio		Home Assignment					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Oral	Total	Passing the exam
LO1	14%		2%	15%	8%
LO2	14%		2%	20%	8%
LO3	14%		3%	15%	8,5%
LO4		14%	3%	15%	8,5%
LO5		14%	3%	20%	8,5%
LO6		14%	3%	15%	8,5%
%	42%	42%	16%	100	50
Share of ECTS	1,68	1,68	0,64	4	2

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	14%	2%	15%	7,5%
LO2	14%	2%	20%	10%
LO3	14%	3%	15%	7,5%
LO4	14%	3%	15%	7,5%
LO5	14%	3%	20%	10%
LO6	14%	3%%	15%	7,5%
%	84%	16%	100	50
Share of ECTS	3,36	0,64	4	2

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
Intel® FPGA Academic Program Teaching Materials	https://www.intel.com/content/www/us/en/developer/topic-technology/fpga-academic/materials.html	25
P. Zenzerović: Složeni integrirani sklopovi, Školska knjiga, 2023.	https://edu.asoo.hr/wp-content/uploads/2024/03/132_Slo%C5%BEeni-integrirani-sklopovi.pdf	25
C. Ünsalan, et al.: Digital system design with FPGA implementation using Verilog and VHDL	https://www.pdfdrive.com/digital-system-design-with-fpga-implementation-using-verilog-and-vhdl-d195130048.html	25

1.10. *Supplementary readings*

V. Pedroni: Circuit Design with VHDL

C. Maxfield: The Design Warrior's Guide to FPGAs

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Adam Stančić, prof.**	
Course name	**Internet of Things (IoT)**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Elective	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	4
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of the course is to introduce students to the use of the Internet of Things in the implementation of automated and "smart" solutions in industry and everyday activities. Using available hardware and software support, students will apply the procedures of simulation, retrieval, storage, analysis, visualization and evaluation of collected data. In addition, additional emphasis will be placed on the security and use of the Internet of Things in cloud computing.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO 1: Evaluate the different architectures and protocols used in the Internet of Things
LO 2: Compare different sensor and communication technologies in IoT systems
LO 3: Defend the position on the choice of platform and software tools for the development of IoT systems
LO 4: Conclude about the reliability and efficiency of the IoT solution
LO 5: Recommend appropriate security measures to protect IoT devices and networks
LO 6: Critically assess the impact of IoT technologies on the protection of privacy and personal data

1.4. *Course content*

1. Introduction and basic concepts: basic concepts, circuitry and software support.
2. IoT devices: sensors, actuators, microcontrollers, devices and software support.
3. IoT platforms: overview of available hardware and software solutions on the market.
4. Device connectivity: network connectivity and communication protocols.
5. Data manipulation: data collection, processing, analysis and visualization.
6. System automation: management and automation of IoT systems.
7. Security and personal data: ensuring authenticity, credibility and integrity of data.
8. Implementation of IoT solutions: development, testing and application of IoT systems in practice.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops	☒ independent work ☐ multimedia and network

	☒ practical's ☐ remote learning ☐ field work	☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is obliged to attend classes regularly and fulfill the obligations according to the teaching plan in accordance with the Study Regulations. Absences from classes during the semester may not exceed 20% of the lecture and practical hours of the course for full-time students, or 40% for part-time students. A student who has missed more than 50% of the class hours (regardless of the reasons for the absence) is obliged to re-enroll in that course in the following academic year.

Attendance is mandatory, and taking an exam is the student's right and is carried out according to the continuity conditions. The continuity conditions include the prerequisites for enrolling in a course and taking an exam.

At the beginning of the semester, the teacher announces the conditions under which classes are conducted: the percentage of mandatory attendance and participation in classes, and the number and method of knowledge assessment during the semester, including their evaluation (the right to sign, exemption from part or all of the exam, etc.).

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class		Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Homework	X				

1.8. *Assessment and evaluation of student work during classes and the final exam*

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Seminar paper	Total	Passing the exam
LO1	13,33%		3,33%	16,66%	8,33%
LO2	13,33%		3,33%	16,66%	8,33%
LO3	13,33%		3,33%	16,66%	8,33%
LO4		13,33%	3,33%	16,66%	8,33%
LO5		13,33%	3,33%	16,66%	8,33%
LO6		13,33%	3,33%	16,66%	8,33%
%	40,00%	40,00%	20,00%	100,00%	50,00%
Share of ECTS	1,60	1,60	0,80	4,00	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	11,66%	5,00%	16,66%	8,33%
LO2	11,66%	5,00%	16,66%	8,33%
LO3	11,66%	5,00%	16,66%	8,33%
LO4	11,66%	5,00%	16,66%	8,33%
LO5	11,66%	5,00%	16,66%	8,33%
LO6	11,66%	5,00%	16,66%	8,33%
%	70,00%	30,00%	100,00%	50,00%
Share of ECTS	2,80	1,20	4,00	

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
J. Soldatos: A 360-Degree View of IoT Technologies	https://www.math.hkust.edu.hk/~machas/numerical-methods.pdf	

1.10. Supplementary readings

D. Guinard, V. Trifa, Building the Web of Things, Manning Publications, 2016

D. Hanes, et al.: IoT Fundamentals, Cisco Press

1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive

application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**mr. sc. Vedran Vyroubal, s. lecturer**	
Course name	**Robot Programming (ROS)**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Elective	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	4
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The aim of the course is to develop the ability to model, simulate, and program robotic systems using ROS, including the implementation of advanced techniques such as SLAM for optimizing mobile robots. Students will learn to integrate system functionalities and optimize robotic systems for real-time operation by analyzing physical interactions in simulations and real-world applications.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Rank robots and environments for various applications by analyzing physical interactions in simulations.
LO2: Support robotic systems using ROS to validate system functionality.
LO3: Re-examine control systems for mobile robots using ROS and evaluate techniques such as SLAM.
LO4: Recommend real-time systems based on application requirements.

1.4. *Course content*

1. Introduction to robotic systems and environment modeling for simulations – Introduction to the fundamentals of robotic systems and modeling methods for simulations. Understanding physical interactions (kinematics, dynamics) in simulations and applying tools for modeling objects and environments.
2. Development and simulation of robotic systems – Modeling robotic systems with a focus on kinematics and dynamics. Application of coordinate systems, transformations, and kinematic equations, as well as trajectory and path creation for various tasks.
3. Understanding and applying ROS for robotic systems – Fundamentals of ROS: nodes, messages, topics, and packages. Development and configuration of ROS nodes for robot control and application of advanced ROS packages for mobile and industrial robots.
4. SLAM (Simultaneous Localization and Mapping) for mobile robots – Introduction to SLAM techniques for robot localization and map generation in unknown environments. Implementation of SLAM in ROS for mobile robots in simulation environments.
5. Programming robotic systems in real time – Challenges of real-time programming. Optimization of robotic systems for real-time operation, task management, and experimentation in the lab (e.g., mobile robots with the Optitrack system).

6. Advanced applications and case studies in robotic systems – Application of learned concepts in advanced use cases such as autonomous robot navigation. Analysis of case studies from industry and research.		
1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☒ practicals ☐ remote learning ☐ field work	☒ independent work ☐ multimedia and network ☒ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfill obligations in accordance with the course delivery plan, as stipulated by the Study Regulations. Absences during the semester must not exceed 20% of the total lecture and exercise hours for full-time students, and 40% for part-time students. A student who misses more than 50% of the total hours (regardless of the reason) must re-enroll in the course in the following academic year. Class attendance is an obligation, while taking the exam is a student's right and is subject to prerequisite conditions. These conditions include course enrollment requirements and exam eligibility. At the beginning of the semester, the instructor announces the conditions under which the course will be delivered: the required percentage of attendance and participation, as well as the number and method of knowledge assessments during the semester, including their evaluation (eligibility for course signature, exemption from parts or the entirety of the final exam, etc.).

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper	X	Experimental work	
Written exam	X	Oral exam	X	Essay		Research	
Project		Continuous assessment of knowledge	X	Student report		Practical work	X
Portfolio		Home Assignment					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Oral	Total	Passing the exam
LO1	15%	10%		25%	12,5%
LO2	15%	10%		25%	12,5%
LO3		10%	15%	25%	12,5%
LO4		10%	15%	25%	12,5%
%	30%	40%	30%	100	50
Share of ECTS	1,2	1,6	1,2	4	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	15%	10%	25%	12,5%
LO2	15%	10%	25%	12,5%
LO3	15%	10%	25%	12,5%
LO4	15%	10%	25%	12,5%
%	60%	40%	100	50
Share of ECTS	2,4	1,6	4	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*

J. M. O'Kane: A Gentle Introduction to ROS	https://jokane.net/agitr/	25
ROS Official documentation	http://wiki.ros.org/ROS/Tutorials	25
ROS Robot Programming	https://www.pishrobot.com/wp-content/uploads/2021/05/ros-robot-programming-book-by-turtlebo3-developers-en.pdf	25

1.10. *Supplementary readings*

1.11. *Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.*

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

COURSE DESCRIPTION

GENERAL INFORMATION		
Lead instructor	**dr. sc. Nikola Šimunić, prof.**	
Course name	**Maintenance of Machinery and Systems**	
Study programme	**Professional graduate study MECHATRONICS**	
Course status	Elective	
Year	2.	
Number of credits and mode of delivery	ECTS student workload coefficient	4
	Number of hours (L+P+S)	30+30+0

COURSE DESCRIPTION

1.1. *Course aims*

The course aims to provide students with both theoretical knowledge and practical experience in maintaining individual machines and complex industrial systems.

1.2. *Course enrolment requirements*

-

1.3. *Intended course learning outcomes*

LO1: Compare different maintenance strategies: preventive (scheduled), corrective, and reactive maintenance.
LO2: Recognize maintenance as an integral component of established quality control systems.
LO3: Recommend appropriate resources for maintenance processes.
LO4: Evaluate maintenance planning procedures.
LO5: Forecast requirements for developing maintenance schedules.
LO6: Assess the purpose and activities involved in maintenance operations.

1.4. *Course content*

1) Introduction to Maintenance and Its Importance: Fundamental maintenance concepts and the role of maintenance in industrial plants, including work with conventional machine tools.
2) General Maintenance Principles and CNC Machine Maintenance: Overview of industry-wide maintenance principles, with a focus on the specific requirements for maintaining CNC machine tools.
3) Maintenance within Quality Control and Industrial Hoists: Maintenance as a key element of quality control, applied to the upkeep of industrial hoist systems.
4) Maintenance Technology Design and Pipeline Systems: Designing maintenance strategies for various industrial systems, including pipelines and their monitoring.
5) Network-Based Maintenance Planning in Industrial Facilities: The importance of network planning for optimizing maintenance processes in “S”-type industrial plants.
6) Classification of Maintenance Tools and Equipment for Pumping Stations: Tools and equipment used for maintaining industrial pumping station systems.

7) Maintenance for Readiness Scheduling and Base Station Infrastructure: Principles of maintenance in the context of operational readiness planning, illustrated by base station (telecom tower) maintenance.
8) Equipment Downtime and Base Station Maintenance – Antenna Supports: Impact of equipment failures on production processes, focusing on maintenance of telecom base station antenna mounts.
9) Maintenance under Regulatory Requirements and Transport Systems: Regulatory frameworks governing maintenance, including upkeep of inclined and horizontal transport systems such as winches.
10) Cost Analysis of Equipment Downtime and Ropeway Maintenance: Evaluating downtime costs and maintenance strategies for ropeway systems in industrial and tourism applications.
11) Preventive Maintenance Planning and Its Impact on Production Cycles: Planning preventive maintenance, assessing its effects on production cycles and product costs, with examples such as biodisk systems.
12) Advanced Maintenance Technologies and Bioreactor Rotor Upkeep: New maintenance technologies and approaches, with applications to industrial bioreactor rotor systems.
13) Field Study of Ropeway Operation under Real Conditions: Analysis of ropeway system operation through on-site training at ropeway and winch facilities.
14) Role of Pumping Station Components in Maintenance (Field Training): Examining the function of pumping station elements via hands-on field exercises.
15) Sliding Bearing Maintenance in Industry and Base Stations: Specific practices for maintaining sliding bearings, including field training focused on telecom base station bearings.

1.5. *Modes of delivery (mark the appropriate boxes with an X)*	☒ lectures ☐ seminars and workshops ☐ practicals ☐ remote learning ☒ field work	☒ independent work ☐ multimedia and network ☐ laboratory ☐ supervision ☐ other _____

1.6. *Student obligations*

The student is required to regularly attend classes and fulfil obligations according to the syllabus in accordance to the Regulations on Studying. Class absence during the semester must not exceed 20% of the total hours of lectures and practicals for full-time students and 40% for part-time students. A student who has missed more than 50% of the hours of scheduled lectures (regardless of the reasons for the absence) must re-enrol in the course the following academic year.

Class attendance is mandatory while taking the exam is a student's right performed in accordance with course sequencing. Course sequencing includes pre-requisites for enrolling into the class and taking the exam. At the beginning of the semester, the lead instructor announces conditions under which teaching takes place: the percentage of mandatory attendance and participation in class, and the number and manner of examination during the semester, including evaluation (exemption from parts or the entire exam, etc.)

1.7. *Monitoring student work (mark the appropriate boxes with an X)*

Class attendance	X	Participation in class	X	Seminar paper		Experimental work	
Written exam	X	Oral exam	X	Essay		Research	

Project		Continuous assessment of knowledge	X	Student report		Practical work	
Portfolio		Home Assignment					

1.8. *Assessment and evaluation of student work during classes and the final exam*

Student assessment is defined by Regulations on Evaluation and Regulations on Studying, and is based on the evaluation of specific learning outcomes of the course defined in the course syllabus. Assessment methods of learning outcomes are: written tests, oral tests, participation in class and extra-curricular activities. Assessment takes place continously or on the exam date through written or oral tests. The student has achieved learning outcomes if she/he has acquired at least 50% of intended points for each learning outcome of the course.

Continuous verification:

Outcome	Colloquium 1	Colloquium 2	Colloquium 3	Total	Passing the exam
LO1	20%			20%	10%
LO2	10%			10%	50%
LO3		15%		15%	7,5%
LO4		15%		15%	7,5%
LO5			20%	20%	10%
LO6			20%	20%	10%
%	30%	30%	40%	100	50
Share of ECTS	1,2	1,2	1,6	4	

Exam period:

Outcome	Written exam	Oral exam	Total	Passing the exam
LO1	10%	5%	15%	7,5%
LO2	10%	5%	15%	7,5%
LO3	10%	10%	20%	10%
LO4	10%	5%	15%	7,5%
LO5	10%	5%	15%	7,5%
LO6	10%	10%	20%	10%
%	60%	40%	100	50
Share of ECTS	2,4	1,6	4	

The national numerical grading system and the European Credit Transfer and Accumulation System (ECTS) are used for assessment:

Percent	Grade description	Numeric grade	ECTS grade
90% - 100%	Excellent	5	A
80% - 89,9%	Very Good	4	B
65% - 79,9%	Good	3	C
50% - 64,9%	Satisfactory	2	D
0% - 49,9%	Fail	1	F

The course syllabus may determine types of assignments that can be assessed without testing or through descriptive assessment.

1.9. *Required readings and number of copies relative to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
I. Čala: Održavanje opreme	https://www.fsb.unizg.hr/atlantis/upload/newsboard/20_03_2011__12557_Odrzavanje_050310.pdf	
B. Mijović: Održavanje strojeva i uređaja	https://www.vuka.hr/images/50013954/Budimir_Mijovic_Odrzavanje_strojeva_i_uredjaja.pdf	

1.10. *Supplementary readings*

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1.11. Methods of quality monitoring that ensure the acquisition of knowledge, skills and competences.

Quality monitoring is carried out in accordance with the Regulations on Quality Assurance and the Regulations on Studying. Quality monitoring entails registration procedures, implementation of teaching and examination, and completition of studies, aimed at ensuring student mobility within and between higher education systems. Monitoring methods include surveys of students and teachers. Quality monitoring is conducted continously by collecting and monitoring information on student's progress, and through a retroactive application based on gathered information to ensure conditions and support related to improving the quality of studying.

4.2. ADDITIONAL ANNEXES

1. Decision of the University Council on initiating the professional graduate study programme in Mechatronics and appointing the Committee for drafting the proposal for the professional graduate study programme in Mechatronics

   Decision Annex

2. Opinion of the Quality Assurance Committee of the Karlovac University of Applied Sciences
3. Decision of the Council of the Karlovac University of Applied Sciences on the acceptance of the professional graduate study programme in Mechatronics
4. Decision of the Governing Board on accepting the professional graduate study programme in Mechatronics
5. Teachers' CVs
6. Decisions on appointment to the position of teacher

List of internal regulations of the University:

1. Quality assurance policy
2. Regulations on Quality Assurance
3. Regulations on the Procedure for Developing, Improving and Revising Study Programmes
4. Regulations on Studying
5. Regulations on Assessment
6. Regulations on Awarding ECTS Credits
7. Regulations on Proceedings Following the Evaluation of Teaching Performance of Teachers and Study Programmes
8. Regulations on Student Practice
9. Regulations on the Internal Organisation and Structure of Work Positions of the Karlovac University of Applied Sciences
10. Regulations on Library Work
11. Regulations on the Organisation and Activities of the Centre for Support for Students with Disabilities

In Karlovac, July 23rd, 2025

Dean

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Ivan Štedul, MSc, senior lecturer

PLEASE NOTE:

- The signed and verified application form must be submitted, along with the required documentation, in electronic form to: pisarnica@azvo.hr

- If the submitted documents are not complete, the applicant shall be notified of the need to submit additional documents in writing.