S V E U Č I L I Š T E U S P L I T U

FACULTY OF ELECTRICAL ENGINEERING, MECHANICAL ENGINEERING AND NAVAL ARCHITECTURE

DETAILED PROPOSAL OF THE STUDY PROGRAMME

GRADUATE UNIVERSITY STUDY IN INDUSTRIAL ENGINEERING

SPLIT, May 2025

1.1. List of mandatory and elective courses

List of courses								
Year of study: 1.								
Semester: I.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
	FETM01	Machine Tools and Systems	30	0	0	30	0	5
	L = Lectures, S = Seminar, AE = Auditory Exercises, LE = Laboratory Exercises, DE = Design Exercises							

List of courses								
Year of study: 1.								
Semester: II.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
Mandatory	FESM15	Computer Aided Design 2	30	0	0	0	30	5
	FESM05	Optimization Methods 2	45	0	0	15	0	5
	FETL16	Quality Assurance	30	0	15	15	0	5
	FESM04	Rational Use of Energy	30	0	30	0	0	5
	L = Lectures, S = Seminar, AE = Auditory Exercises, LE = Laboratory Exercises, DE = Design Exercises							

List of elective courses								
Year of study: 2.								
Semester: III.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
Elective	FETL26	Design for Assembly	30	0	0	0	30	5
	FESL40	Innovations in Technics	30	0	30	0	0	5
	FESL37	Refrigeration	30	0	30	0	0	5
	L = Lectures, S = Seminar, AE = Auditory Exercises, LE = Laboratory Exercises, DE = Design Exercises							

1.2. Course description

NAME OF THE COURSE	MACHINE TOOLS AND SYSTEMS						
Code	FETM01	Year of study	1				
Course teacher	Dražen Bajić, Ph. D., Full Professor Sonja Jozić, Ph. D., Assistant Professor	Credits (ECTS)	5				
Associate teachers	Mario Veić, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	30	0
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for: - understanding of basic machine tool parts, types of machine tools and their possible application. - acquisition of knowledge about the modern machine systems, - acquisition of knowledge of machine tools manual programming and programming in CAD/CAM systems for producing parts with simple and complex geometry.		
Course enrolment requirements and entry competences required for the course	None		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - present the principles of operation and application of machine tools - characterize features of machine tools - identify motives of high speed and multi-operation machine tools development - analyze the rule of CAD/CAM systems in modern design and production - generate the program for automatic machining on CNC machine tool - compare and highlite deferences between manual programming and programming in CAD/CAM systems.		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction to machine tools. State of the art and machine tools development. Classification of machine tools.	2	
	Basics of construction machine tools. Testing of machine tools accuracy.	2	
	Main parts of machine tools. Bearing elements, guides, spindle bearings.	2	
	Driving system of machine tools.	2	
	Machine tools control system.	2	
	Turning machines: Classification and basic concepts. Milling machines: Classification and basic concepts	2	
	Machine tools for drilling, broaching, sawing, grinding. Machines for gear wheels manufacturing.	2	
	First midterm exam		
	Automatic tool change. Automatic workpiece change.	2	
	Machine tools for high performance machining operation. Machining center. Turning center. Grinding center.	2	
	High Speed machine tools. Parallel kinematics for machine tools	2	

	Flexible manufacturing structures: flexible machining cells, flexible machining systems, flexible transfer lines.	2	
	Basic concept of CNC manual and automatic programming.	2	
	Examples of NC programming. Softwares for CAD/CAM	2	
	Second midterm exam		
	List of laboratory or design exercises		LE hours
	Movement, typical parts and mechanisms of machine tools installed in the laboratory. Determination of degree of machine tool workspace efficency.		2
	Determination of gerabox efficiency on turning machine. Determination of efficiency		2
	Determination of gearbox efficiency on drilling machine.		2
	Testing of geometric accuracy lathes and drills. Influence of machine tool on the machining accuracy.		2
	Manual programming: CNC turning machine		2
	Manual programming: CNC turning machine		2
	Manual programming: CNC turning machine		2
	Rigidity of the system machine-tool-woorkpiece		2
	Zero point of the workpiece and zero point of the tool at vertical machining center.		2
	Automatic CNC programming in CATIA		2
	Automatic CNC programming in CATIA		2
	Automatic CNC programming in CATIA		2
	Creation of CNC profram for vertical machining center		2

Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☒ independent assignments ☒ multimedia ☒ laboratory ☐ work with mentor ☐ (other)
Student responsibilities	The presence on lectures in the amount of at least 70 % of the times scheduled. Performed all required laboratory exercises.	

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	2	Research		Practical training	
	Experimental work		Report		Individual work	3
	Essay		Seminar essay		(Other)	
	Tests		Oral exam		(Other)	
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	There are two midterms and final exams. The first midterm exam is after 7 weeks of lecturing and the second one is after the next 6 weeks. In the final exams students that did not pass the midterm exams take part. In the makeup exam students take the entire exam. The midterm, final and makeup exams are carried out as written tests. The requirements for passing grade is: 1. Positive assessment of programing task “Manual programming of CNC lathes” 2. 50 % points on each midterm exam or the final exam. Grade (in percentage) is formed according to the formula: Grade(%) = 0,2 L + 0,4 (M1 + M2) L – result of programing task “Manual programming of CNC lathes” M1, M2 – test results of first and second midterm exam. Final grade is determined according to: Percentage Grade

	50% do 61% sufficient (2) 62% do 74% good (3) 75% do 87% very good (4) 88% do 100% excellent (5) Examination terms: according to the timetable		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Xun Xu: „Integrating Advanced Computer-Aided Design, Manufacturing, and Numerical Control: Principles and Implementations“, University of Auckland, New Zealand, 2009		
	Hoffmann M.: „CAD/CAM mit CATIA V5“, Hanser Verlag, Muenchen, 2005.		
	Lopez de Lacalle, Lamikiz "Machine tools for high performance machining", Springer, 2008.		
Optional literature (at the time of submission of study programme proposal)	- Cebalo, R., "Alatni strojevi – Odabrana poglavlja", Vlastito izdanje, Zagreb, 2001. - Pahole, I., Balič, J., "Obdelovalni stroji", Univerza v Mariboru, Maribor 2003.		
Quality assurance methods that ensure the acquisition of exit competences	- Keeping records of class attendance - Evaluation of results in accordance with the above learning outcomes - Feedback from students via surveys - Self-evaluation of teachers - Feedback information from graduated students		
Other (as the proposer wishes to add)			

NAME OF THE COURSE	**COMPUTER AIDED DESIGN 2**						
Code	FESM15	Year of study	1				
Course teacher	Gojko Magazinović, Ph. D., Full Professor	Credits (ECTS)	5				
Associate teachers	Ivan Pivac, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	0	30
Status of the course	Obligatory	Percentage of application of e-learning	50				
COURSE DESCRIPTION							
Course objectives	Training students for: - understanding the role and significance of CAD/CAE software in contemporary design and manufacturing systems, - performing engineering calculations using a spreadsheet software, - building geometric models, generating its technical drawings, and performing its static structural analyses using a contemporary CAD system.						

<table>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="3">Completion of Computer Aided Design 1 course</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="3">Students will be able to:
- solve simple engineering problems by using a spreadsheet tool,
- draw a graph by using a spreadsheet tool,
- use a computer aided design and analysis tool,
- generate geometric models and assemblies of moderate complexity,
- link geometric models with spreadsheet analyses,
- determine the peak stress and deformation within the simple geometric models.</td></tr>
<tr><td rowspan="30">Course content broken down in detail by weekly class schedule (syllabus)</td><td>Course content</td><td>L or S hours</td><td>AE hours</td></tr>
<tr><td>Introduction to a course. Description of an e-learning portal.</td><td>2</td><td></td></tr>
<tr><td>History of computing and computers; computer representation of numbers; engineering calculations; sample workbooks.</td><td>2</td><td></td></tr>
<tr><td>Graphical representation of engineering results.</td><td>2</td><td></td></tr>
<tr><td>Spreadsheet numerical integration.</td><td>2</td><td></td></tr>
<tr><td>Spreadsheet equation solver; systems of equations.</td><td>2</td><td></td></tr>
<tr><td>The environment of CAD software; references; design intent.</td><td>2</td><td></td></tr>
<tr><td>Curve and surface modeling.</td><td>2</td><td></td></tr>
<tr><td>First midterm exam</td><td></td><td></td></tr>
<tr><td>Feature parent-child relationship; model editing.</td><td>2</td><td></td></tr>
<tr><td>Model and section properties; measurements; material definition.</td><td>2</td><td></td></tr>
<tr><td>Degrees of freedom and assemblies; geometric tolerances; surface finishes.</td><td>2</td><td></td></tr>
<tr><td>Analysis as a feature; linking models and analysis.</td><td>2</td><td></td></tr>
<tr><td>Examples of models, analysis, and optimization.</td><td>2</td><td></td></tr>
<tr><td>Structural analysis: h-methods; p-methods; boundary conditions; result analysis.</td><td>2</td><td></td></tr>
<tr><td>Second midterm exam</td><td></td><td></td></tr>
<tr><td>List of laboratory or design exercises</td><td colspan="2">LE or DE hours</td></tr>
<tr><td>Spreadsheet tool elements; making a simple worksheet; built-in functions.</td><td colspan="2">2</td></tr>
<tr><td>Absolute and relative cell addressing; complex expressions.</td><td colspan="2">2</td></tr>
<tr><td>Working with data series; conditional formatting; graphing.</td><td colspan="2">2</td></tr>
<tr><td>Numerical integration: trapezoidal and Simpson's rule.</td><td colspan="2">2</td></tr>
<tr><td>Equations; linear systems; nonlinear systems.</td><td colspan="2">2</td></tr>
<tr><td>Basic modeling; parameters; relations; Project, part I: simple parts.</td><td colspan="2">2</td></tr>
<tr><td>Curves and surfaces.</td><td colspan="2">2</td></tr>
<tr><td>Project, part II: advanced parts.</td><td colspan="2">2</td></tr>
<tr><td>Project, part III: assembly.</td><td colspan="2">2</td></tr>
<tr><td>Project, part IV: technical drawing.</td><td colspan="2">2</td></tr>
<tr><td>Analysis feature.</td><td colspan="2">2</td></tr>
<tr><td>Modeling, analysis, and optimization.</td><td colspan="2">2</td></tr>
<tr><td>Static structural analysis of simple parts.</td><td colspan="2">2</td></tr>
<tr><td>Format of instruction</td><td colspan="3">☒ lectures
☐ seminars and workshops
☒ exercises
☐ on line in entirety
☒ partial e-learning
☐ field work
☐ independent assignments
☒ multimedia
☒ laboratory
☐ work with mentor
☒ computer work</td></tr>
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<table>
<tr><td>Student responsibilities</td><td colspan="6">Attendance of at least 70% lectures and all design exercises.</td></tr>
<tr><td rowspan="5">Screening student work (name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)</td><td>Class attendance</td><td>2</td><td>Research</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Report</td><td></td><td>Individual work</td><td>0,8</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>Computer work</td><td>2</td></tr>
<tr><td>Tests</td><td>0,2</td><td>Oral exam</td><td></td><td>(Other)</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>Project</td><td></td><td>(Other)</td><td></td></tr>
<tr><td>Grading and evaluating student work in class and at the final exam</td><td colspan="6">There are two midterm exams during the semester (carried out by using computer and e-learning portal; 90 minutes duration; first exam: five theoretical questions, two numerical and one design problems; second exam: five theoretical questions and three design problems). The final exams attend students that didn't pass the midterm exams. The requirements for passing grade are the fulfillment of student responsibilities and at least 50% points on each midterm exam or the final exam. Grade (in percentage) is determined as follows:
Grade(%) = (M1 + M2)/2
where M1 and M2 are the midterm grades. The final grades are: satisfactory (2), grades from 50% to 61%; good (3), grades from 62% to 74%; very good (4), grades from 75% to 87%; and excellent (5), grades from 88% to 100%.</td></tr>
<tr><td rowspan="4">Required literature (available in the library and via other media)</td><td colspan="3">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="3">G. Magazinović, Bilješke uz predavanja, FESB</td><td>-</td><td>e-learning portal</td></tr>
<tr><td colspan="3">R. Toogood: Creo Parametric 2.0 Tutorial and Multimedia DVD, SDC Publications, Mission, 2013.</td><td>1</td><td>https://books.google.hr</td></tr>
<tr><td colspan="3">B. Plazibat, i drugi: Informatika 1, Sveučilišni studijski centar za stručne studije, Split, 2010.</td><td>-</td><td>Link at e-learning portal</td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">- K. Lee: Principles of CAD/CAM/CAE Systems, Addison-Wesley, Reading, 1999.
- C. McMahon, J. Browne: CADCAM: Principles, Practice and Manufacturing Management, Prentice-Hall, Harlow, 1998.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- Evaluation of results by the above learning outcomes
- Feedback from students via surveys
- Institutional and non-institutional evaluations</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="6"></td></tr>
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<table>
<tr><td>NAME OF THE COURSE</td><td colspan="6">OPTIMIZATION METHODS 2</td></tr>
<tr><td>Code</td><td>FESM05</td><td>Year of study</td><td colspan="4">1</td></tr>
<tr><td>Course teacher</td><td>Damir Vučina, Ph. D., Full Professor</td><td>Credits (ECTS)</td><td colspan="4">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Igor Pehnec, Ph. D., Teaching assistant
Ivo Marinić- Kragić, Teaching assistant</td><td rowspan="2">Type of instruction (number of hours)</td><td>L</td><td>S</td><td>AE</td><td>LE</td><td>DE</td></tr>
<tr><td>45</td><td>0</td><td>0</td><td>15</td><td>0</td></tr>
<tr><td>Status of the course</td><td>Obligatory</td><td>Percentage of application of e-learning</td><td colspan="4">0</td></tr>
<tr><td colspan="7">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="6">Acquiring theoretical know-how in basic numerical methods and algorithms in engineering optimization.
Developing competences in applying computers in engineering numerical optimization.
Acquire competences in applying numerical tools in engineering problems.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="6">Completed pre-graduate studies which include courses equivalent to computer-aided analysis. Competences in basic engineering analysis methods and program development in MATLAB</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="6">After completing the course the students will be able to:
- formulate the engineering problem as an engineering problem of decision making
- model the set of decision variables, constraints and excellence functions for engineering problems
- make flowcharts for different optimization methods
- apply gradient optimization methods (HJ, NM) to engineering problems
- apply non-gradient optimization methods (SD, CG, N, BFGS) to engineering problems
- solve nonlinear optimization problems with constraints
- apply evolutionary optimization methods and metaheuristics (GA; ACO, SA, NN) to engineering problems
- apply optimization methods to network problems: min. path, min. spanning tree, max. flow, ..
- develop and test own optimization models and methods in MATLAB</td></tr>
<tr><td rowspan="7">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="4">Course content</td><td>L hours</td><td>AE hours</td></tr>
<tr><td colspan="4">Introduction, basic theoretical concepts. Basic terms and examples of application.</td><td>3</td><td></td></tr>
<tr><td colspan="4">Basic concepts, theoretical aspects, optimization models</td><td>3</td><td></td></tr>
<tr><td colspan="4">Linear programming, standard model</td><td>3</td><td></td></tr>
<tr><td colspan="4">Linear programming, simplex method</td><td>3</td><td></td></tr>
<tr><td colspan="4">Nonlinear programming, 1D methods: Interval halving, Fibonacci, Golden section, Interpolation methods, reduction of nD problems to 1D</td><td>3</td><td></td></tr>
<tr><td colspan="4">Nonlinear programming, n-dimensional methods for unconstrained problems: direct methods (Random search, Hookee-Jeeves, Powell, Nelder-Mead, other)</td><td>3</td><td></td></tr>
</table>

	Nonlinear programming, n-dimensional methods for unconstrained problems: gradient methods (Steepest descent, Conjugate directions method, Newton and Quasi-Newton methods)	3	
	First midterm exam		
	- Nonlinear programming, constrained n-dimensional method: transformation methods (external and intternal penalty methods, other)	3	
	- Nonlinear programming, constrained n-dimensional method: basic concepts in direct methods: (feasible directions, generalized reduced gradients, SLP, SQP,..)	3	
	Basic concepts in evolutionary methods and special chapters: simulated annealing, genetic algorithms, etc.	3	
	Basic concepts in evolutionary methods and special chapters: neural networks as approximators	3	
	Basic concepts and procedures: optimization with discrete variables, branch and bound, GAs. Network problems shortest path, min. spanning tree, max. flow	3	
	Examples of setting-up physical and mathematical models for optimization for different engineering problems. Development of algorithms. Development of progams in C and MATLAB.	3	
	Second midterm exam		

	List of laboratory exercises	LE hours
	Basic terms and examples of application.	1
	Optimization models	1
	Linear programming, standard model, examples	1
	Linear programming, Simplex method, examples	1
	Nonlinear programming, 1D methods, examples	1
	Nonlinear programming, unconstrained n-dimensional methods, examples	1
	Nonlinear programming, unconstrained n-dimensional methods, examples	1
	Nonlinear programming, (NLP) constrained n-dimensional methods, examples	1
	Nonlinear programming, (NLP) constrained n-dimensional methods, examples	1
	Examples of application of neural networks	1
	Examples in evolutionary methods, genetic algorithms	1
	Examples in evolutionary methods, genetic algorithms	1
	Examples of application in engineering and modeling	1

Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☐ independent assignments ☐ multimedia ☒ laboratory ☐ work with mentor ☐ (other)
Student responsibilities	The presence on lectures in the amount of at least 70 % of the times scheduled. Performed all required laboratory exercises.	

Screening student work *(name the proportion of ECTS*	Class attendance	3	Research		Practical training	
	Experimental work		Report		Individual work	2

credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)	Essay		Seminar essay		Laboratory exercises	
	Tests		Oral exam		Preparation for laboratory exercises	
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	There are two midterms and final exams. The first midterm exam is after 7 weeks of lecturing and the second one is after the next 6 weeks. Each midterm test consists of respective theoretical questions and numerical problems. The final tests consist of overall theoretical questions and numerical problems. In the final exams, students that did not pass the midterm exams take part. The midterm and final exams are carried out as written tests. The requirement for passing grade is the positive assessment of laboratory exercises and 50 % points on each midterm exam or the final exam. Grade (in percentage) is formed according to the formula: Grade(%) = 0,5 (M1 + M2) the activities in percentage: • M1, M2 – test results.		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	- D. Vučina, 'Metode inženjerske numeričke optimizacije', Sveučilište u Splitu, FESB 2005		
	- J. S. Arora, “Introduction to Optimum Design”, McGraw Hill, 1989		
	I.Pehnec, Materijali za laboratorijske vježbe		
Optional literature (at the time of submission of study programme proposal)	- G. Vanderplaats, "Numerical Optimization Techniques for Engineering Design", - Vanderplaats Research and Development, 1999 - A. D. Belegundu, T. R. Chandrupatla, “Optimization Concepts and Applications in Engineering”, Prentice Hall, 1999 - S.S. Rao, “Engineering Optimization”, Wiley Interscience, 1996 - D.E. Goldberg, "Genetic algorithms in search, optimization and machine learning", Addison Wesley, 1989 - S. Haykin, "Neural Networks", Prentice Hall International, 1999		
Quality assurance methods that ensure the acquisition of exit competences	- Evaluation of results in accordance with the above learning outcomes - Feedback from students via surveys - Self-evaluation of teachers - Institutional and non-institutional evaluations		
Other (as the proposer wishes to add)			

NAME OF THE COURSE	QUALITY ASSURANCE						
Code	FETL16	Year of study	1.				
Course teacher	Boženko Bilić, Ph. D., Full Professor	Credits (ECTS)	5				
Associate teachers	Marko Mladineo, Ph. D., Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	15	15	0
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	- The promotion of quality as a fundamental criterion for survival companies in the market - Introducing students with modern principles, techniques and methods of quality assurance - Introducing students with the modern systems and principles of quality management.		
Course enrolment requirements and entry competences required for the course	Completed undergraduate study industrial engineering, shipbuilding or mechanical engineering.		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - Distinguish quality control, quality assurance and quality management - Construct a control charts for variables and control charts for attributes - Apply some sampling procedures for inspection by attributes and by variables - Assess the capability of process - Apply the some tools and methods of quality assurance - Explain the establishment and operation of a quality management system - Comment different quality management systems - Evaluate (teamwork) quality management system according to requirements of international standard ISO 9001		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	INTRODUCTION: Definitions of quality. The historical development of quality. Traditional and modern approach to quality. QUALITY LEVELS: quality control, quality assurance, quality management. QUALITY AND LEGISLATION - Responsibility as a result of poor quality. QUALITY COSTS	2	0
	QUALITY AND RELIABILITY	2	2
	QUALITY CONTROL: Internal and external quality control. On-line quality control and off-line quality control. Basic quality control tools	2	0
	APPLICATION OF THE THEORY OF PROBABILITY AND STATISTICS IN THE QUALITY CONTROL.	2	3
	STATISTICAL PROCESS CONTROL: Variation in process (special causes of variations and common causes of variations). Process capability analysis - process capability indexes	2	2
	STATISTICAL PROCESS CONTROL: Control charts for variables. Control charts for attributes.	2	2
	STATISTICAL QUALITY CONTROL: Acceptance sampling by attributes and by variables.	2	2
	First midterm exam		
	QUALITY ASSURANCE.	3	2

	QUALITY ASSURANCE: Taguchi method. QFD method.		
	QUALITY MANAGEMENT: Seven Management and Planning Tools (7QMT). FMEA method. Six-Sigma.	2	0
	QUALITY MANAGEMENT: Quality and standardization. Standard ISO 9000. Requirements of this International Standard ISO 9001.	2	0
	QUALITY MANAGEMENT: The establishment of quality management systems - Requirements that a company must fulfill. Preparing the necessary documentation. The application of the quality management system	2	0
	QUALITY MANAGEMENT: Internal audit of quality management system. Management review of quality management system. External audit of quality management system conducted by external independent auditing organization.	3	0
	Second midterm exam		
	List of laboratory exercises		LE hours
	Measurement and control of physical quantities		3
	FTA method		2
	FMEA method		2
	QFD method		2
	5S		2
	Six sigma		2

Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☒ independent assignments ☒ multimedia ☒ laboratory ☐ work with mentor ☐ (other)
Student responsibilities	The presence on lectures in the amount of at least 70 % of the times scheduled. Performed all required laboratory exercises.	

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	1,5	Research		Practical training	
	Experimental work		Report		Individual work	2,5
	Essay		Seminar essay	0,5	Laboratory exercises	0,5
	Tests		Oral exam		Preparation for laboratory exercises	0
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	During semester there are two midterm exams. The first midterm exam is after 7 weeks of lecturing and the second one is after the next 6 weeks. The student can take the first midterm exam if he/she regularly attended classes. Requirements for access to the second midterm exam are: regularly attended classes, at least 25% of points achieved at the first midterm and positively evaluated individual seminar. Midterm exams are conducted in written form. They consist of theoretical questions and numerical problems. The teacher reserves the right to hold a midterm exam in oral form. Positive assessment represents minimal 50% points on each midterm exam: Grade (%) = 0,5 (M1 + M2) M1 – first midterm grade (%), i.e. percentage points achieved on the first midterm M2 – second midterm grade (%), i.e. percentage points achieved on the second midterm Requirements for access to the final exams are: regularly attended classes and positively evaluated individual seminar. In the two final exams students that did not pass at least one of the midterm exams take part. In the third and fourth final exams students take the whole exam regardless results of midterm exams. Final exams are conducted in written form. They consist

<table>
<tr><td></td><td colspan="3">of theoretical questions and numerical problems. The teacher reserves the right to hold a final exams in oral form. The requirement for passing grade is minimal 50% points on final exam.

Grade (%): Final mark:
50% - 60% sufficient (2)
61% - 75% good (3)
76% - 90% very good (4)
91% - 100% excellent (5)

Grade (%) is average points achieved on midterm exams expressed as a percentage or number of points achieved on the final exam expressed as a percentage.</td></tr>
<tr><td rowspan="5">Required literature (available in the library and via other media)</td><td>Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td>B. Bilić: Kvaliteta – Planiranje, analiza i upravljanje, University of Split, FESB, 2016.</td><td>5</td><td></td></tr>
<tr><td>I. Oslić: Kvaliteta i poslovna izvrsnost, M.E.P. Consult, Zagreb, 2008.</td><td>0</td><td></td></tr>
<tr><td>N. Vulić: Sustavi upravljanja kvalitetom, Veleučilište u Splitu, Split, 2001.</td><td>0</td><td></td></tr>
<tr><td>N. Injac: Mala enciklopedija kvalitete, I. dio – Upoznajmo normu ISO 9000, Oskar, Zagreb, 2002.</td><td>0</td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="3">- B. Bilić: Predavanja postavljena na e-learning portalu
- J. M. Juran, F. M. Gryna: Planiranje i analiza kvalitete, MATE, Zagreb, 1999.
- N. Injac: Mala enciklopedija kvalitete, II. dio – Informacije; dokumentacija; auditi", Oskar, Zagreb, 2002.
- M. Drljača: Mala enciklopedija kvalitete, V dio - Troškovi kvalitete, Oskar, Zagreb, 2004.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="3">- Keeping records of the attendance of students
- Annual evaluation of results in accordance with the above learning outcomes
- Feedback from students via surveys
- Self-evaluation of teachers
- Feedback from students who have already graduated related to the relevance of the course content</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="3"></td></tr>
</table>

NAME OF THE COURSE	RATIONAL USE OF ENERGY						
Code	FESM04	Year of study	1				
FESC06	Sandro Nižetić, Ph. D., Associate Professor	Credits (ECTS)	5				
Nižetić Sandro Ivan Tolj Dario Bezmalinović Grubišić-Čabo Filip	Ivan Tolj, Ph. D., Teaching assistant Dario Bezmalinović, Ph. D., Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	30	0	0	0
	Obligatory	Percentage of application of e-learning					
Obavezni							
Course objectives	Training students for: - Classify and elaborate base terms related to the energy sustainability, - Implement general thermodynamic laws on different energy systems and components, - Classify and elaborate renewable energy sources						
Course enrolment requirements and entry competences required for the course	Thermodynamics, Mathematics 1, Mathematics 2.						
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - Consider and clarify basic terms related to the sustainable energy development, - Describe and implement general thermodynamic laws on different energy systems and components in order to compute their efficiency, - Classify and describe unfavourable impacts to the environment due to energy related issues, - Classify and consider implementation of the renewable energy sources, - Determine and describe basic economic parameters related to the energy projects.						
Course content broken down in detail by weekly class schedule (syllabus)	Course content		L or S hours		AE hours		
	Introduction to the process engineering's, basic terms and laws.		2 hours		2 hours		
	Calculation of the energy flows for different properties.		2 hours		2 hours		
	Calculation examples of energy flows for different plants.		2 hours		2 hours		
	Calculation examples of energy flows for different plants.		2 hours		2 hours		
	Enthalpy change and chemical reactions.		2 hours		2 hours		
	Calculation examples of energy flows for different combustion processes, exergy of fuels.		2 hours		2 hours		
	Energy balance equations and exergy analysis.		2 hours		2 hours		
	Exergy analysis.		2 hours		2 hours		
	Heat exchangers.		2 hours		2 hours		
	Pumps and fans in energy systems.		2 hours		2 hours		
	Heat pumps.		2 hours		2 hours		

	Cogeneration plants.	2 hours	2 hours
	Rational use of renewable energy sources.	2 hours	2 hours
	Rational use of renewable energy sources.	2 hours	2 hours
	Economic analysis for energy related projects.	2 hours	2 hours

Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☒ independent assignments ☒ multimedia ☐ laboratory ☐ work with mentor ☐ (other)
Student responsibilities	The presence on lectures in the amount of at least 70 % of the times scheduled. Performed all required auditorium exercises.	

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*						
	Class attendance	2	Research	3	Practical training	
	Experimental work		Report		(Other)	
	Essay		Seminar essay		(Other)	
	Tests		Oral exam		(Other)	
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	S. Nižetić, online predavanja, Racionalno Korištenje Energije, FESB, 2011.		
	G. Boyle: Renewable energy, power for a sustainalble future, Oxford (2004)	1	
	L.D.D. Harvey, Energy Efficiency and the demand for energy services, 2010.	1	
	F. Bošnjaković: Nauka o toplini (I i II dio), Tehnička knjiga, Zagreb, 1970 i 1976	2	

Optional literature (at the time of submission of study programme proposal)	
	Grupa autora, HVAC Applications, ASHRAE, 2003 Priručnik za energetsko certificiranje zgrada, UNDP, 2010. Grupa autora, ‘’Energy analysis of 108 industrial processes’’ ,U.S. Department of energy, USA, (1997), Š.Hadžiefendić, A. Lekić, E. Kulić, ‘’Kogeneracija i alternativne tehnologije proizvodnji električne energije, Bosna, Sarajevo, (2003), S.Kakac, H. Liu, ‘’Heat exchangers’’, CRC Press, New York, (2002), LJ. Majdandžić, ‘’Obnovljivi izvori energije’’, Graphis, Zagreb (2008).

Quality assurance methods that ensure the acquisition of exit competences	- Evaluation of results in accordance with the above learning outcomes - Feedback from students via surveys - Self-evaluation of teachers - Institutional and non-institutional evaluations
Other (as the proposer wishes to add)	

NAME OF THE COURSE	**DESIGN FOR ASSEMBLY**						
Code	FETL26	Year of study	2				
Course teacher	Nikola Gjeldum, Ph.D. Assistant Professor	Credits (ECTS)	5				
Associate teachers	Marina Crnjac, Teaching assistant, Ivan Peko, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	0	30
Status of the course	Elective	Percentage of application of e-learning	0 %				

COURSE DESCRIPTION

Course objectives	Objectives: – Understanding and application of Design for Assembly basic principles – Teach students to design a product with its elements in Siemens NX CAD software – Teach student to design a product taking into account a simplicity and suitability of assembly process	
Course enrolment requirements and entry competences required for the course	None	
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: – design a product elements in Siemens NX CAD software ("part design") – connect designed product elements in assembly ("assembly design") – generate designed product drawings ("drawing") – redesign a product according to assembly process requirements – make an assembly process plan for designed product	
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours
	Introduction and basic principles. Historical development of product assembly process	2
	Product architecture	2
	Product design for assembly	2
	Methods of product design for assembly	3
	Measures and tolerances in assembly process	2
	Product design modifications	1

	Assembly process	2
	First midterm exam	2
	Making a plan for manual assembly process	2
	Chart of assembly process traceability	2
	Organizational structures in manual assembly process	2
	Lean methods for assembly processes	2
	Development from primary labor division phase to autonomous working groups	2
	Balancing of assembly process workstations	2
	Second midterm exam	2
	List of design exercises	DE hours
	Introduction in Siemens NX CAD software	2
	Part design in Siemens NX	8
	Assembly design in Siemens NX	10
	Generating product drawings in Siemens NX	4
	Simulation in Siemens NX	2

Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☐ independent assignments ☒ multimedia ☒ laboratory ☐ work with mentor ☐ (other)
Student responsibilities	The presence on lectures and exercises in the amount of at least 70 % of the times scheduled.	

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	1	Research		Practical training	1
	Experimental work		Report		Individual work	2,7
	Essay		Seminar essay		(Other)	
	Tests	0,2	Oral exam		(Other)	
	Written exam	0,1	Project		(Other)	

Grading and evaluating student work in class and at the final exam	During semester there are two midterm exams. The first midterm exam is after 7 weeks of lecturing and the second one is after the next 6 weeks. In the first two final exams students that did not pass at least one of the midterm exams take part. In the third and fourth final exams students take the whole exam regardless results of midterm exams. The requirements for passing grade are positive assessment of individual project and positive assessment in exam. Positive assessment represents minimal 50% points on each midterm exam or minimal 50% points on final exam. Final exams are conducted in written form. Midterm exams and final exams consist of theoretical questions and numerical problems. Grade (%) = (D + E) / 2 D – Individual project grade (%) E – average points achieved on midterm exams expressed as a percentage or number of points achieved on the final exam expressed as a percentage. E = (M1 + M2)/2 M1, M2 – average points achieved on midterm exams expressed as a percentage.

<table>
<tr><td></td><td colspan="3">Grade (%): Final mark:
50% - 61% sufficient (2)
62% - 74% good (3)
75% - 87% very good (4)
88% - 100% excellent (5)</td></tr>
<tr><td rowspan="4">Required literature (available in the library and via other media)</td><td>Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td>Gjeldum, N.: "Dizajn za montažu", lectures on e-learning, FESB Split</td><td></td><td>Internet (e-learning)</td></tr>
<tr><td>Marinescu, I., Boothroyd, G.: "Product design for manufacture and assembly", Marcel Dekker, New York, 2002.</td><td>1</td><td></td></tr>
<tr><td>Whitney Daniel E.: "Mechanical Assemblies – Their Design, Manufacture, and Role in Product Development", Massachusetts Institue of Technology, Oxford University Press, 2004.</td><td>1</td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="3">1. A.J.D.Lambert Surendra M. Gupta: "Disassembly Modeling for Assembly, Maintenance, Reuse, and Recycling", CRC Press, 2000.
2. Molloy, O., Tilley, S., Warman, E.: "Design for manufacturing and assembly – Concepts, architectures and implementation, Springer Science + Bussines Media, 1998.
3. WEB publications on DFA</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="3">– keeping records of the attendance of students
– annual evaluation of teachers
– periodical evaluation of individual project advancement
– feedback from students via surveys
– self-evaluation of teachers
– institutional and non-institutional evaluations</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="3"></td></tr>
</table>

NAME OF THE COURSE	TECHNICAL INNOVATIONS						
Code	FESL40	Year of study	1.				
Course teacher	Branko Klarin, Ph. D., Full Professor	Credits (ECTS)	5				
Associate teachers	Goran Gašparović, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	30	0	0
Status of the course	Elective	Percentage of application of e-learning	0				

COURSE DESCRIPTION			
Course objectives	Training students for: - acquire knowledge and understanding of the innovation processes, - application and analysis of procedures for the creative work of interest for technical applications, - evaluation procedures and intellectual property protection, - implement and lead the innovation process from idea to patent.		
Course enrolment requirements and entry competences required for the course	English language		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - recognize the importance of innovation mainly technical, in the development of human society, - evaluate and self-evaluate of innovation potential, - recognize the importance of innovation in different technical fields, - appoint institutions and intellectual property organisations, - link and select the parameters important for innovation, - identify steps to innovate and design of project tasks, - connect various sources of ideas and design ideas, to design their own innovation, - recognize steps and design patent applications, create own patent applications.		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction. Etymology and basic definitions. The history and role of invention and innovation.	2	2
	Great explorers and inventors. Examples of the invention. The most significant inventions and innovations.	2	2
	Innovative potential innovators. Basics for evaluation and self-assessment.	2	2
	The implications of innovation in the research, management and policy. Indexation and the Global Innovation Index.	2	2
	Institutions and intellectual property organization.	2	2
	Basics for personal innovative work and membership in associations of innovators.	2	2
	Innovation processes and outcomes.	2	2
	Systematic innovation and design. The design spiral.	2	2
	Association, diffusion of innovation, the S-curve and other features.	2	2
	Eco-innovation and sustainability.	2	2
	Review of the EU attitude and incentives to innovation. Open innovation.	2	2
	Legal aspects of intellectual property protection and realization.	2	2
	Protected and protective symbols. Copyright, trademark, patent license.	2	2

	List of laboratory or design exercises	LE or DE hours

Format of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☒ field work	☐ independent assignments ☒ multimedia ☒ laboratory ☐ work with mentor ☐ (other)
Student responsibilities	The presence on lectures in the amount of at least 70 % of the times scheduled. Performed all required laboratory exercises.	

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*						
	Class attendance	3,5	Research		Practical training	
	Experimental work		Report		Individual work	
	Essay		Seminar essay	1,5	Laboratory exercises	
	Tests		Oral exam		Preparation for laboratory exercises	
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	There are two midterms and final exams. The first midterm exam is after 7 weeks of lecturing and the second one is after the next 6 weeks. Each midterm test consists of seminar essay progress. In the final exams students that did not pass the midterm exams take part. The final exams are carried out as finished seminar essay acceptance. The requirement for passing grade is the positive grade of seminar essay. Grade (in percentage) is formed according to the formula: Grade(%) = 0,5 (M1 + M2) where in percentage: • M1, M2 – seminar essay status.

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	- Klarin B.: Inovacije u tehnici, autorizirana predavanja, FESB		e-learning portal
	- Von Hippel, Eric: The Sources of Innovation, Oxford University Press, 1988.		book
	- Tuomi, Ilkka: Networks of Innovation – Change and Meaning in the Age of the Internet, Oxford University Press, 2002.		book

Optional literature (at the time of submission of study programme proposal)	- Bray, D.A.; Konsynski, B.; Streator, J.: Being a Systems Innovator, National Defense University - Information Resources Management College, 2007. - Europe 2020. Flagship Initiative Innovation Union, 2010.
Quality assurance methods that ensure the acquisition of exit competences	- Evaluation of results in accordance with the above learning outcomes - Feedback from students via surveys - Self-evaluation of teachers - Institutional and non-institutional evaluations

Other (as the proposer wishes to add)	- Feedback from graduate students about the course relevance

NAME OF THE COURSE	**REFRIGERATION**						
Code	FESL37	Year of study	2				
Course teacher	Nižetić Sandro, Ph. D., Associate Professor	Credits (ECTS)	5				
Associate teachers	Ivan Tolj, Ph. D., Teaching assistant Dario Bezmalinović, Ph. D., Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	30	0	0
Status of the course	Elective.	Percentage of application of e-learning					

COURSE DESCRIPTION

Course objectives	Training students for: - Classify and elaborate basic terms related to the refrigeration, - Implement basic thermodynamic calculations for different cooling systems (applications), - Classify and elaborate different refrigeration techniques and systems in general.		
Course enrolment requirements and entry competences required for the course	Thermodynamics 1, Mathematics 1, Mathematics 2.		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: -Consider and elaborate basic terms related to the general refrigeration systems, -Elaborate and implement basic thermodynamic calculations for different refrigeration systems, -Classify and elaborate unfavourable impacts of the refrigerants to the environment, -Describe and classify base equipment of the typical refrigeration system, -Numerate and describe different types of the refrigeration systems.		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction to the refrigeration.	2 hours	2 hours
	Methods to obtain low temperatures. Idealised cooling cycles.	2 hours	2 hours
	Real cooling cycles cascade cooling cycle, multiple compressor stage cooling cycles, and efficiency improvement of the cooling cycles.	2 hours	2 hours

	Characteristics of the refrigerants, impact to the environment, selection of the refrigerant, retrofit of the refrigerant.	2 hours	2 hours
	Compressor types for cooling applications and base characteristics.	2 hours	2 hours
	Evaporators for cooling applications.	2 hours	2 hours
	Condensers for cooling applications.	2 hours	2 hours
	Other equipment of the refrigeration systems.	2 hours	2 hours
	Regulation of the refrigeration systems (basis).	2 hours	2 hours
	Performance of the refrigeration systems, coolers, air-conditioning devices, ice machines, etc.	2 hours	2 hours
	Different refrigeration systems.	2 hours	2 hours
	Different refrigeration systems.	2 hours	2 hours
	Different refrigeration systems.	2 hours	2 hours
	Introduction to the air-conditioning systems	2 hours	2 hours
	Introduction to the cryogenic techniques.	2 hours	2 hours
	List of laboratory or design exercises		LE or DE hours

Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☒ independent assignments ☒ multimedia ☐ laboratory ☐ work with mentor ☐ (other)
Student responsibilities	The presence on lectures in the amount of at least 70 % of the times scheduled. Performed all required auditorium exercises.	

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	2	Research	2	Practical training	
	Experimental work		Report		(Other)	
	Essay		Seminar essay		(Other)	
	Tests		Oral exam		(Other)	
	Written exam		Project	1	(Other)	
Grading and evaluating student						

work in class and at the final exam			
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	S. Nižetić, Online predavanja: Rashladna tehnika, FESB, 2011.		
	Recknagel, Sprenger, Schramek, Čeperković: Grijanje i klimatizacija 2002, Energetika marketing, Zagreb, 2002 (Prijevod sa njemačkog)		
	ASHRAE Handbooks: Fundamentals, Applications, Systems and Equipment, Refrigeration, ASHRAE, Atlanta, USA, 2012		
Optional literature (at the time of submission of study programme proposal)	- Časopis: EGE, Energetika marketing, Zagreb - Časopis: ASHRAE Journal, ASHRAE, Atlanta, USA.		
Quality assurance methods that ensure the acquisition of exit competences	- Evaluation of results in accordance with the above learning outcomes - Feedback from students via surveys - Self-evaluation of teachers - Institutional and non-institutional evaluations		
Other (as the proposer wishes to add)			