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CAS PROD

PROGRAMME SUBJECT DESCRIPTION[1]

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Contents

1 INTRODUCTION

Smart, interconnected products offer opportunities for new functionality, reliability and product utilization. The design and development process of such products requires engineers, technicians and other staff that are not only specialised in one core profession, but with multidisciplinary knowledge and skills. Furthermore, product development rarely only runs in a single company, nor in a single country. This leads to enhanced collaboration requirements and therefore, respective workforce skills.

Although most of the engineering programmes recognise this development paradigm shift, they do not implement it in their education due to the limited staff, knowledge, financial resources, or options regarding international collaboration.

The partners involved in this project believe that with the support of Erasmus+ Strategic Partnership, it is possible to overcome these issues, to start a long-term international collaboration in that field, and to initiate a student exchange between project partner institutions according to the Bologna principles.

This short document together with course mapping is a reference document for development of CASPROD curriculum.

2 CURRICULUM STRUCTURE

The joint master programme between University of Zagreb, Faculty of Mechanical Engineering and Naval Architecture (UZ), University of Ljubljana, Faculty of Mechanical Engineering (UL), and Technical University of Vienna, Faculty of Mechanical Engineering (TUW) is divided into 4 semesters, 30 ECTS each. The first semester will be held at UZ, the second at UL and the third at TUW. The fourth one will be dedicated to master thesis and can be held at any of the stated universities according to student's preferences:

- 1st semester: University of Zagreb
- 2nd semester: University of Ljubljana
- 3rd semester: TU Wien
- 4th semester: Master thesis at UZ, UL or TUW

The contents of the programme are structured into 6 streams of different disciplines:

- Stream 1: Product development
- Stream 2: Digital Manufacturing & Information Systems
- Stream 3: Big Data Systems
- Stream 4: Innovation & Entrepreneurship
- Stream 5: Transferable Skills
- Stream 6: Integration Project

Additionally, the students have to select courses with at least 13 ECTS from a pool of selective subjects. This allows the students to put emphasis on any of first five streams, depending on their preferences. The ECTS are evenly distributed over the first three semesters.

The programme is based on the core characteristics of engineering: the iterative process of designing, predicting performance, building and testing. Such contents of the courses and application of project-based learning as pedagogy will enable building of appropriate technical and professional competences, such as problem solving, communication and teamwork.

3 1ST SEMESTER: UNIVERSITY OF ZAGREB

3.1 1st Semester Courses list – UZ-FSB

3.1.1 Courses table

COURSE	LECTURE HOLDER	ECTS:	Str1: Prod.dev.	Str2: Dig.Manuf. & Inf.sys	Str3: Big data sys.	Str4: Innov.&Entrep.	Str5: Transf. Skills	Integration project	Electives	
Computer Integrated Products Development	Štorga M., Škec S.							4		
Mechatronics and Sensors Systems	Petrić J., Pavković D.		5							
Digital Manufacturing Sytemes	Staroveški T., Brezak D.			5						
Advanced Engineering Informatics	Bojčetić N., Pavković, N.				4					
Innovation Management in Product Development	Škec S., Štorga M.					4				
Design for Sustainability	Štorga M., Škec S.						4			
Elective 1									4	
		SUM:	**5**	**5**	**4**	**4**	**4**	**4**	**4**	**30**

3.1.2 Elective courses

COURSE	LECTURE HOLDER	ECTS:	Str1: Prod.dev.	Str2: Dig.Manuf. & Inf.sys	Str3: Big data sys.	Str4: Innov.&Entrep.	Str5: Transf. Skills
Quality Management in Engineering	Runje B., Horvatic A.	4				4	
Biomimetic Systems and Humanoid Robotics	Jerbić B., Švaco M.	4		4			
Advanced Materials	Žmak I., Matijević B.	4	4				
Electric and Hybrid Vehicles	Deur J., Petrić J.	4	4				
Engineering Logistics	Đukić G., Opetuh T.	4				4	

3.2 Obligatory Courses Descriptions

3.2.1 Computer Integrated Product Development

Štorga Mario, Škec Stanko

<table>
<tr><th colspan="5">1. GENERAL INFORMATION</th></tr>
<tr><td>1.1. Course teacher</td><td colspan="2">Mario Štorga
Stanko Škec</td><td>1.6. Year of the study</td><td>1</td></tr>
<tr><td>1.2. Name of the course</td><td colspan="2">Computer Integrated Product Development</td><td>1.7. ECTS credits</td><td>4</td></tr>
<tr><td>1.3. Associate teachers</td><td colspan="2"></td><td>1.8. Type of instruction (number of hours L + E + S + e-learning)</td><td>30+30</td></tr>
<tr><td>1.4. Study programme (undergraduate, graduate, integrated)</td><td colspan="2">Graduate</td><td>1.9. Expected enrolment in the course</td><td>15</td></tr>
<tr><td>1.5. Status of the course</td><td>☒ mandatory</td><td>☐ elective</td><td>1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)</td><td>2</td></tr>
<tr><th colspan="5">2. COUSE DESCRIPTION</th></tr>
<tr><td>2.1. Course objectives</td><td colspan="4">The goal of the course is to use the project-based learning of integration of the research and development into business strategy of the whole corporation. The focus of the course is on organizational aspects of the product development and teamwork management, usage of computer aided tools in all phases of product development, management of information and knowledge, complexity management and product-service system paradigm introduction.</td></tr>
<tr><td>2.2. Enrolment requirements and/or entry competences required for the course</td><td colspan="4">Basic understanding of the product development process and engineering design methods.</td></tr>
<tr><td>2.3. Learning outcomes at the level of the programme to which the course contributes</td><td colspan="4">Mechanical Engineering - University graduate

General University graduate
Apply modern computer aided technologies to solve engineering problems.
Collaborate efficiently within professional teams and adapt to the teamwork requirements.</td></tr>
</table>

<table>
<tr><td>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td>To explore the technology state of the art for the development of technical systems.
To critically assess existing solutions to the technical problems.
To propose innovative ways to solve technical problems in technical systems development.
To integrate development and simulation of the technical systems and services that are related to their implementation.
To manage complexity in development of the technical systems.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td>
<table>
<tr><th>Week</th><th>Lecture</th><th>Exercises</th></tr>
<tr><td>1.</td><td>Introduction to integrated product development.</td><td></td></tr>
<tr><td>2.</td><td>Smart products development for the industry of the future.</td><td>Project: Technology landscaping, understanding development opportunities and conceptual design of product-service system.</td></tr>
<tr><td>3.</td><td>Computer aided innovativeness (CAI).</td><td>Teamwork.</td></tr>
<tr><td>4.</td><td>Product-service systems development.</td><td>Teamwork.</td></tr>
<tr><td>5.</td><td>Team task 1 presentations.</td><td>Teamwork.</td></tr>
<tr><td>6.</td><td>Complexity management in product development.</td><td>Teamwork.</td></tr>
<tr><td>7.</td><td>Numerical and analytical modelling in product development.</td><td>Teamwork.</td></tr>
<tr><td>8.</td><td>Statistical analysis of the prototype experimentation in product development.</td><td>Teamwork.</td></tr>
<tr><td>9.</td><td>Computer aided decision making and multi-criteria decision making.</td><td>Teamwork.</td></tr>
<tr><td>10.</td><td>Team task 2 presentations.</td><td>Teamwork.</td></tr>
<tr><td>11.</td><td>Computer synthesis in product development.</td><td>Teamwork.</td></tr>
<tr><td>12.</td><td>Business aspects of the development projects.</td><td>Teamwork.</td></tr>
<tr><td>13.</td><td>Data-driven product development.</td><td>Teamwork.</td></tr>
<tr><td>14.</td><td>New ICT in product development.</td><td>Teamwork.</td></tr>
<tr><td>15.</td><td>Team task 3 presentations.</td><td>Teamwork.</td></tr>
</table>
</td></tr>
</table>

2.6. Format of instruction:	☒ lectures ☐ seminars and workshops ☐ exercises ☐ online in entirety ☐ partial e-learning ☐ field work			☒ independent assignments ☐ multimedia and the internet ☐ laboratory ☒ work with mentor ☐ (other)			2.7. Comments:		
2.8. Student responsibilities									
2.9. Monitoring student work	Class attendance	**YES**	NO	Research	YES	NO	Oral exam	YES	**NO**
	Experimental work	YES	**NO**	Report	**YES**	NO	Project work	**YES**	NO
	Essay	YES	**NO**	Seminar paper	YES	**NO**	(other)	YES	**NO**
	Preliminary exam	YES	**NO**	Practical work	YES	**NO**	(other)	YES	**NO**
	Project	**YES**	NO	Written exam	YES	**NO**	ECTS credits (total)	4	

	Title	**Number of copies in the library**	**Availability via other media**
2.1. Required literature (available in the library and/or via other media)		1	
		1	
		1	
2.11. Optional literature	Handouts from the lectures.		
2.12. Other (as the proposer wishes to add)			

3.2.2 Mechatronics and Sensors Sytems

Petrić Joško, Pavković Danijel

1. GENERAL INFORMATION				
1.1. Course teacher	Prof. dr.sc. Joško Petrić Prof. dr.sc. Danijel Pavković		1.6. Year of the study	1
1.2. Name of the course	Mechatronics and Sensor Systems		1.7. ECTS credits	5
1.3. Associate teachers	Dr.sc. Mario Hrgetić Dr.sc. Mihael Cipek		1.8. Type of instruction (number of hours L + E + S + e-learning)	30+30+0+0
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.9. Expected enrolment in the course	15
1.5. Status of the course	**X** mandatory	☐ elective	1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	2, (10%)
2. COUSE DESCRIPTION				
2.1. Course objectives	The Mechatronics concerns the synergistic application of mechanics, electronics and control systems. The course objective is to get acquainted with modeling, analysis and synthesis of mechatronic systems. After completing the course, students should acquire basic knowledge and skills on the analysis and synthesis of mechatronic products or production processes. This implies knowledge of basic concepts from mechatronics, knowledge of the basics of modeling and control of mechanical systems, and knowledge of the basic elements of a mechatronic system. It also provides an overview of methods and practical solutions of digital microprocessor control, with reference to digital control elements, microcomputers, connection circuits, sensors and actuators, and time-sensitive (digital) control algorithms. The course objective is to complement the theoretical background of lectures with exercises on experimental laboratory systems.			
2.2. Enrolment requirements and/or entry competences required for the course	No special requirements.			
2.3. Learning outcomes at the level of the programme to which the course contributes	• To actively use and participate in the development of information technology for resolving engineering issues. • To take on a leading role in an interdisciplinary team of experts. • To participate in lifelong learning processes and scientific research work and continue further education at specialist and doctoral studies.			

<table>
<tr><td>2.4. Exected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td colspan="3">• To apply advanced knowledge in the field of natural and technical sciences to solve complex technical problems in the interdisciplinary context.
• To apply acquired knowledge about the elements of the smart technical systems and processes, and their interactions throughout their entire life cycle.
• To use advanced techniques for modelling smart technical systems and processes in the function of creative solving of complex problem.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td>Week</td><td>Lecture</td><td>Exercises</td></tr>
<tr><td></td><td>1.</td><td>Introduction in mechatronics, historical review</td><td>Getting acquainted with some mechatronic examples</td></tr>
<tr><td></td><td>2.</td><td>Mathematical models of mechanical systems aimed for control</td><td>Transfer function, blocks algebra, model in Matlab / Simulink</td></tr>
<tr><td></td><td>3.</td><td>Analysis of mechanical system model in time domain</td><td>Response to standard input functions, time response properties, damping coefficient and time constant</td></tr>
<tr><td></td><td>4.</td><td>Controllers, stability and error analysis</td><td>PID controller, design and tuning</td></tr>
<tr><td></td><td>5.</td><td>Frequency domain analysis</td><td>Obtaining frequency characteristics, Bode diagrams</td></tr>
<tr><td></td><td>6.</td><td>Introduction into hydraulic and pneumatic actuators</td><td>Basic hydraulics or pneumatics elements and schemes</td></tr>
<tr><td></td><td>7.</td><td>Electro-pneumatic control</td><td>Design and analysis of electro-pneumatic control examples</td></tr>
<tr><td></td><td>8.</td><td>Some aspects of control of mechatronics systems, recapitulation</td><td>1st Colloquium</td></tr>
<tr><td></td><td>9.</td><td>Structure of microcontroller system</td><td>Industrial programmable logic controllers</td></tr>
<tr><td></td><td>10.</td><td>Concepts of input/output data transfer, I/O devices</td><td>Control logic, programming examples</td></tr>
<tr><td></td><td>11.</td><td>A/D and D/A converters, implementations and performance</td><td>Analysis of typical D/A and A/D converter circuits</td></tr>
<tr><td></td><td>12.</td><td>Sensors and actuators, designs, specifications and characteristics</td><td>Analysis of sensor-transducer measurement chain, low-power DC electric drive as typical actuator in mechatronic systems</td></tr>
</table>

	13.	Introduction to digital control, control system structure, sampling and Shannon theorem, aliasing effect	Analysis of sampled signals, illustration of aliasing effect and benefits of inclusion of anti-aliasing filters
	14.	Z transform and closed-loop system transfer function, pole locations of the closed-loop control system	Equivalent continuous-time domain effects of signal sampling, equivalent closed-loop model, discrete-time PID controller design in continuous-time Laplace domain
	15.	Practical aspects of digital PID control algorithm implementation: controller structures, introduction of direct feed-forward action, controller output limitation and reset-anti-windup intervention	2nd Colloquium

2.6. Format of instruction:	**X** lectures ☐ seminars and workshops **X** exercises ☐ online in entirety ☐ partial e-learning ☐ field work	☐ independent assignments **X** multimedia and the internet **X** laboratory ☐ work with mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	Teaching consists of lectures, auditoriums and laboratory exercises where the attendance of a student is compulsory. Laboratory exercises will be important way of studying this subject. Lectures are organized to better understand the work of real mechatronic systems. The elements for forming the final grade are the activity, the preparation of independent tasks, the two written preliminary exam (or colloquiums), (or one written exam substitution) and the oral exam, and the elements of the assessment are given in the following proportions: 10% of the final grade is participation in the classroom, including taking part in exercises, making practical work and experimenting; 30% make each of the two colloquiums in the final grade (alternatively, 60% of the marks make a success on a written exam); 30% of the final grade makes the seminar work or knowledge shown on the final (oral) exam.		

2.9. Monitoring student work	Class attendance	YES		Research		NO	Oral exam	YES	
	Experimental work	YES		Report		NO	(other)	YES	NO
	Essay		NO	Seminar paper	YES		(other)	YES	NO
	Preliminary exam	YES		Practical work	YES		(other)	YES	NO

	Project		NO	Written exam	YES		ECTS credits (total)	

	Title	**Number of copies in the library**	**Availability via other media**
2.10. Required literature (available in the library and/or via other media)	Internal teaching material for the subject	NO	YES
	W.S. Levine, The Control Handbook – Control Systems Fundamentals, CRC Press, 2011.	YES	YES
	C. L. Phillips, T. Nagle, A. Chakrabortty: "Digital control systems, Analysis & Design", 4th edition, Prentice-Hall, 2014.	NO	NO
2.11. Optional literature	1. K.J. Astrom and R.M. Murray, Feedback Systems – An Introduction for Scientists and Engineers, Princeton University Press, 2008. 2. C.W. de Silva, Mechatronics – An Integrated Approach, CRC Press, 2004. 3. D.K. Lindner, Introduction to Signals and Systems, Mc-Graw-Hill, 1999 4. K.J. Åström, and T. Hägglund, PID Controllers: Theory, Design and Tuning, 2nd ed., Instrument Society of America, 1995.		
2.12. Other (as the proposer wishes to add)			

3.2.3 Digital Manufacturing Systems

Brzak Danko, Staroveški Tomislav

1. GENERAL INFORMATION				
1.1. Course teacher	Tomislav Staroveski Danko Brezak		1.6. Year of the study	1
1.2. Name of the course	Digital Manufacturing Systems		1.7. ECTS credits	5
1.3. Associate teachers			1.8. Type of instruction (number of hours L + E + S + e-learning)	30+30+0+0
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.9. Expected enrolment in the course	15
1.5. Status of the course	☑ mandatory	☐ elective	1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	1
2. COUSE DESCRIPTION				
2.1. Course objectives	Introduction to signals (analog and digital) used in manufacturing systems. Industrial networks and communication systems - wired and wireless networks used for integration of different machine components with its control system, as well as for interconnection of multiple machines and/or manufacturing systems. Characteristics of different types of sensors used in the manufacturing systems (machine vision, force, pressure, temperature, acceleration, acoustic emission, position and velocity measuring, etc.). Programmable logic controllers - interfaces for communication and control, programming, applications. Computer numerical control (CNC) systems of machine tools - elements of CNC system, types of electromotors and drives used in manufacturing systems, control loop configurations and controller parameters adjustment, real-time control. Direct and indirect monitoring systems - characteristics, applications, advantages/disadvantages.			

<table>
<tr><td>2.2. Enrolment requirements and/or entry competences required for the course</td><td>Passed courses related to basics of automation control, machining systems and artificial intelligence algorithms</td></tr>
<tr><td>2.3. Learning outcomes at the level of the programme to which the course contributes</td><td>• To conduct oral and written communication on engineering issues, and publicly present professional results and own conclusions at the international level
• To actively use and participate in the development of information technology for resolving engineering issues.
• To take on a leading role in an interdisciplinary team of experts.
• To apply acquired knowledge about the elements of the smart technical systems and processes, and their interactions throughout their entire life cycle.
• To evaluate solutions and calculations of elements of smart technical systems and processes in the field of narrower specialisation.
• To design smart technical systems and processes in the area of functional specialisation and conduct prototyping and documentation.</td></tr>
<tr><td>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td>• To identify and chose suitable type of industrial communication system
• To choose and implement adequate industrial sensors
• To choose and implement programmable logic controllers
• To compare different types of servo-systems
• To tune parameters of P-I-D type of controllers
• To integrate servo-systems and monitoring modules into an advanced CNC system.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td>
<table>
<tr><td>Week</td><td>Lecture</td><td>Exercises</td></tr>
<tr><td>1.</td><td>Basics of computer numerical control (CNC) systems</td><td>Demonstration on CNC machine tool</td></tr>
<tr><td>2.</td><td>Industrial networks and communication systems</td><td>Demonstration on different machines</td></tr>
<tr><td>3.</td><td>CNC system structure – interpolators</td><td>Demonstration on CNC machine tool</td></tr>
<tr><td>4.</td><td>Sensors in feedback control</td><td>Position and velocity sensors of the servo-system</td></tr>
<tr><td>5.</td><td>Electric servo-motors – synchronous and asynchronous</td><td>Characteristics of electrical motors</td></tr>
<tr><td>6.</td><td>Open and closed loop control of machine drives</td><td>Programmable logic controllers</td></tr>
<tr><td>7.</td><td rowspan="2">Synthesis of the closed-loop control</td><td>Cascade loop tuning – torque/current loop</td></tr>
<tr><td>8.</td><td>Cascade loop tuning – velocity loop</td></tr>
<tr><td>9.</td><td>Vision systems – types and characteristics</td><td>Cascade loop tuning – position loop</td></tr>
</table>
</td></tr>
</table>

	10.		Design of direct monitoring system – equipment selection and measurement
	11.	Vision systems – data processing	Design of direct monitoring system – data processing
	12.	Indirect monitoring systems – types and characteristics	Design of indirect monitoring system – equipment selection and measurement
	13.	Indirect monitoring systems – data processing	Design of indirect monitoring system – data processing
	14.	Machining process control - adaptive control systems	OAC systems
	15.	Machining process control - optimal control systems	OAC systems

2.6. Format of instruction:	☑ lectures ☐ seminars and workshops ☑ exercises ☐ online in entirety ☐ partial e-learning ☐ field work	☐ independent assignments ☐ multimedia and the internet ☑ laboratory ☐ work with mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	To attend lecturers and exercises, successful completion of laboratory exercises, writing term paper and oral exam.		

2.9. Monitoring student work	Class attendance	YES	NO	Research	YES	NO	Oral exam	YES	NO
	Experimental work	YES	NO	Report	YES	NO	(other)	YES	NO
	Essay	YES	NO	Seminar paper	YES	NO	(other)	YES	NO
	Preliminary exam	YES	NO	Practical work	YES	NO	(other)	YES	NO
	Project	YES	NO	Written exam	YES	NO	ECTS credits (total)	5	

	Title	Number of copies in the library	Availability via other media
2.10. Required literature (available in the library and/or via other media)	1. Altintas, Y.: Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and Cnc Design, Cambridge UniversityPress, 2012.		☑
	2. Suh, S.-H., Kang, S.-K., Chung, D.-H., Stroud, I.: Theory and Design of CNC Systems, Springer-Verlag London, 2008		☑
2.11. Optional literature	PPT presentation and other course materials		
2.12. Other (as the proposer wishes to add)			

3.2.4 Advanced Engineering Informatics

Bojčetić Nenad, Pavković Neven

1. GENERAL INFORMATION				
1.1. Course teacher	Neven Pavković Nenad Bojčetić		1.6. Year of the study	1
1.2. Name of the course	Advanced Engineering Informatics		1.7. ECTS credits	4
1.3. Associate teachers	Jasmin Juranić Filip Valjak		1.8. Type of instruction (number of hours L + E + S + e-learning)	30+30+0+0
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.9. Expected enrolment in the course	15
1.5. Status of the course	☒ mandatory	☐ elective	1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	2
2. COUSE DESCRIPTION				
2.1. Course objectives	Introduction to artificial intelligence. Getting basic knowledge of expert systems. Obtaining a deeper understanding of engineering design, and how advanced information technologies might be used to support it and study it. Working on experimental development project of advanced IT (AI) system for design process support in particular domain. Introduction to methods and tools for developing IoT (Internet of Things) compliant products.			
2.2. Enrolment requirements and/or entry competences required for the course	Basic skills in computer programming. Basic understanding of FBD (Feature Based Design) and 3D CAD model creation. Medium understanding of computer usage and working principles.			

<table>
<tr><td>2.3. Learning outcomes at the level of the programme to which the course contributes</td><td>Mechanical Engineering - University graduate
Apply advanced knowledge of natural and engineering sciences for the purpose of solving complex technical problems in an interdisciplinary context.
Plan, undertake and monitor activities for solving complex technical problems.
Use advanced techniques for modelling technical systems and processes for the purpose of creative solving of complex problems in the field of mechanical engineering and allied engineering fields.
Evaluate solutions and calculations of elements of technical systems and processes in the area of specialization.
Design technical systems and processes in the area of specialization and manage the preparation of technical documentation.
General University graduate
Communicate engineering issues both in oral and written form and present professional results and own conclusions in public on the international level.
Use and participate in the development of computer technology in the area of engineering.
Lead an interdisciplinary team.</td></tr>
<tr><td>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td>By mastering the course the student will be able:
- to independently develop a programming tool for solving a partial problem in product development process
- To design and develop a component of complex software system - the emphasis is put on numerical calculations and CAD systems
customizations and extensions
- to justify the investments for development and/or purchasing of complex (advanced) software support
- to rank the current programming techniques and methodologies, to be aware of and able to compete with problems in development and implementation of complex software tools and systems
- to understand basic principles of IoT and its role in product design.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td>
<table>
<tr><th>Week</th><th>Lecture</th><th>Exercises</th></tr>
<tr><td>1.</td><td>Introduction to artificial intelligence. A historical survey of AI development and application areas.</td><td>Refresh in programming skills</td></tr>
<tr><td>2.</td><td>Basics of techniques and tools in AI</td><td>Refresh in programming skills</td></tr>
<tr><td>3.</td><td>Basic introduction to Big Data</td><td>Advances in programming skills</td></tr>
<tr><td>4.</td><td>AI frameworks</td><td>Individual work</td></tr>
<tr><td>5.</td><td>Extended CAD systems: designer's workbenches.</td><td>Individual work</td></tr>
<tr><td>6.</td><td>Extended CAD systems: customization - basics</td><td>CAD application customization: teaching example</td></tr>
<tr><td>7.</td><td>Extended CAD systems: customization - support</td><td>CAD application customization: real industry example</td></tr>
<tr><td>8.</td><td>Extended CAD systems: customization - examples</td><td>CAD application customization: individual work</td></tr>
<tr><td>9.</td><td>Internet of Things: system thinking</td><td>CAD application customization: individual work</td></tr>
<tr><td>10.</td><td>Internet of Things: what it is</td><td>IoT: getting started</td></tr>
<tr><td>11.</td><td>Internet of Things: application examples</td><td>IoT: acquiring sensor data</td></tr>
<tr><td>12.</td><td>Internet of Things: relevance in engineering</td><td>IoT: controlling DC motors</td></tr>
<tr><td>13.</td><td>Internet of Things: frameworks</td><td>IoT: REST (IoT server communication)</td></tr>
</table>
</td></tr>
</table>

	14.	Internet of Things: analytics	IoT: individual work
	15.	Recapitulation, discussions and conclusions.	IoT: individual work

2.6. Format of instruction:	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ partial e-learning ☐ field work	☐ independent assignments ☐ multimedia and the internet ☐ laboratory ☒ work with mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities			

2.9. Monitoring student work	Class attendance	**YES**	NO	Research	YES	**NO**	Oral exam	**YES**	NO
	Experimental work	YES	**NO**	Report	YES	**NO**	(other)	YES	**NO**
	Essay	YES	**NO**	Seminar paper	YES	**NO**	(other)	YES	**NO**
	Preliminary	YES	**NO**	Practical	**YES**	NO	(other)	YES	**NO**
	Project	YES	**NO**	Written exam	YES	**NO**	ECTS credits (total)	4	

	Title	**Number of copies in the library**	**Availability via other media**
2.10. Required literature (available in the library and/or via other media)	Peter Jackson, Introduction to expert systems, Addison Wesley, 1998.		
	Stuart Russell, Artificial Intelligence: A Modern Approach, 2015.		
	Andry Burkov, The Hundred-Page Machine Learning Book, 2019.		
	Sebastian Raschka and Vahid Mirjalili, Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow, 2nd Edition, 2017.		
	Jesse Liberty, Learning Visual Basic .Net, 2002.		
	Kathy Sierra and Bert Bates, Head First Java, 2nd Edition, 2005.		
2.11. Optional literature	Handouts from the lectures.		
2.12. Other (as the proposer wishes to add)			

3.2.5 Innovation Management in Product Development

Škec Stanko, Štorga Mario

1. GENERAL INFORMATION				
1.1. Course teacher	Stanko Škec Mario Štorga		1.6. Year of the study	1
1.2. Name of the course	Innovation Management in Product Development		1.7. ECTS credits	4
1.3. Associate teachers			1.8. Type of instruction (number of hours L + E + S + e-learning)	15+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.9. Expected enrolment in the course	15
1.5. Status of the course	☒ mandatory	☐ elective	1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	2
2. COUSE DESCRIPTION				
2.1. Course objectives	Goal of the course is studying of the conditions necessary for realisation of technical innovation in existing and new companies as a presumption for company concurrences. The innovation process is in focus of the learning including creation of the innovation friendly environment, innovation portfolio and evaluation of innovations from social, technological and financial perspectives.			
2.2. Enrolment requirements and/or entry competences required for the course	Basic understanding of the product development process in socio-technical context.			
2.3. Learning outcomes at the level of the programme to which the course contributes	**Mechanical Engineering - University graduate** Apply advanced knowledge of natural and engineering sciences for the purpose of solving complex technical problems in an interdisciplinary context. Plan, perform and monitor activities of solving complex technical problems. Use of advanced techniques for modelling technical systems and processes for the purpose of solving complex mechanical engineering problems Evaluate materials, technologies and technical systems from business, social and environmental perspective. **General University graduate** Communicate engineering issues both in oral and written form and present professional results and own conclusions in public on the international level.			

<table>
<tr><td></td><td>Participate in long-long education programs and scientific research and pursue further education at the specialist and doctoral level of study.
Take a lead in interdisciplinary team of experts.
Apply ethical principles of the profession.</td></tr>
<tr><td>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td>To analyse patent database.
To explore the state of art and trends in technology.
To evaluate new proposals/designs of technical systems.
To propose and lead product innovation projects.
To manage innovation potential on team and organisation level.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td>
<table>
<tr><th>Week</th><th>Lecture</th><th>Exercises</th></tr>
<tr><td>1.</td><td>Introduction to course. Concepts definition, innovation process.</td><td>Innovation process and methods - examples.</td></tr>
<tr><td>2.</td><td>Business perspectives of technological innovation. Innovation systematisation.</td><td>Innovation task Z1: Analysis of the company and innovation potential.</td></tr>
<tr><td>3.</td><td>Technical innovation dynamics, implications to market and technology.</td><td>Teamwork / Consultation Z1.</td></tr>
<tr><td>4.</td><td>Innovation development methodology.</td><td>Teamwork / Consultation Z1.</td></tr>
<tr><td>5.</td><td>Presentation and discussion Z1.</td><td>Presentation and discussion Z1.</td></tr>
<tr><td>6.</td><td>Organisational aspects of innovation - teams and processes.</td><td>Innovation task Z2: Innovation space research.</td></tr>
<tr><td>7.</td><td>Social aspects of innovation.</td><td>Teamwork / Consultation Z2.</td></tr>
<tr><td>8.</td><td>Guest lecture: Innovation in manufacturing sector - technological platform, realisation, validation.</td><td>Teamwork / Consultation Z2.</td></tr>
<tr><td>9.</td><td>Presentation and discussion Z2.</td><td>Presentation and discussion Z2.</td></tr>
<tr><td>10.</td><td>Internal and external sources of innovations.</td><td>Innovation task Z3: Innovation proposal - argumentation and analysis.</td></tr>
<tr><td>11.</td><td>Monitoring of technological changes.</td><td>Teamwork / Consultation Z3.</td></tr>
<tr><td>12.</td><td>Emerging technologies.</td><td>Teamwork / Consultation Z3.</td></tr>
<tr><td>13.</td><td>Assessment of technological possibilities development potential and portfolio management.</td><td>Teamwork / Consultation Z3.</td></tr>
<tr><td>14.</td><td>Innovation management and decision making.</td><td>Teamwork / Consultation Z3.</td></tr>
<tr><td>15.</td><td>Presentation and discussion Z3.</td><td>Presentation and discussion Z3.</td></tr>
</table>
</td></tr>
</table>

2.6. Format of instruction:	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ partial e-learning ☐ field work			☐ independent assignments ☐ multimedia and the internet ☐ laboratory ☐ work with mentor ☐ (other)			2.7. Comments:		
2.8. Student responsibilities	Attending to course, participating to the innovation tasks solving, successful results of seminar task.								
2.9. Monitoring student work	Class attendance	**YES**	NO	Research	**YES**	NO	Oral exam	YES	**NO**
	Experimental work	YES	**NO**	Report	YES	**NO**	Project work	**YES**	NO
	Essay	YES	**NO**	Seminar paper	**YES**	NO	(other)	YES	**NO**
	Preliminary	YES	**NO**	Practical work	YES	**NO**	(other)	YES	**NO**
	Project	YES	**NO**	Written exam	YES	**NO**	ECTS credits (total)	4	

	Title	**Number of copies in the library**	**Availability via other media**
2.10. Required literature (available in the library and/or via other media)	Arthur, W. Brian. 2009. The Nature of Technology: What It Is and How It Evolves. Free Press.	1	YES
	Shina, S.G., 2014. Engineering Project Management for the Global High-technology Industry. McGraw-Hill.	1	YES
	Trott, P., 2008. Innovation management and new product development. Pearson education.	1	YES
	Le Masson, P., Weil, B. and Hatchuel, A., 2010. *Strategic management of innovation and design*. Cambridge University Press.	1	YES
	Ewersheim, W. (ed.)., 2009. *Innovation Management for Technical Products.* Springer.	1	YES
2.11. Optional literature	Lecture handouts.		
2.12. Other (as the proposer wishes to add)			

3.2.6 Design for Sustainability

Štorga Mario, Škec Stanko

1. GENERAL INFORMATION				
1.1. Course teacher	Mario Štorga Stanko Škec		1.6. Year of the study	1
1.2. Name of the course	Design for Sustainability		1.7. ECTS credits	4
1.3. Associate teachers			1.8. Type of instruction (number of hours L + E + S + e-learning)	15+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.9. Expected enrolment in the course	15
1.5. Status of the course	☒ mandatory	☐ elective	1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	2
2. COUSE DESCRIPTION				
2.1. Course objectives	Goal of the course is focusing the student to the environment and natural resources related issues caused by product life cycle. Based on the sustainability tasks, students learn about methods and tools, and study socio-technical aspects and strategies for improvement of environment condition through eco-design.			
2.2. Enrolment requirements and/or entry competences required for the course	Basic understanding of the product development process in socio-technical context.			
2.3. Learning outcomes at the level of the programme to which the course contributes	**Mechanical Engineering - University graduate** Apply advanced knowledge of natural and engineering sciences for the purpose of solving complex technical problems in an interdisciplinary context. Evaluate solutions and calculations of elements of technical systems and processes in the area of specialization. Evaluate materials, technologies and technical systems from business, social and environmental perspective. **General University graduate** Communicate engineering issues both in oral and written form and present professional results and own conclusions in public on the international level.			

	Participate in long-long education programs and scientific research and pursue further education at the specialist and doctoral level of study. Apply ethical principles of the profession.
2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)	Estimate influence of the technical system on environment and society. Compare methods and strategies for improvement of environment state that are used during development of technical systems. Integrate criteria for sustainability in the development of technical systems. Design the modes for raising awareness about the importance of sustainability and eco-design. Evaluate the contribution of the research results in eco-design research field and applicability to practice.

2.5. Course content (syllabus)

Week	Lecture	Exercises
1.	Introduction to sustainability and eco-design.	
2.	Nature and evolution of sustainability and sustainable development.	Seminar task S1: Research perspective on methods and tools for sustainability and eco-design.
3.	Economic development, globalization and sustainability.	Individual work.
4.	Government policies to foster innovation, economic growth and employment	Individual work.
5.	Emergence and evolution of sustainable development.	Individual work.
6.	Product development strategies for sustainability.	Individual work.
7.	Presentation and discussion S1.	Presentation and discussion S1.
8.	Presentation and discussion S1.	Presentation and discussion S1.
9.	Presentation and discussion S1.	Presentation and discussion S1.
10.	Design for disassembling and recycling.	Project task P1: Application of design for sustainability and eco-design methods and tools for redesign of known products.
11.	Design for energy efficient products.	Teamwork.
12.	Social aspects of eco-design (anthropology/culture/emotions).	Teamwork.
13.	Marketing potential and eco design-based business models.	Teamwork.
14.	Eco-design driven innovation.	Teamwork.
15.	Presentation and discussion P1.	Presentation and discussion P1.

2.6. Format of instruction:			2.7. Comments:
	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ partial e-learning	☐ independent assignments ☐ multimedia and the internet ☐ laboratory ☒ work with mentor ☐ (other)	

	☐ field work		

2.8. Student responsibilities									
2.9. Monitoring student work	Class attendance	**YES**	NO	Research	**YES**	NO	Oral exam	YES	**NO**
	Experimental work	YES	**NO**	Report	YES	**NO**	Project work	**YES**	NO
	Essay	YES	**NO**	Seminar paper	**YES**	NO	(other)	YES	**NO**
	Preliminary exam	YES	**NO**	Practical work	YES	**NO**	(other)	YES	**NO**
	Project	YES	**NO**	Written exam	YES	**NO**	ECTS credits (total)	4	

	Title	**Number of copies in the library**	**Availability via other media**
2.10. Required literature (available in the library and/or via other media)	Ashford, N. A., and Hall R.P. "Technology, globalization, and sustainable development: transforming the industrial state", Yale University Press, 2011.	1	
	McAloone T., Bey N.: "Environmental improvement through product development: A guide", Danish Environmental Protection Agency, 2009.	1	
	Mulder K.: "Sustainable Development for Engineers: A Handbook and Resource Guide", Greenleaf Publishing, 2006.	1	
2.11. Optional literature	Handouts from the lectures.		
2.12. Other (as the proposer wishes to add)			

3.3 Elective courses description

3.3.1 Quality Management in Engineering

Biserka Runje

1. GENERAL INFORMATION				
1.1. Course teacher	Biserka Runje		1.6. Year of the study	1
1.2. Name of the course	Quality Management in Engineering		1.7. ECTS credits	4
1.3. Associate teachers	Amalija Horvatić Novak		1.8. Type of instruction (number of hours L + E + S + e-learning)	(20+0+16+9)
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.9. Expected enrolment in the course	15
1.5. Status of the course	☐ mandatory	☒ elective	1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	3
2. COUSE DESCRIPTION				
2.1. Course objectives	Introducing students with contemporary settings, strategies, management systems and ways to ensure and improve quality in engineering. Student's education for the practical application of tools and methods for quality control. Encourage students to express critical opinions based on scientific research.			
2.2. Enrolment requirements and/or entry competences required for the course	No prerequisites.			
2.3. Learning outcomes at the level of the programme to which the course contributes	To conduct oral and written communication on engineering issues, and publicly present professional results and own conclusions at the international level. To take on a leading role in an interdisciplinary team of experts. To participate in lifelong learning processes and scientific research work and continue further education at specialist and doctoral studies.			

<table>
<tr><td>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td>To design and independently conduct testing procedures and quality management processes in the field of narrower specialisation.
To apply acquired knowledge about the elements of the smart technical systems and processes, and their interactions throughout their entire life cycle.
To design smart technical systems and processes in the area of functional specialisation and conduct prototyping and documentation.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td>
<table>
<tr><th>Week</th><th>Lecture</th><th>Exercises</th></tr>
<tr><td>1.</td><td>Today’s significance of Quality. Customer Satisfaction. Customer Satisfaction Measurement Methods. Development of Quality Management System. TQC.</td><td>Discussion regarding Quality Definitions. Examples of customer satisfaction measurement.</td></tr>
<tr><td>2.</td><td>Basic principles of TQC. Role of Quality Management System in the Modern Business Management.</td><td>Practical demonstration of TQC fundamentals.</td></tr>
<tr><td>3.</td><td>Process approach to Quality Management. Connection of Management System.</td><td>Example of Quality Management Process Model. Constructing the Process Interaction Matrix.</td></tr>
<tr><td>4.</td><td>Components of the Quality Management System. Policies and aims of Quality. System Documentation. Quality Manual.</td><td>Discussion regarding Components of Quality Management System according to ISO 9001: 2015.</td></tr>
<tr><td>5.</td><td>Basic principles of Quality Management. The Role and Responsibilities of Management. Tasks, responsibilities and authorities within the system. Responsibility Matrix.</td><td>Discussion regarding Quality Management System Responsibilities. Process owners. Possibility of Responsibility Transfer.</td></tr>
<tr><td>6.</td><td>Communications. Motivation and Rewards. Management review.</td><td>Basic elements of Motivation and Rewarding. Construction of Ishikawa diagram regarding motivation.</td></tr>
<tr><td>7.</td><td>Resource Management. Human Resources. (Knowledge Management) Infrastructure, Work environment, Financial Resources. Process of permanent education.</td><td>Description of training in the field of Quality. Explanation of individual topics within this training.</td></tr>
<tr><td>8.</td><td>Suppliers. Business cooperation. Interested parties.</td><td>Supplier Evaluation. Examples of Quality Indices.</td></tr>
<tr><td>9.</td><td>Process of permanent improving. Process efficiency and effectiveness. Quality planning and determination of measurable aims of quality.</td><td>Examples of Process Capability and Efficiency calculation.</td></tr>
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	10.	Method of permanent improving. Prerequisites for implementing improvements. Priority selection Methods.	Example of data analysis and data processing with the aim of choosing priorities.
	11.	Fundamental elements of FMEA analysis.	Explanation of Example of FMEA analysis.
	12.	Fundamental elements of QFD analysis.	Example of construction QFD matrices.
	13.	Methods for determining Measurement System Capability. Elements for estimation of capability.	Example of tolerance analysis and estimation of Measurement System Capability.
	14.	Contemporary requirements of Product and Production Quality Control.	Specific generic requirements for the management of measurement systems.
	15.	Trends in development of Quality Management System.	Final Test.

2.6. Format of instruction:	☒ lectures ☒ seminars and workshops ☐ exercises ☒ online in entirety ☒ partial e-learning ☐ field work	☐ independent assignments ☐ multimedia and the internet ☐ laboratory ☐ work with mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities			

2.9. Monitoring student work	Class attendance	YES	NO	Research	YES	NO	Oral exam	YES	NO
	Experimental work	YES	NO	Report	YES	NO	(other)	YES	NO
	Essay	YES	NO	Seminar paper	**YES**	NO	(other)	YES	NO
	Preliminary exam	YES	NO	Practical work	YES	NO	(other)	YES	NO
	Project	YES	NO	Written exam	**YES**	NO	ECTS credits (total)		

	Title	**Number of copies in the library**	**Availability via other media**
2.10. Required literature (available in the library and/or via other media)	Thomas Pyzdek, Paul Keller, The Six Sigma Handbook, Fourth Edition Hardcover - April 22, 2014		Yes
	ISO 9001:2015 Quality Management Systems - Requirements		Yes
	David Hoyle, Quality Management Essentials 2007 Feigenbaum,		Yes
	Total Quality Control, McGraw-Hill, 1991		Yes

2.11. Optional literature			
2.12. Other (as the proposer wishes to add)			

3.3.2 Biomimetic Systems and Humanoid Robotics

Bojan Jerbić

1. GENERAL INFORMATION				
1.1. Course teacher	Bojan Jerbić		1.6. Year of the study	1
1.2. Name of the course	Biomimetic systems and humanoid robotics		1.7. ECTS credits	4
1.3. Associate teachers	Bojan Šekoranja Filip Šuligoj Marko Švaco		1.8. Type of instruction (number of hours L + E + S + e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.9. Expected enrolment in the course	15
1.5. Status of the course	☐ mandatory	☐ elective	1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	2
2. COUSE DESCRIPTION				
2.1. Course objectives	The aim of the course is to provide a basic understanding of the theory of biomimetic systems and humanoid robots and practical knowledge of locomotion system, perception of the environment, manipulation of objects and interaction between man and robot.			
2.2. Enrolment requirements and/or entry competences required for the course				
2.3. Learning outcomes at the level of the programme to which the course contributes	To conduct oral and written communication on engineering issues, and publicly present professional results and own conclusions at the international level. To actively use and participate in the development of information technology for resolving engineering issues. To take on a leading role in an interdisciplinary team of experts. To apply advanced knowledge in the field of natural and technical sciences to solve complex technical problems in the interdisciplinary context. To use advanced techniques for modelling smart technical systems and processes in the function of creative solving of complex problems. To design smart technical systems and processes in the area of functional specialisation and conduct prototyping and documentation.			

2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)	After successfully mastering a course, students will be able to: 1. Explain the principles of work and define concepts related to biomimetic robotic systems 2. List the main features and classify humanoid robots 3. Use the principles of teamwork and collaboration among teams in shaping technical solutions 4. Use the knowledge acquired to develop technical solutions for solving the elementary problems in robotics 5. Analyze and critically evaluate the performance of biomimetic and humanoid robots

2.5. Course content (syllabus)

Week	Lecture	Exercises
1.	Biomimetic systems and humanoid robotics, overview and underlying problems	Demonstration of a humanoid robot
2.	Modern robotic systems and their application	Using robot's sensor array
3.	Current and future technical problems, a review of contemporary research	Analysis of the collected sensory information
4.	Biomimetic mechatronics and structural elements	Analysis of the collected sensory information
5.	Robot locomotion system	Programming a humanoid robot
6.	Kinematics and dynamics of humanoid movement	Kinematics analysis
7.	Research in the area of bipedal robot movement	Kinematics analysis
8.	Biomimetic sensors and perception	Environment perception based on 2D vision sensors
9.	Environment perception based on 2D and 3D vision sensors	Environment perception based on 3D vision sensors
10.	Robotic navigation	Designing a model for performing a task with the robot - motion planning
11.	Localization and registration of objects of interest	Designing a model for performing a task with the robot - motion planning
12.	Grasp planning based on functional-geometric features of the gripper	Grasp planning
13.	Applying force sensors for object manipulation	Applying force sensors for object manipulation
14.	Human-robot interaction	Applying a simple interaction model
15.	Case Study - Solving a Practical Problem	Applying a simple interaction model

2.6. Format of instruction:	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ partial e-learning ☐ field work	☒ independent assignments ☐ multimedia and the internet ☒ laboratory ☐ work with mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities			

2.9. Monitoring student work

Class attendance	YES		Research		NO	Oral exam		NO
Experimental work	YES		Report		NO	(other)		
Essay		NO	Seminar paper		NO	(other)		

	Preliminary exam	YES		Practical work	YES		(other)		
	Project		NO	Written exam	YES		ECTS credits (total)	4	

	Title	**Number of copies in the library**	**Availability via other media**
2.10. Required literature (available in the library and/or via other media)	B. Siciliano and O. Khatib, Eds., Springer Handbook of Robotics. Cham: Springer International Publishing, 2016.	2	
	R. Vepa: "Biomimetic Robotics: Mechanisms and Control," Cabridge University Press, 2009.	2	
2.11. Optional literature			
2.12. Other (as the proposer wishes to add)			

3.3.3 Advanced Materials

Žmak, Irena

1. GENERAL INFORMATION				
1.1. Course teacher	Žmak, Irena		1.6. Year of the study	1
1.2. Name of the course	Advanced Materials		1.7. ECTS credits	4
1.3. Associate teachers	Matijević, Božidar		1.8. Type of instruction (number of hours L + E + S + e-learning)	2L+1S
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.9. Expected enrolment in the course	15
1.5. Status of the course	☐ mandatory	☒ elective	1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	1

2. COUSE DESCRIPTION	
2.1. Course objectives	Becoming acquainted with the advanced engineering materials, their properties, applications and production methods.
2.2. Enrolment requirements and/or entry competences required for the course	Bachelor of Engineering or Bachelor of Science.
2.3. Learning outcomes at the level of the programme to which the course contributes	To conduct oral and written communication on engineering issues, and publicly present professional results and own conclusions at the international level. To participate in lifelong learning processes and scientific research work and continue further education at specialist and doctoral studies. To implement the moral and ethical standards of the profession.
2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)	To apply advanced knowledge in the field of natural and technical sciences to solve complex technical problems in the interdisciplinary context. To develop, prescribe and evaluate groups of materials and technologies in the field of narrower specialisation, given the requirements of the smart technical systems and the constraints that result from the quality and cost-effectiveness. To validate materials, technology and technical systems from business and social context and environmental concerns.

2.5. Course content (syllabus)

Week	Lecture	Exercises
1.	The principles of modern materials, material production and material forming.	Fundamentals of design in almost final form - positive features and limitations.
2.	Production and properties of powders.	Defining process parameters for powder production.

	3.	Shaping full volume powder parts.	Sintering of ceramics.
	4.	Hot isostatic pressing.	Properties of hot isostatic pressed parts.
	5.	Properties of sintered materials.	Applications of metal-based sintered materials.
	6.	Rapid prototyping and tooling – spraying three-dimensional, stereo lithography.	Procedures of digitizing shapes.
	7.	Rapid prototyping and tooling - laser sintering powders, ultrasound forming.	Properties of laser sintered parts.
	8.	Midterm exam.	
	9.	Materials for advanced casting processes.	Advantages of modern casting processes.
	10.	Metals for semi-solid injection moulding.	Advantages of thixomolding.
	11.	Advanced polymer composites. Particles spraying and plasma shaping.	Advanced polymer processing methods.
	12.	Advanced metal and ceramic composites.	Applications of advanced metal and ceramic composites.
	13.	Polymer, metallic and ceramic foams.	Production of metallic foams.
	14.	Nanomaterials, aerogels, biomimetic materials.	Safety of nanomaterials. Environmental concerns of advanced materials.
	15.	Final examination.	

2.6. Format of instruction:	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ partial e-learning ☐ field work	☒ independent assignments ☒ multimedia and the internet ☒ laboratory ☐ work with mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	Attend lectures. Pass the written examinations. Prepare an essay.		

2.9.	Class attendance	YES		Research	YES		Oral exam		NO
	Experimental work		NO	Report		NO	Oral presentation	YES	
	Essay	YES		Seminar paper		NO	(other)		
	Preliminary exam		NO	Practical work		NO	(other)		
	Project		NO	Written exam	YES		ECTS credits (total)	4	

	Title	Number of copies in the library	Availability via other media
2.10. Required literature (available in the library and/or via other media)	The Handbook of Advanced Materials: Enabling New Designs, John Wiley & Sons, Inc., 2004		e-book
2.11. Optional literature	Carbon Materials for Advanced Technologies, Elsevier, 1999 ; Nanomaterials and devices: processing and applications, Stafa-Zurich: Trans Tech Publications, 2009; Nano Materials, Birkhäuser Architecture, 2008		
2.12. Other (as the proposer wishes to add)			

3.3.4 Electric and Hybrid Vehicles

Deur Joško, Petrić Joško

1. GENERAL INFORMATION				
1.1. Course teacher	Prof. dr. sc. Joško Deur Prof. dr. sc. Joško Petrić		1.11. Year of the study	1
1.2. Name of the course	Electric and Hybrid Vehicles		1.12. ECTS credits	4
1.3. Associate teachers	Dr. sc. Mihael Cipek Dr. sc. Branimir Škugor		1.13. Type of instruction (number of hours L + E + S + e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.14. Expected enrolment in the course	15
1.5. Status of the course	☐ mandatory	☒ elective	1.15. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	2, 10%
2. COUSE DESCRIPTION				
1.6. Course objectives	The course deals with modelling and analysis techniques and energy management control principles for electric and hybrid vehicles. The course objective is to make students familiar with different electric and hybrid vehicle configurations, kinematic and dynamic powertrain models, power flow analysis techniques, control variable optimisation tools, control system design methods, and computer simulation verification tools. The consideration will be extended to e-mobility systems including smart charging techniques and vehicle-grid integration aspects.			
1.7. Enrolment requirements and/or entry competences required for the course	No particular requirements			
1.8. Learning outcomes at the level of the programme to which the course contributes	• To actively use and participate in the development of information technology for resolving engineering issues. • To take on a leading role in an interdisciplinary team of experts. • To participate in lifelong learning processes and scientific research work and continue further education at specialist and doctoral studies. • To apply advanced knowledge in the field of natural and technical sciences to solve complex technical problems in the interdisciplinary context. • To use advanced techniques for modelling smart technical systems and processes in the function of creative solving of complex problems. • To evaluate solutions and calculations of elements of smart technical systems and processes in the field of narrower specialisation.			

<table>
<tr><td>1.9. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td>

To understand various concepts and configurations of electric and hybrid vehicles
To develop mathematical and simulation models of hybrid vehicle powertrains
To conduct power flow analyses for complex hybrid powertrains
To acquire knowledge on hybrid powertrain control variable optimisation
To design energy management strategies
To use and adapt computer simulation tools for advanced vehicle powertrains
To understand e-mobility systems including electric vehicle-grid integration aspects

</td></tr>
<tr><td>1.10. Course content (syllabus)</td><td>
<table>
<tr><th>Week</th><th>Lecture</th><th>Exercises</th></tr>
<tr><td>1.</td><td>Introduction to electric and hybrid vehicles, history of hybrid vehicles, basic configuration and operating principles of electric and hybrid vehicles</td><td>Real-life examples of electric and hybrid vehicles</td></tr>
<tr><td>2.</td><td>Kinematic models of hybrid electric vehicle (HEV) components and powertrains</td><td>Derivation of HEV kinematics models</td></tr>
<tr><td>3.</td><td>Power flow analysis of HEV powertrains (series-parallel configurations)</td><td>Numerical examples of power flow analysis</td></tr>
<tr><td>4.</td><td>Modelling of HEV dynamics</td><td>Development of simulation models of HEV powertrain components</td></tr>
<tr><td>5.</td><td>Modelling and simulation of HEV powertrains including low-level control subsystems</td><td>Development of HEV powertrain dynamics simulation models</td></tr>
<tr><td>6.</td><td>Control variable optimisation and analysis of optimal energy management behaviour of HEVs</td><td>Illustrating control variable optimisation tools, running optimisation and interpreting optimisation results</td></tr>
<tr><td>7.</td><td>HEV energy management relying on rule-based control strategy</td><td>Simulation of rule-based control system</td></tr>
<tr><td>8.</td><td>HEV energy management relying on equivalent fuel consumption minimisation strategy</td><td>Simulation of equivalent fuel consumption minimisation strategy-based control system</td></tr>
<tr><td>9.</td><td>Extended range and plug-in hybrid electric vehicles</td><td>Simulation of extended range electric vehicle powertrain (series-parallel configuration)</td></tr>
<tr><td>10.</td><td>Parallel and mild HEVs</td><td>Simulation of parallel HEV including automatic transmission control</td></tr>
<tr><td>11.</td><td>Hybrid hydraulic vehicles</td><td>Simulation of hybrid hydraulic vehicle</td></tr>
<tr><td>12.</td><td>Hybrid pneumatic vehicles</td><td>Simulation of hybrid pneumatic vehicle</td></tr>
<tr><td>13.</td><td>Hybrid mechanical vehicles</td><td>Simulation of hybrid mechanical vehicle</td></tr>
</table>
</td></tr>
</table>

	14.	E-mobility systems (electric vehicle fleets, vehicle tracking system, charging infrastructure, interoperability)	Real-life examples of e-mobility systems including electric vehicle sharing systems
	15.	Electric vehicle-grid integration and optimal charging management	Examples of charging management algorithms

1.11. Format of instruction:	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ partial e-learning ☐ field work	☒ independent assignments ☐ multimedia and the internet ☒ laboratory ☒ work with mentor ☒ computer exercises (other)	1.12. Comments:

1.13. Student responsibilities	• To attend lectures and exercises • To write and defend seminar work related to modelling, power flow analysis or control of a hybrid vehicle configuration • To pass final/oral exam								
1.14. Monitoring student work	Class attendance	YES		Research		NO	Oral exam	YES	
	Experimental work	YES		Report		NO	(other)		NO
	Essay		NO	Seminar paper	YES		(other)		NO
	Preliminary		NO	Practical		NO	(other)		NO
	Project		NO	Written exam		NO	ECTS credits (total)	4.00	

1.15. Required literature (available in the library and/or via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Teaching materials from lectures	N/A	*web*
	Teaching materials and simulation models from computer exercises	N/A	*web*

1.16. Optional literature	• Guzzella, L. and Sciaretta, A., "Vehicle Propulsion Systems", 2nd ed., Springer, Berlin, 2007. • Pistoia, G., „Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market", Elsevier 2010. • Hu, H., Baseley, S., Smaling, R.M., „Advanced Hybrid Powertrains For Commercial Vehicles", SAE International, 2012. • Collection of lecturers' R&D papers on the topic (see www.fsb.hr/acg) – to be available to students		
1.17. Other (as the proposer wishes to add)			

3.3.5 Engineering Logistics

Đukić Goran

1. GENERAL INFORMATION				
1.1. Course teacher	Đukić Goran		1.6. Year of the study	1
1.2. Name of the course	Engineering Logistics		1.7. ECTS credits	4
1.3. Associate teachers	Opetuk Tihomir		1.8. Type of instruction (number of hours L + E + S + e-learning)	2+0+1+0
1.4. Study programme (undergraduate, graduate, integrated)	Graduate		1.9. Expected enrolment in the course	15
1.5. Status of the course	☐ mandatory	☒ elective	1.10. Level of application of e-learning (level 1, 2, 3), percentage of online instruction (max. 20%)	1
2. COUSE DESCRIPTION				
2.1. Course objectives	The goal of the course is to introduce students with the definition, objective, importance and key activities of logistics and Supply Chain Management, as well as with selected engineering logistics models, methods and tools for logistics systems/processes design and management. Presentation of concepts in automated storage and retrieval systems design and order picking system design within warehouses, providing guidelines for analysis and improvement of existing systems as well as design of new systems. Introducing students with computerized warehouse management systems (WMS) and application of modern identification and communication technologies in warehouses. Presentation of transportation management systems (TMS) and problems, focusing on vehicle routing problems (VRP) and solution algorithms. Presentation of discrete-event simulation (DES) theory and practice of practice of using commercial software tools for building simulation models of manufacturing and logistics systems.			
2.2. Enrolment requirements and/or entry competences required for the course	-			
2.3. Learning outcomes at the level of the programme to which the course contributes	To conduct oral and written communication on engineering issues, and publicly present professional results and own conclusions at the international level. To actively use and participate in the development of information technology for resolving engineering issues.			

<table>
<tr><td></td><td>To participate in lifelong learning processes and scientific research work and continue further education at specialist and doctoral studies.
To apply advanced knowledge in the field of natural and technical sciences to solve complex technical problems in the interdisciplinary context.
To use advanced techniques for modelling smart technical systems and processes in the function of creative solving of complex problems.
To validate materials, technology and technical systems from business and social context and environmental concerns.</td></tr>
<tr><td>2.4. Expected learning outcomes at the level of the course (3 to 10 learning outcomes)</td><td>To define logistics and supply chain management’s goals, importance, activities, similarities and differences.
To identify, select and/or evaluate the systems and equipment of automated storage and retrieval systems and/or order-picking systems.
To evaluate auto identification and communication technologies in logistics warehousing systems.
To understand tasks of transportation management.
To understand different types of transportation problems and to apply appropriate algorithms to solve them.
To explain the basics of the Discrete Event Simulation (DES) and determine when this is a useful engineering tool.
To create a simulation model and to run simulation experiment of a manufacturing or logistics system using a professional (commercial) DES software.</td></tr>
<tr><td>2.5. Course content (syllabus)</td><td>
<table>
<tr><th>Week</th><th>Lecture</th><th>Exercises</th></tr>
<tr><td>1.</td><td>Logistics management and SCM – definitions, importance, goals and activities. Business logistics and Engineering logistics. Trends in logistics/SCM.</td><td>Tutorial examples of ED10 simulation software.</td></tr>
<tr><td>2.</td><td>Logistics activities: procurement, transportation, warehousing, inventory management, reverse logistics, distribution,</td><td>Tutorial examples of ED10 simulation software.</td></tr>
<tr><td>3.</td><td>Warehousing systems: review of key processes and system components.</td><td>Tutorial examples of ED10 simulation software.</td></tr>
<tr><td>4.</td><td>Automated storage and retrieval systems (AS/RS) – classification, history, advantages and disadvantages, trends.</td><td>Tutorial examples of ED10 simulation software.</td></tr>
<tr><td>5.</td><td>Crane-based AS/RS – types, applications, design models and control policies.</td><td>Tutorial examples of ED10 simulation software.</td></tr>
<tr><td>6.</td><td>Vertical and horizontal carousels, vertical lift modules (VLM), shuttle-based S/RS - – types, applications, design models and control policies..</td><td>Tutorial examples of ED10 simulation software.</td></tr>
</table>
</td></tr>
</table>

	7.	Order picking systems -types, characteristics and overview of technical solutions (picker-to-part and part-to-picker systems; pallet, case and item systems).	Tutorial examples of ED10 simulation software.
	8.	Routing methods in manual order-picking systems. Storage methods (random storage, dedicated storage, class-based storage) and influence on order-picking cycle times. Order picking methods (batch picking, zone picking, wave picking). Order picking area layout design.	Tutorial examples of ED10 simulation software.
	9.	Warehouse management systems (WMS). Identification and communication systems (pick to light, RF handheld, voice picking, vision picking).	Tutorial examples of ED10 simulation software.
	10.	Transportation management and TMS. Transportation problems and models. Transportation problem, Traveling salesman problem (TSP), Vehicle routing problems (VRP), arc routing problems.	Tutorial examples of ED10 simulation software.
	11.	Algorithms for TSP, VRP and arc routing problems.	Application of ED10 - examples of simulation of manufacturing/logistics problems (individual work on small projects with supervisor)
	12.	Algorithms for TSP, VRP and arc routing problems (cont.)	Application of ED10 - examples of simulation of manufacturing/logistics problems (individual work on small projects with supervisor in PC lab)
	13.	Introduction to system simulations. Discrete Events Simulation (DES) - definition, terminology, application examples, simulation project methodology.	Application of ED10 - examples of simulation of manufacturing/logistics problems (individual work on small projects with supervisor in PC lab)
	14.	Simulation languages and professional simulation tools. Enterprise Dynamics10 (ED10) software suite. Objects (concept of atoms). Connecting Objects, Attributes, Event Management.	Presentations of individual projects.
	15.	Examples of simulation of manufacturing/logistics problems.	Presentations of individual projects.

2.6. Format of instruction:	☒ lectures ☐ seminars and workshops ☒ exercises	☒ independent assignments ☐ multimedia and the internet ☐ laboratory	2.7. Comments: All exercises are in PC lab, concentrated in the last part of the

	☐ online in entirety ☐ partial e-learning ☐ field work	☐ work with mentor ☐ (other)	semester. Students will use simulation software for modelling various examples.
2.8. Student responsibilities	Regular class attendance.		

2.9. Monitoring student work									
	Class attendance	**YES**		Research		NO	Oral exam		NO
	Experimental work		NO	Report		NO	Small project	**YES**	
	Essay	**YES**		Seminar paper		NO	(other)		NO
	Preliminary exam		NO	Practical work		NO	(other)		NO
	Project		NO	Written exam	**YES**		ECTS credits (total)	1,5+0,5+1+1=4	

2.10. Required literature (available in the library and/or via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Prepared lecture notes (presentations).	-	yes
	ED10 simulation software materials (educational classroom licence)	-	yes

2.11. Optional literature	Waters D.: Logistics An Introduction to Supply Chain management, Palgrave, NY, 2003 Dolgui A, Proth JM.: Supply Chain Engineering - Useful Methods, Springer 2010 J. Bartholdi and S. Hackman, Warehouse & Distribution Science, www.warehouse-science.com Tompkins et al: Facilities Design,2nd ed., PWS Publishing, Boston,1997 Banks J et al., Discrete-Event System Simulation, 4th ed., 2005.
2.12. Other (as the proposer wishes to add)	Grading: 10% class attendance, 20% essay, 20% simulation program and presentation, 50% written exam.

4 2ND SEMESTER: UNIVERSITY OF LJUBLJANA

4.1 2nd Semester Courses list – UL-FME

4.1.1 Courses table

COURSE	LECTURE HOLDER	ECTS:	Str1: Prod.dev.	Str2: Dig.Manuf. & Inf.sys	Str3: Big data sys.	Str4: Innov.&Entrep.	Str5: Transf. Skills	Integration project	Electives	
Data modelling	Povh J.	5			5					
Big data analysis	Kos L., Povh J.				5					
Information Security and Privacy	Trček D. (FRI)			5						
Assembly and handling systems	Herakovič N.		5							
Engineering design techniques	Žavbi R., Kos L., Vukašinović N.							5		
Elective 2									5	
		SUM:	**5**	**5**	**10**	**0**	**0**	**5**	**5**	**30**

4.1.2 Elective courses

COURSE	LECTURE HOLDER	ECTS:	Str1: Prod.dev.	Str2: Dig.Manuf. & Inf.sys	Str3: Big data sys.	Str4: Innov.&Entrep.	Str5: Transf. Skills
Mechatronic prototyping	Vrabič R.	5					
Multisensory systems, machine vision	Podržaj	5					
Design with non-metallic materials	Vukašinović N., Pepelnjak T.	5		5			
Distributed systems	Vrabič R.	5	5				

4.2 Obligatory Courses Description

4.2.1 Data modelling

Povh Janez

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Podatkovno modeliranje
Course title:	Data modelling

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		1.	2.
		1st	2nd

Vrsta predmeta / Course type	Obvezni/compulsory
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	15	30			75	5

Nosilec predmeta / Lecturer:	Izr. prof. dr. Janez Povh

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Vsak vpisan študent se lahko vključi v ta predmet.	Every student enrolled to this program can join the course.

Vsebina:	**Content (Syllabus outline):**
• Uvod v modeliranje podatkov: kaj je podatkovni model, kako izračunati in validirati podatkovni model; • Viri podatkov: senzorski podatki; zbirke podatkov; odprti podatki; podatkovna skladišča,…; • Nadzorovano učenje: regresija, klasifikacija (nevronske mreže, logistična regresija, metoda podpornih vektorjev); analiza modelov nadzorovanega učenja (prečno preverjanje, klasifikacijska matrika, natančnost, točnost, …), bootstrapping; • Nenadzorovano učenje: združevanje v skupine, analiza glavnih komponent; vrednotenje novih skupin (čistost, normalizirana vzajemna informacija, Randov indeks,…) • Metode podatkovnega rudarjenja: pravila združevanja, odločitvena drevesa; • Priporočilni sistemi: podatkovni model za priporočilne sisteme, priporočanje na osnovi vsebine; zmanjševanje razsežnosti; • Globoko učenje: prepoznavanje slik in govora	• Introduction to data modelling: what is data model, how to compute and validate data model; • Sources of data: sensor data; data repositories; open data; data warehouses,…; • Supervised learning: regression, classification (neural networks, logistic regression, support vector machines); analysis of supervised learning models (cross-validation, confusion matrix, precision, accuracy, recall); bootstrapping • Unsupervised learning: clustering, principal component analysis; evaluating the unsupervised models (purity, normalized mutual information, Rand index,…) • Data Mining methods: association rules, decision trees • Recommendation systems: data model for a recommendation systems, content-based recommendations; • Deep learning: image and speach recogniiton

• Modeliranje podatkov z najsodobnejšo odprtokodno programsko opremo: R, WEKA, Orange	• Data modelling with state of the art open source software: R, WEKA, Orange

Temeljni literatura in viri / Readings:

- RAJARAMAN, ANAND in ULLMAN, JEFFREY DAVID (2012) *Mining of massive datasets.* New York: Cambridge university press.
- GARETH JAMES, WITTEN, DANIELA, HASTIE, TREVOR IN TIBSHIRANI, ROBERT (2013) An Introduction to Statistical Learning: with Applications in R, Springer Science & Business Media
- WITTEN, I.H., EIBE, F. in HALL, M.A.: Data mining: Practical machine learning tools and techniques, 3. Izdaja, Morgan Kaufman Publishers, 2011.

Cilji in kompetence:	**Objectives and competences:**
Glavni cilj predmeta je usposobiti študente za izvajanje zahtevnejših nalog podatkovnega modeliranja: *Splošne kompetence:* • uporaba metodoloških orodij, tj. izvajanje, usklajevanje in organizacija raziskav, uporaba različnih kvantitativnih raziskovalnih metod in tehnik; • uporaba in združevanje znanja iz različnih disciplin • sposobnost uporabe informacijskih in komunikacijskih tehnologij ter orodij za analizo podatkov v inženirstvu • sposobnost zbiranja, shranjevanja, analiziranja in interpretacije velikih podatkov *Predmetno specifične kompetence:* • sposobnost pridobivanja in trajnostnega shranjevanja podatkov; • sposobnost oblikovanja in validiranja statističnih modelov; • obvladovanje nadzorovanih in nenadzorovanih statističnih učnih metod; • obvladovanje ključnih metod rudarjenja podatkov; • obvladovanje vsaj ene najsodobnejše programske opreme za statistično modeliranje (R, Weka, Orange)	*The main objective of this course is to make the students competent to perform advanced data modelling tasks:* *General competences:* • the use of methodological tools, ie. implementation, coordination and organization of research, application of various quantitative research methods and techniques • the use and combining the knowledge from different disciplines • the ability to use information and communications technologies and data analytic tools in engineering • ability to collect, store, analyse and interpret big data Subject-specific competences: • ability of collecting data and performing and sustainable management of data; • ability of creating and validating advanced data models; • mastering supervised and unsupervised statistical learning methods; • mastering the key data mining methods; • mastering at least one state-of-the- art tool for statistical modelling (R, Weka, Orange)

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študent bo: • razumel pomen in potencial podatkovnega modeliranja; • obvladal ključne statistične metode, na katerih temelji modeliranje podatkov; • sposoben uporabljati najsodobnejša programska orodja za izvajanje naprednega podatkovnega modeliranja (R, Weka, Orange).	Knowledge and understanding: *The student will:* • understand the importance and potentials of data modelling; • master the key statistical methods underlying the data modelling; • learn how to use state-of-the-art software tools to perform advanced data modelling (R, Weka, Orange)

Metode poučevanja in učenja:	**Learning and teaching methods:**
• *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov, predstavitve) • *vaje* v računalniški učilnici • *seminarji: študentje bodo dobili individualne naloge povezane z analizo konkretnega vira velikih podatkov. Rezultati nalog bodo predstavljeni na seminarju.*	• *lectures* (explanation with discussions, questions, case-studies, presentations) • *tutorials* in the computer classroom • *seminars: the students will get individual projects that will be related to analysis of particular source of big data. Results will be presented at the seminar.*

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt) • pisni izpit • ustni izpit • seminarska naloga, v kateri naredijo analizo enega vira velikih količin podatkov	50 30 20	Type (examination, oral, coursework, project): • written exam • oral exam • project work

4.2.2 Big data analysis

Povh Janez, Kos Leon

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Analiza velikih količin podatkov
Course title:	Big data analysis

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		1.	2.
		1st	2nd

Vrsta predmeta / Course type	Obvezni/compulsory
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	15	30			75	5

Nosilec predmeta / Lecturer:	Izr. prof. dr. Janez Povh, doc. dr. Leon Kos

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Vsak vpisan študent se lahko vključi v ta predmet.	Every student enrolled to this program can join the course.

Vsebina:	**Content (Syllabus outline):**
• *Uvod v analizo velikih podatkov: kaj so veliki podatki, kje jih najdemo, kako jih shranimo?* • *Vizualizacije velikih podatkov: kateri programi in diagrami so primerni za prikazovanje velikih podatkov.* • *Enostavna analiza velikih podatkov: iskanje podobnih enot,* iskanje med najbližjimi sosedi, povzemanje podatkov z ohranjanjem podobnosti • *Analiza povezav*: PageRank algoritem; Nezaželene povezave; Vozlišča in avtoritete; • *Podatkovni tokovi:* podatkovni modeli za podatkovne tokove; vzorčenje podatkov; filtriranje podatkov v tokovih; štetje različnih enot v tokovih; senzorski podatke, oblikovanje odločitev na osnovi senzorskih podatkov; • *Nadzorovano in nenadzorovano učenje: združevanje v skupine, klasifikacijske metode, regresijska analiza;* • *Hadoop: kaj je Hadoop in kaj porazdeljen datotečni sistem, map-reduce okvir, kako ustvarjamo in načrtujemo opravila, povezana s podatki.* • *Prvi koraki v R in RHadoop - predstavili bomo programski jezik R in Hadoop knjižnice rmr in rhdfs. Poleg tega bo predstavljen RStudio kot GUI.*	• *Introduction to the big data analysis*: what is big data, where we find it, how to store it? • *Visualizations of big data*: which tools and diagrams are suitable for representing big data. • *Simple big data analysis: search for similar items*: near neighbour search, similarity preserving summaries of sets. • *Network and Link analysis*: PageRank algorithm; Link spam; Hub and authorities; • *Data streams*: the stream data models; sampling data in a stream; filtering streams; sensors data, decision rules based on sensor data; • *Supervised and unsupervised learning from big data*: clustering, classification and regression analysis, • *Hadoop: what is Hadoop distributed file system, how map-reduce framework works, how do we generate and schedule data-related jobs.* • *First steps in R and RHadoop – we will introduce programming language R and Hadoop libraries rmr and rhdfs. Additionally, RStudio as GUI will be introduced. Students will*

Študenti bodo prejeli virtualni računalnik z nameščeno programsko opremo.

- *Analiza, vizualizacija in učenje nad velikimi podatki z uporabo RHadoop*
- *Preizkušanje RHadoop na superračunalnikih: študentje bodo imeli dostop do superračunalnika na Univerzi v Ljubljani za izvedbo analize realnega vira velikih podatkov*

receive virtual machine with these software installed.

- *Analysis, visualisation and statistical learning from big data using RHadoop*
- *Testing RHadoop on supercomputers: students will get access to a supercomputer at University of Ljubljana to perform really big data analysis*

Temeljni literatura in viri / Readings:

- RAJARAMAN, ANAND in ULLMAN, JEFFREY DAVID (2012) *Mining of massive datasets.* New York: Cambridge university press.
- DEEPAYAN SARKAR (2008) *Use R!*. New York: Springer.
  MINELLI, MICHAEL, CHAMBERS, MICHELE in DHIRAJ, AMBIGA (2013) *Big data, big analytics : emerging business intelligence and analytic trends for today's businesses*. Hoboken, New Jersey: John Wiley & Sons.
- MCCALLUM, ETHAN; WESTON, STEPHEN *Parallel R*. O'Reilly Media, Inc., 2011.

Cilji in kompetence:

Glavni cilj predmeta je usposobiti študente za delo z velikimi količinami podatkov z uporabo najsodobnejših računalniških in programskih orodij.
Splošne kompetence:

- uporaba metodoloških orodij, tj. izvajanje, usklajevanje in organizacija raziskav, uporaba različnih kvantitativnih raziskovalnih metod in tehnik
- uporaba in združevanje znanja iz različnih disciplin
- sposobnost uporabe informacijskih in komunikacijskih tehnologij ter orodij za analizo podatkov v inženirstvu
- sposobnost zbiranja, shranjevanja, analiziranja in interpretacije velikih podatkov

Predmetno-specifične kompetence:

- poznavanje posebnih značilnosti velikih podatkov
- poznavanje metod, prilagojenih za analizo velikih podatkov
- poznavanje orodij za analizo velikih podatkov
- sposobnost uporabe visoko zmogljivih računalnikov za analizo velikih podatkov
- obvladovanje R in Hadoop za analizo velikih podatkov

Objectives and competences:

The main objective of this course is to make the students competent to work with big data using state of the art hardware and software tools.
General competences:

- the use of methodological tools, ie. implementation, coordination and organization of research, application of various quantitative research methods and techniques
- the use and combining the knowledge from different disciplines
- the ability to use information and communications technologies and data analytic tools in engineering
- ability to collect, store, analyse and interpret big data

Subject-specific competences:

- knowledge of the specific features of big data
- knowledge of methods adjusted for the analysis of big data
- knowledge of tools for analyzing big data
- the ability to use high-performance computers to analyze big data
- mastering R and Hadoop for Big Data analysis

Predvideni študijski rezultati:

Znanje in razumevanje:

Študent bo:

- razumel specifičnost analize velikih podatkov v primerjavi s klasično analizo podatkov
- obvladal metode, namenjene analizi velikih podatkov s poudarkom na aplikacijah v inženirstvu;

Intended learning outcomes:

Knowledge and understanding:

The student will:

- understand the specificity of big data analysis compared to classical data analysis
- master the methods, designed for big data analysis with focus to the applications in engineering;

• usvojil znanje glede uporabe visoko zmogljivih računalnikov in najsodobnejše odprto-kodne programske opreme (RHadoop) za pridobivanje, shranjevanje in analiziranje velikih podatkov	• learn how to use high performance computers and state of the art open source software (RHadoop) to retrieve, store and analyse big data

Metode poučevanja in učenja:	**Learning and teaching methods:**
• *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov, predstavitve) • *vaje* v računalniški učilnici • *seminarji: študentje bodo dobili individualne naloge povezane z analizo konkretnega vira velikih podatkov. Rezultati nalog bodo predstavljeni na seminarju.*	• *lectures* (explanation with discussions, questions, case-studies, presentations) • *tutorials* in the computer classroom • *seminars: the students will get individual projects that will be related to analysis of particular source of big data. Results will be presented at the seminar.*

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt) • pisni izpit • ustni izpit • seminarska naloga, v kateri naredijo analizo enega vira velikih količin podatkov	50 30 20	Type (examination, oral, coursework, project): • written exam • oral exam • project work

4.2.3 Information Security and Privacy

Trček Denis

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	**Informacijska varnost in zasebnost**
Course title:	**Information Security and Privacy**

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**

Vrsta predmeta / Course type	**strokovni izbirni predmet / specialist elective course** Tematski sklopi / Thematic set: Programska oprema / Software Informacijski sistemi in sistemi za upravljanje / Information and management systems Omrežja in varnost / Computer networks and security FRI 1 / FRI 1 FRI D / FRI D
Univerzitetna koda predmeta / University course code:	**63521**

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **Laboratory work**	**Druge oblike študija** **Field work**	**Samost. delo** **Individ. work**	**ECTS**
45	/	30	/	/	105	6

Nosilec predmeta / Lecturer:	prof. dr. Denis Trček

Jeziki / Languages:	**Predavanja / Lectures:**	angleščina / English
	Vaje / Tutorial:	angleščina / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Opravljanje študijskih obveznosti je opredeljeno v internih aktih Univerze v Ljubljani in Fakultete za računalništvo in informatiko.	As specified by internal acts of the University of Ljubljana and Faculty of Computer and Information Science.

Vsebina:	**Content (Syllabus outline):**
• Uvodni pregled področja. • Ključne organizacije in standardi (ISO, ITU-T, IETF, W3C, OASIS, OMA). • Varnostni mehanizmi in varnostne storitve (principi in praktične izvedbe overjanja, zaupnosti, celovitosti, nezatajljivosti, nadzora dostopa, beleženja in alarmiranja), infrastruktura javnih ključev (časovna normala, upravljanje imenskega prostora, operativni protokoli), osnove kvantnega procesiranja (kvantna izmenjava ključev).	• Introduction. • Key standards and organizations (ISO, ITU-T, IETF, W3C, OASIS, OMA). • Security mechanisms, security services (principles and practical implementations of authentication, confidentiality, integrity, non-repudiation, access control, logging and alarming), public key infrastructure (time base, name space management, operational protocols), quantum computing basics (quantum key exchange).

- Infrastruktura za overjanje, avtorizacijo in nadzor (principi, primeri standardiziranih rešitev – RADIUS in Diameter).
- Varovanje na fizičnem in linijskem sloju (protokoli WEP, WPA1 in WPA2).
- Varovanje na mrežnem, transportnem in aplikacijskem sloju, vključno z internetom stvari in računalništvom v oblaku (protokoli IPSec, TLS, S/MIME, SET, XMLSec, SAML, XACML, WS-*).
- Formalne metode (taksonomija formalnih metod in primeri kot so metoda R. Rueppla, logika BAN).
- Celovito obvladovanje varnosti in zasebnosti (internet stvari, sistemi RFID) in obvladovanje zaupanja ter ugleda v storitvenih arhitekturah.
- Varnostno usmerjeno programsko inženirstva (prverjanje modelov).
- Obvladovanje tveganj pri varovanju informacijskih sistemov, organizacijski pristopi ter obvladovanje človeškega dejavnika (varnostne politike, modeliranje človeškega dejavnika in simulacije).
- Akreditacijski in nadzorno-revizijski postopki varnosti informacijskih sistemov (ISO 2700X, CISSP) ter evalvacijski postopki za zagotavljanje varnosti strojno-programskih komponent (Common Criteria).
- Temeljna zakonodaja (direktive EU in nacionalne implementacije).
- Zaključki.
- Addendum: Mini vložki s praktičnim delom, ki pokrivajo najnovejše trende.

- Authentication, authorization and accounting infrastructure (principles, examples of standardized solutions like RADIUS and Diameter).
- Security of physical and data layers (example protocols are WEP, WPA1 and WPA2).
- Security of network, transport and application layers, including internet of things and clouds (example protocols are IPSec, TLS, S/MIME, SET, XMLSec, SAML, XACML, WS-*).
- Formal methods (taxonomy of formal methods, examples like R. Rueppl's method, logic BAN).
- Security and privacy by design (internet stvari, RFID systems) with trust management and reputation management basics in services oriented architectures.
- Secure programming (model checking).
- Risk management in IS, organizational views and human factor views (security policies, human factor modelling and simulations).
- Accreditation and auditing of IS related to security (ISO 2700X, CISSP), and standards for technical implementations of hardware and software components (Common Criteria).
- Basic legislation in the area of IS security and privacy (EU directives, national implementations).
- Comclusions.
- Addendum: Mini practical tasks covering the latest selected technological issues.

Temeljni literatura in viri / Readings:

- D. Trček: Information Systems Security and Privacy, Springer, New York, Heidelberg, 2006.
- D. Trček, Information security and privacy, slides copies, FRI UL 2018-2019.

Cilji in kompetence:

Cilj predmeta je, da študentje aktivno osvojijo znanja varovanja omrežij in zasebnosti v sodobnih informacijskih sistemih (IS), ki vključujejo internet stvati in sicer za namen skrbništva (administracije), kot tudi namen razvoja novih rešitev.

Kategorizirane kompetence:
-Razvijanje sposobnosti kritičnega, analitičnega in sintetičnega razmišljanja.
-Sposobnost definiranja, razumevanja in reševanja kreativnih profesionalnih izzivov na področju računalništva in informatike.
-Sposobnost profesionalnega komuniciranja v materinem in tujem jeziku.
-Sposobnost biti skladen z varnostnimi, funkcionalnimi in okoljskimi zahtevami.
-Sposobnost razumevanja in uporabe znanja računalništva in informatike na drugih relevantnih področjih (ekonomija, organizacija, umetnost, itd.).

Objectives and competences:

The goal of the course is to educate students to be able to actively provide security and privacy in contemporary information systems (IS), which include internet of thins, be it as systems administrators, or developers of new solutions.

Categorized competences:
- Developing skills in critical, analytical and synthetic thinking.
- The ability to define, understand and solve creative professional challenges in computer and information science.
- The ability of professional communication in the native language as well as a foreign language.
- Compliance with security, functional, economic and environmental principles.
- The ability to understand and apply computer and information science knowledge to other

-Praktična znanja in sposobnosti na področju strojne in programske opreme ter informacijske tehnologije za uspešno profesionalno delo.	technical and relevant fields (economics, organisational science, fine arts, etc). -Practical knowledge and skills of computer hardware, software and information technology necessary for successful professional work in computer and information science.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Poznavanje principov varovanja informacijskih virov in podatkov (zasebnosti) v sodobnih globalnih informacijskih okoljih, ki vključujejo internet stvari in pametne sisteme. **Uporaba:** Aplikacija na nivoju skrbništva IS in na nivoju razvoja ter raziskav področja varnosti in zasebnosti, vključno z internetom stvari in pametnimi strukturami. **Refleksija:** Celostno razumevanje obvladovanja informacijske varnosti in zasebnosti. **Prenosljive spretnosti - niso vezane le na en predmet:** Predmet se navezuje na problematiko op. sistemov, računalniških komunikacij, poslovnega vidika obvladovanja informacijskih sistemov ter razvoja novih proizvodov in storitev.	**Knowledge and understanding:** Knowledge of the principles for protection of information resources, data, and privacy in a modern global information environment that includes internet of things and smart devices. **Application:** Administration of security and privacy IS solutions, and their development, including internet of things and smart structures. **Reflection:** Holistic understanding of information security and privacy. **Transferable skills:** The course is related to areas of operating systems, computer communications, and business views of IS security and privacy. Further, the acquired skills are also aimed at the development of new products and servivces.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, vaje s projektnim delom (praktične prototipne implementacije), lastne predstavitve. Udeležba na vajah je obvezna (zahtevan procent udeležbe se določi ob začetku študijskega leta). Nosilec predmeta lahko določi obvezno udeležbo tudi na predavanjih.	Lectures, laboratory work (with practical prototype implementations), students' presentations. Attendance of laboratory work is mandatory (the exact percentage is announced at the beginning of a study year). The lecturer may impose mandatory attendance of lectures.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

50 % ocene predstavlja sprotno delo študenta v obliki preverjanj na vajah (domače naloge, kvizi, praktičen projekt), 50 % ocene pa predstavlja izpit, ki je načeloma v pisni obliki, lahko pa tudi v pisni in ustni obliki (pri čemer lahko nosilec namesto ustnega izpita uvede zagovor seminarja). Za uspešno opravljene obveznosti pri predmetu morata biti pozitivni obe delni oceni. Pristop k pisnemu izpitu je možen le po uspešno opravljenih obveznostih pri vajah (in v primeru dodatnih zahtev, ki se nanašajo na predavanja, po izpolnitvi le-teh). Ocene: 6-10 pozitivno, 1-5 negativno.	**50%** **50%**	50% of the final grade is obtained on the basis of on-going laboratory work (home-works, quizzes, practical project implementations and presentations). The other 50% is obtained on the basis of a written exam, or written and oral exam (the lecturer may decide that a coursework replaces the oral exam). To be eligible for the written exam, a candidate must have successfully completed laboratory work, and fulfilled other obligations related to lecturing that the lecturer may have imposed. For successful completition of the course both grades have to be positive. Grading: 6-10 pass, 1-5 fail.

4.2.4 Assembly and Handling Systems

Herakovič Niko

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Montažni in strežni sistemi
Course title:	Assembly and Handling Systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		1.	2.
		1st	2nd

Vrsta predmeta / Course type	Izbirni predmet/Elective course
Univerzitetna koda predmeta / University course code:	0319/0319

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
30		30			65	5

Nosilec predmeta / Lecturer:	Prof. dr. Niko Herakovič

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Zaključen 1. stopnja študija strojništva ali naravoslovnih smeri ali drugih smeri z znanjem osnov na področju proizvodnega strojništva.	Completed first level studies in mechanical engineering or natural sciences or other fields with knowledge of fundamentals in the field of production engineering.

Vsebina:	**Content (Syllabus outline):**
Predavanja – glavne teme: 1. Pregled in vloga montažnih in strežnih sistemov (MiSSP) v proizvodnem procesu. 2. Razlogi in pogoji za avtomatizacijo MiSSP, osnovni koncepti in strategije avtomatizacije MiSSP. 3. Ekonomski vidiki avtomatizacije MiSSP. 4. Koncepti pametnih ročnih montažnih procesov in sistemov. Koncepti togo in fleksibilno avtomatiziranih MiSSP. Analiza realnih primerov montažnih in strežnih sistemov ter procesov. Struktura izdelka in procesa. 5. Načrtovanje MiSSP. Integralni koncept snovanja. Povezava z izdelkom in njegovo strukturo. Oblikovanje izdelka za enostavnejšo montažo in strego ter metode. 6. Zanesljivost in razpoložljivost MiSSP. 7. MiSSP v Tovarni prihodnosti. Ključne tehnologije Industrije 4.0 v MiSSP. 8. Digitalni dvojčki MiSSP - modeliranje in simulacija.	Lectures – main topics: 1. Overview and the role of assembly and handling systems and processes (AaHSP) in the production process. 2. The reasons and conditions for AaHSP automation, basic concepts and strategies AaHSP automation. 3. Economic aspects of AaHSP automation. 4. Concepts of smart manual assembly and handling processes and systems. Concepts of rigid and flexible automated AaHSP. Analysis of real cases of assembly and handling processes and systems. Product and process structure. 5. Planning of AaHSP. Integral approach. Relation to the product and its structure. Design for ease of assembly and handling and methods. 6. Reliability and Availability of AaHSP. 7. AaHSP in the factory of the future. Key technologies of Industry 4.0 in AaHSP. 8. Digital twins of AaHSP – modelling and simulation.

9. Robotizirani montažni in strežni sistemi. Kolaborativni roboti v MiSSP
10. Sestav industrijskega robota (IR): prostostne stopnje, tipični IR, sestavni deli, delovni prostor (priročni in dosežni), pogoni, senzorika,
11. Vodenje IR in varnost. Sodelovanje človek-robot. Programiranje IR: on in off-line programiranje.
12. Zunanji senzorji v robotiziranih MiSS, taktilni senzorji in robotski vid.
13. Prijemala, manipulacijska prijemala in tehnološka orodja, senzorika prijemal.
14. Standardi in varnost v robotiziranih MiSS.

Vaje - glavne teme:

- Osnove kinematičnega modeliranja: kinematika IR, povezave med hitrostmi in pospeški koordinat, generiranje delovnih gibov, podajanje nalog, profili, interpolacije.
- Krmiljenje majhnega robota preko PC.
- Krmiljenje rotacijske in linearne servo osi za uporabo v avtomatizaciji.
- Načrtovanje ročnega montažnega mesta z računalnikom – modeliranje in simulacija.
- Modeliranje MiSSP, dizajn eksperimentov za izvajanje optimizacije s simulacijo.
- Avtomatizirana izdelava strukture izdelka iz 3D modela izdelka z računalniškim programom.
- Modeliranje MiSSP v 3D.

9. Robotized assembly and handling systems. Collaborative robots in AaHSP.
10. Structure of industrial robot (IR) degrees of freedom, a typical IR, components, workspace (handy and reach), drives, sensors
11. Control of IR and security. Human-robot cooperation. Programming IR: on and off-line programming
12. External sensors in robotized AaHS, tactile sensors and robot vision
13. Grippers, manipulation grippers and technological tools, sensors of grippers.
14. Standards and safety in robotized AaHS.

Tutorials – main topics:

- Basics of kinematic modeling: kinematics of IR, the connection between the speeds and accelerations of coordinates, generating a working moves, giving tasks, profiles, interpolations
- Controlling of small robots via PC
- Control of the rotary and linear servo axis for use in the automation.
- Manual workplace design using a computer – modelling and simulation.
- Modelling of production and assembly processes, design of experiments for optimization and simulation performing.
- Creating the product structure of the 3D product model by a computer on the base of model structure.
- Modelling of production and assembly processes in 3D.

Temeljni literatura in viri / Readings:

[1] Boothroyd, G.: Assembly Automation and Product Design, Second edition, CRC Press, 2005
[2] Boothroyd, G., Dewhurst, P., Knight, W. A.: **Product Design for Manufacture and Assembly, CRC Press, 2010**
[3] Monkman, G.J., Hesse, S., Steinmann, R., Schunk, H.: Robot Grippers, Wiley-VCH, Weinheim, 2007
[4] Groover, M.P.: Automation, Production Sytems, and Computer-Integrated Manufacturing, Third Edition, Prentice Hall, 2008
[5] Groover, M.P., Weiss, M., Nagel, R.N., Odrey, N.G.: Industrial Robotics - Technology, Programming and Applications, McGraw-Hill, 1986 (Internet update 2009)
[6] Gemeinschaftsausschuss CIM: Rechnerintegrierte Konstruktion und Produktion, Band 8: Flexible Montage, VDI verlag, 1992
[7] S.Y. Nof, W.E. Wilhelm, H.-J. Warnecke, Industrial Assembly, Chapman & Hall, London, 1997
[8] H.K. Rampersad, Integrated and Simultaneous Design for Robotic Assembly, 1994 - John Wiley & Sons, Inc. New York, NY, USA.
[9] Herakovic, N.: Lecture and Study material, University of Ljubljana, Faculty of Mechanical Engineering, LASIM, 2018

Cilji in kompetence:

Cilj predmeta:

- Naučiti študente osnov metodologije izbire, snovanja, analize in vrednotenja avtomatiziranih montažnih in strežnih sistemov in procesov (MiSSP) in njihovo integracijo v proizvodni proces tovarn prihodnosti.

Objectives and competences:

Goals:

- To teach the students the fundamentals of methodology used in the selection, design, analysis and evaluation of automated assembly and handling systems and processes (AaHSP), and about the integration thereof into the production process of the factories of the future

- Pridobitev osnovnih znanj za načrtovanje in integracijo robotiziranih MiSSP v proizvodni proces tovarn prihodnosti.

Kompetence:
- Sposobnost izbire, snovanja, analize in vrednotenja avtomatiziranih in robotiziranih MiSS, ter njihove integracije v proizvodni process.
- Sposobnost uporabe modernih pristopov analize, modeliranja, optimizacije im simulacije proizvodnih sistemov in procesov.
- Razumevanje ekonomskih vidikov avtomatizacije in robotizacije MiSS.
- Poznavanje pomena standardov in varnosti v robotiziranih MiSS.

- Acquisition of basic knowledge for planning and integration of robotic AaHSP into the production process of the factories of the future.

Competences:
- The ability to select, design, analyse and evaluate automated and robotic AaHS, as well as the integration thereof into the production process.
- The ability to use modern approaches of analysis, modeling, optimization and simulation of production systems and processes.
- Understanding the economic aspects of automation and robotization of AaHS.
- Knowing the significance of standards and safety in robotic AaHS.

Predvideni študijski rezultati:

Znanje in razumevanje:
Študent se nauči in razume:
- Osnove avtomatiziranih montažnih in strežnih sistemov ter procesov, metod in modelov.
- Osnove robotike, strukture, relacije, robotske aplikacije v avtomatiziranih MiSSP.
- Osnove MiSSP v tovarnah prihodnosti.
- Osnove tehnologije prijemanja v avtomatiziranih MiSSP in osnove robotskih prijemal.
- Pomen standardov in varnosti vrobotiziranih MiSSP.

Uporabnost:
Študenti uporabljajo pridobljeno znanje za načrtovanje in analizo MiSSP, kot tudi za njihovo integracijo v proizvodni proces.

Refleksija:
Uporaba predstavljenih metodologij in tehnologij pri reševanju realnih problemov v MiSSP.

Prenosljive veščine - povezane z več kot enim predmetom:
Uporaba literature - tiskani in internetni viri.
Identifikacija problemov in metod njihovega reševanja.
Sposobnost načrtovanja in upravljanja projektov, osredotočenih na snovanje sistemov za montažo in strego.

Intended learning outcomes:

Knowledge and understanding:
The student learns and understands:
- The fundamentals of automated assembly and handling systems and processes, rules and models.
- The fundamentals of robotics, the structures, relations, robotic applications in automated AaHSP.
- The fundumentals of AaHSP in the factories of the future.
- The fundamentals of gripper technology in automated AaHSP and the fundamentals of robotic grippers.
- The significance of standards and safety in robotic AaHSP.

Usage:
The students use the knowledge attained for planning and analysing of AaHSP, as well as for the integration thereof into the production process.

Reflection:
Using the presented methodologies and technologies in solving real AaHSP problems.

Transferrable skills – related to more than one course:
Using literature – hard copies and internets sources.
Problem identification and methods of problem solving.
The ability to plan and manage projects focused on designing assembly and handling systems.

Metode poučevanja in učenja:

Predavanja, vaje, sodelovanje v timskem delu, sodelovanje v realnih znanstvenih, razvojnih in industrijskih projektih.

Learning and teaching methods:

Lectures, exercises, participation at team work, collaboration in real scientific, development and industrial projects.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

Kolokviji Pisni izpit Ustno izpraševanje Timsko delo	60 100 20 20	Colloquia Written exam Oral examination Team work

4.2.5 Engineering design techniques

Žavbi Roman, Kos Leon, Vukašinović Nikola

1. Course title	DESIGN TECHNIQUES				
2. Unit code		3. Number of ECTS credits			5
4. Number of contact hours	Total 60	Lecture 30	Exercise 30[(a)] 0	Seminar	Other
5. Level	Master	6. Year	1.	7. Semester	1.
8. Study programme	MECHANICAL ENGINEERING – R & D Programme		9. Study field	Design and mechanics	
10. Programme pillar	Compulsory specialised course		11. Language	English	
12. Specialities	[(a)] Under the basic programme field, the course is executed in the form of exercises.				

13. Objectives of the course and intended learning outcomes (competences)	Goals: To present the design technique for different subject matters and products and for different phases of product development. The difference between product developmnt in serial, small batch, and one-of-a-kind production will be explained specifically, so the students can use their knowledge in the practice to determine the content and scope of work at the beginning of the design and development process according to the level of treatment: design or planning. Competences: The students learn the principles of defining the development and design process for a specific product. Based on the process requirements, they determine the execution of tasks, structured according to the »golden loop« model and some other models such as automotive industry. All the starting points are employed that were taught in the Product design and development course and the Design methodology course. This knowledge qualifies the students to recognise the necessary methods and activities for an accelerated product development.
14. Contents (Syllabus outline)	Design levels, S-curve of product maturity, different models for product development Product (service) design requirements (according to the design levels and type of production) Product / system concepts variations. Patents search, intelectual property, TRIZ methodology – ideality, contradictions, system approach. Original design (the approach to problem identification and methods for problem definition)

	EU regulation and legislation as constraint and opportunity. CE mark, certificates for products, product safety, risk management, eco-design. Robust product / process design according to good practice in automotive industry. Design methods: APQP, FMEA, SPC, MSA, CP, Poka Yoke. Module and system cost-efficient design (manufacturing, total, and lifecycle costs; fixed, and vairable costs; material, personal, and capital costs). Selected product development methods: concurrent engineering (CE), set-based CE, design for six-sigma, design of experiments. Virtual and phisical prototyping through product development. Product verification and validation. Design concepts in variant design, the influence of parameter and value interval consideration. Product development and support with PDM/PLM system, management of product variants, implementation of standardisation. Innovation design with the variation of working principles and derivations. Application of technical information system: document management, workflow, product modelling, knowledge management.
15. Fundamental literature	[1] STJEPANDIĆ, Josip (ur.), WOGNUM, Nel (ur.), VERHAGEN, Wim J. C. (ur.). Concurrent engineering in the 21st century : foundations, developments and challenges. Cham [etc.]: Springer. 2015, f. 639-670 [2] David Ullman: The Mechanical Design Process, Mc Graw Hill, 2006 [3] Detail Mechanical Design A practical Guide, ASME book,2000 [4] Sakao Tomohiko, Lindahl Mattias: Introduction to Product/Service-System Design, 2009 [5] Michael Ashby: Material selection in Mechanical Design, Elsevier, 2005 [6] Duhovnik Jože, Kljajin Milan: Razvoj izdelka, teorija in metodologija, under preparation [7] Karl Tl Ulrich, Steven D. Eppingr, Product design and development, McGraw-Hill, 2000. [8] Ehrlenspiel K., Kiewert A., Lindemann U., Hundal M.S. (Ed.), Cost-Efficeint Design, Springer 2007. [9] Žavbi R., Tavčar J., Verlinden J., Educating future product developers in virtual collaboration : five years of the E-GPR course. V: KISIELNICKI, Jerzy (ur.). Virtual Technologies : concepts, methodologies, tools, and and applications. Hershey PA: Information Science Reference, cop. 2008, pp. 101-128.

16. Intended learning outcomes	*16.1 Knowledge and understanding* The students assimilate the fundamental knowledge about the methods in design techniques, enabling them to prepare the data and knowledge for different levels of design and variant planning.
	16.2 Usage Direct use in planning and execution of details in scope of design and planning.
	16.3 Reflection In the phase of preparation for the execution of any project or design, it is important that all the data is prepared to reasonably ensure the quality of planning and design. A special emphasis is placed on the details related to the manufacturing technologies and natural processes/systems.
	16.4 Transferrable skills – related to more than one course The students learn the capability to recognise the different levels of planning and design through all product development phases.They have competences for proper selection and application of the method according to design level and phase in product development process. The attained knowledge and the assimilated methods make it possible to quickly master the development of objects and products.
17. Learning and teaching methods	The lectures take place in the lecture room and using the materials, accessible to the candidates on the web site. The lectures begin by the presentation of theory and the derivation of methods. One or more examples are given for each technique. The exercises are conducted in groups of up to 15 students, where the students verify the presented methods on selected cases of structural design. The majority of the cases is selected in the field of machine and device building, and some of them include the injection moulds and forming dies.
18. Requirements for inclusion into work and for the execution of study obligations	The course provides basic knowledge in the field of development and design. The student must know the theoretical foundations and the methods to participate at the exercises. At the exercises, the students must grasp the second stage of computer-supported modeling and the creation of technical documentation.
19. Assessment methods and grading scale	A written paper and oral defence are graded. The integral method of grading is used. The evaluation methods and the grading scale are defined in Point 4.8 of the application for approval of Level 2 masters' study programme MECHANICAL ENGINEERING.
20. Quality assessment	The understanding at the lectures is tested with two colloquia during the year. Above all the attained knowledge is assessed. The previous knowledge available to the students is determined by asking appropriate questions.

	The student work at the exercises is continuously monitored each week. The assignments are delivered in electronic and written form, to ensure a better reliability of monitoring.
Course coordinator and other lecturers	Prof. dr. Roman Žavbi, doc. dr. Leon kos, doc. dr. Nikola Vukašinović

4.3 Elective courses description

4.3.1 Mechatronic prototyping

Vrabič Rok

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Prototipiranje mehatronskih sistemov
Course title:	Mechatronic prototyping

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Magistrski študijski program 2. stopnje STROJNIŠTVO – Razvojno raziskovalni program	**Mehatronika in laserska tehnika**	**1.**	**2.**
2nd cycle master's study programme in mechanical engineering – Development research program	**Mechatronics and Laser Technology**	**1st**	**2nd**

Vrsta predmeta / Course type	
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
45		**30**			**50**	**5**

Nosilec predmeta / Lecturer:	assist. prof. dr. Rok Vrabič

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
Opravljen predhodni predmet: Mehatronski in senzorski sistemi Znanja: elektrotehnika, matematika (diferencialne enačbe), kinematika in dinamika, osnovno znanje programiranja	Prerequisite course: Mechatronics and Sensors Systems Knowledge: electrical engineering, mathematics (differential equations), kinematics and dynamics, basic programming knowledge

Vsebina:	**Content (Syllabus outline):**
1. Proces načrtovanja mehatronskih sistemov. 2. Simulacija mehatronskih sistemov. 3. Pristopa strojna-oprema-v-zanki in krmilnik-v-zanki. 4. Načrtovanje elektronike za mehatronske sisteme. 5. Integrirana vezja. 6. Načrtovanje in izdelava tiskanih vezij. 7. Prototipiranje mehatronskih sistemov. 8. Potrjevanje delovanja in testiranje mehatronskih prototipov.	1. The mechatronic system design process. 2. Simulation of mechatronic systems. 3. Hardware-in-the-loop and controller-in-the-loop approaches. 4. Design of electronics for mechatronic systems. 5. Integrated circuits. 6. Printed circuit board (PCB) design and manufacture. 7. Mechatronic system prototyping. 8. Validation and testing of mechatronic prototypes.

Temeljni literatura in viri / Readings:

Bishop, R. H. (2005). Mechatronics: an introduction. CRC Press.
Dorf, R. C., & Bishop, R. H. (2011). Modern control systems. Pearson.
Nise, N. S. (2007). Control Systems Engineering. John Wiley & Sons.
Horowitz, P., & Hill, W. (1989). The art of electronics. Cambridge Univ. Press.
Kaltjob, P. O. (2018). Mechatronic Systems and Process Automation: Model-Driven Approach and Practical Design Guidelines. CRC Press.
Karnopp, D. C., Margolis, D. L., & Rosenberg, R. C. (2012). System dynamics: modeling, simulation, and control of mechatronic systems. John Wiley & Sons.

Cilji in kompetence:	**Objectives and competences:**
Predmet vpeljuje principe, metode, tehnike in orodja za prototipiranje mehatonskih sistemov. Obravnavan je celoten proces razvoja mehatronskega sistema, od specifikacije do izdelave prototipa. Predstavljene so metode simulacije mehatronskih sistemov. Simulacije so nadgrajene s principi, ko je strojna-oprema-v-zanki in krmilnik-v-zanki. Predstavljena so orodja in tehnike za prototipiranje elektronike. Vpeljana je metodologija za razvoj tiskanih vezij. Predstavljene so metode potrjevanja delovanja in testiranja mehatronskih sistemov.	The course objectives are to introduce the principles, methods, techniques, and tools used in mechatronic system prototyping. The mechatronic system design process, from specification to prototype manufacturing, is detailed. Mechatronic system simulation is presented. Simulation methods are augmented with hardware-in-the-loop and controller-in-the-loop approaches. Electronic prototyping tools and techniques are introduced. Printed circuit board (PCB) design methodology is presented. Validation and testing of mechatronic prototypes is introduced.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Razumevanje in spozobnost izvedbe procesa načrtovanja mehatronskih sistemov, od specifikacij do prototipa. Sposobnost uporabe simulacijskih orodij za podporo procesu prototipiranja. Znanje za izdelavo tiskanih vezij in prototipov mehatronskih sistemov.	Knowledge and understanding: To understand and be able to perform the mechatronic system design process from specification to prototyping. To be able to use simulation tools to guide the prototyping process. To have the ability to create a printed circuit board design and prototype for a mechatronic system.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja. Predavalniške vaje. Laboratorijske vaje za računalnikom. Laboratorijske vaje z opremo. Projektno-usmerjeno laboratorijsko delo.	Lectures. Tutorials in lecture rooms (on whiteboard). Tutorials on computers. Tutorials on physical equipment. Project-based lab work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt) Pisni izpit z ustnim zagovorom (50%) Pisni test za praktični del (25%) Ocena individualnega projekta (25%)		Type (examination, oral, coursework, project): Written and oral exam (50%) Written exam for practical part (25%) Individual project (25%)

4.3.2 Multisensory systems, machine vision

PODRŽAJ Primož

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Multisensory systems, machine vision

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		1.	1.
Joint European Master in Smart Products Development		1st	2nd

Vrsta predmeta / Course type	
Univerzitetna koda predmeta / University course code:	

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
30		30			60	5

Nosilec predmeta / Lecturer:	Assoc. Prof. Dr. Primož Podržaj

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisits:

Vsebina:	Content (Syllabus outline):
	• Sensor overview • Sensor fusion, its challanges and advantages • Digital image acquisition • Basic point and neighborhood processing • Image processing software overview • Most common image processing applications

Temeljni literatura in viri / Readings:

Klein, L. A.: Sensor and data fusion: a tool for information assessment and decision making. SPIE press, 2012
De Silva, C. W.: Sensors and actuators: Engineering system instrumentation. CRC Press, 2015
Moeslund, T. B.: Introduction to video and image processing: Building real systems and applications. Springer Science & Business Media, 2013
Sundararajan, D.: Digital Image Processing: A Signal Processing and Algorithmic Approach. Springer, 2017.

Cilji in kompetence:	Objectives and competences:

	The course is divided into two parts. In the multisensory system part the students will first get an overview of various sensors and their capabilities. Then the benefits of sensor fusion will be discussed. As a result the students will be able to couple various sensors and extract optimal performance of such a combination. The second part of the course is focused on machine vision. In this part the students will get a basic understanding of a digital image and its acquisition. Image processing will then be discussed from mathematical point of view. Consequently the students will get the capability of designing algorithms for various machine vision tasks. After an overview of image processing software will be given, and some most common applications presented, the students will start working on a project. As a result, they will get the capability of designing a real life machine vision application and also be able to assess all the potential risk involved in such a project. This will make the competent to execute such projects in future without too much difficulties.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	• to get an overview of existing sensors, their capabilites, advantages and weaknesses • to get an understanding for benefits of sensor fusion • to get the basic understanding of digital image acquisition • to develop necessary skilly for successful and efficient image processing application development • to get an overview of possible image processing packages in various programming languages • to assess the time needed for accomplishing the above mentioned task and execute it in a real life project

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lectures, Practical work, Project work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
		Written exam 30% Oral exam 30% Project work 40%

4.3.3 Designing with non-metal materials

Vukašinovič Nikola, Pepelnjak Tomaž

1. Course title	DESIGNING WITH NON-METAL MATERIALS				
Unit code		3. Number of ECTS credits			5
4. Number of contact hours	Total 60	Lecture 30	Exercise 30	Seminar	Other
5. Level	Master	6. Year	2.	7. Semester	3.
8. Study programme	Smart products, Masters' Study Programme		9. Study field	Design and mechanics	
10. Programme pillar	Compulsory specialised course		11. Language	English	
12. Specialities	None				

13. Objectives of the course and intended learning outcomes (competences)	Goals: To teach the students about designing typical elements from non-metal materials. Learning about the influence of the processing and manufacturing technologies on the design of a structural element. Understanding the manufacturability of detailed product designs. The calculation methods for typical structural elements: materials joints, inseparable joints, positioning elements, springs, folding elements and complex shapes. Competences: The students are first acquainted with typical processing and manufacturing technologies. After that, they can commence the design of loaded products. They are able to determine the stress states in characteristic structural elements: materials joints, inseparable joints, positioning elements, springs, folding elements and complex shapes.
14. Contents (Syllabus outline)	Basic non-metal material processing and manufacturing technologies: wood, polymers, composites, ceramic. Engineering foundations of polymers and composites: viscoelasticity, adhesiveness, damping, tribology and conductivity. This is followed by a discussion of characteristic forms of machine elements and assemblies, made of non-metal materials. Plastic parts design rules, rib design, cold joints, shrinkage, quality limitations. Material joints: film joints, separable joints, welding of plastic, screew in plastic, metal inserts. Inseparable joints. Snap fit design. Functions and calculations.

	Properties of symmetric and asymmetric beams. Shafts bindings and polymer bearings. Polymer gears. Injection molding tool design. Sustainable product design from polymers. Engineering ceramic.
15. Fundamental literature	[1] Daniel Gay: Composite materials: Design and application, 2007, CRC [2] Jordan Rotheser, Joining of Plastics, Hanbook for Designers and Engineers, Hanser, Munich, 2009 [3] Paul R. Bonenberger, The First Snap-Fit Handbook, Creating and Managing Attachments for Plastic Parts, Munich, 2005 [4] Gottrried W. Ehrenstein, Mit Kunststoffen konstruiren, Hanser, Munich, 2007 [5] James C. Gerdeen: Engineering Design with Polymers and Composites 2005, Willey
16. Intended learning outcomes	*16.1 Knowledge and understanding* The students obtain the fundamental knowledge for sizing typical polymeric machine elements and assemblies. They are able to understand the relations between the processing and manufacturing technology and the final product form, based on the design characteristics.
	16.2 Usage Direct use in planning and execution of details in scope of design and planning.
	16.3 Reflection In the phase of preparation for the execution of any project or design, it is important that all the data is prepared to reasonably ensure the quality of planning and design of products made of polymeric, or generally non-metal materials.
	16.4 Transferrable skills – related to more than one course The students attain the ability of sizing elements and complex products made of non-metal materials. The purpose of the course is to ensure a comprehensive understanding of product design from manufacturing to testing.

17. Learning and teaching methods	The lectures take place in the lecture room and using the materials, accessible to the candidates on the web site. The lectures begin by the presentation of theory and the derivation of methods. Some characteristic examples of sizing are presented. The exercises are conducted in groups of up to 15 students, where the students verify the presented methods on selected cases of structural design. The majority of the cases is selected in the field of machine and equipment building, and some of them include the injection moulds and forming dies.
18. Requirements for inclusion into work and for the execution of study obligations	The course delivers supplemental knowledge in the field of developing and designing non-metal material products. The student must know the theoretical foundations and the methods to participate at the exercises. At the exercises, the students must grasp the second stage of computer-supported modeling and the calculation of stresses in visco-elastic materials.
19. Assessment methods and grading scale	A written paper and oral defence are graded. The integral grading method is used. The evaluation methods and the grading scale are defined in Point 4.8 of the application for approval of Level 2 masters' study programme MECHANICAL ENGINEERING.
20. Quality assessment	The understanding at the lectures is assessed with two colloquia during the year. Mainly the attained knowledge is assessed. The previous knowledge available to the students is determined by asking appropriate questions. The student work at the exercises is continuously monitored each week. The assignments are delivered in electronic and written form, to ensure a better reliability of monitoring.

4.3.4 Distributed systems

Vrabič Rok

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	Porazdeljeni sistemi
Course title:	Distributed systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Magistrski študijski program 2. stopnje STROJNIŠTVO – Razvojno raziskovalni program	**Mehatronika in laserska tehnika**	**2.**	**1.**
2nd cycle master's study programme in mechanical engineering – Development research program	**Mechatronics and Laser Technology**	**2nd**	**1st**

Vrsta predmeta / Course type

Univerzitetna koda predmeta / University course code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
30		**30**			**65**	**5**

Nosilec predmeta / Lecturer: assist. prof. dr. Rok Vrabič

Jeziki / Languages:		
	Predavanja / Lectures:	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Znanje: matematika (kombinatorika, matrična algebra), statistika

Prerequisits:

Knowledge: mathematics (combinatorics, matrix algebra), statistics

Vsebina:

9. Markovski odločitveni proces
10. Iteracija vrednosti in strategije
11. Q-učenje
12. Uvod v teorijo iger
13. Igre v normalni obliki
14. Igre v razširjeni obliki
15. Teorija mrež
16. Naključne mreže
17. Analiza mrež
18. Modeliranje porazdeljenih sistemov
19. Informacijsko komunikacijske strukture v porazdeljenih sistemih
20. Analiza primerov

Content (Syllabus outline):

9. Markov decision process
10. Value and policy iteration
11. Q-learning
12. Introduction to game theory
13. Normal form games
14. Extensive form games
15. Network theory
16. Random networks
17. Network analysis
18. Distributed system modelling
19. Information-communication infrastructure for distributed systems
20. Analysis of case studies

Temeljni literatura in viri / Readings:

Puterman, M. L. (2014). Markov decision processes: discrete stochastic dynamic programming. John Wiley & Sons.
Gibbons, R. (1992). A primer in game theory. Harvester Wheatsheaf.
Harsanyi, J. C., & Selten, R. (1988). A general theory of equilibrium selection in games. MIT Press Books, 1.
Barabási, A. L. (2003). Linked: The new science of networks.
Wasserman, S., & Faust, K. (1994). Social network analysis: Methods and applications (Vol. 8). Cambridge university press.

Cilji in kompetence:

Glavni cilj predmeta je predstavitev teorije in praks porazdeljenih sistemov, modliranje le-teh in analiza primerov iz področja proizvodnih sistemov. Predmet obravnava odločanje posameznega agenta s pomočjo Markovskih odločitvenih procesov, odločanje v večagentnih sistemih prek teorije iger in modeliranje večagentnih sistemov s teorijo in analizo omrežij. Poudarek je dan na informacijsko komunikacijske strukture sedanjih in prihodnjih proizvodnih sistemov. Predstavljenih je več študij primerov.

Objectives and competences:

The main objective of the course is to introduce the theory and practice of distributed systems, their modelling, and applications relevant for manufacturing systems. The course deals with decision making of a single agent through Markov decision process theory, multi-agent decision making through game theory, and multi-agent system modelling using network theory and analysis. The emphasis is given to information and communication structure for modern and future manufacturing systems. Several case studies are presented.

Predvideni študijski rezultati:

Znanje in razumevanje:
Razumevanje odločitvenih procesov posameznega agenta, razumevanje odločitvenih procesov, ko je agent soočen z okolji v katerih so prisotni drugi agenti, modeliranje in analiza porazdeljenih sistemov s teorijo mrež, razumevanje informacijsko komunikacijskih struktur sedanjosti in prihodnosti.

Intended learning outcomes:

Knowledge and understanding:
Understanding decision-making of a single agent, understanding decision-making, when an agent is faced with an environment that includes other agents, modelling and analysis of distributed systems using network theory, knowledge and understanding of modern and future information-communication structures.

Metode poučevanja in učenja:

Predavanja.
Predavalniške vaje.
Laboratorijske vaje za računalnikom.
Laboratorijske vaje z opremo.
Projektno-usmerjeno laboratorijsko delo.

Learning and teaching methods:

Lectures.
Tutorials in lecture rooms (on whiteboard).
Tutorials on computers.
Tutorials on physical equipment.
Project-based lab work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt) Pisni izpit z ustnim zagovorom (50%) Pisni test za praktični del (25%) Ocena individualnega projekta (25%)		Type (examination, oral, coursework, project): Written and oral exam (50%) Written exam for practical part (25%) Individual project (25%)

5 3RD SEMESTER: TU WIEN

5.1 3rd Semester Courses list – TUW

5.1.1 Courses table

COURSE	LECTURE HOLDER	ECTS:	Str1: Prod.dev.	Str2: Dig.Manuf. & Inf.sys	Str3: Big data sys.	Str4: Innov.&Entrep.	Str5: Transf. Skills	Integration project	Electives	
Virtual Product Development	Grafinger, M.; Gerhard, D.		5							
Industrial Manufacturing Systems	Kittl, B.; Bleicher, F.			4						
Industrial Information Systems	Gerhard, D.			5						
Controlling, Project and Process Management	Schwaiger, W.; Schlund, S.					5				
Innovation Theory	Filzmoser, M.					3				
Project Work Virtual Product Development	Grafinger, M.; Gerhard, D.							5		
Elective 3									3	
		SUM:	**5**	**9**	**0**	**8**	**0**	**5**	**3**	**30**

5.1.2 Elective courses

COURSE	LECTURE HOLDER	ECTS:	Str1: Prod.dev.	Str2: Dig.Manuf. & Inf.sys	Str3: Big data sys.	Str4: Innov.&Entrep.	Str5: Transf. Skills
E-Tutoring, Moderation of E-Learning	Herbst, I.R.; Rakoczi, G.	3				3	
Further Education and Lifelong Learning	Csanyi, G.	3				3	
Communication and Rhetoric	Pichlmair, M.	3				3	
Human Resource Management and Leadership	Köszegi, S.	3				3	
Design of Information Systems for Production Management	Erol, S.; Ansari, F.	3		3			
Marketing Basics	Grasser, T.	3				3	

5.2 Obligatory courses description

5.2.1 Virtual Product Development

Grafinger Manfred, Gerhard Detlef

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Virtual Product Development

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Lecture and Excercise
Univerzitetna koda predmeta / University course code:	307.414 & 307.422

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**5**

Nosilec predmeta / Lecturer:	Ao.Univ.Prof. Dipl.-Ing. Dr.techn. Manfred Grafinger Univ.Prof. Dipl.-Ing. Dr.-Ing. Detlef Gerhard

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	• Introduction to process development, management, and control • Modelling of functional and active structures • Methods of Systems Engineering • Product configuration and rule-based mapping of product knowledge • IT processes for the early stages of product development • Techniques and tools used in virtual product development projects (calculation, simulation, DMU, FMU) • Process chains illustrations (CAD / CAE, CAD / CAM) • High-end visualization, virtual and augmented reality in product development (kinematic analysis, tolerance analysis, collision analysis)

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**
	In this couse, a comprehensive introduction to the application of special IT-based methods in the product development process is given. The following skills and competences are particularly encouraged: • Operation of standard software systems in the field of virtual product development • Cross-sectoral competence to include other domains during the product development, such as electrical engineering or computer science
Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: The aim of this course is to provide the students with the capabilities to decisively shape product development activities and understand the functioning of corresponding IT systems. The students can rate and apply methodological concepts and select appropriate IT procedures. Through the use of appropriate IT tools, the students acquire the practical skills to operate the corresponding IT systems and the ability to adapt the systems to company-specific circumstances.
Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
		<u>307.414</u>
	100%	**Examination**
		<u>307.422</u>
	100%	**Project**

5.2.2 Industrial Manufacturing Systems

Kittl Burkhard, Friedrich Bleicher

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Industrial Manufacturing Systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Lecture and Exercise
Univerzitetna koda predmeta / University course code:	311.114 & 311.120

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**4**

Nosilec predmeta / Lecturer:	Ao.Univ.Prof. Dipl.-Ing. Dr.techn. Burkhard Kittl Univ.Prof. Dipl.-Ing. Dr.techn. Bleicher Friedrich

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	• Introduction to machine tools (operating area, component tool and workpiece handling) • Requirements on machine tools (quality, efficiency, flexibility, integration, costs) • Machine tool concepts • Automated machine tools • Manufacturing Systems (machining center, manufacturing cell, manufacturing system, transfer line) • Integration of machine tools • Manufacturing Execution Systems

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**

	In this course, an introduction to the manufacturing process is given. This includes the coordination of human, machine, material, and information with the goal to optimize the finishing accuracy, the production time, the production costs, the flexibility, the overall organization, the technology, and the ergonomic aspects.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: The aim of the course is to provide the students with a comprehensive overview over the machine tools, the requirements on machine tools, the machine tool concepts according to technology, and the variety of automated machine tools. The students become aware of modern manufacturing systems and the integration of machine tools in manufacturing execution systems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
		<u>311.114</u>
	100%	**Examination**
		<u>311.120</u>
	100%	**Coursework**

5.2.3 Industrial Information Systems

Kittl Burkhard, Gerhard Detlef

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Industrial Information Systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Lecture and Excercise
Univerzitetna koda predmeta / University course code:	307.413 & 307.421

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**5**

Nosilec predmeta / Lecturer:	Univ.Prof. Dipl.-Ing. Dr.-Ing. Detlef Gerhard

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	• Introduction to Industrial Information Systems • Definitions Business processes oriented aspects • Technical foundations (database technology, web technologies, architectures etc..) • Basic concepts for operational information management • Operational standard software systems (ERP systems, PLM/PDM systems, Groupware, CSCW etc.) • Enterprise Application integration • Enterprise-wide information systems

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**

	In this course, an comprehensive introduction to the main IT systems of an enterprise from the technical perspective is given. This includes an overview over operational information systems and over the methods and tools utilized to build such IT systems.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: The aim of the course is to provide the students with a comprehensive overview over operational information systems. The students are aware of the tasks and functions, such those systems fulfil. Further, the students become acquainted with the methods for project and change management in the context of introductory projects.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture and individual assignments

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
		<u>307.413</u>
	100%	**Examination**
		<u>307.421</u>
	50%	**Coursework**
	50%	**Examination**

5.2.4 Controlling, Project and Process Management

Schwaiger Walter, Schlund Sebastian

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Controlling, Project and Process Management

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Combined Lecture and Exercise
Univerzitetna koda predmeta / University course code:	330.240 & 330.181

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**5**

Nosilec predmeta / Lecturer:	Univ.Prof. Mag.rer.soc.oec. Dr.rer.soc.oec. Walter Schwaiger Univ.Prof. Dr.-Ing. Sebastian Schlund

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	Part 1: Controlling • Modeling Management Processes as PDCA-Diagrams • Modeling Management Processes as MGT-Activity-Diagrams • Cost Management: Reactive Closed Loop Management • Stochastic Control Theory in R • Forecasting in R: Classification and Regression Trees (CART) • Filtered Probability Spaces and Stochastic Processes • Cost-Volume-Profit-Management under Uncertainty • Production Management I: Time-based Optimal Control • Production Management II: State-based Optimal Control • Financial Management: Stochastic Optimal Control Part 2: Project and Process Management

	• Projekts & Project Management • Project Planning (Development of a Project) • Sequencing & Scheduling • Capacity and Ressource Planning • Cost Planing • Risik Planning • Project Controlling • Project Organization • Basics of Process Management • Qualitative and quantitative Analysis of Process Mangement • Process Modeling

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**
	The overall goal of the lecture consists out of developing the knowlegde, skills and competences in project, business process, and control thinking. The integrated planning and control methodology allows the recognition of project, process and control management processes, the assessment of their effectiveness, and the adjustments needed to improve them. The planning and control skills should not be limited to the cost, risk and financial domains of an enterprise. Rather, the planning and control competences should be applicable to all kinds of management domains.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: After completing this course, the students understand the differences, needs and basics of projects and processes in companies. Further, they can apply the methods of project planning (sequencing, scheduling, capacity and cost planning, risk planning), project controlling, project management and organization. The students are able to perform project planning and management using a software tool (MS-Project), and to name and explain basic theories, concepts, methodologies and tools for business process management and controlling. Finally, the students can model and visualize business, quality, and control processes with a state-of-the-art modelling language and software tool.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture and group assignments

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

Način (pisni izpit, ustno izpraševanje, naloge, projekt)		Type (examination, oral, coursework, project):
		<u>330.240</u>
	30%	**Assignment**
	70%	**Examination**
		<u>330.181</u>
	100%	**Examination**

5.2.5 Innovation Theory

Filzmoser Michael

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Innovation Theory

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Combined Lecture and Exercise
Univerzitetna koda predmeta / University course code:	330.258

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**3**

Nosilec predmeta / Lecturer:	Associate Prof. Mag.rer.soc.oec. Michael Filzmoser

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	• Fundamentals of Innovation • Innovation systems and processes • Innovation strategies • Diffusion and limitations of innovations • Critical factors for successful innovations and innovation management.

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**
	In this course, a comprehensive introduction to innovation processes on the enterprise level, innovation strategies, diffusion of innovation, critical factors for successful innovations and innovation management is given. The course aims to establish a basic understanding of innovation management. Based on lectures of theoretical approaches and case studies, the instruments of innovation management are demonstrated. Further, this knowledge is applied and depend in individual and group exercises.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: After completing this course, the students are understanding the concepts of innovation and can work with innovation systems and processes. Further, the students are aware of innovation strategies, the diffusions and limitations of innovations, and critical factors for successful innovations and innovation management.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture with assignments

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)	**50 %** **50 %**	Type (examination, oral, coursework, project): **Assignments** **Examination**

5.2.6 Project Work Virtual Product Development

Gerhard Detlef

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Project Work Virtual Product Development

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Project
Univerzitetna koda predmeta / University course code:	307.420

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
					X	**5**

Nosilec predmeta / Lecturer:	Ao.Univ.Prof. Dipl.-Ing. Dr.techn. Manfred Grafinger Univ.Prof. Dipl.-Ing. Dr.-Ing. Detlef Gerhard

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	Independent development of a project work related to the virtual development of a product.

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**
	The goal of the integration project is the acquisition of skills in the application of special IT-based methods during the product development process.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: The students are in a position to decisively shape product development activities and understand the functioning of corresponding IT systems. Using appropriate IT tools, the students acquire the practical skills to operate the corresponding IT systems and the ability to adapt the systems to company-specific circumstances.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Independent development of a project work related to the virtual development of a product.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)	**100%**	Type (examination, oral, coursework, project): **Project**

5.3 Elective Courses Description

5.3.1 E-Tutoring, Moderation of E-Learning

Herbst Ilona Renate, Rakoczi Gergely

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	E-Tutoring, Moderation of E-Learning

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Combined Lecture and Exercise
Univerzitetna koda predmeta / University course code:	015.087

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **Clinical work**	**Druge oblike študija**	**Samost. delo** **Individ. work**	**ECTS**
X						**3**

Nosilec predmeta / Lecturer:	Mag.phil. Herbst Ilona Renate Dipl.-Ing. Mag.rer.soc.oec. Dr.techn. Rakoczi Gergely

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**

	• Knowledge of common fields of activity of e-tutors
	  ○ Use of e-tutoring in various e-learning models
	  ○ Aspects of target group oriented motivation and organization
	  ○ Strategic use of e-learning in companies, universities and in adult education
	• Competence profiles and tasks of e-tutors
	• Roles of e-tutors in different organizational structures
	• Online communication in e-learning
	  ○ Knowledge of common communication tools
	  ○ Moderation and design competence of communication processes
	  ○ Special requirements for e-learning content (gender-equitable, barrier-free, intercultural etc. processing)

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**
	This course aims at introducing the basics of e-tutoring and the moderation of e-learning. On the basis of selected practical examples and course excerpts, different e-learning approaches are analyzed and appropriate support methods are tested. The participants develop competencies to effectively support learners in an e-learning supported course as e-tutors. In addition to supervision aspects of higher education, those of the adult education and tertiary education sectors are also taught.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: After completing this course, the students are able to: • identify and explain essential topics and problem areas in the care of learners in e-learning • activly use the basic competences for the appropriate practice through exemplary preoccupation with possible solutions • apply moderation skills for student support • use different communication and moderation tools in the field of e-learning • illustrate selected didactic application scenarios

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)	**100%**	Type (examination, oral, coursework, project): **Coursework**

5.3.2 Further Education and Lifelong Learning

Gottfried Csanyi

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Further Education and Lifelong Learning

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Combined Lecture and Exercise
Univerzitetna koda predmeta / University course code:	015.118

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**3**

Nosilec predmeta / Lecturer:	Dr.Gottfried Csanyi

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Prerequisits:

None

Vsebina:

Content (Syllabus outline):

- Background of lifelong learning (LLL)
- Constructivist models of learning and their implications on LLL
- Individual learning habits and their implications on LLL
- Enabling competences
- Organization of learning processes
- Different teaching styles for different target groups
- Potentials and limitations of technology enhanced learning and online communication

Temeljni literatura in viri / Readings:

Cilji in kompetence:

Objectives and competences:

This course aims at introducing the basics of lifelong learning and their implications on the participants. The participants will develop a computer-based game that reveals the effects of different influences on an individual's educational biography.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: After completing this course, the students are: • able to describe constructivist models of learning and their implications for lifelong learning. • aware of the existence of individual learning habits and can describe their implications for lifelong learning. • able to describe the function of enabling competences in a concept of lifelong learning. • able to describe the resulting consequences (of 3) to be derived for the organization of learning processes in a LLL approach in contrast to traditional educational concepts. • able to argue for the need for different teaching styles for different target groups (e.g. adult vs. youth, hearning impaired vs. normal hearing). • able to describe the potentials and limitations of technology enhanced learning and online communication. • able to present the results of their learning in an understandable.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)	**100%**	Type (examination, oral, coursework, project): **Coursework incl. Oral Presentation**

5.3.3 Communication and Rhetoric

Pichlmair Markus

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Communication and Rhetoric

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Lecture
Univerzitetna koda predmeta / University course code:	181.200

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**3**

Nosilec predmeta / Lecturer:	Univ.Lektor Mag.rer.soc.oec. Dr.rer.soc.oec.Markus Pichlmair

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	• Communication models • Basics of perception • Guides for creating a presentation • Body language • Practical exercises and feedback

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**
	This course aims at improving the perception, communication skills, presentation techniques and basic rhetoric competencies.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: After completing this course, the students: • Have an improved perception of their environment as well as of themselfs. • Improved their skills in communication and buidling relationships

	• Are aware of common presentation techniques and have aquired basic rhetoric competencies.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)	**100%**	Type (examination, oral, coursework, project): **Coursework**

5.3.4 Human Resource Management and Leadership

Köszegi Sabine Theresia

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Human Resource Management and Leadership

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Lecture
Univerzitetna koda predmeta / University course code:	330.188

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**3**

Nosilec predmeta / Lecturer:	Univ.Prof. Mag.rer.soc.oec. Dr.rer.soc.oec. Sabine Theresia Köszegi

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	• Introduction and theoretical foundations • Organization of Human Resource (HR) Management • HR planning, recruitment and selection • Performance and reward management, training and development • Leadership and management • Specific topics of HR management

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**
	The course provides the knowledge, tools and instruments necessary to manage human performance during the entire employee lifecycle. Further it adresses the analytical and synthetical skills in the evaluation of complex socio-economical problems, critical discussion and evalutation of alternative or conflicting theories and concepts. Interactive parts of the courses deepen teamwork and conflict management competences.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: After completing this course, the students possess the theoretical foundations and basic instruments of Human Resource (HR) management and leadership.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)	**100%**	Type (examination, oral, coursework, project): **Examination**

5.3.5 Design of Informational Systems for Production Management

Selim Erol, Fazel Ansari Chaharsoughi

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Design of Information Systems for Production Management

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Lecture
Univerzitetna koda predmeta / University course code:	330.279

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**3**

Nosilec predmeta / Lecturer:	Univ.Lektor Dipl.-Ing. Dr.rer.soc.oec. Selim Erol Univ.Ass. Dr.-Ing. Fazel Ansari Chaharsoughi, MSc

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	• Background and History of Management Information Systems (MIS) • Typology and Examples of Management Information Systems (Types of MIS, Application areas of MIS, MIS and the industrial organization) • Design and Engineering Process of MIS in the context of Cyber-physical Production Systems (Systems/Software Engineering Processes and Methods) • Architecture of Information Systems (Components (Hard-, Software) of an Information System, Layers) • Modeling of Management Information Systems – Requirements specification (Informal Requirements Elicitation and Analysis (Interviews, Personas, …), Semi-formal requirements specification techniques (UML use-case modeling, BPMN process modeling, Scenarios)) • Modeling of Management Information Systems – System specification (Database specification

	techniques (ER, UML class modeling), Application logic specification techniques (Process, Activity modeling)) • User-interface specification techniques (Wireframing, Storyboards, ...) • Management Information System Selection and Evaluation • Case-studies of MIS

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**
	This course aims at introducing the basics of information systems (IS) and software design with a focus on cyber-physical production systems. This covers the theoretical foundations and practical methods for the design and specification of cyber-physical production systems from an information systems perspective. The course aims to close the knowledge gap between classical industrial engineering competencies and information systems design competencies.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: After completing this course, the students are capable of: • Naming and distinguishing different methodological approaches for information systems design and evaluation. • Elicitation and specification of requirements for the design of cyber-physical production systems. • Modeling of cyber-physical production systems from an information systems and engineering perspective. • Selecting and applying appropriate systems modeling methods and tools according to domain/company/process specific problems.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)	**100%**	Type (examination, oral, coursework, project): **Examination**

5.3.6 Marketing Basics

Grasser Tibor

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	
Course title:	Marketing Basics

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
		2.	**3.**
		2st	**3st**

Vrsta predmeta / Course type	Lecture
Univerzitetna koda predmeta / University course code:	360.173

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical work	Druge oblike študija	Samost. delo Individ. work	ECTS
X						**3**

Nosilec predmeta / Lecturer:	Univ.Prof. Dipl.-Ing. Dr.techn. Tibor Grasser

Jeziki / Languages:	**Predavanja / Lectures:**	**English**
	Vaje / Tutorial:	**English**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisits:**
	None

Vsebina:	**Content (Syllabus outline):**
	The content of this lecture covers the 6 chapters of a marketingplan: • Analysis • Objective • Strategies • Marketing tools • Implementations • Controlling

Temeljni literatura in viri / Readings:

Cilji in kompetence:	**Objectives and competences:**
	This course aims at introducing the basics of marketing with its chapters analysis, objective, strategies, marketing tools, implementations, controlling. The marketing mix is analyzed and discussed with examples. Key elements for the marketing mix are product creation and practice of marketing concepts for procucts like IT, engineering, electrotechnics, chemistry, physics, communications, architecture, machinery , etc. The very important aspects

	of multimedia and "internet marketing" (Marketing 4.0) is dealt within a special chapter.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje:	Knowledge and understanding: After completing this course, the students have a basic understanding of the basics of marketing. Further, they are capable of marking products from domains like IT, engineering, electrotechnics, chemistry, physics , communications, architecture, machinery , etc.

Metode poučevanja in učenja:	**Learning and teaching methods:**
	Lecture

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način (pisni izpit, ustno izpraševanje, naloge, projekt)	**100%**	Type (examination, oral, coursework, project): **Written and Oral Examination**

4TH SEMESTER: ALL INSTITUTIONS

Details are still under coordination with project partners.