SVEUČILIŠTE U SPLITU

FACULTY OF ELECTRICAL ENGINEERING, MECHANICAL ENGINEERING AND NAVAL ARCHITECTURE

DETAILED PROPOSAL OF THE STUDY PROGRAMME

UNDERGRADUATE VOCATIONAL STUDY IN MECHANICAL ENGINEERING

SPLIT, May 2025

1.1. List ofmandatory and elective courses

List ofcourses								
Year of study:1.								
Semester: II.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
	FESR04	Mechanics of Materials	45	0	30	0	0	6
	FEMY02	Applied Mathematics	30	0	30	0	0	5
	FESR18	Technical Drawing and Descriptive Geometry 2	30	0	0	0	30	5
	L = Lectures, S = Seminar, AE = AuditoryExercises, LE = LaboratoryExercises, DE = Design Exercises							

List ofcourses								
Year of study:2.								
Semester: III.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
Mandatory	FETR12	Machining and MachineTools	45	0	0	30	0	6
	FESR20	Thermodynamics	45	0	15	15	0	6
	FENR01	Electrical Engineering	30	0	15	15	0	5
	L = Lectures, S = Seminar, AE = AuditoryExercises, LE = LaboratoryExercises, DE = Design Exercises							

List ofcourses								
Year of study:2.								
Semester: IV.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
	FESR22	Thermal and Hydraulic Machines	45	0	30	15	0	7
	FETR04	Metal Forming by Deformation	30	0	0	30	0	5
	L = Lectures, S = Seminar, AE = AuditoryExercises, LE = LaboratoryExercises, DE = Design Exercises							

List ofcourses									
Year of study:3.									
Semester: V.									
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
	FESR10	Heating and Air Conditioning	30	0	30	0	0	5
	L = Lectures, S = Seminar, AE = AuditoryExercises, LE = LaboratoryExercises, DE = Design Exercises							

List ofcourses								
Year of study:3.								
Semester: VI.								
STATUS	CODE	COURSE	HOURS IN SEMESTER					ECTS
			L	S	AE	LE	DE	
	FESL24	Energy Efficiency in Buildings	30	0	30	0	0	5
	FETR16	Programming of CNC MachineTools	30	0	0	0	30	5
	FESR16	Noise and Vibration Control	30	0	15	15	0	5
	L = Lectures, S = Seminar, AE = AuditoryExercises, LE = LaboratoryExercises, DE = Design Exercises							

1.2. Course description

NAME OF THE COURSE	MECHANICS OF MATERIALS						
Code	FESR04	Year of study	1.				
Course teacher	Vedrana Cvitanić, Ph. D., AssociateProfessor	Credits (ECTS)	6				
Associate teachers	Marko Vukasović, Ph. D., Teachingassistant Maja Kovačić,Teachingassistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			45	0	30	0	0
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION	
Course objectives	Training students for: • understanding and application of basic knowledge of mechanics of solid bodies, • solving problems related to determination of stress and strain distributions for beams under different types of loading (axial, torsion, bending, shear and combined loading).
Course enrolment requirements and entry competences required for the course	Statics (Technical mechanics 1)
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: 1. explain plane stress state and plane strain state as well as stress-strain relationship (Hooke's law), 2. analyze plane stress state using Mohr's stress circle, 3. calculate geometrical properties of beam cross sections, 4. determine stresses and displacements for beams under tension/compression, torsion loading, bending loading or shear loading, 5. apply allowable stress and allowable strain design procedures to analyze and design simple structures, 6. solve statically indeterminate problems by using additional deformation conditions, 7. analyze beams under combined loading using simple failure theories, 8. summarize problem of column buckling.

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction to mechanics of materials. Problems and methods of mechanics of materials. Modelling of structures. Stress vector, normal and shear stress. Stress tensor.	3	2
	Stress transformation. Principal stresses. Mohr's circle for plane stress state. Strain. Normal strain, shear strain and dilatation. Strain tensor. Strain transformation. Mohr's circle for plane strain state.	3	2
	Stress-strain relationship. Experimental data for technical materials. Hooke's law for uniaxial stress state. Plane stress state. Relationship between elasticity constants. Relationship between internal force components and stress components.	3	2
	Geometrical properties of beam cross sections. First and second moment of area. Transformation of second moments of area under translation of coordinate system. Transformation of second moments of area under rotation of coordinate system. Mohr's circle for second moments of area. Radius of gyration.	3	2
	General approach to problems of mechanics of materials.	3	2

	Axialloadingofbeams. Prismatic beams and beams with variable cross sectional area. Displacement diagram. Stress concentration.		
	Torsion loading of circular beams. Assumptions and constraints. Shear stress and strain. Allowable stress design. Bending of beams. Assumptions and constraints.	3	2
	Stress and strain distributions for pure bending. Stress and strain distributions for transverse bending. Allowable stress design. Ideal section modulus.	3	2
	Differential equation of elastic deflection curve. Moment-area method.	3	2
	Stresses and strains for bending of beams with non-uniform cross section. Shear loading. Statically indeterminate problems in axial loading.	3	2
	Thermal effects, setting misfitsand prestrains. Statically indeterminate problems in torsion loading. Statically indeterminate problems in bending.	3	2
	Strain energy. Failure theories.	3	2
	Failure theories for combined loading problems of beams.	3	2
	Buckling of columns. Stable, unstable and indifferent equilibrium state. Buckling of columns in elastic state. Buckling of columns in plastic state. Design formulas for columns.	3	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)
Studentresponsibilities	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 eachactivity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	2,2	Research		Practical training	
	Experimental work		Report		Individual work	3,5
	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 and one corrective exam term 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 corrective exam students take whole exam. Final number of points is formed according to the formula: Points(%)= (M1 + M2)/2 M1, M2 – points on midexams. Final grade isdeterminedafterthesecondfinalexambyrelative system ofgradingaccording to Regulationsofstudiesandstudy system of University of Split. Based on theachivednumberofpoints students thathavepassedtheexam are distributedintofourgroups: 15% ofthebest students get grade excellent (5), following 35% students get grade verygood (4), following 35% students get grade good (3) andlast 15% students get grade sufficient (2).

<table>
<tr><td rowspan="1"></td><td colspan="3">Ifthe total numberof students thathavepassedtheexam at midtermsandfinalexamsislowerthan 30, thefinal grade isdeterminedbyabsolute system ofgrading. In thiscase, thefinal grade isdetermedbytheachivedfinalnumberofpointsinthefollowingmanner: from 50% to 61% - grade sufficient (2), from 62% to 74% - grade good (3), from 75% to 87% - grade verygood (4) andfrom 88% to 100% - grade excellent (5).

Students canaccessthecorrectiveexamtermiftheyhaveachived at least 10% points on midtermexamsorfinalexams.

According to Article 71 ofFaculty Statue, students are obligate to contributeinalleducationalactivitiesand to attend at least 70% oflectureandexerciselessons. Aboveconditions are necessary to accessmidtermandfinalexams.</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>Alfirević, I., „Nauka o čvrstoći I“, Tehnička knjiga, Zagreb, 1989.</td><td></td><td></td></tr>
<tr><td>Matoković, A., Plazibat, B., „Nauka o čvrstoći 1 – zbirka zadataka“, FESB.</td><td></td><td></td></tr>
<tr><td>Cvitanić, V., „Predavanja iz kolegija Mehanika materijala“, FESB.</td><td></td><td>e-learning portal</td></tr>
<tr><td>Vlak, F., Jurjević, D., „Nauka o čvrstoći 1 – zbirka zadataka“, 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="3">Craig, R., R.: MechanicsofMaterals, John Wiley&Sons, New York, 2000.</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="7">APPLIED MATHEMATICS</td></tr>
<tr><td>Code</td><td>FEMY02</td><td>Year of study</td><td colspan="5">1</td></tr>
<tr><td>Course teacher</td><td>Ivančica Mirošević, Lecturer</td><td>Credits (ECTS)</td><td colspan="5">5</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Lea Dujić, Teachingassistant</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>0</td></tr>
<tr><td>Status of the course</td><td>obligatory</td><td>Percentage of application of e-learning</td><td colspan="5">10</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Training students for:
• applicationofmathematicalconceptsandtoolsfromtheareaofordinarydifferentialequations, numericalmathematics, statisticsandprobability to analyzeandsolveengineeringproblems.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="7">GoodknowledgeofHighSchoolmathematicsandpassed State ExaminMathematics.</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:

- state definitions and theorems from the enitre course,
- illustrate theorems with examples,
- solve some first and second order differential equations,
- apply Laplace transform to linear differential equations
- find approximate solution of a nonlinear equation
- approximate function with Lagrange interpolation polynomial
- approximate empirical data with constant, linear or quadratic function
- solve definite integral and Cauchy problem of the first order approximately
- use statistical techniques in data analysis
- find probability distributions of random variables in random experiments</td></tr>
<tr><td rowspan="11">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. Introduction to DifferentialEquations. Basicconceptsanddefinitions. Equationswithseparablevariables.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">2. Homogeneousdifferentialequations. Lineardifferentialequationsofthefirstorder.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">3. Differentialequationsof ¸thesecondorder. Lineardifferentialequationsofthesecondorderwithconstantcoefficients.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">4. Laplacetransform – definitionandbasicproperties. InverseLaplacetransformandbasicproperties.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">5. SolvinglineardifferentialequationswithwithconstantcoefficientsusingLaplacetransform.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">6. Introduction to Numericalmathematics. Solvingnonlinearequations. Graphicalmethod. Bisectionmethod. Iterativemethod.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">7. Lagrange interpolation polynomial</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">8. Leastsquaremethod. Approximating empirical data with constant, linear or quadratic function.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">9. Numericalintegration. Trapezoidalrule. Simpson'srule. Euler'smethod for Cauchyproblems.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">10. Descriptivestatistics. Discrete data andcontinuous data. Numericalcharacteristics.</td><td>2</td><td>2</td></tr>
</table>

	11. Introduction to Probabilitytheory. Elementaryoutcomes. BasicsofCombinatorics.	2	2
	12. Discreterandomvariable. Expectationandvariance. Binomialdistribution. Poissondistribution.	2	2
	13. Continuousrandomvariable. Expectationandvariance. Normaldistribution.	2	2
	List oflaboratoryor 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)
Studentresponsibilities	Regularattendence to andactiveparticipationinlecturesandexcercises.	

Screening student work *(name the proportion of ECTS credits for eachactivity 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		Selfstudy	2.6
	Essay		Seminar essay		(Other)	
	Tests	0.2	Oral exam		(Other)	
	Written exam	0.2	Project		(Other)	

Grading and evaluating student work in class and at the final exam	Duringsemestertwomid-termexams are held. Thefirstexamisscheduledafter 7 weeksoflectures, andthesecondintheweekfollowingthelectures. At eachmid-termexam students canget 40 points, whiletheremaining 20 points are attainedthroughassignementsduringlecturesandexcercises. Thecondition for passingthecourseis minimum 20 points on eachmid-termexamsand a total of at least 50 points. Aftersemester, twofinalexamsand a correctionexam are held. Students whichdidnotpass one mid-termexam, can take onlythispartoftheexamduringfinalexams. Students whichdidnotpassanymid-termexam, take thefinalexamwithcomprehensivecoursecontent. In thatcase, maximumnumbersofavailablepointsis 80. Thecondition for passingthecourseis minimum 40 pointsinthefinalexamand a total of at least 50 points. The grade isformedafterthesecondfinalexamaccording to article 75 ofthe Statute of FESB: 15% ofthebest students getthemarkexcellent (5), next 35% students getthemarkverygood (4), next 35% students getthemarkgood (3), andthelast 15% students getthetmarksufficient (2). Students whodidnotpassthecourseafterfinalexams, andhaveobtained total of at least 10 points, canattendthecorrectionexam. On thecorrectionexammaximalnumberofpointsis 100, andthe minimum requirement for a passing grade is 50 points. Mid-termexams, finalexamsandcorrectionexams are heldaccording to theexamschedule.

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Lecturematerials on FESB e-learning portal.		https://elearning.fesb.hr/

Optional literature (at the time of submission of study programme proposal)	T. Bradić, J. Pečarić, R. Roki, M. Strunje: Matematika za tehnološke fakultete, Element, Zagreb, 1998. B. P. Demidovič: Zbirka zadataka iz više matematike, Školska knjiga, Zagreb 1998. Ivo Pavlić, Statisticka teorija i primjena, Zagreb, 1971		
Quality assurance methods that ensure the acquisition of exit competences	- homework - short tests - quizzes - mid-termexams - finalexam - student questionnaires		
Other (as the proposer wishes to add)			

NAME OF THE COURSE	**TECHNICAL DRAWING AND DESCRIPTIVE GEOMETRY 2**							
Code	FESR18	Year of study	1					
Course teacher	Tonči Piršić, Ph. D. Associate Professor	Credits (ECTS)	4					
Associate teachers	Petra Bagavac, Teaching assistant, Miro Bugarin, Ph.D., AssistantProfessor Ivan Špar, Teaching assistant,Joško Kunac, Teaching assistant, Dejan Bobić, Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE	
			30	0	0	0	30	
Status of the course	Obligatory	Percentage of application of e-learning	40%					
COURSE DESCRIPTION								
Course objectives	Training students for: •							
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. Ability of drawing technical drawings both by hand and by using the computer. Understanding of basis principles of engineering design.							

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Types of drawings. Drawing formats.	2	2
	Part lists. Scales. Line types and purposes. Layers. Prospective views. Isometric view. Orthogonal view.	4	4
	Cross-sections. Hatching. Reducing the number of views. Simplifications in drawings.	4	4
	Drawing of screw threads. Schematic representation of threads. Dimensioning: line, radius, diameter, arc.	4	4
	Dimensioning of cone and inclination. Dimensioning styles. Surface roughness. Parameters of surface roughness, symbols and application.	4	4
	Blocks and their properties. Using the blocks. Attributes. Prototype drawing. Tolerances and fits. Fit types.	6	4
	ISO system of fits. Geometric tolerances. Basic of AutoCAD.	2	6
	List of laboratory or design exercises		LE or DE hours

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

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

Required literature	**Title**	**Number of copies in the library**	**Availability via other media**
	1. T. Piršić: "Tehničko crtanje", FESB - Split, 2010.		
	2. T. Piršić: "AutoCAD u strojarstvu", FESB - Split, 2010.		

(available in the library and via other media)	3. Grupa autora: Inženjerski Priručnik, IP1 – Temelji inženjerskih znanja (Chapter) "Inženjerska grafika"), Školska knjiga, Zagreb, 1999.		
	4. M. Opalić, M. Kljajin, S. Sebastijanović: "Tehničko crtanje", Zrinski d. d. Čakovec, 2003.		
Optional literature (at the time of submission of study programme proposal)	Ć. Koludrović: "Tehničko crtanje u slici", Naučna knjiga, Beograd, 1985.		
Quality assurance methods that ensure the acquisition of exit competences	– Lectures responsible for the same subject area collaborate closely and monitor each other's work. Occassional class observations and appraisal by Head of Department		
Other (as the proposer wishes to add)			

NAME OF THE COURSE	**MACHINING AND MACHINE TOOLS**						
Code	FETR12	Year of study	2				
Course teacher	Dražen Bajić, Ph. D., FullProfessor	Credits (ECTS)	6				
Associate teachers	Sonja Jozić, Ph. D.,AssistantProfessor Mario Veić, Teachingassistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			45	0	0	30	0
Status of the course	Obligatory	Percentage of application of e-learning	0				
COURSE DESCRIPTION							
Course objectives	Training students for: • acquisitionofbasicknowledgeof metal removalprocesses. • acquisition of technical possibilities of 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: 1. classifymechanicaltechnologies 2. classify metal removalprocessesandexplainimportanceeachofthem 3. sketchmachinetoolsandequipment for particularmachiningoperations 4. presenttheprinciplesofoperationandapplicationofmachinetools 5. characterizefeaturesofmachinetools						

	6. commentexpressions to calculatethecuttingspeed, materialremovalvolume, cuttingforce, power, theoreticalroughnessandthemainmachine time for particularmachiningoperations 7. commentthemechanismsandformsoftoolwearinmachining		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introductionandclassificationof metal-removalprocesses. Tool andworkpiecemotion, basictoolgeometry	3	
	Modelsofchipformation, shapeandsizeofchip. Conditionsofoccurrenceofbuildupedge.	3	
	Cuttingforces, power, vibrationsduringmachining. Thermalphenomenaincutting.	3	
	Tribologyofmachiningprocess.	3	
	Cutting-toolmaterials.	3	
	Qualityofmachinedsurface.	3	
	Classificationofmachinetools. Structureandtechnicalcharateristicsofmachinetools.	3	
	First midterm exam		
	Mainpartsandmechanismsofmachinetools. Bearingelements, guides, spindlebearings, driving system ofmachinetools.	3	
	Conventionalmachinetoolswithdefinedtooledge: turningmachines, drillingmachines	3	
	Conventionalmachinetoolswithdefinedtooledge: millingmachines, planingmachines, broachingmachines, sawingmachines	3	
	Conventionalmachinetoolswithundefinedtooledge. Machines for gearwheelsmanufacturing.	3	
	CNC machinetools. Controlsystems, basicconceptof CNC programming, automatictoolchange, automaticworkpiecechange.	3	
	Machinetools for highperformancemachiningoperation, flexiblemanufacturingcells, flexiblemanufacturingsystems. HighSpeedmachinetools.	3	
	Second midterm exam		
	List oflaboratoryor design exercises		LE or DE hours
	Introduction to machinetoolsinstalledinlaboratory. Turning, toolandworkpiecegeometry, Chipshapes, Cutting-toolsmaterials.		2
	Turning, threadandtaperproduction,		2
	Planingandslotting, compression rate measurement.		2
	Drilling, sinking, andreaming. Measuringtheaxialforceandtorque for drilling.		2
	Sawing, broaching. Measuringthemaincuttingforce for turningusingthepowerconsumption.		2
	Milling. Measuringthesurfaceroughnessinrelationwithcuttingparametars.		2
	Grinding, honing, superfinishing.		2
	Movement, typicalpartsandmechanismsofmachinetoolsinstalledinthelaboratory. Determinationofdegreeofmachinetoolworkspaceefficency.		2
	Determinationofgearboxefficiency on drillingmachine.		2
	Testingofgeometricaccuracylathesanddrills. Influence ofmachinetool on themachiningaccuracy.		2
	Rigidityofthe system machine-tool-woorkpiece. Zero pointoftheworkpieceand zero pointofthetool at verticalmachiningcenter.		2
	Determinationofgearboxefficiency on turningmachine.		2
	CNC programming. Preparationand model productionusing 3D printer.		2
Format of instruction	☒lectures	☒independent assignments	

<table>
<tr><td></td><td colspan="6">☐seminars and workshops
☒exercises
☐*on line*in entirety
☐partial e-learning
☐field work</td><td colspan="2">☒multimedia
☒laboratory
☐work with mentor
☐ (other)</td></tr>
<tr><td>Studentresponsibilities</td><td colspan="8">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 eachactivity so that the total number of ECTS credits is equal to the ECTS value of the course)*</td><td>Class attendance</td><td>2,5</td><td>Research</td><td></td><td>Practical training</td><td>0,5</td></tr>
<tr><td>Experimental work</td><td>0.5</td><td>Report</td><td></td><td>Reports from the laboratory exercises</td><td></td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>(Other)</td><td>2.5</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="8">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% verygood (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="6">**Title**</td><td>**Number of copies in the library**</td><td>**Availability via other media**</td></tr>
<tr><td colspan="6">Bajić, D. “Obrada odvajanjem i alatni strojevi”, autorizirana predavanja.</td><td></td><td>eLearning portal</td></tr>
<tr><td colspan="6">Ekinović S.: “Postupci obrade rezanjem”, Univerzitet u Sarajevu, Mašinski fakultet u Zenici, 2003.</td><td></td><td></td></tr>
<tr><td colspan="6">Ekinović S.: “Mašine alatke”, Univerzitet u Sarajevu, Mašinski fakultet u Zenici, 2001.</td><td></td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="8"></td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="8">- 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>
</table>

Other (as the proposer wishes to add)	

NAME OF THE COURSE	THERMODYNAMICS							
Code	FESR20	Year of study	3					
Course teacher	Frano Barbir, Ph. D., Full Professor	Credits (ECTS)	6					
Associate teachers	Ivan Tolj, Ph. D., Teaching assistant	Type of instruction (number of hours)	L	S	AE	LE	DE	
			45	0	15	15	0	
Status of the course	Obligatory	Percentage of application of e-learning						
COURSE DESCRIPTION								
Course objectives	Training students for: • understanding of the basic concepts and laws of thermodynamics • application of the concepts and laws of thermodynamics to energy processes and systems							
Course enrolment requirements and entry competences required for the course	Mathematics 2							
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: 1. explain the basic concepts and laws of thermodynamics 2. apply the concepts and laws of thermodynamics to the different types of a simple technical energy process 3. calculate the mass balance and simple balance of different types of energy flows 4. calculate the efficiency of the process and energy systems 5. link effects of all studied processes by changes in the environment							

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours	LE hours
	The subject of thermodynamics, two external impacts (work, heat) and pressure, volume and temperature as state functions. State equation of ideal gas.	3	2	1
	Two ways to express quantity of the substances. Mixture of ideal gases. Thermal expansion of solids and liquids.	3	2	1
	The first law of thermodynamics, internal energy and its connection with measurable state functions. Caloric state equation of ideal gas. Application of the first law on ideal gas.	3	2	1
	Isobaric, isochoric, isothermal and adiabatic processes. Polytropic processes. Cycle processes. Otto, Diesel and	3	2	1

	Carnot cycle. Internal and external non-equilibrium processes.			
	The second law of thermodynamics. Two consequences of the second law. The analytical expression of the second law for equilibrium processes. Connection of entropy with measurable state functions of ideal gases. The analytical expression of the second law of nonequilibrium processes.	3	2	1
	Flow processes. Enthalpy and technical work. The first law of thermodynamics for flow processes. The term for steady work flow process. Damping. Typical technical flow processes with heat exchange without work. The processes with work and without heat.	3	2	1
	Real gases – p-V diagrams instead of the state equation Molière h-s diagram and T-s diagram. Using charts and tables. Rankine Clausius cycle with and without steam overheating. The concept of regeneration, efficiency and simplified schemes of steam - power plants.	3	2	1
	Knowledge test – first midterm exam	3		
	Cooling power plants cycles and coefficient of performance. The main properties of refrigerants. Heat pumps.	3	2	1
	Humid air and h-x diagram. Humid air typical processes.	3	2	1
	Fuel combustion. Numerical characterization of the fuel and combustion: heat of combustion, adiabatic combustion temperature and ignition temperature of the fuel. Required air amount. Determination of air excess from the composition of the combustion products.	3	2	1
	Heat transfer: three different mechanisms. Heat conduction.	3	2	1
	Convective heat transfer. The physical mechanism of convection, heat transfer coefficient and Nu number. The process of determining the heat transfer coefficient	3	2	1
	Heat transfer by radiation. The term black body and "black" radiation. Overall heat transfer coefficient, ribs surface. Heat exchangers. Heat exchanger calculations.	3	2	1
	Knowledge test – second midterm exam	3		

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)
Studentresponsibilities		

Screening student work *(name the proportion of ECTS credits for eachactivity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	2	Research		Practical training	
	Experimental work		Report		Individual work	3
	Essay		Seminar essay		(Other)	
	Tests	1	Oral exam		(Other)	
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	During semester there are two midterm exams. Upon completion of the semester the first and second final exam are held as well as corrective and commission exams. The first midterm exam is after 7 weeks of lecturing and the second one is after the next 6 weeks. The midterms are carried out as written tests. The requirement for passing grade is 50 % points on each midterm exam.

<table>
<tr><td rowspan="1"></td><td colspan="3">Grade (in percentage) is formed according to the formula:

Grade(%) = (M1+M2)/2
M1, M2 – test results

The final grade is determined by applying an absolute way of evaluation. The final grade is determined according to the points as follows: from 50% to 61% of the points score mark (2), from 62% to 74% mark (3), from 75% to 87% of the points mark (4) , from 88% to 100% mark (5)

Under Article 71 of the Faculty Statute, the student is required to participate in all forms of teaching and attend lectures and exercises at least 70%. If students do not meet these requirements they will not be allowed to write exams.</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>O. Fabris, OsnoveInženjersketermodinamike, Pomorski fakultet Dubrovnik, 1994</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></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">6. I. Ninić, Uvod u termodinamiku i njenetehničkeprimjene, Sveučilište u Splitu, 2007.
7. F. Bošnjaković, Nauka o toplini I dio, Školskaknjiga Zagreb, 1976.</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="8">ELECTRICAL ENGINEERING</td></tr>
<tr><td>Code</td><td>FENR01</td><td>Year of study</td><td colspan="6">2.</td></tr>
<tr><td>Course teacher</td><td>Ivica Jurić-Grgić, Ph. D., Associate Professor
Nedjeljka Grulović – Plavljanić, Senior Lecturer</td><td>Credits (ECTS)</td><td colspan="6">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 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">Training students for:
• application of basic principles and laws of electrical engineering,
• setting up and solving simple electrical circuits,
• permanent adoption of basic knowledge in the field of electrical machines.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="8">None</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:
1. define the fundamental phenomena, the quantities and the laws of electrical engineering,
2. apply fundamental laws of electrical engineering for the calculation of electromagnetic quantities,
3. analyse simple electrical networks,
4. measure basic electrical values (current, voltage, resistance).
5. describe basic principles of electrical machines.</td></tr>
<tr><td rowspan="10">Course content broken down in detail by weekly class schedule (syllabus)</td><td colspan="6">Course content</td><td>L hours</td><td>AE hours</td></tr>
<tr><td colspan="6">Basic terms. Electrostatics:electricity and physical property of matter. Coulomb's law; Electric field; Electric flux density, Gauss's law.</td><td>2</td><td>1</td></tr>
<tr><td colspan="6">Electrostatics:Electrical work, electrostatic voltage,electrostatic potential, capacitance, capacitance of the capacitors.</td><td>2</td><td>1</td></tr>
<tr><td colspan="6">Electrostatics: Matter in electrical field, capacitors; static electricity; lightning protection.</td><td>2</td><td>1</td></tr>
<tr><td colspan="6">DC currents: Electric circuits; electrical property of matter; Electrical conductivity and electrical resistance; voltage and current sources; Ohm's law; temperature dependence of electrical resistance; series, parallel and combination circuits.</td><td>2</td><td>1</td></tr>
<tr><td colspan="6">DC currents: Kirchhoff's Laws; power and energy of DC current.</td><td>2</td><td>1</td></tr>
<tr><td colspan="6">DC currents: Current and voltage measurements; electrical resistance measurement; Wheatstone bridge; Wye–Delta transformation; circuit analysis techniques; electrolysis and chemical sources of electric current.</td><td>2</td><td>2</td></tr>
<tr><td colspan="6">Magnetism: Basics of magnetism; natural magnet and electromagnet; magnetic flux; Faraday's law; magnetic forces on moving charges and on a current-carrying wire; magnetic force between two parallel current-carrying wires;Biot–Savart law; Ampere's Law;toroidal solenoid.</td><td>2</td><td>1</td></tr>
<tr><td colspan="6">Magnetism: Mutual and self inductance; leakage of magnetic flux; ferromagnetism; magnetic hysteresis;</td><td>2</td><td>1</td></tr>
<tr><td colspan="6">magnetic circuit; magnetic energy; magnetic force.</td><td></td><td></td></tr>
</table>

	AC currents: Current and voltage sinusoidal waveform; form and crest factor; generation of a voltage sinusoidal waveform; Euler's formula for complex numbers; phase relationships in AC Circuits; Ohm's law in complex form; resistive and reactive impedance in AC Circuits; series, parallel and combination AC circuits.	2	2
	AC currents: Power and energy of AC current; circuit analysis techniques using complex numbers; three-phase AC circuits.	2	2
	Transformers	2	0
	Synchronous machines	2	0
	Induction motors	1	0
	DC motors; universal motors.	1	0
	List of laboratory exercises		LE hours
	Series, parallel and combination DC circuits		3
	Kirchhoff's Laws and Thévenin's theorem		3
	Resistive and reactive impedance in AC Circuits		3
	Power of AC current		3
	Open circuit test on transformer		3

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)
Studentresponsibilities	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 eachactivity 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	3
	Essay		Seminar essay		Laboratory exercises	0,5
	Tests	0,2	Oral exam		Preparation for laboratory exercises	0,2
	Written exam	0,1	Project		(Other)	

Grading and evaluating student work in class and at the final exam	During the semester there will be two midterm tests. The first test will be at the eighth week of classes, the second at the first week of the exam period. Student can pass the entire exam by midterm tests. At the two final exams, students take parts of the curriculum that did not pass by midterm tests. If at the first final exam student passes one of the two parts of curriculum that part of curriculum the student does not have to take on another final exam. The condition for positive assessment is that the student has at least 50% of each part of the curriculum at the midterm tests or at the final exams. The final grade (in percent) is formed on the basis of all activities according to the formula: Rating (%) = 0.1 * LV + 0.45 * (G1 + G2) wherein the activity is expressed in percentage according to: LV -percentage obtained by laboratory exercises, G1, G2 - percentage obtained by midterm tests or final exams of the parts of curriculum given in lectures.

<table>
<tr><td></td><td colspan="3">Students who did not pass the exam after two final exams can pass the exam at the last week of August or the first week of September. Last chance to take the exam in this school year is a so-called commission exam. In a so-called commission exam all students take the entire curriculum, and the condition for positive assessment is that the student has at least 50% of entire curriculum.

The final score (in percentage) is formed on the basis of all activities according to the formula:

Rating (%) = 0.1 * LV + 0.9 * G

wherein the activity is expressed in percentage according to:

LV -percentage obtained by laboratory exercises,
G - percentage obtained by exams of the entire curriculum given in lectures.

The final grade is determined as follows:

Rating Grade
50% to 61% sufficient (2)
62% to 74% good (3)
75% to 87% very good (4)
88% 100% excellent (5)</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>I. Jurić-Grgić: Lectures, 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="3">A. Maletić: Osnove elektrotehnike, ELMAP, Split, 1993.
R. Wolf: Osnove električnih strojeva, Školska knjiga, Zagreb, 1985.</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="3">– Evaluation of students presence on lectures
– 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">THERMAL AND HYDRAULIC MACHINES</td></tr>
<tr><td>Code</td><td>FESR22</td><td>Year of study</td><td colspan="5">2.</td></tr>
<tr><td>Course teacher</td><td>Gojmir Radica, Ph. D., FullProfessor</td><td>Credits (ECTS)</td><td colspan="5">7</td></tr>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2">Dario Bezmalinović, Ph. D., Teachingassistant
Ivan Tolj, Ph. D.,Teachingassistant,
Tino Sumić, Teachingassistant</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>30</td><td>15</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">0</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Training students for:
• understanding of basic principles of reciprocating engines, compressors, pumps and fans,
• setting up and solving thermodynamic, fluid mechanic and design parameters of Thermal and hydraulic machines,
• permanent adoption and deepening of knowledge in the field of thermal and hydraulic machines.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="7">Thermodynamics, Fluid Mechanics</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:
- identify different types of thermal and hydraulic machines,
- calculate basic design and performance parameters of internal combustion engines, compressors, pumps,
- analyze the energy transformation in thermal machines and its dependence on basic working and dimensional characteristics of the process,
- select a heat engine, compressor or pump for the particular system based on its energy characteristics,
- analyze of pump parameters and pipe installation in pump plants,
- diagnose conditions of thermal or hydraulic machine.</td></tr>
<tr><td rowspan="7">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">Introduction to thermal machines. Brief history of thermal machines. Internal combustion engines definition. Description of system and engine parts.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Design and operating parameters. Brake power and torque. Indicated work. Mechanical efficiency.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Mean effective pressure. Specific fuel consumption. Air excess ratio. Volumetric efficiency. Emissions. Power. Torque..</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">IC Engine working cycles. Otto cycle. Diesel cycle. Sabathė cycle. Two stroke. Four stroke.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Inlet and exhaust systems. Diesel fuel systems. Direct and indirect injection systems. Fuel characteristics.</td><td>3</td><td>2</td></tr>
<tr><td colspan="5">Otto engines - fuel systems. Gas engines. Formation of mixture.</td><td>3</td><td>2</td></tr>
</table>

	Classification and application of compressors. Thermodynamic fundamentals of single- and multi-stage compressor operation. Compressor power consumption.	3	2
	Reciprocating compressors, design and constructive features. Calculation and design of single- and multi-stage reciprocating compressors. Dynamics of a reciprocating mechanism.	3	2
	Suction and discharge valves of reciprocating compressors. Ideal and actual capacity. Capacity control. Efficiency.Lubrication.	3	2
	Screw compressors, constructive features, capacities and control. Scroll compressors, constructive features capacities and control. Vane compressors. Turbo compressors, constructive features, performance and control.Compressors application.	3	2
	Classification and application of pumps.Pistonpumps.	3	2
	Fluid andenergyflowthroughpump. Suctionlimitsofpistonpumps. Centrifugal turbo pumps. Basic fluid flowlawsapplication.	3	2
	Mainconstructionelementsofpump. Multi stagecentrifugalpumps. Characteristicsofpumpsinstalledin pipe line. Cavitationsand how to avoidit. Flowregulationincentrifugalpumps. Pumpplantandpumpinwork. Centrifugalfans. Axial turbo pumpsandfans. Gearpumps, workcharacteristics	3	2
	List of laboratory or design exercises		LE or DE hours
	Engine parts, technical specification.		2
	Engine constructive and operating parameters.		2
	Brake power and torque. Indicated work. Efficiency. Fuel consumption. Maintenance and diagnostic. Testing.		3
	Compressor parts, technical specification, characteristics.		3
	Characteristicsofpumpsinstalledin pipe line		3

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)
Studentresponsibilities		

Screening student work *(name the proportion of ECTS credits for eachactivity 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		(Other)	3,7
	Essay		Seminar essay		(Other)	
	Tests	0,2	Oral exam		(Other)	
	Written exam	0,1	Project		(Other)	

Grading and evaluating student	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. The midterm and final exams are

work in class and at the final exam	carried out as written tests (oral test-if necessary). The requirement for passing grade is the positive assessment of exercises and 50 % points for theory and exam on each midterm exam or the final exam. Grade (in percentage) is formed according to the formula: Grade(%) = 0,54 (M1 + M2) the activities in percentage: • M1, M2 – test results.		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Radica G.: Predavanja iz predmeta i Toplinski i hidraulički strojevi		e-learning portal
	Grljušić M.:" Motori s unutrašnjim izgaranjem", Sveučilište u Splitu, FESB, 2000	5	
	Fabris O., Grljušić M.:" Kompresori", Sveučilište u Splitu, FESB, 2009.	5	
	Ninić Neven: Osnovi pumpi i ventilatora, FESB Interna skripta, Split, 1994	5	
Optional literature (at the time of submission of study programme proposal)	1.Stone R.:" Introduction to InternalCombustionEngines", University of Oxford, PALGRAVE, N.Y., 1999. 2.Jeras D.:" Klipni motori-uređaji", Školska knjiga, Zagreb, 1992. 3.Andrassy M.:" Kompresori", FSB, Sveučilište u Zagrebu, 2001. 4 J.H. Horlock, D.E WinterboneTheThermodynamicsand gas dynamicofinternal-combustionengines, , Oxford, 1986. 5. J. B. Heywood: Internalcombustionenginesfundamentals, McGraw-Hill, 1988. 6. Pilić-Rabadan Ljiljana: Vodne turbine i pumpe, vjetroturbine, FESB Split, 2000.		
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	**METAL FORMING BY DEFORMATION**		
Code	FETR04	Year of study	2
Course teacher	Branimir Lela, Ph. D., AssistentProfessor	Credits (ECTS)	5
Associate teachers	Jure Krolo, Teaching assistant	Type of instruction (number of hours)	L: 30, S: 0, AE: 0, LE: 30, DE: 0
Status of the course	Obligatory	Percentage of application of e-learning	10%

COURSE DESCRIPTION

Course objectives	Training students for: • getting knowledge about metal forming technologies • getting familiar with specific characteristics of various forming methods based on plastic deformation
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. classify processes of metal forming 2. explain the importance of metal forming technology 3. describe processes and machines used in metal forming 4. consider flow stress and flow rule 5. discus about terms for calculating forces, stresses, strains and strain rates in metal forming processes 6. describe and explain material flow, friction factor, flow stress, work and power in metal forming processes

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

Course content	L hours	AE hours
Introduction; Classification of metal forming processes	2	/
Concept of plastic deformation	2	/
Indicators of deformability	2	/
Changes in materials caused by plastic deformation	2	/
Anisotropy; Strain and strain rate	2	/
Flow stress and flow curves	2	/
Yield criteria	2	/
First midterm exam		
Upsetting and forging processes	2	/
Drawing processes	2	/
Extrusion processes	2	/
Rolling processes	2	/
Sheet metal forming by bending and deep drawing	2	/
Sheet metal forming by spinning and stamping	2	/
Second midterm exam		

List of laboratory exercises	LE hours
Influence of deformation on mechanical properties	2
Examination of material flow	2
Determination of friction factor by upsetting cylindrical specimen	2
Determination of friction factor by ring upsetting	2
Determination of flow stress by upsetting cylindrical specimen	2
Determination of flow stress by strip upsetting	2
Examination of workability by upsetting	2
Examination of workability by open die forging	2

	Examination of workability by drawing					2
	Examination of workability by extrusion					2
	Examination of workability by deep drawing					2
	Sheet forming by bending using rectilinear tool movement					2
	Determination of springback during sheet bending					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)		
Studentresponsibilities	Presence at the lectures at least 70% and at the laboratory exercise 100% of the time scheduled. Preparation and submission of reports from laboratory exercises.					
Screening student work *(name the proportion of ECTS credits for eachactivity 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	1	Report		Individual work	1
	Essay		Seminar essay		Laboratory exercises	1
	Tests		Oral exam		(Other)	
	Written exam		Project		(Other)	
Grading and evaluating student work in class and at the final exam	During the semester there are two midterms and final exams. First midterm exam is after 7 weeks and the second is after 15 weeks of lectures. On final exams students take the exam of those parts of the course content that are not passed on midterms. The requirement for positive grade is positive assessment of the laboratory exercises and 50% points on each midterm. Grade is forming in accordance with the following formula: Grade (%)=(M1 + M2)/2 M1, M2 – score on midterms in percentage (%) Grading policy: *PercentageGrade* 50% do 61% sufficient (2) 62% do 74% good (3) 75% do 87% very good (4) 88% do 100% excellent (5) Students who do not pass midterms attend regularly scheduled final exam which has written and oral part. Examination terms: according to the timetable					
Required literature (available in the library and via other media)	**Title**				**Number of copies in the library**	**Availability via other media**
	Duplančić, I.: "Obrada deformiranjem", Sveučilište u Splitu, FESB, Split 2007.				5	
Optional literature (at the time of submission of study programme proposal)	- Povrzanović, A. "Obradametaladeformiranjem – odabranapoglavlja", Sveučilište u Zagrebu, Fakultet strojarstva i brodogradnje, Zagreb, 1996. - Math M., "Uvod u tehnologijuoblikovanjadeformiranjem", Sveučilište u Zagrebu, Fakultet strojarstva i brodogradnje, Zagreb, 1999. - Lange K.: "Lehrbuch der Umformtechnik I, II, III", Springer - Verlag Berlin, Heidelberg, New York, 1974.					

Quality assurance methods that ensure the acquisition of exit competences	- Keeping records of class attendance - 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	**HEATING AND AIR CONDITIONING**						
Code	FESR10	Year of study	3				
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	Obligatory.	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: 1. Consider base terms and issues related to the thermal comfort, 2. Analyse and compute heat losses and gains according to the standards, 3. Compare fuels in the HVAC systems, i.e. heating and cooling applications and elaborate their impact to the environment, 4. Consider and compute base components of the heating/cooling, i.e. HVAC systems, 5. 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	2				
	Calculation of the heat losses.	2	2				

	Calculation of the heat losses.	2	2
	Heating elements, characteristics, correction of the nominal thermal load.	2	2
	Central heating systems, calculation of the carbon dioxide emissions.	2	2
	Calculation and design of the pipelines in the heating systems.	2	2
	Boilers, types, classification, boiler rooms.	2	2
	Other equipment of the heating systems.	2	2
	Preparation of the hot water and calculation of the heating demands.	2	2
	Regulation of the heating systems.	2	2
	Calculation of the heat gain.	2	2
	Fan coil devices, other cooling elements.	2	2
	Central water based air-conditioning systems, climate chambers, coolants (refrigerants)	2	2
	Ventilation systems, components, calculation of the required airflow for ventilation purpose.	2	2
	Heat pumps, absorption cooling devices.	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)	
Studentresponsibilities	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 eachactivity so that the total number of ECTS credits is*	Class attendance	2	Research	2	Practical training	
	Experimental work		Report		(Other)	
	Essay		Seminar essay		(Other)	
	Tests		Oral exam		(Other)	

equal to the ECTS value of the course)	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 predavanjaGrijanje i Klimatizacijadio I idio II, 2011, FESB.		
	Recknagel, Sprenger, Schramek, Čeperković: Grijanje i klimatizacija 2005, Energetika marketing, Zagreb, 2005 (Prijevodsanjemačkog)		
	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	**ENERGY EFFICIENCY IN BUILDINGS**						
Code	FESL24	Year of study	3.				
Course teacher	Nižetić Sandro, Ph. D., Full 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: • 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: 1. Consider base terms and concepts from the field of energy efficiency in buildings as well as sustainable development in general, 2. Analyse energy consumption in buildings, 3. Elaborate existing legislative related to the energy efficiency in buildings, 4. Analyse and propose energy efficiency measures in buildings, 5. 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	2
	Analysis of the energy consumption for different buildings.	2	2
	Legislative related to the energy efficiency in buildings.	2	2
	Introduction to the energy efficiency measures in buildings (passive and nearly zero buildings, high energy performance buildings).	2	2
	Energy efficiency measures related civil engineering aspect (building thermal envelope, openings, passive architecture elements, etc.)	2	2
	Energy efficiency measures in heating systems and hot water preparation.	2	2
	Energy efficiency measures in heating systems and hot water preparation.	2	2
	Energy efficiency measures in cooling (air-conditioning) systems.	2	2
	Energy efficiency measures in cooling (air-conditioning) systems.	2	2
	Renewable energy sources in buildings (implementation).	2	2
	Calculation techniques for carbon-dioxide emissions.	2	2
	Energy audit.	2	2
	Building energy certification.	2	2
	Introduction to the economic indicators related to the evaluation of the energy efficiency measures.	2	2
	Economic evaluation of the proposed energy efficiency measures.	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)
Studentresponsibilities	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 eachactivity 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						

	Title	Number of copies in the library	Availability via other media
Required literature (available in the library and via other media)	S. Nižetić, Online predavanja; Energetska učinkovitost u zgradarstvu, 2011, FESB.		
	Energy EfficiencyinBuildings'' – Guide F, CIBSE, 2004.		
	Energy EfficiencyGuide for ExistingCommercialBuildings'', 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	PROGRAMMING OF CNC MACHINE TOOLS						
Code	FETR16	Year of study	3				
Course teacher	Dražen Bajić, Ph. D.,FullProfessor Sonja Jozić, Ph.D., AssistantProfessor	Credits (ECTS)	5				
Associate teachers	Mario Veić, Teachingassistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	0	30
Status of the course	Elective	Percentage of application of e-learning					

COURSE DESCRIPTION			
Course objectives	Training students for: • exploringthepossibilitiesofcomputerapplicationinproductionwithanemphasis on programming CNC machinetoolsandadditivetechnology. • masteringof manual programmingandprogrammingin CAD / CAM systemsinmachiningofsimpleworkpiece.		
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. analyzeinteractionsandneed for a comprehensiveapproach to part design andtheirmanufacturing 2. applyacquiredknowledgeandskills to solve a specifictask. 3. applyacquiredknowledgeandskillsinteamwork. 4. generate program for theautomaticpartsproduction on CNC machinetools 5. compareandhighlightdifferencesbetween manual programmingandprogrammingby CAD / CAM systems 6. identifymotivesofapplyingcomputercontrolledmachinetoolsandsystems for rapidprototyping		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L or S hours	AE hours
	Introduction. Basicterms. Historical development.	2	/
	Geometricmodeling.	2	/
	CNC machinetoolsprogramming. NC and CNC programming.	2	/
	Analysisoftechnicaldrawings. Technologicaldocumentation. Programmingmethods. Manual programming. Automatic programming.	2	/

	CNC machinetoolsprogramming. Coordinate system. Measurement system. Reference points. Definingcuttingtools. Thestructureofthe program block.	2	/
	CNC turning. The procedure andmachinetools. Tools for turning.	2	/
	CNC turning. Selectionofcuttingparameters. Manuallyprogramming CNC turning.	2	/
	First midtermexam		
	Automatic programmingof CNC lathes.	2	/
	CNC milling. Differentmachiningoperationsandmachinetools. Toolsclamping. Toolsstorage. Manipulationwithtoolandworkpiece.	2	/
	CNC milling. Endmilling. Face milling. Profile milling.	2	/
	CNC milling. Manuallyprogramming.	2	/
	CNC milling. Automatic programmingin CATIA.	2	/
	Rapidprototyping.	2	/
	Secondmidtermexam		

	List oflaboratoryor design exercises	LE or DE hours
	Constructionofsimplegeometricshapesandtheirextrusion.	2
	Constructionof complex geometricshapesandtheirextrusion.	4
	Technicaldocumentation - Drafting module.	2
	CNC manual programming for lathes.	4
	Automatic programming - turning. Roughingandfinishing, holesandthreads	2
	Module for machining – Single opeartion: milling. Roughing. Generating NC code for machiningcenter.	2
	Communicationbetweencomputersandmachiningcenter. Machining on CNC verticalmachiningcenterSpinner VC560.	2
	Module for machining – multitasking: milling - Roughingandfinishing, holes. Generating NC code for machiningcenter.	2
	Communicationbetweencomputersandmachiningcenter. Machining on CNC verticalmachiningcenterSpinner VC560.	2
	Simulatingandgenerating NC code. Machining on CNC verticalmachiningcenterSpinner VC560.	2
	Rapidprototyping. 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)
Studentresponsibilities	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 eachactivity 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		Manual programming of turning operation	0,5
	Essay		Seminar essay		Individual work	2,25
	Tests	0,25	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 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

work in class and at the final exam	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% verygood (4) 88% do 100% excellent (5) Examinationterms: according to thetimetable.		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	XunXu: „Integrating Advanced Computer-Aided Design, Manufacturing, andNumericalControl: PrinciplesandImplementations", University of Auckland, New Zealand, 2009.		
	Hoffmann M.: „CAD/CAM mit CATIA V5", HanserVerlag, Muenchen, 2005.		
	Bajić, D., Jozić, S., "Computer aidedmanufacturing", lecturing, eLearning, 2015.		eLearning portal
Optional literature (at the time of submission of study programme proposal)	Balič, J.: CAD/CAM postopki, Univerza v Mariboru, Maribor, 2002. McMahon, C., Brown, J.: CAD CAM principles, practiceandmanufacturing management, Pearson Prentice Hall, 1999.		
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	**NOISE AND VIBRATION CONTROL**						
Code	FESR16	Year of study	3				
Course teacher	Željan Lozina, Ph.D., Full Professor Damir Sedlar, Ph.D., Assistant Professor	Credits (ECTS)	5				
Associate teachers	Tomac Ivan, Ph.D., Assistant Professor	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	15	15	0
Status of the course	Elective	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for: – introduce students to the requirements, principles and methods of noise and vibration control; – provide basic knowledge and understanding of noise and vibration control; – provide the application of this knowledge to simple problems; •
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. Explain free and forced vibrations, 2. Determine the natural frequency of the mechanical system with single degree of freedom, 3. Explain the concepts and phenomena: transferability, excitation imbalance, vibration isolation, 4. Explain the principles of noise isolation, 5. Apply the basic techniques of vibration isolation, 6. Handle with manual measuring instruments and operate with sensors to measure acceleration (accelerometer).

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

Course content	L or S hours	AE hours
Single degree of freedom system – free undamped vibration	2	1
Single degree of freedom system – forced undamped vibration	2	1
Single degree of freedom system – free damped vibration	2	1
Single degree of freedom system – forced damped vibration	2	1
Transmissibility	2	1
Base and imbalance excitation, vibration isolation	2	1
Two degree of freedom system	2	1
Wave equation	2	1
Fundamentals of noise	2	1
Humane response to sound	2	1
Sound source, outdoor sound	2	1
Indoor sound	2	1
Sound isolation	2	1

List of laboratory or design exercises	LE or DE hours
Introduction to Labview	2
Single degree of freedom system – free damped vibration	1
Frequency response function SDOF – shaker	1

<table>
<tr><td rowspan="8"></td><td colspan="5">Frequency response function SDOF – unbalance</td><td>1</td></tr>
<tr><td colspan="5">Single plane balancing</td><td>1</td></tr>
<tr><td colspan="5">Frequency response function MDOF – shaker</td><td>2</td></tr>
<tr><td colspan="5">Sound pressure measurement - Labview</td><td>1</td></tr>
<tr><td colspan="5">Sound pressure measurement – Hand tool</td><td>1</td></tr>
<tr><td colspan="5">Sound isolation</td><td>1</td></tr>
<tr><td colspan="5">Reverberation time</td><td>1</td></tr>
<tr><td colspan="5">Kundt tube</td><td>1</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>Studentresponsibilities</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 eachactivity 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>3</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">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. 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)
• M1, M2 – test results.</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">Ž. Lozina: Lectures, FESB
D. Sedlar: Lectures, FESB</td><td></td><td>Elearning portal</td></tr>
<tr><td colspan="4">B.H. Tongue: Principles of vibration, Oxford University press, 1996</td><td></td><td></td></tr>
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<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">M. Norton, D. Karczub: Fundamentals ofNoiseandVibrationAnalysis for Engineers, Cambridge, 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>
</table>

Other (as the proposer wishes to add)	