SVEUČILIŠTE U SPLITU

FACULTY OF ELECTRICAL ENGINEERING, MECHANICAL ENGINEERING AND NAVAL ARCHITECTURE

DETAILED PROPOSAL OF THE STUDY PROGRAMME

GRADUATE UNIVERSITY STUDY IN MECHANICAL ENGINEERING

SPLIT, May 2025

1.1. List of mandatory and elective courses

Module: Structures and Energy Technology - 261

List of courses									
Year of study: 1.									
Semester: I.									
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
Mandatory	FEML01	Mathematics – special topics	30	0	30	0	0	5
	FESL01	Fluid flow	30	0	15	15	0	5
	FESL10	Finite element method	30	0	15	0	15	5
	FESL12	Heat and mass transfer	30	0	30	0	0	5
	FETL18	Machine tools	45	0	0	15	0	5
	FESL23	Heating and air conditioning	30	0	30	0	0	5
	Total		195	0	120	30	15	30
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

List of courses								
Year of study: 1.								
Semester: II.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
	FESL05	Optimization methods	45	0	0	15	0	5
	FETL25	Manufacturing process planning	45	0	0	0	15	5
	FESL22	Renewable energy sources and sustainable development	30	0	30	0	0	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

List of courses								
Year of study: 2.								
Semester: III.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
Mandatory	FESL17	Computer aided design 1	30	0	0	0	30	5
	FESL24	Energy efficiency in buildings	30	0	30	0	0	5
	FESL38	Aerotechnics and wind turbines	30	0	30	0	0	5
	FETL01	Materials 3	30	0	0	30	0	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

Module: Computer-Aided Design and Engineering - 262

List of courses								
Year of study: 1.								
Semester: I.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
Mandatory	FEML01	Mathematics – special topics	30	0	30	0	0	5
	FESL01	Fluid flow	30	0	15	15	0	5
	FESL10	Finite element method	30	0	15	0	15	5
	FETL05	Plant layout	30	0	0	15	15	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

List of courses								
Year of study: 1.								
Semester: II.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
	FESM15	Computer aided design 2	30	0	0	0	30	5
	FESL05	Optimization methods	45	0	0	15	0	5
	FETL07	Computer aided manufacturing	30	0	0	0	30	5
	FESN19	Computational fluid dynamics	30	0	0	30	0	5
	FESL42	Theory of plasticity and viscoelasticity	45	0	15	0	0	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

List of courses								
Year of study: 2.								
Semester: III.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
Mandatory	FETL06	Production planning and control	30	0	15	15	0	5
	FESL49	Numerical synthesis in engineering	45	0	0	0	15	5
	FESL36	Introduction to information systemy	30	0	0	15	0	5
	FESL23	Heating and air conditioning	30	0	30	0	0	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

Module: Production Mechanical Engineering - 263

List of courses

Year of study: 1.

Semester: I.

STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
STATUS	FETL18	Machine tools	45	0	0	15	0	5
	FETL04	Engineering maintenance	45	0	0	15	0	5
	FETL22	Nonconventional machining processes	45	0	0	15	0	5
	FETL01	Materials 3	30	0	0	30	0	5

* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise

List of courses

Year of study: 1.

Semester: II.

STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
Mandatory	FETL25	Manufacturing process planning	45	0	0	0	15	5
	FETL27	Material selection	30	0	30	0	0	5
	FESL05	Optimization methods	45	0	0	15	0	5
	FETL07	Computer aided manufacturing	30	0	0	0	30	5

* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise

List of courses

Year of study: 2.

Semester: III.

STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
Mandatory	FETL06	Production Planning And Control	30	0	15	15	0	5
	FESL01	Fluid flow	30	0	15	15	0	5
	FESL10	Finite element method	30	0	15	0	15	5
	FETL17	Hydraulic and pneumatic systems	30	0	0	15	15	5
	FETL26	Design for assembly	30	0	0	0	30	5

* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise

1.2. Course description

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="7">MATHEMATICS – SPECIAL TOPICS</td></tr>
<tr><td>Code</td><td>FEML01</td><td>Year of study</td><td colspan="5">1</td></tr>
<tr><td>Course teacher</td><td>Ivan Slapničar, Ph.D., Full Professor</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Lana Periša, Teaching assistant
Anita Carević, 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>30</td><td>0</td><td>30</td><td>0</td><td></td></tr>
<tr><td>Status of the course</td><td>obligatory</td><td>Percentage of application of e-learning</td><td colspan="5">15</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Training students for:
- understanding concepts of selected advanced mathematical topics: integrals depending on parameters, calculus of variations, and partiial differential equations
- applications of the above concepts to mechanical engineering and other technical sciences.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="7"></td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="7">Students will be able to:
- derive and apply methods for solving integrals depending on parameters,
- explain the main idea of calculus of variations, derive the necessary conditions and state sufficient conditions for extrema,
- reproduce solutions of classical problems of the shortest time and smallest surface area,
- define Sturm-Liouville problem and explain the structure of the solution, recognize and solve simpler problems,
- derive heat equation, Laplace equation and wave equationa, and state possible initial and boundary conditions,
- prove the uniqueness of the solution and solve the equations with appropriate methods (using eigenfunctions or Fourier and Laplace transforms),
- solve simpler wave equations in the case of linear and nonlinear waves,
- recognize and solve Volterra and Fredholm integral equations,
- define and compute Green function for the Sturm-Liouivuille problems.</td></tr>
<tr><td rowspan="12">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="5">Course content</td><td>L or S hours</td><td>AE hours</td></tr>
<tr><td colspan="5">1. Integrals depending on parameters.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">2. Calculus of variations, necessary and sufficient conditions for extrema.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">3. Examples of calculus of variations, conditional extrema, Euler's method of finite differences.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">4. Fourier and Laplace transform.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">5. Sturm-Liouville problem.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">6. Diffusion equation.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">7. Heat equation.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">8. Laplace equation.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">9. Wave equation - linear waves.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">10. Wave equation – nonlinear waves.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">11. Volterra and Fredholm integral equations.</td><td>2</td><td>2</td></tr>
</table>

	12. Green's function.	2	2
	13. D'Alembert solution of the wave equation.	2	2
	List of laboratory or design exercises		LE or DE hours
Format of instruction	x lectures ☐ seminars and workshops x exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	x independent assignments ☐ multimedia ☐ laboratory ☐ work with mentor ☐ (other)	
Student responsibilities	Regular attendence to and active participation in lectures and excercises.		

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		Self study	2
	Essay		Seminar essay		(Other)	
	Tests	0.5	Oral exam		(Other)	
	Written exam	0.5	Project		(Other)	

Grading and evaluating student work in class and at the final exam	During semester two mid-term exams are held. The first exam is scheduled after 7 weeks of lectures, and the second in the week following the lectures. At each mid-term exam students can get 40 points, while the remaining 20 points are attained through assignements during lectures and excercises. The condition for passing the course is minimum 20 points on each mid-term exams and a total of at least 50 points. After semester, two final exams and two correction exams are held. Students which did not pass one mid-term exam, can take only this part of the exam during final exams. Students which did not pass any mid-term exam, take the final exam with comprehensive course content. In that case, masimum numbers of available points is 80. The condition for passing the course is minimum 40 points in the final exam and a total of at least 50 points. The grade is formed as follows: 85 and more points - excellent (5), 75-84 points - very good (4), 60-74 points - good (3), and 50-59 points - sufficient (2). Students who did not pass the course after final exams, and have obtained total of at leat 10 points, can attend corrections exam. On the correction exam maximal number of points is 80, and the minimum requirement for a passing grade is minimum of 40 points in the exam and a total of at least 50 points. Mid-term exams, final exams and correction exams are held according to the exam schedule.

<table>
<tr><td rowspan="9">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>I. Slapničar, Matematika 2, FESB, Split, 2002, chapters: Integrals depending on parameters and Calculus of variations.</td><td rowspan="3"></td><td rowspan="3">http://www.fesb.unist.hr/mat2</td></tr>
<tr><td>I.</td></tr>
<tr><td></td></tr>
<tr><td>J. D. Logan, Applied Mathematics, 3rd Edition, Wiley and Sons, New York, 2006.</td><td></td><td></td></tr>
<tr><td>Lecture materials on FESB e-learning portal.</td><td></td><td>httpd://elearning.fesb.unist.hr</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3" style="display:none"></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="3">- P. duChateau, D. W. Zachmann, Partial Differential Equations, Schaum's Outline, McGraw Hill, New York, 1986.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="3">- homework
- short tests
- quizzes
- mid-term exams
- final exam
- student questionnaires</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="3"></td></tr>
</table>

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="7">FLUID FLOW</td></tr>
<tr><td>Code</td><td>FESL01</td><td>Year of study</td><td colspan="5">1</td></tr>
<tr><td>Course teacher</td><td>Prof. Zoran Milas, PhD</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2"></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>2</td><td></td><td>1</td><td>1</td><td></td></tr>
<tr><td>Status of the course</td><td>Compulsory</td><td>Percentage of application of e-learning</td><td colspan="5"></td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Training students for:

- understanding of stress-strain relationship in viscous fluids
- solving NS equation and apllying the solutions in various engineering problems .
- deepening knowledge on the boundary layers and on the effect of pressure gradient on boundary layer development.
- being familiar with the limitations of potential flow theory
-modelling the effect of tip vortices on lifting surfaces of finite span</td></tr>
</table>

	- introduction into turbulence modelling		
Course enrolment requirements and entry competences required for the course	Mathematics 2, Fluid Mechanics 1,		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - critically apply the available analytical solutions of Navier-Stokes equation for solving engineering problems associated with viscous fluid flow - evaluate the pressure drop in porous media and the overflow rating of settling tanks. - understand the effect of viscosity on load-carrying capacity of bearings - analyze the distribution of fluid pressure and shear stress around the body in parallel stream and to understand the effect of flow separation - make use of the superposition of elementary potential flows for modelling complex flows - use experimental data on lift-drag of slender bodies and apply correction to the force coefficients for various aspect ratios -understand the effect of turbulence model selection -		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Stress in fluids, Navier equation, rotation and deformation rate in fluids	2	1
	Stokes constitutive relations, Navier-Stokes eq.	2	1
	Hagen-Poiseuill flow in circular pipe, concentric annuli, Kozeny Carman eq. for porous media.	2	1
	Couette flow, hydrodynamic lubrication.	2	1
	Stokes (sphere) flow, settling velocity.	2	1
	Boundary layer theory, friction coefficient for flat plate, Falkner Skan flow,	2	1
	Separation of boundary layer, Karman boundar layer eq.	2	1
	Solution techniques for Karman integral boundary layer eq.	2	1
	Potential flow, stream function, elementary potential flows.	2	1
	Kutta-Joukowsky theorem for isolated profile and for cascade of profiles. Hydrodynamic mass.	2	1
	Tip vortices, vortex sheet, effect of finite span on lift- drag coefficients.	2	1
	Introduction to turbulence modelling.	2	1
	Prandtl mixing length model. Complex turbulence models.	2	1
	List of laboratory or design exercises		LE or DE hours
	Pressure drop in capillary tube		2
	Porous media flow, fluidization		2
	Bag house air filter and sand filter (field work)		2
	Viscometry		2
	Viscous damper		2
	Airfoil drag		1,5
	Leading edge pressure distribution		1,5
Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ *on line* in entirety	☐ independent assignments ☐ multimedia ☒ laboratory ☐ work with mentor	

<table>
<tr><td></td><td colspan="4">☐ partial e-learning
☒ field work</td><td colspan="2">☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="6">Class room attendance min. 70 % . All required laboratory exercises and reports completed.</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>2,0</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 (prep. for test and exam)</td><td>2,3</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>Laboratory exercise reports</td><td>0,4</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>0,1</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 tests and final exams. The first midterm test takes place after 7 weeks of lecturing and the second one 6 weeks later. Each midterm test contains 2-3 numerical problems and 12 short questions (incl. multiple choice questions) and 4 essay questions Students who did not pass the midterm tests exams take part in the final exams. The midterm and final exams are carried out as written tests (closed book).
The requirement for passing grade is the positive assessment of laboratory exercises/reports and 50 % points on each midterm test/ final exam and successful completion of final oral exam.
Grade (in percentage) is formed according to the formula:
Grade(%) = 0,1 LE + 0,4(M1 + M2) +0,1 FOE
the activities in percentage: ·
LV – laboratory assessment, · M1, M2 – test results., FOE-final oral exam</td></tr>
<tr><td rowspan="3">Required literature (available in the library and via other media)</td><td colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">- Milas Z.., Fluid Flow -authorized lectures, FESB, Split, 2015</td><td>5</td><td></td></tr>
<tr><td colspan="4">- Virag Z., Mechanics of Fluids 2“, FSB, Zagreb</td><td>5</td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">White, F. M.: Viscous Fluid Flow, McGraw Hill, New York, 2005</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- Evaluation of results in accordance with the above learning outcomes
- 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="6"></td></tr>
</table>

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="7">FINITE ELEMENT METHOD</td></tr>
<tr><td>Code</td><td>FESL10</td><td>Year of study</td><td colspan="5">1.</td></tr>
<tr><td>Course teacher</td><td>Željan Lozina, Ph. D., Full Professor</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Damir Sedlar, Ph. D., Assistant Professor
Ivan Tomac, Ph. D., Assistant Professor</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>30</td><td>0</td><td>15</td><td>0</td><td>15</td></tr>
<tr><td>Status of the course</td><td>Obligatory</td><td>Percentage of application of e-learning</td><td colspan="5">0</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">- The aim of the course is to teach the students to be able to use Finite Element programs in a practical way to solve problems in linear elastic stress analysis. A student who has studied the course should be able, in a later industrial setting, to undertake the analysis of real problems with a fair understanding of sensible modelling procedures.
- The course is also aimed at providing the necessary theoretical and practical background for more advanced studies within the field of finite elements and structural mechanics.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="7">None</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="7">1. Understand the basic theory behind the finite element method
a) Strong and weak formulation
b) Virtual work and variational formulation
c) Basics of the approximate solution of PDE
2. Use the finite element method for the solution of practical engineering problems
3. Use a commercial FE-package
4. Analyze more advanced topics within the field of finite elements and structural mechanics.</td></tr>
<tr><td rowspan="15">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="5">Course content</td><td>L hours</td><td>KV+DE hours</td></tr>
<tr><td colspan="5">Introduction to basic concepts: One-dimensional equation of extension of bar. Wave equation.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Direct approach: Bar, beam, truss,…</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Virtual work principle.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Interpolation and approximation of functions, shape functions in one dimension.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Strong and weak formulation.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Virtual work approach to bending of bars and FEM.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Two dimensional problems: strong and weak formulation of potential problems.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">First midterm exam</td><td></td><td></td></tr>
<tr><td colspan="5">Shape functions in two and three dimension.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Virtual work principle for two dimension elasticity.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">CST element for two dimension elasticity.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Higher order elements in elasticity.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Finite elements in dynamics.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Finite elements in elastic stability.</td><td>3</td><td>2</td></tr>
</table>

	Second midterm exam		
	List of laboratory exercises		LE 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	2,0	Research		Practical training	
	Experimental work		Report		Individual work	2,9
	Essay		Seminar essay		Laboratory exercises	0
	Tests	0	Oral exam		Preparation for laboratory exercises	0
	Written exam	0,1	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 10 theoretical questions and numerical problems and final tests consist of 20 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 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. Grading according Faculty and University rules.

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Ž. Lozina: Autorizirana predavanja, FESB		e-learning portal
	Ž. Lozina: Metoda konačnih elemenata, FESB, Split.	5	

Optional literature (at the time of submission of study programme proposal)	K.-J. Bathe: Finite Element Procedures, Prentice Hall Inc., 1996.
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	HEAT AND MASS TRANSFER						
Code	FESL12	Year of study	1				
Course teacher	Frano Barbir, Ph. D., Full Professor	Credits (ECTS)	5				
Associate teachers	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	Obligatory	Percentage of application of e-learning					
COURSE DESCRIPTION							
Course objectives	Training students for: - Recognizing mechanisms of heat and mass transfer - Analytical and numerical approaches for solving heat transfer problems - Modeling and analyzing heat and mass transfer processes						
Course enrolment requirements and entry competences required for the course	Thermodynamics 2						
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - Recognize and distinguish the basic mechanisms of heat transfer - Apply analytical and numerical methods on different cases of heat and mass transfer - Choose appropriate equations for calculating the heat transfer coefficient for different cases of heat transfer - Break down and solve different cases of heat and mass transfer - Analyze the heat transfer during evaporation processes - Calculate basic characteristics of cooling towers						

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	The course introduction. Calculation of heat transfer and temperature field for solid bodies. The control volume method (CVM) in one-dimensional steady state heat conduction.	2	2
	Two-dimensional steady state heat conduction, control volumes and methods for solving a system of equations. Relaxation (iterative) method for solving a system of equations.	2	2
	Examples and overview of the equations.	2	2

	One-dimensional transient conduction – the explicit variation of the CVM.		
	Criteria of stability of solutions. Examples of the CVM application for solving multi-dimensional problems	2	2
	Examples and overview of the equations. The implicit variation of the CVM. Examples and comparison with the explicit variation. Accuracy of the CVM.	2	2
	Fundamentals of the convection. Mechanisms of heat transfer for laminar flow.	2	2
	Thickness of the velocity boundary layer for a flat plate. Thickness of the temperature boundary layer for a flat plate. The heat transfer coefficient	2	2
	First midterm exam	2	2
	Link between the boundary layer and the Prandtl number for laminar flow. Laminar flow in pipes. Energy balance, its integral and the Nusselt number for laminar flow in pipes	2	2
	Mechanism of turbulent flow. The Reynolds analogy. Thickness of a turbulent boundary layer for a flat plate.	2	2
	Thickness of a turbulent boundary layer for a flat plate. Heat transfer coefficient for turbulent flow over a flat plate and through a pipe.	2	2
	Heat phenomena during an evaporation process, energy balance, simultaneous heat and mass transfer in cooling towers	2	2
	Characterization of simultaneous heat and mass transfer in diagram. Link between cross flows and co-flows of heat and mass. The Sherwood diagram.	2	2
	Demanded characteristics and physical characteristics of a cooling tower. Thermodynamic limits in heat transfer	2	2
	Second midterm exam	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	To attend at least 70% of all the lectures and exercises		

<table>
<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>2,5</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>(Other)</td><td></td></tr>
<tr><td>Tests</td><td>0,5</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">During the semester there are two midterm exams. The students that do not pass the midterm exams (or are not happy with their grades) have two final exam opportunities at the end of the semester and additional two opportunities at the end of the academic year on pre-decided dates. The first midterm exam takes place after the first 7 weeks of lecturing, while the second midterm exam takes place in after additional 6 weeks of lecturing. All the exams are carried out as written tests. The requirement for a passing grade is >49% points. On the first two final exams (at the end of the semester), the students are required to pass only the part which they failed to pass on the midterm exams. On the second two final exams (at the end of the academic year), the students are required to pass the whole exam, regardless of their success on the midterm exams.

The final average percentage is calculated as follows:

Points (%) = (M1+M2)/2;
where M1 and M2 are percentage points of the first and second midterm test, respectively.

The final grade depends on the final percentage and is calculated as follows:
50% to 61% - fair (2),
62% to 74% - good (3),
75% to 87% - very good (4) and
88% to 100% - excellent (5)

According to the Article 71 of the Faculty Statute, students are required to attend all forms of lectures and exercises by at least 70%. Students who fail to comply with this regulation will not be allowed to take the exams.</td></tr>
<tr><td rowspan="6">Required literature (available in the library and via other media)</td><td colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">F. Barbir: Uvod u prijenos topline i tvari, interna skripta, FESB, 2014.</td><td></td><td>e-learning portal</td></tr>
<tr><td colspan="4">N. Ninić, Elementi prijenosa topline, FESB 2002</td><td></td><td></td></tr>
<tr><td colspan="4"></td><td></td><td></td></tr>
<tr><td colspan="4"></td><td></td><td></td></tr>
<tr><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">1. J.P. Holman, Heat Transfer, 8th ed., McGraw Hill, New York, 1997.
2. E. Ganić, Prijenos toplote, mase i količine kretanja, Svijetlost, Sarajevo 2005.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- Monitoring of students attendance during lectures and exams
- Annual analysis of the average exam success
- Feedback from students via surveys
- Self-evaluation of teachers</td></tr>
</table>

Other (as the proposer wishes to add)	

NAME OF THE COURSE	MACHINE TOOLS						
Code	FETL18	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
			45	0	0	15	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 modular construction of modern numerically controlled machine tools.
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 - categorize features of mechanisms and systems management machine tools - examine the exploitation characteristics of machine tools - identify motives of high speed and multi-operation machine tools development - designing of driving systems and mechanism in machine tools according to machine tool construction.

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.	3	
	Basics of construction machine tools. Testing of machine tools accuracy.	3	
	Main parts of machine tools. Bearing elements, guides, spindle bearings.	3	
	Driving system of machine tools.	3	
	Machine tools control system.	3	
	Turning machines: Classification and basic concepts	3	
	Milling machines: Classification and basic concepts	3	

	First midterm exam		
	Machine tools for drilling, broaching, sawing, grinding. Machines for gear wheels manufacturing.	3	
	Technical calculations related to the machine as the whole unit and its particular parts.	3	
	Automatic tool change. Automatic workpiece change.	3	
	Machine tools for high performance machining operation. Machining center. Turning center. Grinding center.	3	
	High Speed machine tools. Parallel kinematics for machine tools	3	
	Basic concept of CNC programming. CAD/CAM introduction	3	
	Second midterm exam		
	List of laboratory or design exercises		LE or DE hours
	Movement, typical parts and mechanisms of machine tools installed in the laboratory. Determination of degree of machine tool workspace efficency.		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
	Rigidity of the system machine-tool-woorkpiece.		2
	Determination of gearbox efficiency on turning machine.		2
	Zero point of the workpiece and zero point of the tool at vertical machining center.		2
	Automatic CNC programming. Preparation and model production using 3D printer.		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	0.5	Report		Reports from the laboratory exercises	0.25
	Essay		Seminar essay		(Other)	2.25
	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 laboratory exercises 2. 50 % points on each midterm exam or the final exam. Grade (in percentage) is formed according to the formula: Grade(%) = 0,5 (M1 + M2) 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)		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Ekinović S., "Alatne mašine", Mašinski fakultet, Zenica, 2004.		
	Lopez de Lacalle, Lamikiz "Machine tools for high performance machining", Springer, 2008.		
	Bajić, D., Jozić, S., Predavanja objavljena na eLearning portalu, 2015.		eLearning portal
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	- 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	**HEATING AND AIR CONDITIONING**						
Code	FESL23	Year of study	1				
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: - Categorization and description of the HVAC systems, - Compute and general design of the elements inside the HVAC systems according to standards.						

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 base terms and issues related to the thermal comfort, - Analyse and compute heat losses and gains according to the standards, - Compare fuels in the HVAC systems, i.e. heating and cooling applications and elaborate their impact to the environment, - Consider and compute base components of the heating/cooling, i.e. HVAC systems, - Consider and compute ventilation systems.		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction and basic terms (issues) related to the thermal comfort. External and internal design temperatures. Climate conditions.	2 hours	2 hours
	Calculation of the heat losses.	2 hours	2 hours
	Calculation of the heat losses.	2 hours	2 hours
	Heating elements, characteristics, correction of the nominal thermal load.	2 hours	2 hours
	Central heating systems, calculation of the carbon dioxide emissions.	2 hours	2 hours
	Calculation and design of the pipelines in the heating systems.	2 hours	2 hours
	Boilers, types, classification, boiler rooms.	2 hours	2 hours
	Other equipment of the heating systems.	2 hours	2 hours
	Preparation of the hot water and calculation of the heating demands.	2 hours	2 hours
	Regulation of the heating systems.	2 hours	2 hours
	Calculation of the heat gain.	2 hours	2 hours
	Fan coil devices, other cooling elements.	2 hours	2 hours
	Central water based air-conditioning systems, climate chambers, coolants (refrigerants)	2 hours	2 hours
	Ventilation systems, components, calculation of the required airflow for ventilation purpose.	2 hours	2 hours
	Heat pumps, absorption cooling devices.	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 Grijanje i Klimatizacija dio I i dio II, 2011, FESB.		
	Recknagel, Sprenger, Schramek, Čeperković: Grijanje i klimatizacija 2005, Energetika marketing, Zagreb, 2005 (Prijevod sa njemačkog)		
	ASHRAE Handbooks: Fundamentals, Applications, Systems and Equipment, Refrigeration, ASHRAE, Atlanta, USA, 2001, 2002, 2003, 2004		
	Priručnik za Ventilaciju I klimatizaciju, EGE, 2003.		
	Priručnik za grijanje, EGE, 2005		

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)	

NAME OF THE COURSE	**OPTIMIZATION METHODS**							
Code	FESL05	Year of study	1					
Course teacher	Damir Vučina, Ph. D., Full Professor	Credits (ECTS)	5					
Associate teachers	Igor Pehnec, Ph. D., Teaching assistant, Ivo Marinić- Kragić, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE	
			45	0	0	15	0	
Status of the course	Obligatory	Percentage of application of e-learning	0					

COURSE DESCRIPTION			
Course objectives	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.		
Course enrolment requirements and entry competences required for the course	Completed pre-graduate studies which include courses equivalent to computer-aided analysis. Competences in basic engineering analysis methods and program development in C and MATLAB		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	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		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction, basic theoretical concepts. Basic terms and examples of application.	3	
	Basic concepts, theoretical aspects, optimization models	3	
	Linear programming, standard model	3	
	Linear programming, simplex method	3	
	Nonlinear programming, 1D methods: Interval halving, Fibonacci, Golden section, Interpolation methods, reduction of nD problems to 1D	3	
	Nonlinear programming, n-dimensional methods for unconstrained problems: direct methods (Random search, Hookee-Jeeves, Powell, Nelder-Mead, other)	3	

	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	☐ independent assignments ☐ multimedia ☒ laboratory ☐ work with mentor ☐ (other)	

<table>
<tr><td></td><td colspan="4">☐ field work</td><td colspan="2"></td></tr>
<tr><td>Student responsibilities</td><td colspan="6">The presence on lectures in the amount of at least 70 % of the times scheduled.
Performed all required laboratory 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>3</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>2</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>Laboratory exercises</td><td></td></tr>
<tr><td>Tests</td><td></td><td>Oral exam</td><td></td><td>Preparation for laboratory exercises</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 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.</td></tr>
<tr><td rowspan="5">Required literature (available in the library and via other media)</td><td colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">- D. Vučina, 'Metode inženjerske numeričke optimizacije', Sveučilište u Splitu, FESB 2005</td><td></td><td></td></tr>
<tr><td colspan="4">- J. S. Arora, “Introduction to Optimum Design”, McGraw Hill, 1989</td><td></td><td></td></tr>
<tr><td colspan="4">I.Pehnec, Materijali za laboratorijske vježbe</td><td></td><td></td></tr>
<tr><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">- 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</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- Evaluation of results in accordance with the above learning outcomes
- 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="6"></td></tr>
</table>

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="7">MANUFACTURING PROCESS PLANNING</td></tr>
<tr><td>Code</td><td>FETL25</td><td>Year of study</td><td colspan="5">1.</td></tr>
<tr><td>Course teacher</td><td>Nikola Gjeldum, Ph. D., Assistant Professor</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Marina Crnjac, 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>0</td><td>15</td></tr>
<tr><td>Status of the course</td><td>Obligatory</td><td>Percentage of application of e-learning</td><td colspan="5">0</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Training students to:
- select raw material and machine tools for specific production batch
- design optimal manufacturing process
- know how to measure, sort and analyze process times in manufacturing process
- identify losses at work</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="7">None</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="7">Students will be able to:
- analyze product design for manufacturing process design purposes
- select optimal size and shape of raw material
- determine type of production in relation to batch size
- determine elements of process times for batch production
- suggest contemporary manufacturing process and its ability
- test objectivity and accuracy of time measurement personnel
- detect cyclical, periodical and random production steps
- reveal losses at work</td></tr>
<tr><td rowspan="21">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="6">Course content</td><td>L hours</td></tr>
<tr><td colspan="6">Definition of production system, production and manufacturing process. Fundamentals of material flow design in the production process.</td><td>2</td></tr>
<tr><td colspan="6">The basic elements of manufacturing processes: process, composed and group process steps, process step.</td><td>1</td></tr>
<tr><td colspan="6">Definition of technology and technique. Cutting technologies.</td><td>3</td></tr>
<tr><td colspan="6">Characteristics and levels of technologies and manufacturing processes. Manufacturing process capability.</td><td>2</td></tr>
<tr><td colspan="6">The basic principles of manufacturing process design.</td><td>3</td></tr>
<tr><td colspan="6">The selection of raw material.</td><td>2</td></tr>
<tr><td colspan="6">Optimal sequence of manufacturing processes and process steps.</td><td>3</td></tr>
<tr><td colspan="6">Factors influencing on errors in manufacturing processes.</td><td>2</td></tr>
<tr><td colspan="6">Selection of manufacturing baselines.</td><td>2</td></tr>
<tr><td colspan="6">First midterm exam</td><td>2</td></tr>
<tr><td colspan="6">Group technology.</td><td>2</td></tr>
<tr><td colspan="6">Basics of Work and Time Study in production enterprise.</td><td>2</td></tr>
<tr><td colspan="6">The scale of business success in the enterprise.</td><td>1</td></tr>
<tr><td colspan="6">Time standard. Components of working time.</td><td>2</td></tr>
<tr><td colspan="6">Methods for determining the production (working) time.</td><td>6</td></tr>
<tr><td colspan="6">Performance rating.</td><td>1</td></tr>
<tr><td colspan="6">The work of a worker on multiple machines.</td><td>2</td></tr>
<tr><td colspan="6">Types and analysis of losses during the work.</td><td>1</td></tr>
<tr><td colspan="6">Implementation of better work method.</td><td>2</td></tr>
<tr><td colspan="6">Second midterm exam</td><td>2</td></tr>
</table>

	List of design exercises	DE hours
	Design example of manufacturing process.	3
	Detailed elaboration of manufacturing process, raw material selection, tools selection and calculation of process time.	3
	Autonomous students work on manufacturing documentation for individual project tasks	7

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. The presence exercises in the amount of at least 80 % of the times scheduled. Individual project tasks completed.	

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	
Experimental work		Report		Individual work	2,7
Essay		Seminar essay		(Other)	
Tests	0,2	Oral exam		(Other)	
Written exam	0,1	Project	1	(Other)	

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

During semester there are two 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. 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. Final exams are conducted in written form. Midterm exams and final exams consist of theoretical questions and numerical problems.

Grade (%) = 0,4D + 0,6E

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.

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

Required literature (available in the library and via other media)

Title	Number of copies in the library	Availability via other media
Gjeldum, N.: „Tehnološka priprema proizvodnje“, lectures on e-learning, FESB Split		Internet (e-learning)
Gačnik, V., Vodenik, F.: „Projektiranje tehnoloških procesa“, Tehnička knjiga, Zagreb, 1990.	10	
Taboršak, D., "Studij rada", Orgadata, Zagreb, 1994.	2	

	Car, M., Krznar, M., Šimon, K., "Studij rada – zbirka zadataka i rješenja", Liber, Zagreb, 1983.	1	
Optional literature (at the time of submission of study programme proposal)	1. Toboršak, D., Gornik, B., Čala, I., „Priprema proizvodnje“, Inženjerski biro, Zagreb, 1974. 2. Buchmeister, B., Polajnar, A.: „Priprava proizvodnje za delo v praksi“, Fakulteta za strojništvo, Maribor, 2000. 3. Polajnar, A., “Študij dela”, Univerza v Mariboru, Fakulteta za strojništvo, Maribor, 1999 4. WEB catalogues		
Quality assurance methods that ensure the acquisition of exit competences	- 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		
Other (as the proposer wishes to add)			

NAME OF THE COURSE	**RENEWABLE ENERGY SOURCES AND SUSTAINABLE DEVELOPMENT**						
Code	FESL22	Year of study	1				
Course teacher	Ivan Pivac, Ph. D., Assistant Professor	Credits (ECTS)	5				
Associate teachers	Jakov Šimunović, Teaching Assistant	Type of instruction (number of hours)	L	S	AE	LE	D
			30		30		
Status of the course	Elective	Percentage of application of e-learning	0				
COURSE DESCRIPTION							
Course objectives	The ability to interpret the role and significance of renewable energy sources in the modern energy system, and to critically evaluate their potential and limitations. Acquaintance with the cutting edge technologies and systems for utilization of renewable energy sources. The ability to create simple engineering calculations for the dimensioning of components and systems in conjunction with renewable energy sources, and their impact on the environment. The ability to analyze the possibilities and critical judgment of various conceptual technical solutions of the system for utilization of renewable energy sources based on the analysis of						
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: 3. Explain the importance of renewable energy sources, and critically evaluate their advantages and drawbacks 4. Describe and apply suitable the cutting edge technologies in systems for utilization of renewable energy sources 5. Design and evaluate basic systems for utilization of renewable energy sources 6. Perform simple engineering calculations for sizing of components and systems in conjunction with renewable energy sources 7. Propose conceptual technical solutions of the system for the utilization of renewable energy sources based on the performed analysis of economic profitability and analysis of their impact on the environment

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction, definitions, current energy system problems, possible solutions, energy statistics	3	0
	Solar energy, Solar geometry	2	4
	Photovoltaics	2	2
	Solar thermal collectors	2	2
	Solar powerplants	2	2
	Wind energy, wind turbines	3	2
	Hydropower, hydro power plants, water turbines, tidal power, marine current power, wave power	2	2
	Biomass, biofuels, geothermal energy and technologies for its utilization	2	2
	Energy storage; hydrogen energy technologies and their conjunction with renewable energy sources	3	2
	Greenhouse gas emissions; carbon footprint	1	2
	Economic analysis of RES; multi-criteria analysis	2	2
	Energy return on energy invested (EROI); definition of emergy, emergy analysis; future of RES	2	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	To attend at least 70% of all the lectures and 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		(Other)	
	Tests	1	Oral exam		(Other)	
	Written exam		Project		(Other)	

<table>
<tr><td>Grading and evaluating student work in class and at the final exam</td><td colspan="3">After the first 7 weeks of lecturing, there will be the midterm exam, which will consist of the first part of the course content, while the second part of the course content covered in the next 6 weeks of lecturing will be taken at the end of the semester. Students who did not pass a certain part of the course content (or are not satisfied with the grade they achieved), will have additional opportunities to take the final and remedial exams according to the established dates of the teaching calendar. All exams are conducted in written form, and the requirement for a passing grade is to obtain at least 50% of points on both parts of the course content. The final achieved number of points represents the arithmetic mean of the achieved points for each of the passed parts of the course content.

The evaluation of the student's achievement on the course is determined according to the final number of points achieved as follows:
50% to 61% - fair (2),
62% to 74% - good (3),
75% to 87% - very good (4) and
88% to 100% - excellent (5)

According to the Article 71 of the Faculty Statute, students are required to attend all forms of lectures and exercises by at least 70%. Students who fail to comply with this regulation will not be allowed to take the exams.</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>Lj. Majdandžić, Solarni sustavi, Graphis, Zagreb, 2010.</td><td></td><td></td></tr>
<tr><td>B. Labudović, Obnovljivi izvori energije, Energetika marketing, Zagreb, 2002.</td><td></td><td></td></tr>
<tr><td>I. Pivac, authorized lectures</td><td></td><td>e-learning portal</td></tr>
<tr><td>Optional literature (at the time of submission of study programme</td><td colspan="3">G. Boyle, Renewable Energy Power for a Sustainable Future, 2nd Edition, Oxford University Press, 2004 (or newer edition)</td></tr>
<tr><td>proposal)</td><td colspan="3"></td></tr>
<tr><td>Quality assurance methods that ensure</td><td colspan="3">□ Monitoring of students attendance during lectures and exams

□ Annual analysis of the average exam success</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="3"></td></tr>
</table>

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="7">COMPUTER AIDED DESIGN 1</td></tr>
<tr><td>Code</td><td>FESL17</td><td>Year of study</td><td colspan="5">1</td></tr>
<tr><td>Course teacher</td><td>Gojko Magazinović, Ph. D., Full Professor</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Ivan Pivac, 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>30</td><td>0</td><td>0</td><td>0</td><td>30</td></tr>
<tr><td>Status of the course</td><td>Obligatory</td><td>Percentage of application of e-learning</td><td colspan="5">50</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Training students for:
- understanding and application of basic terms and principles of feature-based modeling, parametric modeling, and geometric modeling,
- ability to build simple models, assemblies, and technical drawings by using a geometric modeling tool.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="7">-</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="7">Students will be able to:
- explain fundamental principles of geometric modeling, parametric modeling, and feature based modeling,
- describe an importance and available approaches to the exchange of design data between the different CAD systems,
- explain the fundamental principles of the parametric curve and parametric surface definitions,
- use a computer aided design tool,
- construct simple geometric models and assemblies,
- determine the model cross-section properties,
- determine the model mass properties.</td></tr>
</table>

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction to a course. Description of an e-learning portal.	2	
	Introduction to CAD/CAM/CAE systems, part I: basic terms.	2	
	Introduction to CAD/CAM/CAE systems, part II: applications; the expansion of 3D CAD technology.	2	
	Elements of CAD/CAM/CAE systems; hardware; software.	2	
	Geometric modeling; feature based modeling; parametric modeling.	2	
	Introduction to graphics programming, part I: OpenGL; coordinate systems; homogeneous coordinates; coordinate transformations.	2	
	Introduction to graphics programming, part II: hidden line removal; rendering; shading; ray-tracing.	2	
	First midterm exam		
	CAD data structures; exchange of design data between the different CAD systems.	2	
	Parametric curves, part I: Hermite curve.	2	
	Parametric curves, part II: Bezier curve; B-Spline curve.	2	
	Parametric curves, part III: interpolation curve; geometric continuity; NURBS curves.	2	
	Parametric surfaces: bilinear surface; Bezier surface; B-Spline surface; NURBS surface.	2	
	Modeling and analysis (A brief on structural analysis).	2	

	Second midterm exam	
	List of laboratory or design exercises	LE or DE hours
	The environment of CAD design tool; extrusion of a closed curve.	2
	Sketch tool; extrude; round; chamfer; hole; parameters.	2
	Simple model editing.	2
	Revolving of a closed curve.	2
	Design planes.	2
	Sections; shells, constraints; sketching utilities.	2
	Translation patterns; one- and two-dimensional.	2
	Radial patterns of set features.	2
	Radial patterns of built features; feature copying.	2
	Helical sweep.	2
	Making assemblies.	2
	Technical drawing preparation, part I.	2
	Technical drawing preparation, part II.	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 ☒ computer work (other)
Student responsibilities	Attendance of at least 70% lectures and all design 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	0,8
	Essay		Seminar essay		Computer work	2
	Tests	0,2	Oral exam		(Other)	
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	There are two midterm exams during the semester (carried out by using computer and e-learning portal; 90 minutes duration; each exam: 25 theoretical questions and two 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%.

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	G. Magazinović, Bilješke uz predavanja, FESB	-	e-learning portal
	R. Toogood: Creo Parametric 2.0 Tutorial and Multimedia DVD, SDC Publications, Mission, 2013.	1	https://books.google.hr
Optional literature (at the time of submission of study programme proposal)	- 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.		

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

NAME OF THE COURSE	**ENERGY EFFICIENCY IN BUILDINGS**						
Code	FESL24	Year of study	2.				
			30	0	30	0	0
Status of the course	Elective.	Percentage of application of e-learning					
COURSE DESCRIPTION							
Course objectives	Training students for: - Consider and analyse energy consumption in the buildings, - Obtain techno-economic aspect of proposed energy efficiency measures in building facilities.						
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 base terms and concepts from the field of energy efficiency in buildings as well as sustainable development in general, - Analyse energy consumption in buildings, - Elaborate existing legislative related to the energy efficiency in buildings, - Analyse and propose energy efficiency measures in buildings, - Evaluate economic aspect of proposed energy efficiency measures.						

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction to the energy efficiency in buildings.	2 hours	2 hours
	Analysis of the energy consumption for different buildings.	2 hours	2 hours
	Legislative related to the energy efficiency in buildings.	2 hours	2 hours
	Introduction to the energy efficiency measures in buildings (passive and nearly zero buildings, high energy performance buildings).	2 hours	2 hours
	Energy efficiency measures related civil engineering aspect (building thermal envelope, openings, passive architecture elements, etc.)	2 hours	2 hours

	Energy efficiency measures in heating systems and hot water preparation.	2 hours	2 hours
	Energy efficiency measures in heating systems and hot water preparation.	2 hours	2 hours
	Energy efficiency measures in cooling (air-conditioning) systems.	2 hours	2 hours
	Energy efficiency measures in cooling (air-conditioning) systems.	2 hours	2 hours
	Renewable energy sources in buildings (implementation).	2 hours	2 hours
	Calculation techniques for carbon-dioxide emissions.	2 hours	2 hours
	Energy audit.	2 hours	2 hours
	Building energy certification.	2 hours	2 hours
	Introduction to the economic indicators related to the evaluation of the energy efficiency measures.	2 hours	2 hours
	Economic evaluation of the proposed energy efficiency measures.	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; Energetska učinkovitost u zgradarstvu, 2011, FESB.		
	Energy Efficiency in Buildings'' – Guide F, CIBSE, 2004.		
	Energy Efficiency Guide for Existing Commercial Buildings'', Guide, ASHRAE, 2009.		
Optional literature (at the time of submission of study programme proposal)	-Skupina autora, "Priručnik za energetske savjetnike", UNDP, Zagreb 2008, -Skupina autora, "Tipske mjere", UNDP, Zagreb 2009, -Skupina autora, "Priručnik za ventilaciju i klimatizaciju", EGE, 2003, -Skupina autora, "Priručnik za grijanje", EGE, 2005.		
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	AEROTECHNICS AND WIND TURBINES						
Code	FESL38	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: - explain and apply the basic properties of atmospheric currents, - recognize the effects of air currents in the facilities, especially wind turbines and choose the correct relations to solve them, - analyze and calculate air energy conversion and simple problems.						
Course enrolment requirements and entry competences required for the course							

Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - explain the genesis of the wind in the atmosphere and describe the main impacts on the atmospheric flow, - enumerate and describe the basic devices for monitoring the state of the atmosphere, - analyze the state of wind and specify its main features, - list the parts smaller and larger wind turbines and calculate the basic operating parameters, - to comment on the status and trends of offshore wind farms, - identify and describe the basic features of a rigid sail, - present and comment on the use of priletnika and drones.

Course content broken down in detail by weekly class schedule (syllabus)

Course content	L or S hours	AE hours
Introduction to aerotechnics. Terms and conditions. Relative flow.	2	2
The atmospheric flows and wind genesys. Climate change and the impact of the global flow.	2	2
Atmospheric boundary layer and influences on airflow. The impacts on the air flow. Environmental flow and the complex topography.	2	2
Condition monitoring, meteorological devices and measurements. Wind potential.	2	2
Opposing facilities. Boundary layer around nastrujavanih surface. Lifting surfaces and controls.	2	2
The effect of air flow and gas at various facilities, transport facilities and Turbomachinery (wind turbines).	2	2
Atmospheric singularities. The extreme effects to the objects and humans. Ways to protect people and the environment.	2	2
Wind turbines and small wind turbines. Urban wind powering.	2	2
Off-shore wind farms.	2	2
The rigid sails and semi-rigid sails. Wind assisted ships.	2	2
Flow around cylinder and the turbulent wake.	2	2
Introduction to fly. Ground effect. Drones and unmanned aerial vehicles.	2	2
Selected topics of aerospace and wind tunnels.	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*	Class attendance	3,5	Research		Practical training	
	Experimental work		Report		Individual work	

credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)	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.

	Title	**Number of copies in the library**	**Availability via other media**
Required literature (available in the library and via other media)	B. Klarin: Aerotehnika i vjetroturbine, autorizirana predavanja, FESB		e-learning portal
	- Kuette, A.M. and Chou C.-Y.: Foundations of Aerodynamics: bases of Aerodynamic Design, Wiley, 1997.		book
	- Dyrbye, C.; Hansen, S.O.: Wind Loads on Structures, Wiley, 1996.		book
Optional literature (at the time of submission of study programme proposal)	- McCormick, B.W.: Aerodynamics, Aeronautics, and Flight Mechanics, Wiley, 1995.		
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	**MATERIALS 3**						
Code	FETL01	Year of study	2				
Course teacher	Nikša Čatipović, Ph. D., Assistant Professor	Credits (ECTS)	5				
Associate teachers	Karla Grgić, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30			30	
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	To offer students the basic and specialists knowledge about main engineering materials types – metallic and non-metallic materials - polymeric, ceramics and composites. Among non-ferrous and special metals emphasis is on light structural metals and alloys – aluminium, titanium and magnesium, their properties, manufacturing technologies and typical industrial applications. It is the intention to depict the properties of modern materials used for structures with accent on mechanical and technological properties along with examples ot their typical uses. It is the intention to learn students how to select the adequate material for specific applications.
Course enrolment requirements and entry competences required for the course	Successfully accomplished undergraduate part of the study and passed exams of Materials 1, Materials 2, Technology 1 and Technology or adequate subjects.
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	After successful completion of course students should be able to: .21 distinguish the advantages and drawbacks of main material types and their basic structures as a basis for assessment of certain properties, .22 analyse and evaluate main effects of manufacturing technologies and service conditions on the properties of the engineering materials, .23 recommend the heat treatment procedure of precipitation hardening aluminium alloys and to define the specifics and correlation of microstructure with properties, .24 identify the effects of electric arc welding on light metals, .25 critically evaluate the possibilities of selection and application of light metals, various steels including stainless, nickel alloys, polymeric, ceramic and composite materials and recommend suitable material according to the engineering needs for specific service condition, .26 combine and to apply the acquired knowledge of contemporary structural materials for manufacturing technologies and applications in transport industry, energetics, medical engineering ..., .27 assess the engineering and structural materials regarding impacts on people and environment and to apply that knowledge in the multidisciplinary and team work.

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours
	Introduction, Construction, Materials, Technologies	2
	Light metals, Magnesium, Aluminium bases	2
	Heat treatment of aluminium, Titanium	2
	Polymers	2
	Ceramics	2

<table>
<tr><td rowspan="22"></td><td colspan="5">Composites</td><td>2</td></tr>
<tr><td colspan="5">Corrosion</td><td>2</td></tr>
<tr><td colspan="5">Metal foams</td><td>2</td></tr>
<tr><td colspan="5">Materials for working at elevated temperatures</td><td>2</td></tr>
<tr><td colspan="5">Alloyed tool steels, Wear-resistant materials</td><td>2</td></tr>
<tr><td colspan="5">Surface technology, PVD and CVD processes</td><td>2</td></tr>
<tr><td colspan="5">The influence of alloying elements on steel</td><td>2</td></tr>
<tr><td colspan="5">Materials with shape memory</td><td>2</td></tr>
<tr><td colspan="5">List of laboratory exercises</td><td>LE hours</td></tr>
<tr><td colspan="5">Procedures for testing the mechanical properties of materials</td><td>2</td></tr>
<tr><td colspan="5">Non-destructive material testing procedures</td><td>2</td></tr>
<tr><td colspan="5">Heat hardening of aluminium alloys EN AW 2011 and EN AW 6063</td><td>2</td></tr>
<tr><td colspan="5">The influence of heat treatment on the mechanical properties of titanium alloys</td><td>2</td></tr>
<tr><td colspan="5">Testing the mechanical properties of different polymer properties</td><td>2</td></tr>
<tr><td colspan="5">Production of composites in a closed mold</td><td>2</td></tr>
<tr><td colspan="5">Determination of the relative density of open-type metal foam</td><td>2</td></tr>
<tr><td colspan="5">Determination of the relative density of closed type metal foam</td><td>2</td></tr>
<tr><td colspan="5">Examination of the influence of alloying elements on steel properties</td><td>2</td></tr>
<tr><td colspan="5">Simulating an accelerated corrosion process</td><td>2</td></tr>
<tr><td colspan="5">Copper and zinc electroplating</td><td>2</td></tr>
<tr><td colspan="5">Production of materials with shape memory</td><td>2</td></tr>
<tr><td colspan="6"></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</td><td colspan="3">☐ independent assignments
☒ multimedia
☒ laboratory
☐ work with mentor
☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="6">Mandatory minimum attendance: 70 % for the lectures and 100 % for lab exercises. Approved reports from every lab exercise.</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>1,5</td><td>Research</td><td>---</td><td>Practical training</td><td>---</td></tr>
<tr><td>Experimental work</td><td>0,5</td><td>Report</td><td></td><td>Individual work</td><td>3</td></tr>
<tr><td>Essay</td><td>---</td><td>Seminar essay</td><td>---</td><td>Laboratory exercises</td><td>---</td></tr>
<tr><td>Tests</td><td>---</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">During the semester, there will be two intermediate exams (colloquiums). The first midterm exam is after 7 weeks of classes, and the second after the next 6 weeks of classes. In the final exam, students pass parts of the material that they did not pass in the midterm exams. Each intermediate exam is conducted as a written exam lasting 45 minutes. It consists of test questions and tasks. The condition for a positive grade is a positive grade from the laboratory exercises and all submitted reports and 50% points on each intermediate exam. The final grade is formed on the basis of the achieved percentage of material passed in the intermediate exams. Each of the colloquiums has a share of 40% in the overall grade and reports on laboratory exercises 20%.

Percentage Rating
50% to 61% sufficient (2)</td></tr>
</table>

	62% to 74% good (3) 75% to 87% very good (4) 88% to 100% excellent (5) Exam dates: according to the class calendar! The final grade is determined after the second final exam using the absolute ECTS grading system in accordance with the Rulebook on studies and the study system of the University of Split. Students who did not pass the colloquia can write four additional exams. After that, they have the dean's exam, where they write the part of the material that they have not passed until then.		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the**	**Availability via other media**
	N. Čatipović: Authorized lectures, FESB		MERLIN
Optional literature (at the time of submission of study programme proposal)	Various web materials from subject matter		
Quality assurance methods that ensure the acquisition of exit competences	• Encourage students to attend the lectures and exercises and to control it • Evaluation of results in accordance with the learning outcomes • Feedback from students via surveys • Self-evaluation of teachers		
Other (as the proposer wishes to add)			

NAME OF THE COURSE	**PLANT LAYOUT**						
Code	FETL05	Year of study	2.				
Course teacher	Ivica Veža, Ph. D., Full Professor	Credits (ECTS)	5				
Associate teachers	Marko Mladineo, Ph. D., Teaching assistant	Type of instruction (number of hours)	P	S	AV	LV	KV
			30	0	0	15	15
Status of the course	Obligatory	Percentage of application of e-learning	0				
COURSE DESCRIPTION							
Course objectives	Educate students to be able to: • realize feasibility study in projecting a new production system, • project of phases of production system (define macro and micro locations, surfaces, basic elements of building, basic production structures, work conditions), • understand basics of material flow calculation, human factor, information and energy.						
Course enrolment requirements and entry competences	Course enrolment requirements: None						

<table>
<tr><td>required for the course</td><td colspan="3">Required competences: Competences and skills achieved after finishing bachelor studies of industrial engineering, mechanical engineering and naval architecture</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:
1. Analyse content of previous study realized,
2. Compare criteria in micro and macro location selection phase,
3. Define number of workplaces,
4. Create transport intensity chart,
5. Compare layout according to processing type (Workshop principle) and purpose groups,
6. Define production surface with discontinuity coefficients method,
7. Analyse functional surfaces (sketch machine with functional surface, unit field and height of factory hale),
8. Apply achieved knowledge and skills on real example</td></tr>
<tr><td rowspan="29">Course content broken down in detail by weekly class schedule (syllabus)</td><td>Course content</td><td>P hours</td><td>AV hours</td></tr>
<tr><td>Introduction. Term “system”, system types. Production system.</td><td>2</td><td></td></tr>
<tr><td>Scope, nature and objectives of design of production process.</td><td>2</td><td></td></tr>
<tr><td>Basic principles in production process modelling.</td><td>2</td><td></td></tr>
<tr><td>Interrelations of basic factors in production.</td><td>2</td><td></td></tr>
<tr><td>Previous study.</td><td>2</td><td></td></tr>
<tr><td>Location problems. Main factors for micro and macro location selection.</td><td>2</td><td></td></tr>
<tr><td>Production system segmentation.</td><td>2</td><td></td></tr>
<tr><td>Production surface calculation, defining of functional surfaces on workplace. Distances between machines and elements.</td><td>2</td><td></td></tr>
<tr><td>Calculation of block scheme of surface layout. Election of basic building parameters.</td><td>2</td><td></td></tr>
<tr><td>Material flow types. Spatial structure designing.</td><td>2</td><td></td></tr>
<tr><td>Layout methods for cases with group by types.</td><td>2</td><td></td></tr>
<tr><td>Production and assembly lines balancing</td><td>2</td><td></td></tr>
<tr><td>Workplace and work conditions designing. The appearance of fatigue. Work conditions.</td><td>2</td><td></td></tr>
<tr><td colspan="2">List of laboratory exercises</td><td>LV hours</td></tr>
<tr><td colspan="2">Introduction to spatial structures</td><td>2</td></tr>
<tr><td colspan="2">Layout according to purpose. Production line balancing</td><td>2</td></tr>
<tr><td colspan="2">Layout according to purpose. Modified triangle method</td><td>2</td></tr>
<tr><td colspan="2">Layout with fixed position. Hungary method</td><td>2</td></tr>
<tr><td colspan="2">Layout problem with predefined locations</td><td>2</td></tr>
<tr><td colspan="2">Transportation problems</td><td>2</td></tr>
<tr><td colspan="2">Program task setting</td><td>1</td></tr>
<tr><td colspan="2">List of construction exercises</td><td>KV hours</td></tr>
<tr><td colspan="2">Capacity load calculation</td><td>2</td></tr>
<tr><td colspan="2">Transport units defining</td><td>2</td></tr>
<tr><td colspan="2">Defining of optimal spatial layout</td><td>2</td></tr>
<tr><td colspan="2">Storage calculation</td><td>2</td></tr>
<tr><td colspan="2">Required surface calculation</td><td>2</td></tr>
<tr><td colspan="2">Preparation of technical drawing of projected production system</td><td>2</td></tr>
<tr><td></td><td colspan="2">Handover of program task</td><td>1</td></tr>
<tr><td>Format of instruction</td><td>☒ Lectures
☒ Seminary work and workshops
☒ Exercise
☐ on line in full
☐ mixed e-learning
☐ fieldwork lectures</td><td colspan="2">☒ Solo tasks
☐ Multimedia
☒ Laboratory work
☒ Mentorship
☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="3">Presence on lectures and auditory exercise minimally 70% in total. All laboratory exercise and project task realized.</td></tr>
</table>

<table>
<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>1,0</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>1,5</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>Laboratory exercises</td><td>0,5</td></tr>
<tr><td>Tests</td><td>0</td><td>Oral exam</td><td></td><td>Preparation for laboratory exercises</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>Project</td><td>2,0</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">During the semester it will be realized two colloquiums. First is after 7 weeks of lectures, and second after 6 weeks. Students have possibility to retake again part of the curriculum on final exam, if they didn’t pass in regular dates. Each of colloquiums has to be written as a written exam in duration of 45 minutes. Each colloquium has 5 theoretical questions. Passing condition is 40% of total points on each of colloquiums and project task done.
To students are introduced phases of production system modelling. Therefore, besides lectures, they are attending to laboratory exercises and according to them, they realizing production system modelling. Students presenting their project tasks on colloquium and those tasks are also included in grade forming (grade KV).
• KV – grade from lectures,
• LV – grade from laboratory work,
• M1, M2 – colloquium points.
Final grade (in percent) formed according to formula:
Grade (%) = 0,20 KV + 0,20 LV + 0,3 (M1 + M2)</td></tr>
<tr><td rowspan="5">Required literature (available in the library and via other media)</td><td colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">Veža, I., Bilić, B., Bajić, D., “Projektiranje proizvodnih sustava”, Fakultet elektrotehnike, strojarstva i brodogradnje, Split, 2001.</td><td></td><td>e-learning portal</td></tr>
<tr><td colspan="4"></td><td></td><td></td></tr>
<tr><td colspan="4"></td><td></td><td></td></tr>
<tr><td colspan="4"></td><td></td><td></td></tr>
<tr><td>Optional literature</td><td colspan="6">Aggteleky, B., “Fabrikplanung: Werksentwicklung und Betriebsrationalisierung.-Band 1,2,3”., Carl Hanser Verlag, München, 1990.
Schenk, M., Wurth, S., “Fabrikplanung und Fabrikbetrieb Methoden für die wandlungsfähige und vernetzte Fabrik”, Springer Verlag, Berlin, Heidelberg New York, 2004.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- Evaluation of results in accordance with the above learning outcomes
- Annual analysis of the performance of the examinations
- 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="6"></td></tr>
</table>

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="7">COMPUTER AIDED DESIGN 2</td></tr>
<tr><td>Code</td><td>FESM15</td><td>Year of study</td><td colspan="5">1</td></tr>
<tr><td>Course teacher</td><td>Gojko Magazinović, Ph. D., Full Professor</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Ivan Pivac, 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>30</td><td>0</td><td>0</td><td>0</td><td>30</td></tr>
<tr><td>Status of the course</td><td>Obligatory</td><td>Percentage of application of e-learning</td><td colspan="5">50</td></tr>
</table>

<table>
<tr><th colspan="4">COURSE DESCRIPTION</th></tr>
<tr><td>Course objectives</td><td colspan="3">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.</td></tr>
<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 calculation 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="20">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 colspan="2">List of laboratory or design exercises</td><td>LE or DE hours</td></tr>
<tr><td colspan="2">Spreadsheet tool elements; making a simple worksheet; built-in functions.</td><td>2</td></tr>
<tr><td colspan="2">Absolute and relative cell addressing; complex expressions.</td><td>2</td></tr>
<tr><td colspan="2">Working with data series; conditional formatting; graphing.</td><td>2</td></tr>
</table>

<table>
<tr><td rowspan="10"></td><td colspan="4">Numerical integration: trapezoidal and Simpson's rule.</td><td colspan="2">2</td></tr>
<tr><td colspan="4">Equations; linear systems; nonlinear systems.</td><td colspan="2">2</td></tr>
<tr><td colspan="4">Basic modeling; parameters; relations; Project, part I: simple parts.</td><td colspan="2">2</td></tr>
<tr><td colspan="4">Curves and surfaces.</td><td colspan="2">2</td></tr>
<tr><td colspan="4">Project, part II: advanced parts.</td><td colspan="2">2</td></tr>
<tr><td colspan="4">Project, part III: assembly.</td><td colspan="2">2</td></tr>
<tr><td colspan="4">Project, part IV: technical drawing.</td><td colspan="2">2</td></tr>
<tr><td colspan="4">Analysis feature.</td><td colspan="2">2</td></tr>
<tr><td colspan="4">Modeling, analysis, and optimization.</td><td colspan="2">2</td></tr>
<tr><td colspan="4">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</td><td colspan="3">☐ independent assignments
☒ multimedia
☒ laboratory
☐ work with mentor
☒ computer work</td></tr>
<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="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">G. Magazinović, Bilješke uz predavanja, FESB</td><td>-</td><td>e-learning portal</td></tr>
<tr><td colspan="4">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="4">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</td><td colspan="6">- Evaluation of results by the above learning outcomes
- Feedback from students via surveys</td></tr>
</table>

the acquisition of exit competences	- Institutional and non-institutional evaluations
Other (as the proposer wishes to add)	

NAME OF THE COURSE	**COMPUTER AIDED MANUFACTURING**						
Code	FETL07	Year of study	1.				
Course teacher	Dražen Bajić, Ph. D, Full Professor Sonja Jozić, PhD, 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	0	30
Status of the course	Obligatory/Elective	Percentage of application of e-learning					

COURSE DESCRIPTION			
Course objectives	Training students for: - exploring the possibilities of computer application in production with an emphasis on programming CNC machine tools and additive technology. - mastering of manual programming and programming in CAD / CAM systems in machining of simple and complex workpiece.		
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: - analyze interactions and need for a comprehensive approach to part design and their manufacturing - apply acquired knowledge and skills to solve a specific task. - apply acquired knowledge and skills in teamwork. - consider role of CAD / CAM systems in modern design and manufacture - generate program for the automatic parts production on CNC machine tools - compare and highlight differences between manual programming and programming by CAD / CAM systems - identify motives of applying computer controlled machine tools and systems for rapid prototyping - comment advantages and disadvantages in development and manufacture of prototypes using CNC machining and additive technology.		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction. Basic terms. Historical development of CAM.	2	/
	Geometric modeling. Engineering modeling. Types of geometric models. 2D and 3D geometric models.	2	/
	Geometric modeling. Modeling by means of features. Parametric modeling. Disadvantages of geometric models.	2	/

	CNC machine tools programming. NC and CNC programming. Analysis of technical drawings. Technological documentation. Programming methods. Manual programming. Automatic programming.	2	/
	CNC machine tools programming. Coordinate system. Measurement system. Reference points. Defining cutting tools. The structure of the program block.	2	/
	CNC turning. The procedure and machine tools. Tools for turning. Selection of cutting parameters. Manually programming CNC turning.	2	/
	Automatic programming of CNC lathes. Possibilities of software package CATIA. Associative database. Defining of machining. Machining simulation and CNC code generating.	2	/
	First midterm exam		
	CNC milling. Different machining operations and machine tools. Tools clamping. Tools storage. Manipulation with tool and workpiece.	2	/
	CNC milling. End milling. Face milling. Profile milling.	2	/
	CNC milling. Manually programming. Automatic programming in CATIA.	2	/
	Mill turning. Coaxial and orthogonal mill turning.	2	/
	Rapid prototyping. Stereolithography process. Laminating. Selective sintering.	2	/
	Rapid prototyping. Sintering by precipitation. 3D printing. Hybrid procedure 3DP / SLA.	2	/
	Second midterm exam		
	List of laboratory or design exercises		LE or DE hours
	Construction of simple geometric shapes and their extrusion.		2
	Construction of complex geometric shapes and their extrusion.		4
	Technical documentation - Drafting module.		2
	CNC manual programming for lathes.		4
	Module for machining - turning. Roughing and finishing, holes and threads		2
	Module for machining - milling. Roughing.		2
	Generating NC code for machining center.Communication between computers and machining center. Machining on CNC vertical machining center Spinner VC560.		2
	Module for machining - milling. Roughing and finishing, holes.		2
	Module for machining - milling. Surface machining, profile milling.		2
	Generating NC code for machining center.Communication between computers and machining center. Machining on CNC vertical machining center Spinner VC560.		2
	Rapid prototyping. STL files. 3D printing		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*	Class attendance	2	Research		Practical training	
	Experimental work		Report		Manual programming of turning operation	0,5
	Essay		Seminar essay		Individual work	2,25

<table>
<tr><td rowspan="2">total number of ECTS credits is equal to the ECTS value of the course)</td><td>Tests</td><td>0,25</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 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:
3. Positively evaluated program task "Manually programming CNC turning"
4. 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 (M 1 + M 2)

L – grade of program task "Manually programming CNC turning"
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.</td></tr>
<tr><td rowspan="4">Required literature (available in the library and via other media)</td><td colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">Xun Xu: „Integrating Advanced Computer-Aided Design, Manufacturing, and Numerical Control: Principles and Implementations“, University of Auckland, New Zealand, 2009.</td><td></td><td></td></tr>
<tr><td colspan="4">Hoffmann M.: „CAD/CAM mit CATIA V5“, Hanser Verlag, Muenchen, 2005.</td><td></td><td></td></tr>
<tr><td colspan="4">Bajić, D., Jozić, S., "Computer aided manufacturing“, lecturing, eLearning, 2015.</td><td></td><td>eLearning portal</td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">Balič, J.: CAD/CAM postopki, Univerza v Mariboru, Maribor, 2002.
McMahon, C., Brown, J.: CAD CAM principles, practice and manufacturing management, Pearson Prentice Hall, 1999.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- 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</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="6"></td></tr>
</table>

NAME OF THE COURSE	COMPUTATIONAL FLUID DYNAMICS						
Code	FESN19	Year of study	1				
Course teacher	Assistant professor Igor Pehnec	Credits (ECTS)	5				
Associate teachers	Željko Penga, PhD Nikola Mijalić, MEng	Type of instruction (number of hours)	L	S	AE	LE	CE
			30	0	0	30	0
Status of the course	Elective	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Introduction to full Navier-Stokes equations, continuity and energy equation; physical meaning of the equation terms. Knowledge of discretization methods and numerical solving of discretized equations. Introduction to grid's properties. Main and common pre-processing, processing and post-processing procedures for CFD software. Selection of the appropriate level of modeling and identification of the diminished physical representativness of CFD results.		
Course enrolment requirements and entry competences required for the course	Fluid mechanics		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: – Describe the full Navier Stokes equations and energy eq. – Explain the discretization procedures and numerical solution of discretized equations. – Identify the main causes of reduced physicality CFD simulations. – Apply CFD computer programs for calculating 2D flow (stress and changes of internal energy in the fluid). – Model the problem of flow of viscous flows with heat exchange for use of commercial codes. – Critically evaluate the results.		
Course content broken down in detail by weekly class schedule (syllabus)	Content	L hours	LE hours
	The main flow equation.	2	2
	Classification of the differential equations.	2	2

	Boundary conditions of the equation.	2	2
	Discretization of diff. eq. with Finite Difference Method.	2	2
	The method of the final volume. Error discretization.	2	2
	The generation networks and network types.	2	2
	Stability.	2	2
	Numerical diffusion.	2	2
	Algorithms solving of discretized equations.	2	2
	Installation of boundary conditions.	2	2
	Application of the potential flow incompressible fluid, flow of ideal fluid and viscous flow.	2	2
	Application of the potential flow incompressible fluid, flow of ideal fluid and viscous flow.	2	2
	Application of the potential flow incompressible fluid, flow of ideal fluid and viscous flow.	2	2
Format of instruction	☒ lectures ☒ seminars and workshops ☐ exercises	☒ individual assignments ☐ multimedia ☐ laboratory	
Student responsibilities	Class attendance.		

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	2,0	Research		Practical training	
	Experimental work		Report		Individual work	2,0
	Essay		Seminar essay	0,5	Lab exercises	0,2
	Tests		Oral exam	0,3	(Other)	
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	During the course, students make their homeworks that are given within the lectures and exercises. The students submit their homeworks on the next lecture. At mid-exams the students present their homeworks. The seminar essay is given to the student that is orally presented at the end of semester. Total points (%) = 0.05 (HV + SV) + 0.45 (M1 + M2)

<table>
<tr><td rowspan="1"></td><td colspan="3">HV, SV -% points from homework and seminar work,

M1, M2 -% points at mid-exams.

Corrective Exam: A student who does not pass the exam at the time of teaching and the associated exam period, but has collected at least 25% of the total points, orally explains the seminar work.</td></tr>
<tr><td rowspan="2">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>- Virag Z. Džijan I. , „Računalna dinamika fluida“, FSB, Zagreb</td><td></td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="3">-- Anderson, Dale; Pletcher, Richard H.; Tannehill, John C, "Computational Fluid Mechanics and Heat Transfer", Hemisphere Pub. Corp. McGraw-Hill (1984)

- John Anderson, "Computational FLuid Dynamics the basic and applications", McGraw-Hill Science Engineering Math (1995)

- H. Versteeg, W. Malalasekra, "An Introduction to Computational Fluid Dynamics - The Finite Volume Method", Prentice Hall (2007)

– - Hirsch, C. „Numerical Computation of Internal and External Flows“, Wiley, 1987</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="3">Keeping records of his attendance. The annual analysis of the performance of the examination. Student survey in order to evaluate teachers. Self-evaluation of teachers. Feedback from students who have already graduated from the relevance of the course content.</td></tr>
<tr><td>Other ()</td><td colspan="3"></td></tr>
</table>

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="7">THEORY OF PLASTICITY AND VISCOELASTICITY</td></tr>
<tr><td>Code</td><td>FESL42</td><td>Year of study</td><td colspan="5">1.</td></tr>
<tr><td>Course teacher</td><td>Vedrana Cvitanić, Ph. D., Associate Professor</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2"></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>15</td><td>0</td><td>0</td></tr>
<tr><td>Status of the course</td><td>Elective</td><td>Percentage of application of e-learning</td><td colspan="5">0</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Training students for:
- solving and analyzing problems of structural analysis under conditions of nonlinear (elastoplastic and viscoelastic) material behaviour,
- determination of stress and strain distributions for simple loading of beam elements under conditions of nonlinear material behaviour,
- understanding concepts of elastoplastic and viscoelastic constitutive models and their algorithmic formulations that are used in finite element codes for nonlinear structural analysis.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="7">None</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="7">Students will be able to:
- explain characteristic of mechanical behaviour of elastoplastic materials,
- compute stress and displacement distributions for elastoplastic states, limit load and residual stresses and displacements for beams under axial, torsion loading or bending loading,
- compute limit load for plane beams and frames in elastoplastic states,
- explain concepts and principles of elastoplastic constitutive formulations for three dimensional stress states under conditions of small strains,
- explain algorithm for calculating state variables of elastoplastic process for constitutive formulations based on isotropic yield function and isotropic hardening concept,
- explain characteristic of mechanical behaviour of viscoelastic materials,
- explain Maxwell’s viscoelastic model and Voigt-Kelvin’s viscoelastic model and based on these models derive creep response and stress relaxation response,
- explain solving equations of viscoelastic models by Laplace’s transform,
- explain solving problems of variable loading for beams by Bolzman’s principle of superposition,
- explain principles of viscoelastic constitutive formulations for three dimensional stress states</td></tr>
<tr><td rowspan="3">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="5">Course content</td><td>L hours</td><td>AE hours</td></tr>
<tr><td colspan="5">Introduction to theory of plasticity. Experimental data about material plastic behaviour. Effect of temperature and strain rate on material plastic behaviour. Idealizations of one dimensional plasticity diagrams. Rheological models of plasticity.</td><td>3</td><td></td></tr>
<tr><td colspan="5">Plastic analysis of beams.
Axial loading of beams in plastic region. Limit state. Elastic-perfectly plastic model and elastic-linear hardening model.</td><td>3</td><td>1</td></tr>
</table>

	Torsion loading of beams with circular cross section in plastic region. Limit state. Elastic-perfectly plastic model and elastic-linear hardening model.	3	1
	Pure and transverse bending in plastic region. Limit state. Elastic-perfectly plastic model.	3	2
	Plastic analysis of beams and frames.	3	2
	Yielding criteria for isotropic materials: Tresca yielding criterion, von Mises yielding criterion, Drucker-Prager yielding criterion, Mohr-Coulomb yielding criterion. Yielding criteria for anisotropic materials: Hill and Karafillis-Boyce yielding criterion.	5	1
	Concepts and principles of elastoplastic constitutive formulations for three dimensional stress states under conditions of small strains. Flow rule. Isotropic and kinematic hardening models for three dimensional stress states.	3	
	Algorithms for calculating state variables of elastoplastic process.	3	1
	Examples of complex body loading in plastic state.	1	3
	Introduction to theory of viscoelasticity. Experimental data for viscoelastic materials. Creep and stress relaxation. Effect of temperature and time on viscoelastic material behaviour.	3	
	Rheological models of viscoelasticity. Maxwell's model. Voigt-Kelvin's model. Generalized models.	3	1
	Solving viscoelastic model equations. Laplace's transform. Boltzman's principle of superposition.	3	1
	Principles of visoelastic constitutive formulations for three dimensional stress states.	3	
	List of laboratory exercises		LE 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 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	1,7	Research		Practical training	
	Experimental work		Report		Individual work	3,0
	Essay		Seminar essay		Laboratory exercises	
	Tests	0,2	Oral exam		Preparation for laboratory exercises	
	Written exam	0,1	Project		(Other)	

Grading and evaluating student work in class and at the final exam	There are two midterm exams during the semester. After semester there are two final exam terms, one corrective exam term and one exam term held by commission according to schedule. The first midterm exam is after 7 weeks of lecturing and the second one is after the next 6 weeks of lecturing. Each midterm exam is written and test consists of theoretical questions and numerical problems. The requirement for passing grade is 50% points on each midterm exam. In the final exams students that did not pass the midterm exams take part. In the additional exam terms students take whole exam. Final number of points is formed according to the formula: Points(%)= (M1 + M2)/2 M1, M2 – points on midexams.

<table>
<tr><td rowspan="1"></td><td colspan="3">Final grade is determined by absolute system of grading. Final grade is determed by the achived final number of points in the following manner: from 50% to 61% - grade sufficient (2), from 62% to 74% - grade good (3), from 75% to 87% - grade very good (4) and from 88% to 100% - grade excellent (5).

According to Article 71 of Faculty Statue, students are obligate to contribute in all education activities and to attend at least 70% of lecture and exercise lessons. Above conditions are necessary to access midterm and final exams.</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>Alfirević, I.: "Uvod u tenzore i mehaniku kontinuuma", Golden marketing, Zagreb, 2003.</td><td></td><td></td></tr>
<tr><td>Alfirević, I., Pustaić, D.: "Inženjerski priručnik IP1", poglavlje: Teorija plastičnosti, Školska knjiga, Zagreb, 1996.</td><td></td><td></td></tr>
<tr><td>Alfirević, I., Brnić, J.: "Inženjerski priručnik IP1", poglavlje: Teorija viskoelastičnosti, Školska knjiga, Zagreb, 1996.</td><td></td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="3">Khan, A. S., Huang, S., "Continuum theory of plasticity", Wiley & Sons Inc., New York, 1995.
Simo, J.C., Hughes, T.J.R., "Elastoplasticity and Viscoplasticity - Computational Aspects", Springer-Verlag, 1988.
Bathe, K.J.: "Finite element procedures in engineering analysis", Prentice-Hall, New York, 1996.
Brnić, J.:"Elastomehanika i plastomehanika", Školska knjiga, Zagreb, 1995.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="3">- recording student’s presence on lessons
- evaluation of results in accordance with the above learning outcomes
- 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>

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="8">PRODUCTION PLANNING AND CONTROL</td></tr>
<tr><td>Code</td><td>FETL06</td><td>Year of study</td><td colspan="6">2.</td></tr>
<tr><td>Course teacher</td><td>Boženko Bilić, Ph.D. Full Professor</td><td>Credits (ECTS)</td><td colspan="6">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Marko Mladineo, Ph. D., 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 colspan="2">DE</td></tr>
<tr><td>30</td><td>0</td><td>15</td><td>15</td><td colspan="2">0</td></tr>
<tr><td>Status of the course</td><td>Obligatory</td><td>Percentage of application of e-learning</td><td colspan="6">0</td></tr>
<tr><td colspan="9">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="8">- Introduce students with the basic tasks of production management
- Teach students the basic methods and tools for production management</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="8">Completed undergraduate study industrial engineering, naval architecture or mechanical engineering.</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="8">Students will be able to:
- Explain the strategies of introducing new products to the market
- Recommend organizational structure of the company
- Plan the required production capacity
- Develop basic layout of production equipment
- Design a project network diagram and Gantt chart
- Optimize the total cost of the project
- Plan material inventory for the independent and dependent demand
- Evaluate the quality management system.</td></tr>
<tr><td rowspan="20">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="4">Course content</td><td colspan="2">L hours</td><td colspan="2">AE hours</td></tr>
<tr><td colspan="4">Introduction. Types of industrial productions. Organizational structures</td><td colspan="2">2</td><td colspan="2">0</td></tr>
<tr><td colspan="4">Production function and production strategy</td><td colspan="2">2</td><td colspan="2">0</td></tr>
<tr><td colspan="4">Strategies for new product introduction. Process of new product development.</td><td colspan="2">3</td><td colspan="2">3</td></tr>
<tr><td colspan="4">Product lifecycle management</td><td colspan="2">2</td><td colspan="2">1</td></tr>
<tr><td colspan="4">Basis of production and manufacturing processes design.</td><td colspan="2">3</td><td colspan="2">3</td></tr>
<tr><td colspan="4">Types of production plans. The cycles of production.</td><td colspan="2">2</td><td colspan="2">0</td></tr>
<tr><td colspan="4">First midterm exam</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="4">PROJECT MANAGEMENT</td><td colspan="2">4</td><td colspan="2">3</td></tr>
<tr><td colspan="4">INVENTORY PLANNING AND CONTROL: Inventories in an independent demand</td><td colspan="2">3</td><td colspan="2">0</td></tr>
<tr><td colspan="4">INVENTORY PLANNING AND CONTROL: Inventories in an dependent demand</td><td colspan="2">2</td><td colspan="2">3</td></tr>
<tr><td colspan="4">QUALITY MANAGEMENT</td><td colspan="2">3</td><td colspan="2">0</td></tr>
<tr><td colspan="4">Second midterm exam</td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="6">List of laboratory exercises</td><td colspan="2">LE hours</td></tr>
<tr><td colspan="6">QFD metoda.</td><td colspan="2">2</td></tr>
<tr><td colspan="6">Project management: Project network diagrams (network planning techniques) and gantt chart. Project structure analysis - project phases and activities. Project time management using project network diagrams.</td><td colspan="2">4</td></tr>
<tr><td colspan="6">Project management: Project cost management using project network diagrams.</td><td colspan="2">2</td></tr>
<tr><td colspan="6">Project management: Resource planning.</td><td colspan="2">2</td></tr>
<tr><td colspan="6">5S method</td><td colspan="2">1</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Format of instruction</td><td colspan="3">☒ lectures</td><td colspan="5">☒ independent assignments</td></tr>
</table>

<table>
<tr><td></td><td>☐ seminars and workshops
☒ exercises
☐ *on line* in entirety
☐ partial e-learning
☐ field work</td><td colspan="4">☒ multimedia
☒ laboratory
☐ work with mentor
☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="5">The presence on lectures and exercises in the amount of at least 70 % of the times scheduled. Perform all laboratory exercises. Individual project tasks completed.</td></tr>
</table>

<table>
<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>1,5</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>2,5</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td>0,5</td><td>Laboratory exercises</td><td>0,5</td></tr>
<tr><td>Tests</td><td>0</td><td>Oral exam</td><td></td><td>Preparation for laboratory exercises</td><td>0</td></tr>
<tr><td>Written exam</td><td>0</td><td>Project</td><td></td><td>(Other)</td><td></td></tr>
</table>

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. The requirement for passing grade represents minimal 50% points on each midterm exam:

$$\text{Grade (\%)} = 0{,}5(M1 + M2)$$

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 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 positive assessment in exam. Positive assessment represents 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.

<table>
<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>J. B. Dilworth: Operations Management: Providing value in goods and services, South-Western College Pub, 1999.</td><td>0</td><td></td></tr>
<tr><td>J. W. Stevenson: Production/Operations Management, Irwin Professional Publishing, 1998.</td><td>1</td><td></td></tr>
<tr><td>R. G. Schroeder: Upravljanje proizvodnjom: Odlučivanje u funkciji proizvodnje, MATE d.o.o., Zagreb, 1999.</td><td>0</td><td></td></tr>
</table>

Optional literature (at the time of submission of study programme proposal)	- B. Bilić: Predavanja postavljena na e-learning portalu - ***"Inženjerski priručnik IP4 – sv. 3", str. 195-236, Školska knjiga, Zagreb, 2002. - A. Vila, A., Z. Leicher: Planiranje proizvodnje i kontrola rokova", Informator, Zagreb, 1983.
Quality assurance methods that ensure the acquisition of exit competences	- 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
Other (as the proposer wishes to add)	

NAME OF THE COURSE	NUMERICAL SYNTHESIS IN ENGINEERING						
Code	**FESL49**	Year of study	5				
Course teacher	Prof.dr.sc.Damir Vučina	Credits (ECTS)	5				
Associate teachers	Igor Pehnec	Type of instruction (number of hours)	L	S	AE	LE	DE
			45			15	
Status of the course	elective	Percentage of application of e-learning					
COURSE DESCRIPTION							
Course objectives	- Acquire theoretical foundations, methods and algorithms related to shape synthesis for given functionality by applying geometric modelling and multi-objective optimization - Develop competences in applying computers in numerical synthesis in engineering - Acquire capacity to competently apply numerical tools to engineering problems						
Course enrolment requirements and entry competences required for the course	Succesfully completed courses equivalent to Computer-aided analysis and Optimization methods. Competences related to basic methods of engineering analysis and program development in C and MATLAB						
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - Formulate the engineering problem as a parametric model for shape optimization - Model the problem as a set of decision variables, constraints and excellence functions - Model the excellence using valuation methods - Develop flowcharts for numerical workflows involving modula for geometric modelling, simulation (e.g.FEA) and optimization - Solve multiobjective problems related to constrained non-linear programming						

<table>
<tr><td></td><td colspan="6">- Apply evolutionary optimization methods and metaheuristics
- Apply surrogate models replacing simulators,
- Develop and test complex models and numerical computational processes using advanced integral tools
-</td></tr>
<tr><td rowspan="24">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="4">Course content</td><td>L or S hours</td><td>AE hours</td></tr>
<tr><td colspan="4">Inroductory concepts</td><td>3</td><td></td></tr>
<tr><td colspan="4">Modelling 2D shape and configuration</td><td>3</td><td></td></tr>
<tr><td colspan="4">Modelling 3D shape</td><td>3</td><td></td></tr>
<tr><td colspan="4">Modelling functionality and excellence</td><td>3</td><td></td></tr>
<tr><td colspan="4">Modelling project value of project elements</td><td>3</td><td></td></tr>
<tr><td colspan="4">Shape optimization</td><td>3</td><td></td></tr>
<tr><td colspan="4">Multi-objective optimization</td><td>3</td><td></td></tr>
<tr><td colspan="4">Evolutionary algorithms and operators</td><td>3</td><td></td></tr>
<tr><td colspan="4">Metaheuristics</td><td>3</td><td></td></tr>
<tr><td colspan="4">Model reduction and surrogate models</td><td>3</td><td></td></tr>
<tr><td colspan="4">Parameterization and optimization of shape and topology</td><td>3</td><td></td></tr>
<tr><td colspan="4">Numerical workflows in shape optimization</td><td>3</td><td></td></tr>
<tr><td colspan="4">Engineering applications</td><td>3</td><td></td></tr>
<tr><td colspan="5">List of laboratory or design exercises</td><td>LE or DE hours</td></tr>
<tr><td colspan="5">Introductory application examples</td><td>1</td></tr>
<tr><td colspan="5">Modelling 2D and 3D shape and configuration</td><td>3</td></tr>
<tr><td colspan="5">Modelling project value of project elements</td><td>1</td></tr>
<tr><td colspan="5">Multi-objective optimization</td><td>1</td></tr>
<tr><td colspan="5">Evolucijski algoritmi i operatori</td><td>1</td></tr>
<tr><td colspan="5">Metaheuristics</td><td>1</td></tr>
<tr><td colspan="5">Surrogate models</td><td>1</td></tr>
<tr><td colspan="5">Numerical workflows in shape optimization</td><td>3</td></tr>
<tr><td colspan="5">Engineering applications</td><td>1</td></tr>
<tr><td>Format of instruction</td><td colspan="3">v lectures
☐ seminars and workshops
v exercises
☐ on line in entirety
☐ partial e-learning
☐ field work</td><td colspan="3">v independent assignments
☐ multimedia
v laboratory
☐ work with mentor
☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="6"></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>3</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>Project work</td><td>2</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>(Other)</td><td></td></tr>
<tr><td>Tests</td><td></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">Exam: theoretical and practical or project

Grade(%) = 0,5*M1 + 0,5*M2
M1, M2 – percentage at mid-term exam and final exam respectively

50% do 61% (2)
62% do 74% (3)</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">75% do 87% (4)
88% do 100% (5)</td></tr>
<tr><td rowspan="6">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>-D. Vučina, 'Metode inženjerske numeričke optimizacije', Sveučilište u Splitu, FESB 2005</td><td></td><td></td></tr>
<tr><td>K. Deb, Multi-objective optimization using Evolutionary Algorithms, Wiley, 2001</td><td></td><td></td></tr>
<tr><td>S. Haykin, "Neural Networks", Prentice Hall International, 1999</td><td></td><td></td></tr>
<tr><td>D. Rogers, An Introduction to NURBS, Morgan Kaufmann Publishers, 2000</td><td></td><td></td></tr>
<tr><td>-D. Vučina, 'Metode inženjerske numeričke optimizacije', Sveučilište u Splitu, FESB 2005</td><td></td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="3">J. S. Arora, “Introduction to Optimum Design”, McGraw Hill, 2012
S.S. Rao, “Engineering Optimization”, Wiley Interscience, 1996
G. Farin, Curves and Surfaces for Computer Aided Geometric Design: A Practical Guide, Morgan Kaufmann Publishers/ Academic Press, 2002
A. Saxena, B. Sahay, Computer-aided engineering design, Springer 2005</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="3">The annual analysis of examination efficacy. Student survey in order to evaluate teachers. Self-evaluation of teachers. Feedback from students who have already graduated from the relevance of the course content.</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="3">In English or Croatian language.</td></tr>
</table>

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="7">INTRODUCTION TO INFORMATION SYSTEMS</td></tr>
<tr><td>Code</td><td>FESL36</td><td>Year of study</td><td colspan="5">2</td></tr>
<tr><td>Course teacher</td><td>Damir Vučina, Ph. D. Full Professor</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Igor Pehnec, Ph. D. Teaching assistant
Ivo Marinić- Kragić, Teaching assistant
Milan Ćurković, Ph. D., 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>30</td><td>0</td><td>0</td><td>15</td><td>0</td></tr>
<tr><td>Status of the course</td><td>Elective</td><td>Percentage of application of e-learning</td><td colspan="5">0</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Capability of applying computers in building information systems.
Acquiring knowledge and application skills: HTML, basic terms in databases, basics of SQL, script languages, active web pages, IS</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="7">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="7">After completing the course, students will be able to:
Describe information systems, specify architecture and functionality, elements, technologies
Develop sets of HTML files for the IS
Develop simple client scripts in Vbscript
Create simple databases
Develop simple SQL queries
Build simple dynamic web pages using ASP</td></tr>
<tr><td rowspan="20">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="5">Course content</td><td>L hours</td><td>AE hours</td></tr>
<tr><td colspan="5">Introduction. systems, business processes, information processing</td><td>2</td><td></td></tr>
<tr><td colspan="5">Information systems IS, MIS, elements of IS</td><td>2</td><td></td></tr>
<tr><td colspan="5">Information systems IS, functional specifications of IS, architecture of IS</td><td>2</td><td></td></tr>
<tr><td colspan="5">Infrastructure and devices for the IS, protocols</td><td>2</td><td></td></tr>
<tr><td colspan="5">Internet, services, www</td><td>2</td><td></td></tr>
<tr><td colspan="5">Development of content for the web</td><td>2</td><td></td></tr>
<tr><td colspan="5">Basics of HTML</td><td>2</td><td></td></tr>
<tr><td colspan="5">Basics of programming, basic elements of programs</td><td>2</td><td></td></tr>
<tr><td colspan="5">Script languages, Vbscript</td><td>2</td><td></td></tr>
<tr><td colspan="5">Databases: basic terms and elements of design</td><td>2</td><td></td></tr>
<tr><td colspan="5">First midterm exam</td><td></td><td></td></tr>
<tr><td colspan="5">Databases: basics of SQL, IS and databases</td><td>2</td><td></td></tr>
<tr><td colspan="5">Simple active pages, ASP. Basic concepts of web applications</td><td>2</td><td></td></tr>
<tr><td colspan="5">Integration of IS elements</td><td>2</td><td></td></tr>
<tr><td colspan="5">Second midterm exam</td><td></td><td></td></tr>
<tr><td colspan="6">List of laboratory exercises</td><td>LE hours</td></tr>
<tr><td colspan="6">Information systems IS modeling, functional specifications of IS</td><td>1</td></tr>
<tr><td colspan="6">Develop sets of HTML files for the IS</td><td>2</td></tr>
</table>

	Scripting and Vbscript examples	2
	Databases, modelling, normalization	2
	SQL	2
	Active pages, ASP, applications	2
	Integration of IS	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	3	Research		Practical training	
	Experimental work		Report		Individual work	2
	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.

	Title	Number of copies in the library	Availability via other media
Required literature (available in the library and via other media)	D. Vučina, M. Šušnjar, M. Uvodić 'Uvod u informacijske sustave', internal material		
	Steven Alter, 'Information Systems: Foundation of E-Business		
	Ch J. A. O'Brien, 'Management Information Systems', Irwin Inc.		
	Online skripts: w3schools - 'HTML', 'VBScript', 'ASP', 'SQL'		

Optional literature (at the time of submission of study programme proposal)	• NCSA, 'A Beginner's Guide to HTML', ili ' • HTML - An Interactive Tutorial for Beginners' • MS VBScript Tuturial • MS ASP pages R. Leinecker, 'Using ASP.net', Que, 2002
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	**HEATING AND AIR CONDITIONING**						
Code	FESL23	Year of study	1				
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: - Categorization and description of the HVAC systems, - Compute and general design of the elements inside the HVAC systems according to standards.						
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 base terms and issues related to the thermal comfort, - Analyse and compute heat losses and gains according to the standards, - Compare fuels in the HVAC systems, i.e. heating and cooling applications and elaborate their impact to the environment, - Consider and compute base components of the heating/cooling, i.e. HVAC systems, - Consider and compute ventilation systems.						

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction and basic terms (issues) related to the thermal comfort. External and internal design temperatures. Climate conditions.	2 hours	2 hours
	Calculation of the heat losses.	2 hours	2 hours
	Calculation of the heat losses.	2 hours	2 hours
	Heating elements, characteristics, correction of the nominal thermal load.	2 hours	2 hours

	Central heating systems, calculation of the carbon dioxide emissions.	2 hours	2 hours
	Calculation and design of the pipelines in the heating systems.	2 hours	2 hours
	Boilers, types, classification, boiler rooms.	2 hours	2 hours
	Other equipment of the heating systems.	2 hours	2 hours
	Preparation of the hot water and calculation of the heating demands.	2 hours	2 hours
	Regulation of the heating systems.	2 hours	2 hours
	Calculation of the heat gain.	2 hours	2 hours
	Fan coil devices, other cooling elements.	2 hours	2 hours
	Central water based air-conditioning systems, climate chambers, coolants (refrigerants)	2 hours	2 hours
	Ventilation systems, components, calculation of the required airflow for ventilation purpose.	2 hours	2 hours
	Heat pumps, absorption cooling devices.	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 Grijanje i Klimatizacija dio I i dio II, 2011, FESB.		
	Recknagel, Sprenger, Schramek, Čeperković: Grijanje i klimatizacija 2005, Energetika marketing, Zagreb, 2005 (Prijevod sa njemačkog)		
	ASHRAE Handbooks: Fundamentals, Applications, Systems and Equipment, Refrigeration, ASHRAE, Atlanta, USA, 2001, 2002, 2003, 2004		
	Priručnik za Ventilaciju I klimatizaciju, EGE, 2003.		
	Priručnik za grijanje, EGE, 2005		
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)			

NAME OF THE COURSE	**MACHINE TOOLS**						
Code	FETL18	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
			45	0	0	15	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 modular construction of modern numerically controlled machine tools.						

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 - categorize features of mechanisms and systems management machine tools - examine the exploitation characteristics of machine tools - identify motives of high speed and multi-operation machine tools development - designing of driving systems and mechanism in machine tools according to machine tool construction.		
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.	3	
	Basics of construction machine tools. Testing of machine tools accuracy.	3	
	Main parts of machine tools. Bearing elements, guides, spindle bearings.	3	
	Driving system of machine tools.	3	
	Machine tools control system.	3	
	Turning machines: Classification and basic concepts	3	
	Milling machines: Classification and basic concepts	3	
	First midterm exam		
	Machine tools for drilling, broaching, sawing, grinding. Machines for gear wheels manufacturing.	3	
	Technical calculations related to the machine as the whole unit and its particular parts.	3	
	Automatic tool change. Automatic workpiece change.	3	
	Machine tools for high performance machining operation. Machining center. Turning center. Grinding center.	3	
	High Speed machine tools. Parallel kinematics for machine tools	3	
	Basic concept of CNC programming. CAD/CAM introduction	3	
	Second midterm exam		
	List of laboratory or design exercises		LE or DE hours
	Movement, typical parts and mechanisms of machine tools installed in the laboratory. Determination of degree of machine tool workspace efficency.		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
	Rigidity of the system machine-tool-woorkpiece.		2
	Determination of gearbox efficiency on turning machine.		2
	Zero point of the workpiece and zero point of the tool at vertical machining center.		2
	Automatic CNC programming. Preparation and model production using 3D printer.		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)	

<table>
<tr><td>Student responsibilities</td><td colspan="6">The presence on lectures in the amount of at least 70 % of the times scheduled.
Performed all required laboratory 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>0.5</td><td>Report</td><td></td><td>Reports from the laboratory exercises</td><td>0.25</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>(Other)</td><td>2.25</td></tr>
<tr><td>Tests</td><td></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 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:
5. Positive assessment of laboratory exercises
6. 50 % points on each midterm exam or the final exam.

Grade (in percentage) is formed according to the formula:
Grade(%) = 0,5 (M1 + M2)

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)</td></tr>
<tr><td rowspan="4">Required literature (available in the library and via other media)</td><td colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">Ekinović S., "Alatne mašine", Mašinski fakultet, Zenica, 2004.</td><td></td><td></td></tr>
<tr><td colspan="4">Lopez de Lacalle, Lamikiz "Machine tools for high performance machining", Springer, 2008.</td><td></td><td></td></tr>
<tr><td colspan="4">Bajić, D., Jozić, S., Predavanja objavljena na eLearning portalu, 2015.</td><td></td><td>eLearning portal</td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">Cebalo, R., "Alatni strojevi – Odabrana poglavlja", Vlastito izdanje, Zagreb, 2001.
- Pahole, I., Balič, J., "Obdelovalni stroji", Univerza v Mariboru, Maribor 2003.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- Evaluation of results in accordance with the above learning outcomes
- 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="6"></td></tr>
</table>

NAME OF THE COURSE	**ENGINEERING MAINTENANCE**							
Code	FETL04	Year of study	2					
Course teacher	Jani Barle, Ph. D., Full Professor	Credits (ECTS)	5					
Associate teachers	Stipe Perišić, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	CE	
			45	0	0	15	0	
Status of the course	Obligatory	Percentage of application of e-learning	0					

COURSE DESCRIPTION

Course objectives	Upon completion the student will be able to critically evaluate and compare various concepts related to technical system life assessment, usage, maintenance and safety.		
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: 1. Evaluate different actions and suggest maintenance strategy. 2. Comment maintenance procedures and risks associated with usage. 3. Link different reliability and availability modeling concepts. 4. Estimate availability and maintenance costs. 5. Compare impacts on technical system endurance.		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	LE hours
	The role and scope of the maintenance engineering. Historical aspects, principles and applications of maintenance actions (corrective, preventive, predictive, proactive). RCM and TPM strategies. Bathtub curve.	3	
	Maintenance-related case studies.		1
	Standards (IEC EN 61508). Maintenance assets register. Technical performance indicators. Failure, failure cause, failure mode and consequence. Failure Mode and Effect Analysis (FMEA) and Root Cause Analysis (RCA).	3	
	FMEA examples.		1
	An overview of the failure modes. Human errors in maintenance. Nonparametric life estimate procedures and parametric life models.	3	
	Nonparametric life data analysis procedures - 1.		1
	Reliability and availability data sources, standards and recommendations. Analysis of complete and censored data.	3	
	Nonparametric life data analysis procedures - 2.		1
	Parametric reliability models of component. Constant and time-dependent failure models (Exponential, Weibull, Log-normal). Probability plots. Maximum likelihood. Confidence interval.	3	
	Parametric life data analysis - 1.		1
	Reliability of systems. Reliability block diagrams (RBD): serial configuration and redundancy models.	3	
	Parametric life data analysis - 2.		1
	Maintainability and Availability. Overview of the factors that influences maintainability.	3	
	Maintainability case studies.		1
	Repairable items. Markov model fundamentals. Load-sharing. System deterioration models with and without repair. Counting processes (HPP and NHPP).	3	
	Examples of the repairable items.		1

	Data sources and/or expert judgments. Burn-In. Bayesian analysis in formal safety assessment (FSA).	3	
	Reliability data sources - examples.		1
	The role and applications of technical diagnostics. Procedure, types, indicators and sensors.	3	
	Technical diagnostics case studies.		1
	Physical reliability models. Accelerated testing and burn-in procedures.	3	
	Covariate damage models.		1
	Planning, purchasing and storage of maintenance-related actions and inventory.	3	
	Width and depth of spare parts stock.		1
	Optimal preventive maintenance scenarios and models. Maintenance information system, documents and organization structure.	3	
	Numerical analysis of optimal preventive maintenance model.		1

Format of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☐ individual assignments ☒ multimedia ☒ laboratory ☐ work with mentor ☐ individual project (other)
Student responsibilities	Class attendance, tests, project presentation and oral exam.	

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	2,0	Research		Practical training	
	Experimental work		Report	0,5	Individual work	2,0
	Essay		Seminar essay		Lab exercises	0,3
	Tests	0,2	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-week session classes and the second one is after the next 6 weeks. The first midterm is carried out as written test on basic issues covered within the first session. The second midterm is seminal paper on selected and more advanced topic. Selected topic must be discussed with respect to the course framework. The requirement for passing grade is the positive assessment on each midterm exam (>49%) or the final exam.
The final score is:

$$Score\ (\%) = 0,35 \times A_1 + 0,35 \times A_2 + 0,20 \times A_3 + 0,10 \times A_4$$

- *midterm 1: A_1 = 50 – 100 %,*
- *midterm 2 (seminal paper): A_2 = 50 – 100 %,*
- *oral exam: A_3 = 50 – 100 %.*
- *class attendance: A_4 = 70 – 100 %.*

Score	Grade
50% - 62%	sufficient (2)
63% - 76%	good (3)
77% - 88%	very good (4)
89% - 100%	excellent (5)

Required literature (available in the library and via other media)	Title	Number of copies in the library	Availability via other media
	Barle, J.: Reliability in maintenance management, (student handbook in Croatian:		e-learning portal

	Pouzdanost u funkciji održavanja tehničkih sustava), FESB, Split, 2009.		
Optional literature (at the time of submission of study programme proposal)	Rausand, M.; Høyland, A., "System Reliability Theory: Models, Statistical Methods, and Applications", 2nd ed., Wiley-Interscience, 2003. Ebeling, C., "An Introduction To Reliability and Maintainability Engineering", McGraw-Hill, 1996. Rausand, M., "Reliability of Safety-Critical Systems: Theory and Applications", Wiley, 2014.		
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	**NONCONVENTIONAL MACHINING PROCESSES**						
Code	FETL22	Year of study	1				
Course teacher	Sonja Jozić, Ph. D., Assistant Professor	Credits (ECTS)	5				
Associate teachers		Type of instruction (number of hours)	L	S	AE	LE	DE
			45	0	0	15	0
Status of the course	Elective	Percentage of application of e-learning	0				
COURSE DESCRIPTION							
Course objectives	Training students for: - acquisition of basic knowledge of nonconventional methods in the field of machining. - acquisition of technical knowledge about possibilities of nonconventional machining processes in order to solving engineering problems in this area						
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: - identify nonconventional machining processes and their application - analyze the role of different types of energy in nonconventional machining processes - identify the motive of application of nonconventional machining processes						

	from the viewpoint of workpiece material - create a diagram of nonconventional machining processes that connects the power source, working fluid and interaction with the workpiece material - present machining system and the effects of nonconventional machining processes - combine nonconventional machining processes according to the product requirements - present application of nonconventional machining processes in modern industries		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction. Main terms, definitions and classification of nonconventional machining processes.	3	
	Mechanical processes. Ultrasonic machining. Water jet machining. Abrasive jet machining.	3	
	Mechanical processes. Abrasive water jet machining. Ice jet machining. Magnetic abrasive finishing.	3	
	Chemical processes. Chemical milling. Photochemical milling. Electropolishing.	3	
	Electrochemical processes. Electrochemical machining. Electrochemical drilling.	3	
	Thermal processes. Electrodiscarge machining. Mechanism of material removal. The machining system.	3	
	Thermal processes. Electrodiscarge machining. Types of machining. Application of EDM.	3	
	First midterm exam		
	Thermal processes. Laser beam machining.Introduction in LBM. Types of industrial laser. Interaction with workpiece material.	3	
	Thermal processes. Laser beam machining. Mechanism of material removal. Application of the LBM.	3	
	Thermal processes. Electron beam machining. Plasma beam machining. Ion beam machining.	3	
	Comparison of different nonconventional machining processes. Surface quality and effectveness of nonconventional machining processes.	3	
	Hybrid nonconventional machining processes	3	
	Thermal assisted conventional machining processes. Trends of development of nonconventional machining processes.	3	
	Second midterm exam		
	List of laboratory or design exercises		LE or DE hours
	Mechanical processes - organized students visit to the Shipyard Brodosplit		3
	Thermal processes - organized students visit to the Shipyard Brodosplit		3
	Chemical processes - demonstration		2
	Electrochemical processes - demonstration		2
	Determining of the parameters of ultrasound and abrasive machining		2
	Determining of the parameters of electrochemical and electrodischarged machining		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	0,25	Report		Reports from the laboratory exercises (Other)	0,25
	Essay		Seminar essay		Preparation for lecturing	0,25
	Tests		Oral exam		Individual work	2,25
	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: 7. Positive assessment of laboratory exercises 8. 50 % points on each midterm exam or the final exam. Grade (in percentage) is formed according to the formula: Grade(%) = 0,5 (M 1 + M 2) 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.

	Title	Number of copies in the library	Availability via other media
Required literature (available in the library and via other media)	S. Jozić: „Nonconventional machining processes“ lecturing, eLearning, 2015.	0	eLearning portal
	H.A.G. El-Hofy, "Advanced Machining Processes", McGraw-Hill, 2005.	0	
	Walker, J., R., "Machining Fundametals", The Goodheart-Willcox Company, Inc. Tinley Park, Illinois, 2000.	0	

Optional literature (at the time of submission of study programme proposal)	Hocheng H., Tsai H.Y. (editors) H.A.G. "Advanced Analysis of Nontraditonal Machining", Springer Science+Bussiness Media New York, 2013. - Čuš, F., "Postopki odrezavanja", Univerza v Mariboru, Fakulteta za strojništvo, Maribor, 2009.
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	MANUFACTURING PROCESS PLANNING						
Code	FETL25	Year of study	1.				
Course teacher	Nikola Gjeldum, Ph. D., Assistant Professor	Credits (ECTS)	5				
Associate teachers	Marina Crnjac, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			45	0	0	0	15
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students to: - select raw material and machine tools for specific production batch - design optimal manufacturing process - know how to measure, sort and analyze process times in manufacturing process - identify losses at work
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: - analyze product design for manufacturing process design purposes - select optimal size and shape of raw material - determine type of production in relation to batch size - determine elements of process times for batch production - suggest contemporary manufacturing process and its ability - test objectivity and accuracy of time measurement personnel - detect cyclical, periodical and random production steps - reveal losses at work

Course content broken down in detail by weekly class schedule (syllabus)

Course content	L hours
Definition of production system, production and manufacturing process. Fundamentals of material flow design in the production process.	2
The basic elements of manufacturing processes: process, composed and group process steps, process step.	1
Definition of technology and technique. Cutting technologies.	3
Characteristics and levels of technologies and manufacturing processes. Manufacturing process capability.	2
The basic principles of manufacturing process design.	3
The selection of raw material.	2
Optimal sequence of manufacturing processes and process steps.	3
Factors influencing on errors in manufacturing processes.	2

	Selection of manufacturing baselines.	2
	First midterm exam	2
	Group technology.	2
	Basics of Work and Time Study in production enterprise.	2
	The scale of business success in the enterprise.	1
	Time standard. Components of working time.	2
	Methods for determining the production (working) time.	6
	Performance rating.	1
	The work of a worker on multiple machines.	2
	Types and analysis of losses during the work.	1
	Implementation of better work method.	2
	Second midterm exam	2
	List of design exercises	DE hours
	Design example of manufacturing process.	3
	Detailed elaboration of manufacturing process, raw material selection, tools selection and calculation of process time.	3
	Autonomous students work on manufacturing documentation for individual project tasks	7

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. The presence exercises in the amount of at least 80 % of the times scheduled. Individual project tasks completed.	

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	
Experimental work		Report		Individual work	2,7
Essay		Seminar essay		(Other)	
Tests	0,2	Oral exam		(Other)	
Written exam	0,1	Project	1	(Other)	

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

During semester there are two 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. 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. Final exams are conducted in written form. Midterm exams and final exams consist of theoretical questions and numerical problems.

$$\text{Grade (\%)} = 0{,}4D + 0{,}6E$$

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.

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

	91% - 100% excellent (5)		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Gjeldum, N.: „Tehnološka priprema proizvodnje“, lectures on e-learning, FESB Split		Internet (e-learning)
	Gačnik, V., Vodenik, F.: „Projektiranje tehnoloških procesa“, Tehnička knjiga, Zagreb, 1990.	10	
	Taboršak, D., "Studij rada", Orgadata, Zagreb, 1994.	2	
	Car, M., Krznar, M., Šimon, K., "Studij rada – zbirka zadataka i rješenja", Liber, Zagreb, 1983.	1	
Optional literature (at the time of submission of study programme proposal)	5. Toboršak, D., Gornik, B., Čala, I., „Priprema proizvodnje“, Inženjerski biro, Zagreb, 1974. 6. Buchmeister, B., Polajnar, A.: „Priprava proizvodnje za delo v praksi“, Fakulteta za strojništvo, Maribor, 2000. 7. Polajnar, A., “Študij dela”, Univerza v Mariboru, Fakulteta za strojništvo, Maribor, 1999 8. WEB catalogues		
Quality assurance methods that ensure the acquisition of exit competences	- 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		
Other (as the proposer wishes to add)			

NAME OF THE COURSE	**MATERIAL SELECTION**						
Code	FETL27	Year of study	1				
Course teacher	Dražen Živković, Ph. D., Full Professor	Credits (ECTS)	5				
Associate teachers	Nikša Čatipović, mag.ing. Zvonimir Dadić mag.ing.	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	16	14	0	0
Status of the course	Obligatory	Percentage of application of e-learning	30				
COURSE DESCRIPTION							
Course objectives	Introducing students with: - lifecycle of products and materials, - technical materials and their properties, - factors influencing the choice of the material product,						

	- diagrams of material properties, - selecting materials according to legal, technical, economic, human and aesthetic conditions, - material selection methods, - optimization methods for materials selection, - selection of production processes.	
Course enrolment requirements and entry competences required for the course	Completed undergraduate Mechanical engineering studies.	
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - determine the selecting methodology for real products materials, - chose the methods for selecting materials both from the point of view of products and production processes, - analyze the life cycle of the product, - describe and identify the factors that influence the selection of materials product	
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours
	Lifecycle of material. Materials and energy. Ecological factors in materials selection. Materials and industrial design. Development of engineering materials.	2
	Surfaces and their contacts. The basics of friction theory.	2
	Significance of wear mechanisms in material selection. Selection Materials selection according with tribological principles.	2
	Functional connection: material-shape-processing. Product development technologies. Original shape. Adaptive - developmental design. Design tools and material data.	2
	Engineering materials. Material properties (mechanical, thermal, electrical, optical, ecological).	2
	Materials property diagrams: thermal conductivity - thermal capacity; thermal expansion - thermal conductivity; thermal expansion - Young-module; strength - maximum working temperature;	2
	Materials property diagrams: tear and wear; friction coefficient; consistency of wear - hardness; material cost chart; Young's module - cost of materials; strength - cost of materials	2
	The basics of material selection. Selection principles. Harmonization of shape requirements. Selection of appropriate material groups according to the shape limitation.	2
	Selection ranking using the goal function. Searching for detailed information. Material Indexes. Material selection procedure.	2
	Materials selection by computer program. Structure indexes. Selection of production procedure. Classification of production procedures. Shaping procedures. Joining procedures. Finishing operations.	2
	Systematic selection process for material processing. Selection process diagram. Diagrams: materials - processes; process - shape; processes - mass area; processes - wall thickness; processes - tolerances; processes - surface roughness.	2
	Ranking the cost-cutting process. Economic criteria for selection of producing processes. Cost forming. Search and selection of producing process using a computer program.	2
	Material selection in case of multi-criteria limitations. Usability and constant conversion function.	2
	Materials selection and shapes. Factors of shape. Micro structural factors of shape. Shapes usability limits.	2
	Materials and industrial design. Pyramid requirement. Product characterization. Use of materials and producing processes to achieve product uniqueness.	2
	List auditory exercises	AE hours
	Analysis of tribological system and materials selection.	2

<table>
<tr><td rowspan="6"></td><td colspan="5">Concept - development - detailed elaboration.</td><td>2</td></tr>
<tr><td colspan="5">Material selection procedure.</td><td>2</td></tr>
<tr><td colspan="5">Application of material property diagrams.</td><td>2</td></tr>
<tr><td colspan="5">Multiple limitations and contradictory goals.</td><td>2</td></tr>
<tr><td colspan="5">Solving computer tasks using CES-EduPack - demo software</td><td>2</td></tr>
<tr><td colspan="5">Selection of material handling procedures. Materials selection and shapes. Economic criteria for process selection.
Ecological principles in materials selection.</td><td>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</td><td colspan="3">☒ independent assignments
☒ multimedia
☐ laboratory
☐ work with mentor
☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="6">The presence in lectures and exercises in the amount of at least 70%.</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>1</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>Self-directed learning</td><td>2,5</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td>0,53</td><td>Auditory exercises</td><td>0,47</td></tr>
<tr><td>Tests</td><td>0,5</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">During the semester there will be two mid-term exams (tests). The first mid-term, after 7 weeks of classes and the second after the next 6 weeks of classes. At the final exam students have to take part material that did not pass the mid-term. Each test is carried out as written exam lasting 45 minutes. The requirements for a positive evaluation are: positively evaluated seminar papers and at least 50% of the points earned on each test. The final grade is based on the resulting percentage on mid-term exams.
Percentage - Rating
50% to 61% - sufficient (2)
62% to 74% - good (3)
75% to 87% - very good (4)
88% to 100% - excellent (5)
The final grade is determined at the end of the examination deadlines. The students who did not pass the exam in the summer exam period have a correction final exam in the autumn exam period. At the final exam the students have to pass the whole lectures. The exam lasts 90 minutes. Students wanted higher grade may obtain it on an additional oral exam.</td></tr>
<tr><td rowspan="2">Required literature (available in the library and via other media)</td><td colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">D. Živković, the author's lecture, FESB</td><td></td><td>E-learning portal</td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6">1.Filetin, T., Izbor materijala pri razvoju proizvoda, FSB, Zagreb, 2000.
2.Ashby, M.F., Materials Selection and Mechanical Design, 5th edition, Elsevier Science & Technology Books, 2016.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- Evaluation of results in accordance with the above learning outcomes
- Feedback from students via surveys
- Self-evaluation of teachers
- Institutional and non-institutional evaluations</td></tr>
</table>

Other (as the proposer wishes to add)	

NAME OF THE COURSE	**HYDRAULIC AND PNEUMATIC SYSTEMS**							
Code	FETL17	Year of study	1					
Course teacher	Jani Barle, Ph. D., Full Professor	Credits (ECTS)	5					
Associate teachers	Alen Kovač, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	CE	
			30	0	0	15	15	
Status of the course	Elective	Percentage of application of e-learning	0					

COURSE DESCRIPTION				
Course objectives	Upon completion the student will be introduced to essential features of industrial hydraulic or pneumatic systems. They will be able to draw, explain and assemble schematic diagram and to demonstrate ability to identify hydraulic or pneumatic system elements by symbol and function and to use that skills for fault finding and solving.			
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: 1. Present general concepts associated with industrial appliaction of hydraulics and pneumatics. 2. Identify components of the system and draw related symbols. 3. Arrange and assemble simple hydraulic and pneumatic systems. 4. Combine various elements with respect to size and design concept. 5. Critically assess workability and supportability of complex hydraulic and pneumatic systems. 6. Develop hydraulic or pneumatic system.			
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	LE hours	CE hours
	Historical aspect and scope of hydraulics and pneumatics. Introduction to pneumatics. Basic physical principles of pneumatics.	2		
	Typical pneumatic systems demonstrations.		2	
	Compressed air generation and distribution. Standards and Symbols.	2		
	Compressed air generation and distribution.			2
	Basic elements of pneumatic systems (check, pressure control and directional control valves).	2		
	Methods for development of pneumatic systems.			2

	Basic elements of pneumatic systems (directional control valves, valve actuation types, accessories).	2		
	More complex pneumatic circuits (introduction to laboratory exercises).			2
	Basic elements of pneumatic systems (cylinders and motors).	2		
	Circuit assembling on pneumatic didactic table (guided).		2	
	Electric valves and electropneumatic systems. Proportional pneumatics.	2		
	Circuit assembling on pneumatic didactic table.		2	
	Introduction to hydraulics. Basic physical principles of hydraulics, oils and theoretical background. Energy efficiency of hydraulic systems. Fundamental hydraulic problems: cleanness, temperature, cavitation - bubble entrainment and evacuation.	2		
	Typical hydraulic systems demonstrations.		2	
	Hydraulic elements for energy conversion: cylinders, pumps and motors with constant and adjustable displacement.	2		
	Hydraulic elements and their most important parts.		2	
	Basic control elements in hydraulics: check valves, direct acting and pilot operated pressure-relief valves.	2		
	Hydraulic elements and their most important parts.		2	
	Basic control elements in hydraulics: direct acting and pilot operated directional control valves, pressure regulators, flow control valves.	2		
	Hydraulic cylinders - parallel and series circuit. Synchronizing cylinder movement and load.			2
	Typical design solutions of hydraulic elements for energy conversion (cylinders, pumps and motors with constant and adjustable displacement)	2		
	Typical hydraulic circuits: accumulator holding, pump unloading, braking, counter balance. Hydraulic presses.			2
	Pressure control circuits. Flow and speed control circuits.	2		
	Flow control circuits (introduction to laboratory exercises).			2
	Closed flow hydraulic circuits. Load sensing (LS) systems.	2		
	Hydraulic didactic model. Motor speed adjustment with throttle valve. Speed control with two and three-way flow control valves.		2	

Format of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☒ individual assignments ☒ multimedia ☒ laboratory ☐ work with mentor ☐ individual project (other)
Student responsibilities	Minimum of 70 percent lecture attendance. Completing all the 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	2,0	Research		Practical training	
	Experimental work		Report		Individual work	2,0
	Essay		Seminar essay		Preparation for exercises	0,8
	Tests	0,2	Oral exam		(Other)	
	Written exam		Project		(Other)	

Grading and evaluating student	There are two midterms and final exams. The first midterm exam is after 7-week session classes and the second one is after the next 6 weeks. The midterms are carried out as

<table>
<tr><td>work in class and at the final exam</td><td colspan="3">written tests, made up of three questions relating to the basic issues and schematics. The oral exam is focused on the student's interpretation skills. The requirement for passing grade is the positive assessment on each midterm exam (>49%) or the final exam.
The final score is:
$$Score\ (\%) = 0,35 \times A_1 + 0,35 \times A_2 + 0,20 \times A_3 + 0,10 \times A_4$$
• midterm 1: A_1 = 50 – 100 %,
• midterm 2: A_2 = 50 – 100 %,
• oral exam: A_3 = 50 – 100 %.
• class attendance: A_4 = 70 – 100 %.
Score Grade
50% - 62% sufficient (2)
63% - 76% good (3)
77% - 88% very good (4)
89% - 100% excellent (5)</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>Barle, J.: Hydraulics and pneumatics, (student handbook and workbook in Croatian: Hidraulika i pneumatika), FESB, Split, 2010.</td><td></td><td>e-learning portal</td></tr>
<tr><td>Nikolić, G.: Pneumatika, Školske novine, Zagreb, 1994.</td><td></td><td></td></tr>
<tr><td>Koroman, V.; Mirković, R.: Hidraulika i pneumatika, Školska knjiga, Zagreb, 1991.</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="3">Lang, R.A. (ed.): Hydraulic Trainer 1; Planning and Design of Hydraulic Power Systems, Mannesmann Rexroth AG, 1998.
Rabie, M.: Fluid Power Engineering, McGraw-Hill, 2009.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="3">- Evaluation of results in accordance with the above learning outcomes
- 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>

<table>
<tr><td>NAME OF THE COURSE</td><td colspan="7">DESIGN FOR ASSEMBLY</td></tr>
<tr><td>Code</td><td>FETL26</td><td>Year of study</td><td colspan="5">2</td></tr>
<tr><td>Course teacher</td><td>Nikola Gjeldum, Ph. D., Assistant Professor</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Marina Crnjac, Teaching assistant.
Ivan Peko, 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>30</td><td>0</td><td>0</td><td>0</td><td>30</td></tr>
<tr><td>Status of the course</td><td>Elective</td><td>Percentage of application of e-learning</td><td colspan="5">0 %</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">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</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="7">None</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="7">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</td></tr>
<tr><td rowspan="18">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="6">Course content</td><td>L hours</td></tr>
<tr><td colspan="6">Introduction and basic principles. Historical development of product assembly process</td><td>2</td></tr>
<tr><td colspan="6">Product architecture</td><td>2</td></tr>
<tr><td colspan="6">Product design for assembly</td><td>2</td></tr>
<tr><td colspan="6">Methods of product design for assembly</td><td>3</td></tr>
<tr><td colspan="6">Measures and tolerances in assembly process</td><td>2</td></tr>
<tr><td colspan="6">Product design modifications</td><td>1</td></tr>
<tr><td colspan="6">Assembly process</td><td>2</td></tr>
<tr><td colspan="6">First midterm exam</td><td>2</td></tr>
<tr><td colspan="6">Making a plan for manual assembly process</td><td>2</td></tr>
<tr><td colspan="6">Chart of assembly process traceability</td><td>2</td></tr>
<tr><td colspan="6">Organizational structures in manual assembly process</td><td>2</td></tr>
<tr><td colspan="6">Lean methods for assembly processes</td><td>2</td></tr>
<tr><td colspan="6">Development from primary labor division phase to autonomous working groups</td><td>2</td></tr>
<tr><td colspan="6">Balancing of assembly process workstations</td><td>2</td></tr>
<tr><td colspan="6">Second midterm exam</td><td>2</td></tr>
<tr><td colspan="6">List of design exercises</td><td>DE hours</td></tr>
<tr><td colspan="6">Introduction in Siemens NX CAD software</td><td>2</td></tr>
</table>

<table>
<tr><td rowspan="4"></td><td colspan="5">Part design in Siemens NX</td><td>8</td></tr>
<tr><td colspan="5">Assembly design in Siemens NX</td><td>10</td></tr>
<tr><td colspan="5">Generating product drawings in Siemens NX</td><td>4</td></tr>
<tr><td colspan="5">Simulation in Siemens NX</td><td>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</td><td colspan="3">☐ independent assignments
☒ multimedia
☒ laboratory
☐ work with mentor
☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="6">The presence on lectures and exercises in the amount of at least 70 % of the times scheduled.</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>1</td><td>Research</td><td></td><td>Practical training</td><td>1</td></tr>
<tr><td>Experimental work</td><td></td><td>Report</td><td></td><td>Individual work</td><td>2,7</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>(Other)</td><td></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>0,1</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">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.

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 colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">Gjeldum, N.: "Dizajn za montažu", lectures on e-learning, FESB Split</td><td></td><td>Internet (e-learning)</td></tr>
<tr><td colspan="4">Marinescu, I., Boothroyd, G.: "Product design for manufacture and assembly", Marcel Dekker, New York, 2002.</td><td>1</td><td></td></tr>
<tr><td colspan="4">Whitney Daniel E.: "Mechanical Assemblies – Their Design, Manufacture, and Role in Product</td><td>1</td><td></td></tr>
</table>

	Development", Massachusetts Institue of Technology, Oxford University Press, 2004.		
Optional literature (at the time of submission of study programme proposal)	9. A.J.D.Lambert Surendra M. Gupta: "Disassembly Modeling for Assembly, Maintenance, Reuse, and Recycling", CRC Press, 2000. 10. Molloy, O., Tilley, S., Warman, E.: "Design for manufacturing and assembly – Concepts, architectures and implementation, Springer Science + Bussines Media, 1998. 11. WEB publications on DFA		
Quality assurance methods that ensure the acquisition of exit competences	– 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		
Other (as the proposer wishes to add)			