U N I V E R S I T Y O F S P L I T

FACULTY OF ELECTRICAL ENGINEERING, MECHANICAL ENGINEERING AND NAVAL ARCHITECTURE

DETAILED PROPOSAL OF THE STUDY PROGRAMME

GRADUATE UNIVERSITY STUDY IN COMPUTING

SPLIT, February 2022

1.1. List ofmandatory and elective courses

List ofcourses								
Yearofstudy: 1.								
Semester: I.								
STATUS	CODE	COURSE	HOURS IN SEMESTER*					ECTS
			L	S	AE	LE	DE	
Mandatory	FEMK01	Numerical analysis	30	0	30	0	0	5
	FELK04	Computer graphics	30	0	0	30	0	5
* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise								

List ofcourses								
Yearofstudy: 1.								
Semester: II.								
STATUS	CODE	COURSE	HOURS IN SEMESTER*					ECTS
			L	S	AE	LE	DE	
Mandatory	FELK05	Programming languages and compilers	30	0	0	30	0	5
	FELG33	Optoelectronic measurement methods	30	0	0	30	0	5
	FELK07	Advanced computerar chitectures	30	0	0	30	0	5
Elective	FELK16	Data Warehouse	30	0	0	30	0	5
	FELK34	Computer games programming	30	0	0	30	0	5
* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise								

List ofcourses								
Yearofstudy: 2.								
Semester: III.								
STATUS	CODE	COURSE	HOURS IN SEMESTER*					ECTS
			L	S	AE	LE	DE	
Mandatory	FELK08	Multimedia systems	30	0	0	30	0	5
	FELK11	Grid computing systems	30	0	30	0	0	5
	FETK01	Business information systems	30	0	0	30	0	5
	FELK12	Embedded systems	30	0	0	30	0	5
	FELH40	Programming mobile robots and drones	30	0	0	30	0	5
	FELH18	Medical devices	30	0	0	30	0	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">NUMERICAL ANALYSIS</td></tr>
<tr><td>Code</td><td>FEMK01</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
Anita Carević</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></td><td>30</td><td></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">20</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Training students for:
- understandingconceptsandskillsofnumericalanalysis: erroranalysisofcomputeraruthmetics, solvingsystemsoflinearequations, polynomialinterpolation, splines, leastsquaresmethod, numericalintegration, solvingnonlinearequations, solvingdigfferentialequations,
- applicationsoftheaboveconcepts to naturalsciencesandengineering.</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:
- performanalysisofnumericalalgorithmsandestimatebackwardandforwardstability,
- estimatedurationofthealgorithm,
- explainmainideasbehibndnumericalmethods,
- derivebasicnumericalmathodsandillustratetheirpropertiesbyexamples,
- writesimplecomputerprograms for numericalmethodsin some ofhigler-levellanguages (Matlabor Julia),
- findand use computerprograms for numericalmathodsavailable on Internet andcriticallyestimatetheirproperties,
- chooseappropriatenumericalmethodsandapplyownorthird party computerprograms for solvingengineeringproblems.</td></tr>
<tr><td rowspan="13">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">1. Computer arithmeticanderroranalysis.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">2. Stable and unstable computations – condition number.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">3. Solving systems of linear equations- Gaussian elimination and iterative methods.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">4. Evaluating functions – Horner's method.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">5. Approximating functions – interpolation polynomials.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">6. Splines.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">7. Least squares method and minimax method.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">8. Solving nonlinear equations – bisection, Newton's method and secant method.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">9. Fixed-point theorem and functional iteration.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">10. Numerical integration – trapezoidal rule, Simpson's formula and error estimates.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">11. Gaussian quadrature, Romberg's algorithm and adaptive integration.</td><td>2</td><td>2</td></tr>
<tr><td colspan="5">12. Numerical solution of ordinary differential equations – single-step methods.</td><td>2</td><td>2</td></tr>
</table>

	13. Multi-step methods and Runge-Kutta methods.	2	2
	List oflaboratoryor design exercises		LE or DE hours

Format of instruction	xlectures ☐seminars and workshops xexercises ☐*on line*in entirety ☐partial e-learning ☐field work	x 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		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

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, twofinalexamsandtwocorrectionexams are held.

Students whichdidnotpass one mid-termexam, can take onlythispartoftheexamduringfinalexams.

Students whichdidnotpassanymid-termexam, take thefinalexamwithcomprehensivecoursecontent. In thatcase, masimumnumbersofavailablepointsis 80. Thecondition for passingthecourseis minimum 40 pointsinthefinalexamand a total of at least 50 points. The grade isformed as follows:
85 and more points - excellent (5),
75-84 points - verygood (4),
60-74 points - good (3), and
50-59 points - sufficient (2).

Students whodidnotpassthecourseafterfinalexams, andhaveobtained total of at leat 10 points, canattendcorrectionsexam. On thecorrectionexammaximalnumberofpointsis 80, andthe minimum requirement for a passing grade is minimum of 40 pointsintheexamand a total of at least 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**
	R. Scitovski, Numerička matematika, drugo izdanje, Sveučilište J. J. Strossmayera, Odjel za matematiku, Osijek, 2004.		http://www.mathos.hr/~scitowsk/NM/Num.PDF
	I.		

	Lecture materials on FESB e-learning portal.		https://elearning.fesb.hr
	FESBMat		https://github.com/ivanslapnicar/FESBMat
	Netlib		http://www.netlib.org
Optional literature (at the time of submission of study programme proposal)	- D. Goldberg, Whateverycomputerscientistshouldknowaboutfloating-pointarithmetic, http://docs.sun.com/source/806-3568/ncg_goldberg.html - D. Kincaid, W. Cheney, Numerical Analysis-Mathematics of Scientific Computing, Brooks/Cole Publishing Company, 2002. - G. W. Stewart, Afternotes on Numerical Analysis, SIAM, Philadelphia, 1996. - S. Singer, Numeričkamatematika, Predavanja, Sveučilište u Zagrebu, FSB, Zagreb, 2009. - S. Singer, Numeričkamatematika, Vježbe, Sveučilište u Zagrebu, FSB, Zagreb, 2009		
Quality assurance methods that ensure the acquisition of exit competences	– homework – short tests – quizzes – mid-term exams – final exam – student questionnaires		
Other (as the proposer wishes to add)			

NAME OF THE COURSE	COMPUTER GRAPHICS						
Code	FELK04	Year of study	1.				
Course teacher	Vladan Papić, Ph.D., FullProfessor	Credits (ECTS)	5				
Associate teachers	Denis Štajduhar, mag. ing.	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	30	0
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for: - understanding of basic principles and algorithms of computer graphics, - understanding of computer graphics technologies, - design and applications of computer graphics algorithms in C programming language and utilization of graphical libraries in programming..
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: - explain graphical pipeline, - analyse basic algorithms of computer graphics, , - connect sequence of graphical transformations in order to achieve needed transformation for view, - recommend type of shading and animation in order to achieve desired result, - critical argue on possibilities and limitations of various display and hardcopy technologies, - model simpler objects with computer modelling software tools, , - create simpler animations with software tools, - create simpler computer programs for object presentation using graphical libraries.

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Uvod	2	
	Imageelements, vectorand raster systems, interactivegraphicsconcept	2	
	Basicalgorithmsofcomputergraphics	2	
	Primitivesfillingandclipping	2	
	Graphical hardware	4	
	Antialiasing	2	
	Geometrictransformations	2	
	Objectsin 3D space	2	
	Curvesandsurfaces	3	
	Lightningandshading	3	
	Animation	2	
	List of laboratory exercises		LE hours
	Introducton to OpenGL		4
	OpenGLexercise: Animation		2
	OpenGLexercise: Textures		2
	OpenGLexercise: Texturefilters		2
	OpenGLexercise: Ligthingandinteraction		2
	OpenGLexercise: Colorblending		2
	OpenGLexercise: 3D		4

	Blender: modelling	4
	Blender: animation	4

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	1,5	Research		Practical training	
	Experimental work		Report		Individual work	1,4
	Essay		Seminar essay	0,8	Laboratory exercises	0,5
	Tests	0,2	Oral exam		Preparation for laboratory exercises	0,5
	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. In the final exams students are answering parts they did not pass in the midterms. The midterm and final exams are carried out as written testsanditlasts for max. 60 minutes. The requirement for passing grade is 50% points on eachmidtermexamorfinalexam, writtenandaccepted seminar workandpositive assessment of laboratory exercises. In finalgrading (inpercentage), eachmidtermexamcontributeswithmax. 30%, seminar workwithmax. 30%, lab. exerciseswithmax. 10% outof total possiblepoints (30%+30%+30%+10%). Final grade isformedinthefollowingway: Percentage Grade 50% to 61% sufficient (2) 62% to 74% good (3) 75% to 87% verygood (4) 88% to 100% excellent (5)

	Title	**Number of copies in the library**	**Availability via other media**
Required literature (available in the library and via other media)	• T Papić, V.: Introduction to computergraphics, Facultytextbook, 2013. (in Croatian)		e-learning portal
Optional literature (at the time of submission of study programme proposal)	• J.D.Foley, A.Dam, S.K.Feiner, J.F.Hughes, Computer Graphics: PrinciplesandPractice (secondeditionin C), Addison-WesleyPublishing Company, 1996. • D.Hearn, M.P.Baker, Computer Graphics, C Version, Prentice Hall; 2nd edition, 1996. • F.S.Hill, Jr. i S.M. Kelley, Computer GraphicsUsingOpenGL, 3rd edition, Pearson education, 2007. • Shreiner, D., Woo, M., Neider, J., Davis, T., OpenGL vodič za programere, Kompjuter biblioteka, 2007.		
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 LANGUAGES AND COMPILERS						
Code	FELK05	Year of study	1.				
Course teacher	Ivo Mateljan, Ph.D., FullProfessor Marjan Sikora, Ph.D., AssistantProfessor	Credits (ECTS)	5				
Associate teachers	Marjan Sikora, Ph.D., AssistantProfessor	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	30	
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for: - Understandingof imperative, OOP, functionalandlogicprograminglanguages - Understandingoflexicalanalysisand LL(1) and LR(1) parsing - Use ofcompilergeneratorsprograms: ELL, LEX and YACC
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: - Understandprogramminginassembler, imperative, OOP, functionalandlogicprograminglanguages - Define language grammar with BNF and EBNF - Make recursive descent parser - Make parser using ELL parser generator - Make lexical analyser using program LEX - Make LR(1) parser using program YACC - Define program structures for compilers: symbol tables and AST - Define attributed grammar and semantic actions - Make simple interpreter - Define assembler code for source code translation

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Historyandelementsofprogramminglanguages	2	
	Lexical, syntaticandsemanticanalysis	2	
	Recursivedescentparser	2	
	Embeddingsemanticanalysis	2	
	Lexicalanalysisand DFA	2	
	Generatorsof LL and LR table drivenparsers	2	
	Attributedgrammar	2	
	Structures for semanticanalysis	2	
	Assemblerandrun-time structures	2	
	Introduction to codegeneration	2	
	Functionallanguages – Scheme	2	
	Logicallanguage – Prolog	2	
	Scriptlanguages	2	
	List oflaboratoryor design exercises		LEhours
	Intepreterofmathematicalexpressions		2
	Using LEX		2
	Using YAC		2
	Interpreter design using LEX and YACC		2
	Writingassembler program		2
	Codegeneration for C—language		2

	WritingScheme program	2
	Writing Prolog program	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		

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		Individualwork	2
	Essay		Seminar essay		Progr. Exercise	0.5
	Tests		Oral exam		Exercise test	0.2
	Written exam	0.1	Project	0.2		

Grading and evaluating student work in class and at the final exam	There are seminar work and final exams. There are learning check out on every laboratory exercise. The requirement for passing grade is the positive assessment of laboratory exercises and 50 % points on each seminar work or the final exam. Grade (in percentage) is formed according to the formula: Grade(%) = 0,1 SR + 0,1 LV + 0,8 UI the activities in percentage: • SR – seminar, • LV – laboratory assessment, • UI – final exam.

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Ivo Mateljan: Prevoditelji i interpreteri, skripta, FESB, 2004		Internet
	LEX – manual, UNIX		Internet
	YACC – manual, UNIX		Internet

Optional literature (at the time of submission of study programme proposal)	Aho, Sethi, Ullman: Compilers - Principles, TechniquesandTools, AdisonWesley, 1986. A. Appel: ModernCompilerImplementationin C, Cambridge University Press, 1997
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	OPTOELECTRONIC MEASUREMENT METHODS						
Code	FELG33	Year of study	1				
Course teacher	Ivo Stančić, Ph.D., Assistant Professor	Credits (ECTS)	5				
Associate teachers		Type of instruction (number of hours)	L	S	AE	LE	DE
			30			30	
Status of the course	Elective	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for: - Understand the basic principles of camera and optical lens elements - Operate with linear, IR / night and heat cameras - Apply camera to control industrial process or use it as a sensor - Operate and analyze data from laser range finders and LIDAR
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: – Have detail knowledge of camera and camera optical elements – Apply algorithms for 3D reconstruction of motion – Apply algorithm for surface reconstruction – Analyze data from laser range finders and create map of area

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

Course content	L hours	AE hours
Introduction to optoelectronics	2	
Machinevisionaandcomputervision	2	
Mathematicaldescriptionofcamerasandgeometryof a space	4	
Lenseoptical system anddistorsions	2	
Color system andphotosensitivechips	2	
Inudstrialcameras, linearcameras, motioncapturesystems	2	
IR camerasandapplications	2	
Stereovisionsystems	2	
3D scanners	2	
Laser rangefindersand LIDAR	2	
Nightvisioncamerasandimageintensifiers	2	
Future ofoptoelectronics	2	
Introduction to optoelectronics	2	

List oflaboratoryor design exercises	LE hours
Introduction to Matlab: image loading, capture and editing	2
Introduction to Matlab: video loading, capture and editing	2
Camera calibration and distortion removal	2
Movement reconstruction from single camera in single plane	2
Movement reconstruction with stereovision system in space	2
Laser and IR rangefinders	2
3D scanners and surface reconstruction	2
Lidar and applications in robotics	2
Cameras in visible and IR spectrum. Presentation of night optics	2
IR thermal camera and temperature calculation	2

<table>
<tr><td>Format of instruction</td><td colspan="3">☐lectures
☐seminars and workshops
☐exercises
☐on linein 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"></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>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>Impended research</td><td>1,7</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td>1</td><td>Laboratory exercises</td><td>1</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 the semester there are two midterm exams according to teaching calendar or project assignments will be handed out depending on student preferences.

The requirement for passing grade is the positive assessment of laboratory exercises and 50 % points on average midterm exam ((M1 + M2)/2) or the final exam. Students are allowed to have at least 45% of total points on each midterm exams, as long as the final midterm average is at least 50% of total points.

Midterm consists of both theoretical questions and numerical problems. The midterms consist of 4 questions while final exam test consists of 6 questions divided into two groups.

In determining the final grade (in percentages) each midterm contributes with 30% (or project assignment with 60%), while laboratory exercises contribute with 40%.

Final grade (based on percentages) is formed as follows:

Percentage Grade
50% do 62% sufficient (2)
63% do 74% good (3)
75% do 86% very good (4)
87% do 100% excellent (5)

In case student does not complete midterms or project exams he/she needs to take the final exam in which case it contributes with 60% toward final grade, and laboratory exercises again with 40%.</td></tr>
<tr><td rowspan="3">Required literature (available in the library and via other media)</td><td colspan="3">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="3">• Hartley, R., Zisserman, A.: ‘Multipleviewgeometryincomputervision’ (Cambridge University Press, 2003)</td><td></td><td></td></tr>
<tr><td colspan="3">• Shapiro, G., Stockman, G.C.: ‘Computer vision’ (Prentice-Hall, 2001)</td><td></td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="6"></td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- Keeping records of student attendance.
- Annual analysis of course statistics in terms of midterm and finals exams.
- Feedback from students via surveys.
- Teacher self-evaluation.</td></tr>
</table>

	- Feedback from graduated students (or senior students) on course content relevance.
Other (as the proposer wishes to add)	/

NAME OF THE COURSE	**ADVANCED COMPUTER ARCHITECTURES**						
Code	FELK07	Year of study	1				
Course teacher	Sven Gotovac, Ph.D., FullProfessor	Credits (ECTS)	5				
Associate teachers	Dunja Gotovac, TeachingAssistant	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	Training students for: 1. Recognize the architecture of modern computer systems. 2. Choose the appropriate computer architecture according to the problem being solved computer architecture 3. Estimates the impact of computer architecture and its components on system performance 4. Develop, adapt and implement solutions on multi-processor and multi-core systems.		
Course enrolment requirements and entry competences required for the course	Computer Architecture		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: 1. Understand the Architecture of Modern Computer Systems 2. Determine the impact of individual components on the performance of a computer system 3. Choose the appropriate computer architecture according to the problem being solved 4. Develop and implement solutions on selected architecture (multi-processor, multi-core, many-core.).		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction to the course, Brief description of the topics to be considered, Brief subjects from the course Digital Architecture: Programming Architecture, Pipeline, Fast Memory	2	
	Pipeline architecture	2	
	Instruction execution parallelism. Problems and Solutions.	2	
	Out of Order Execution. Branch Prediction	2	
	Cache. Various Cache Architecture	2	
	Memory Performance Optimization	2	
	ChipSet	2	
	MESI Protocol	2	

	Multi Core Processors	2	
	Many Core Processor – Xeon Phi	4	
	Graphical Processing Unit - GPU	4	
	Application Examples	4	
	List oflaboratoryor design exercises		LE hours
	Multi-threading programming. Performance exmples		4
	Cache impact on execution performance		4
	GPU CUDA Programming		4
	Problem implementation on Multi-Core, Many-Core and CUDA architecture. Performance comparison.		14

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	0	Report	1	Laboratory exercises	1
	Essay		Seminar essay		Preparation for laboratory exercises	0,5
	Tests		Oral exam		Self-study	0,5
	Written exam		Project	1		

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. First midterm test lasts 60 minutes and consists of 5 to 7 theoretical questions and numerical problems, second midterm is practical example and final tests consist of 6 theoretical questions and numerical problems and example solving. 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(%) = 0,33 LV + 0,33 (M1 + M2) the activities in percentage: • LV – laboratory assessment, • M1, M2 – test results. The final grade will be determined after the first test term by applying a relative ECTS grading system in accordance with the Regulations on the study and study system of the University of Split. The group of students who passed the exam is divided into four groups: 15% of the best gets the grade A (excellent), 35% of the following B (very good), the next 35% rating C (good), and the last 15% rating D, E). A group of students who did not pass the exam gains FX score (additional work is required), or F (significant additional work is required). In accordance with the Rulebook for Exam, only two exam periods are organized in the exam period after the completion of classes. According to Article 65 of the Statute of the Faculty, the student is obliged to participate in all forms of teaching and attend: lectures at least 70% of teaching hours and laboratory exercises 100% of teaching hours. If you do not meet these conditions, the student will not be able to access the exam

	Title	Number of copies in the library	Availability via other media
Required literature (available in the library and via other media)	• Hennesy& Patterson, "Computer Architecture: A QuantitativeApproach", 5rd edition, Morgan Kaufmann, 2011.	2	Electronic copy On e-learning
	• Edward Kandrotand Jason Sanders, CUDA byExample: An Introduction to General-Purpose GPU, NVidi, 2010.	1	Electronic copy On e-learning
Optional literature (at the time of submission of study programme proposal)	• Ribarić, S.: Naprednije arhitekture mikroprocesora, Tehnička knjiga, Zagreb		
Quality assurance methods that ensure the acquisition of exit competences	1. Class attendance records. 2. Evaluation of results in accordance with the above learning outcomes 3. Feedback from students via surveys 4. Self-evaluation of teachers 5. Feedback from students who have already graduated. 6. Institutional and non-institutional evaluations		
Other (as the proposer wishes to add)			

NAME OF THE COURSE	**DATA WAREHOUSE**						
Code	FELK16	Year of study	1.				
Course teacher	Stipo Čelar, Ph.D., Associate Professor	Credits (ECTS)	5				
Associate teachers		Type of instruction (number of hours)	L	S	AE	LE	DE
			30			30	
Status of the course	Elective	Percentage of application of e-learning	0				
COURSE DESCRIPTION							
Course objectives	Training students for: - understanding of the role of Data Warehouse (DW) in information systems and business systems, - understanding of the DW architecture, - understanding and applying of dimensional data model, - using DW environment, - applying of small DW project.						
Course enrolment requirements and entry competences required for the course	The students should previously pass one of the two courses - *Databases* or - understand the concept of relational database (if this course is emroled without passing of the above mentioned course).						
Learning outcomes expected at the level of the course (4 to	Students will be able to: - define the role, advantages and technologies of DW in information systems and business systems,						

<table>
<tr><td>10 learning outcomes)</td><td colspan="3">- identify and critically evaluate DW architectures for a small business system (up to 10 dimensions),
- design a dimensional model for a small business system,
- develop a whole DW project for a small business system,
- work as a part of a larger DW project team.</td></tr>
<tr><td rowspan="20">Course content broken down in detail by weekly class schedule (syllabus)</td><td>Course content</td><td>L hours</td><td>AE hours</td></tr>
<tr><td>Introduction to Data Warehouse (DW)</td><td>2</td><td></td></tr>
<tr><td>DW technologies & environment</td><td>2</td><td></td></tr>
<tr><td>DW architecture. Concepts. Cube. OLAP. Data Mart</td><td>2</td><td></td></tr>
<tr><td>DW history and characteristics</td><td>2</td><td></td></tr>
<tr><td>Business processes (introduction)</td><td>2</td><td></td></tr>
<tr><td>ETL</td><td>2</td><td></td></tr>
<tr><td>Dimensional model. Star schema vs. snowflake schema</td><td>2</td><td></td></tr>
<tr><td>First midterm pause</td><td></td><td></td></tr>
<tr><td>Fact table. Examples</td><td>2</td><td></td></tr>
<tr><td>Dimensional table. Surrogate keys. Examples</td><td>2</td><td></td></tr>
<tr><td>DW projects and methodologies</td><td>2</td><td></td></tr>
<tr><td>OLAP tools and analysis. CubePlayer</td><td>2</td><td></td></tr>
<tr><td>Business Intelligence. Data Mining</td><td>2</td><td></td></tr>
<tr><td>DW projects examples</td><td>2</td><td></td></tr>
<tr><td>Second midterm pause</td><td></td><td></td></tr>
<tr><td>List of laboratory exercises</td><td colspan="2">LE hours</td></tr>
<tr><td>Introduction to the work method. Defining of project teams</td><td colspan="2">2</td></tr>
<tr><td>Installation and configuration of DW environment.
Business process (BP) selection</td><td colspan="2">4</td></tr>
<tr><td>BP analysis – short presentation</td><td colspan="2">2</td></tr>
<tr><td>DW architecture design</td><td colspan="2">2</td></tr>
<tr><td>Dimensional model design – logical design (short presentation)</td><td colspan="2">4</td></tr>
<tr><td>DW physical design</td><td colspan="2">2</td></tr>
<tr><td>DW detailed design (with data)</td><td colspan="2">4</td></tr>
<tr><td>OLAP cube</td><td colspan="2">4</td></tr>
<tr><td>Reporting – short presentation</td><td colspan="2">2</td></tr>
<tr><td>Format of instruction</td><td colspan="3">☒ lectures
☐ seminars and workshops
☒ exercises
☐on line in entirety
☐ partial e-learning
☐ field work
☒ independent assignments
☐ multimedia
☒ laboratory
☒ work with mentor
☐ (other)</td></tr>
<tr><td>Studentresponsibilities</td><td colspan="3">The presence on lectures in the amount of at least 70 % of the times scheduled.
Well made (written material) and personally presented project.</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 colspan="3"><table>
<tr><td>Class attendance</td><td>1</td><td>Research</td><td>0,8</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>1</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>Laboratory exercises</td><td>0,2</td></tr>
<tr><td>Tests</td><td></td><td>Oral exam</td><td>0,5</td><td>Preparation for laboratory exercises</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>Project</td><td>0,5</td><td>(Other)</td><td></td></tr>
</table></td></tr>
<tr><td>Grading and evaluating student work in class and at the final exam</td><td colspan="3">There is no midterms and final exams (tests). During the semester the students work on a practical project – they create your own Data Warehouse. The project is done in small project teams, under the professor’s mentorship. The teams present their work on a project (business problem, concept, model, design, reports) several times in a semester.</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">The exam is taken individually or in small groups (project teams), carried out as practical oral exam (based on team's project). The exam is public and may be attended by all students who had passed it already.
Grade (in percentage) is formed according to the formula:

Grade(%) = 0,8 OE + 0,2 LE

the activities in percentage:
• OE – oral exam,
• LE – laboratory assessment (written project material).</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>• S. Čelar: Authorised lectures, FESB</td><td></td><td>e-learning portal</td></tr>
<tr><td>• William Inmon: Building the Data Warehouse (2005) John WileyandSons, ISBN 978-81-265-0645-3</td><td></td><td></td></tr>
<tr><td>• Kimball, R., Ross, M.: The Data Warehouse Toolkit, TheDefinitiveGuide to DimensionalModeling, Third Edition, John Wiley&Sohns, 2013</td><td></td><td></td></tr>
<tr><td>• S. Čelar: Authorised instructions for laboratoryexercises, 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">• Kimball, R., Ross, M.: The Data Warehouse Toolkit, TheCompleteGuide to DimensionalModeling, SecondEdition, Wiley Computer Publishing, 2002</td></tr>
<tr><td></td><td colspan="3">• Todman, C.: Designing a Data Warehouse: SupportingCustomerRelationship Management , 1st Edition, Prentice Hall PTR, ISBN: 0-13-089712-4, 2000</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>

NAME OF THE COURSE	COMPUTER GAMES PROGRAMMING						
Code	FELK34	Year of study	1.				
Course teacher	Jadranka Marasović, Ph.D., FullProfessor	Credits (ECTS)	5				
Associate teachers	Tea Marasović, Ph.D., AssistantProfessor	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	30	0
Status of the course	Elective	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Enabling students to acquire basic theoretical and practical knowledge on design and development of computer video games – from concept to final implementation – by working through different game examples, with emphasis placed on their programming.
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)	After completing this course, students will be able to: - use Unity game development platform to create interactive 2D and 3D content;explain how the physics engine works; - build a simple world using built-in primitive shapes, readily available assets and animated characters imported from 3D modelling programs; - arrange and edit basic GUI elements; - use C# programming language to set up basic game functionality; - incorporate artificial intelligence in the game; - make a simple computer video game and prepare it for publishing.

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

Course content	L hours	AE hours
Introduction. History of computer games.	2	0
General game development guidelines.	2	0
Getting started with Unity. Creating, editing and transforming objects. Materials and textures.	2	0
Scripting in Unity.	2	0
Designing the game's GUI: buttons, sliders, status bars and clocks.	4	0
Introduction to game physics. Rigid bodies. Collison detection and object interaction. Displaying results.	2	0
Adding sound effects and music. Working with cameras.	2	0
Particle systems. Skeletal animation basics.	2	0
Multi-player games. Tic Tac Toe.	2	0
Artificial intelligence in games. State machines.	4	0
Lighting the world. Creating the final build.	2	0

List oflaboratoryor design exercises	LE hours
Making a simple game: Pong.	2
Making a simple collection game.	2
Maze game: Setting up basic functionality.	2
Maze game: Animating objects in Unity.	2
Maze game: Saving and loading the game.	2
3D puzzle game: Level design. Light maps.	2
3D puzzle game: Staging props.	2
3D puzzle game: Importing animated characters. Creating movement mechanics.	4

<table>
<tr><td></td><td colspan="5">3D puzzle game: The game manager.</td><td>2</td></tr>
<tr><td>Format of instruction</td><td colspan="3">☒lectures
☐seminars and workshops
☐exercises
☐on linein 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">Minimum of 70 percent lecture attendance. Completing all the 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>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>1</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>Laboratory exercises</td><td>1.5</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>0.5</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 will be two mid-term exams – according to the class schedule – and/or a project assignment, depending on the agreement with the students. The requirement for the positive grade is the attendance and commitment at the laboratory exercises and a minimum of 40 percent correct answers at each mid-term.

The final grade is determined based on the total number of points earned, which is calculated as follows:

Grade [%] = 0.5 * M1 + 0.5*M2

Percentage Grade
50% to 61% sufficient (2)
62% to 74% good (3)
75% to 87% verygood (4)
88% to 100% excellent (5)

The final exam encompasses the entire course load or selected parts of it that students' did not pass at either of mid-term exams. The correction exam encompasses the entire course load. The requirement for passing the exam is minimum of 50 percent correct answers. The exams are held according to the class schedule.</td></tr>
<tr><td rowspan="2">Required literature (available in the library and via other media)</td><td colspan="3">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="3">1. T. Marasović, J. Marasović; Authorizedlectures</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. T. Miller; “Beginning 3D Game Programming“, SamsPublishing, 2004, ISBN: 0-672-32661-2.
2. K. C. Finney; “3D Game Programming All in One”, Premier Press, 2004. ISBN: 1-59200-136-X.
3. S. Blackman; “Beginning 3D Game Development withUnity”, Apress, 2011, ISBN: 978-1-4302-3422-7</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="6">- Keeping records on class attendance
- Annual analysis of exam results
- Student survey on teaching performance
- Teacher self-evaluation
- Feedback information from graduates regarding course content relevancy</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="6"></td></tr>
</table>

NAME OF THE COURSE	MULTIMEDIA SYSTEMS						
Code	FELK08	Year of study	2.				
Course teacher	Mladen Russo, Ph.D., Assistant Professor	Credits (ECTS)	5				
Associate teachers	Jelena Čulić, mag. ing. Martina Bašić, mag. ing.	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	30	0
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for: - understanding of multimedia systems and virtual reality - knowledge of the properties and methods for generating speech, audio, image and video signals (including 3D images and video) - understanding of the most important algorithms for compressing speech, audio, image and video signals
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: - describe the basic principles of human speech, hearing and vision - explain the basic principles of psychoacoustics and their application in compression of audio signals - demonstrate the frequency masking effect - define the most important algorithms for compression of speech, audio, image and video signals - demonstrate the basic mechanisms of JPEG compression

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction. History of multimedia systems. Basic terms. Overview of multimedia software tools. Design of multimedia applications.	2	0
	Audio signal. How humans hear and speak. Speech modelling.	2	0
	Generic compression techniques for audio signals. Audio specific algorithms (mp3).	2	0
	Speech specific algorithms (LPC, CELP, RELP, MPE, RPE) and applications in mobile telephony. Review of standards for encoding speech and audio signals.	2	0
	Color in images and video signal. The perception of color (how people perceive electromagnetic radiation). Theory of mixing colors.	2	0
	Color models for image signal (RGB, CMY, CMYK). Color models for video signal (YUV, YIQ, YCbCr). Software-oriented color models (HSB, HLS, HSV). Gamma correction. Image signal (resolution, depth, memory requirements). Image formats (gif, tiff, jfif, ps, bmp).	2	0
	Basics of video and television. Analog television and video. Digital television and video. Video formats and memory requirements.	2	0
	Image compression. JPEG modes.	2	0
	Video compression: H.261. H.263.	2	0
	Video compression: MPEG-1. MPEG -2.	2	0
	Video compression: MPEG-4.	2	0
	Video compression: H.264.	2	0

	Fundamentals of virtual reality. History. Stereoscopic (3D) vision. Software and hardware for virtual reality.	2	0
			LE hours
	Sound recording. Searching of voiced and unvoiced speech. Pitch period.		2
	Speech specific algorithms (LPC)		2
	Frequency masking		2
	3D sound		2
	Image compression (JPEG)		2
	Image compression (JPEG)		2
	Image compression (JPEG)		2
	MPEG – influence of I, P, B frames on video quality		2
	Multimedia systems on mobile devices (Android programming)		2
	Multimedia systems on mobile devices (Android programming)		2
	Multimedia systems on mobile devices (Android programming)		2
	3D images		2
	CAVE system		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	3	Research		Practical training	
	Experimental work		Report		Individual work	1,7
	Essay		Seminar essay		(Other)	
	Tests	0,2	Oral exam		(Other)	
	Written exam	0,1	Project		(Other)	

Grading and evaluating student work in class and at the final exam	During a semester there are two midterms and final exam. Final exam and midterms are held according to the calendar of classes. At the final exam students take the test from the complete course if they do not have a positive grade on the midterms or take the midterm that they did not pass. At the make-up and commission exam students take the test from the complete course. 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+0,5*M2; M1, M2 – midterm test results. The final grade is determined as follows: Percentage Grade 50% to 61% sufficient (2) 62% to 74% good (3) 75% to 87% very good (4) 88% to 100% excellent (5)

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	• H. Dujmić: Multimedijskisustavi, internal script	1	e-learning portal
Optional literature (at the time of	• Steinmetz, Nahrstedt: "Multimedia Fundamentals: Media CodingandContent Processing", Prentice Hall, 2002		

submission of study programme proposal)	• Rao, Bojkovic, Milovanovic: "Multimedia Communication Systems: Techniques, StandardsandNetworks", Prentice Hall, 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	**GRID COMPUTING SYSTEMS**						
Code	FELK11	Year of study	2.				
Course teacher	Eugen Mudnić, Ph.D., Assistant Professor	Credits (ECTS)	5				
Associate teachers		Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	30		
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for - Understanding and application of Grid computing systems. - Further evolving of knowledge and skills for design and use of distributed computing systems.		
Course enrolment requirements and entry competences required for the course	Previously taken courses : Distributed computing systems, Programming languages.		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - Determine applicability of grid computing for different computational tasks. - Install and use virtualized computer environments. - Install and use Grid computing system. - Write and execute complex jobs in Grid environment. - Determine job costs and performance in Grid environment.		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction to Grid systems. Technological background of Grid computing.	2	2
	Grid architecture and functionality.	2	2
	Grid systems classification.	2	2
	Virtualization and Grid systems.	2	2
	Grid data management – functions, requirements	2	2
	Replication and efficient data management.	2	2
	Metadata in Grid systems	2	2

	Job brokering for Grid systems.	2	2
	First midterm exam		
	Job scheduling algorithms for parallel computers	2	2
	Job scheduling algorithms for meta-computers	2	2
	HTCondor - distributed parallelization of computationally intensive tasks	2	2
	Grid security	2	2
	Cloud computing systems	2	2
	Second midterm exam	2	2
	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)
Studentresponsibilities	The presence on lectures 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	1,7	Research		Practical training	
	Experimental work		Report		Individual work	2,0
	Essay		Seminar essay		Laboratory exercises	0,0
	Tests	0,2	Oral exam		Preparation for laboratory exercises	0,0
	Written exam	0,1	Project	1,0	(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 20 questions 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. Final grade (in percentage) is formed according to the formula: Grade(%) = 0.1 NP + 0.45 (M1 + M2) the activities in percentage: • NP - attendance at lectures, • 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)	• E. Mudnić: Authorised Lectures, FESB		e-learning portal

Optional literature (at the time of submission of study programme proposal)	Introduction to Grid Computing, Frédéric Magoulès, Jie Pan, Kiat-An Tan, Abhinit Kumar, CRC Press, Taylor & Francis Group, 2009
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 - Feedback from graduated students
Other (as the proposer wishes to add)	

NAME OF THE COURSE	**BUSINESS INFORMATION SYSTEMS**						
Code	FETK01	Year of study	2.				
Course teacher	Stipo Čelar, Ph.D., Associate Professor	Credits (ECTS)	5				
Associate teachers	MiliTurić, mag. comp. Ivan Drnasin, mag. Comp.	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	Training students for: - understanding and application of Business Information Systems (BIS) types, - understanding and analyse of product's and material's life cycle in business systems (BS) and in information systems (IS), - understanding of basic functionalities of ERP solutions, - application of design, implementation and maintenance of transactional IS.		
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: - classify different types of BIS, - design a small BIS, - participate in development, implementation and maintenance of ERP solutions, - choose technologically and functionally adequate BIS solution for a bigger business environments, - plan and manage a larger BIS implementation project.		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction to Business Information Systems (BIS). Role of BIS inthebusiness	2	
	BIS types	2	
	BIS development methodologies. UML. RUP	2	
	Business Process Modelling. ARIS	2	

	Process. Event. Information. Document. Function	2	
	The basic concepts of transactional IT systems	2	
	Financial and accounting processes. The processes of document management	2	
	First midterm exam		
	Item - the product - (repro) material - raw materials – commodities in business and information system	2	
	Work order. Bill of Materials.	2	
	Types of production (discrete, process, repeatable). Traceability	2	
	Price calculation (purchase and production). VAT calculation	2	
	MRP and ERP systems. Cloud systems	2	
	Methodologies selection and implementation of information systems	2	
	Second midterm exam		
	List of laboratory exercises		LE hours
	Introduction to the work method. Defining of project teams and seminar topics selecting		2
	Weekly meetings with a mentor (professor / assistant)		4
	Exercisesinthe test ERP system – .NET technology		10
	Exercisesinthe test system – JAVA technology		6
	Seminar presentation (with colleagues)		4

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	0,4	Practical training	
	Experimental work		Report		Individual work	2
	Essay		Seminar essay	0,5	Laboratory exercises	0,7
	Tests	0,2	Oral exam	0,2	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 of lecturing. Each midterm test consists of 5 to 10 theoretical questions and numerical problems. The final test consists of aprox. 10 theoretical questions and numerical problems. In the final exams students that did not pass the midterm exams take part. The midterms 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. After that the students take the oral exam. Grade (in percentage) is formed according to the formula: Grade(%) = 0,3 OE + 0,2 LE + 0,25 (M1 + M2) the activities in percentage: • OE – oral exam, • LE – laboratory assessment, • M1, M2 – test results.

Required literature (available in the	**Title**	**Number of copies in the library**	**Availability via other media**

library and via other media)	• S. Čelar: Authorised lectures, FESB		e-learning portal
	• S. Čelar: Authorised instructions for seminar, FESB		e-learning portal
	• M. Turić; S. Čelar: Authorised instructions for laboratoryexercises, FESB		e-learning portal
Optional literature (at the time of submission of study programme proposal)	• Nancy H. Bancroft. 1996. *Implementing SAP R/3*. Prentice Hall PTR, UpperSaddleRiver, NJ, 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	**EMBEDDED SYSTEMS**						
Code	FELK12	Year of study	2				
Course teacher	Sven Gotovac, Ph.D., FullProfessor	Credits (ECTS)	5				
Associate teachers	Dunja Gotovac, TeachingAssistant	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	Training students to: 1. Analyze and design embedded computing systems. 2. Create related software support. 3. Select and customize system support according to the system requirements 4. Select and match the circuits and software solution (hardware-software co-design) 5. Analyze complexity and system performance.		
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: 1. Design embedded computer system. 2. Design and build related software support. 3. Select and match the needs of system software support. 4. Analyze and evaluate overall system performance.		
Course content broken down in detail by weekly	Course content	L hours	AE hours
	Introduction, Importance and scope of application of embedded computing systems.	2	

class schedule (syllabus)	Design methods of embedded computing systems	2	
	Tools for design of embedded computing systems.	2	
	Embedded systems hardware and their interconnections.	2	
	Microprocessor, microcontroller	2	
	Digital signal processors	2	
	Different peripherals and their interconnection	2	
	The interface problem is considered at the level of computer architecture, logic circuits, time diagrams, and protocols.	2	
	Connecting analog and digital systems.	2	
	Sensors and actuators	2	
	Software support for embedded computing systems.	2	
	Operating Systems of Embedded Systems.	2	
	Operating systems for real-time operation.	2	
	Hardware-software codesign. Examples.	4	
	List oflaboratoryor design exercises		LE hours
	ARM and AVR microprocessors/microcontrollers.		6
	Assembler programming		4
	EMBEST IDE board, Raspberry PI board, Arduino board		4
	Application for one of the boards		4
	Project		12

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		Laboratory exercises	1
	Essay		Seminar essay		Preparation for laboratory exercises	0,5
	Tests		Oral exam		Self-study	0,5
	Written exam		Project	2		

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. First midterm test lasts 60 minutes and consists of 5 to 7 theoretical questions and numerical problems, second midterm is practical example and final tests consist of 6 theoretical questions and numerical problems and example solving. 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:

$$\text{Grade}(\%) = 0{,}33\ LV + 0{,}33\ (M1 + M2)$$

the activities in percentage:

- LV – laboratory assessment,
- M1, M2 – test results.

The final grade will be determined after the first test term by applying a relative ECTS grading system in accordance with the Regulations on the study and study system of the University of Split. The group of students who passed the exam is

<table>
<tr><td></td><td colspan="3">divided into four groups: 15% of the best gets the grade A (excellent), 35% of the following B (very good), the next 35% rating C (good), and the last 15% rating D, E). A group of students who did not pass the exam gains FX score (additional work is required), or F (significant additional work is required). In accordance with the Rulebook for Exam, only two exam periods are organized in the exam period after the completion of classes.
According to Article 65 of the Statute of the Faculty, the student is obliged to participate in all forms of teaching and attend: lectures at least 70% of teaching hours and laboratory exercises 100% of teaching hours. If you do not meet these conditions, the student will not be able to access the exam</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>• Wayne Wolf, Computers as ComponentsPrinciplesofEmbedded Computing Systems Design, Morgan Kaufmann 2008.</td><td>1</td><td>Electronic copy On e-learning</td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="3">• Frank Vahid, Tony D. Givargis, Embedded System design: A Unified Hardware/Software Introduction, John Wiley 2001, ISBN 0-471-38678-2
• Qing Li, Caroline Yao, "Real-Time Concepts for Embedded Systems", Publishedby CMP Books, 2003. ISBN: 1-57820-124-1</td></tr>
<tr><td>Quality assurance methods that ensure the acquisition of exit competences</td><td colspan="3">1. Class attendance records.
2. Evaluation of results in accordance with the above learning outcomes
3. Feedback from students via surveys
4. Self-evaluation of teachers
5. Feedback from students who have already graduated.
6. Institutional and non-institutional evaluations</td></tr>
<tr><td>Other (as the proposer wishes to add)</td><td colspan="3"></td></tr>
</table>

NAME OF THE COURSE	PROGRAMMING MOBILE ROBOTS AND DRONES						
Code	FELH40	Year of study	2.				
Course teacher	Mirjana Bonković, Ph.D., Full Professor Josip Musić, Ph.D., Assistant Professor	Credits (ECTS)	5				
Associate teachers	Miroslav Dujmović, BSc (external collaborator)	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	30	0
Status of the course	Elective	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for: - understanding basic working principles and limitations of individual robot components (actuators, sensors and control units). - understanding and applying number of different techniques for solving problems in the robotics domain such as control and navigation, as well as programming robot/drone to perform desired task.
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: - describe basic mobile robot and drone components. - describe properties of widely used sensors in mobile robotics. - explain different modes of mobile robot control. - develop PID controller for mobile robot control. - design algorithms for data fusion based on Kalman filter. - formulate algorithm for path planning, obstacle avoidance and simple navigation. - demonstrate application of computer vision in mobile robot control (visual servoing). - apply acquired knowledge in higher level programming languages (e.g. Visual C#, Python, Java). - evaluate efficiency of path planning and navigation algorithms.

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours
	Introduction: mobile robot (drone) components.	2
	Microcontrollers. Arduino IDE for robot control.	2
	Sensors: sensor characteristics, uncertainty representation, sensor types: incremental encoders, position and orientation sensors, inertial sensors, vision sensors.	4
	Mobile robot kinematics. Drive. Mobile robot control modes: on-off control, PID controller, speed and position controller.	4
	Robot localization: Kalman, particle and information filter.	4
	Navigation: planning and control.	2
	Control with navigation error as input.	2
	Visual servoing.	2
	Selected practical examples of control of mobile robots and drones.	4

	List of laboratory or design exercises	LE hours
	Arduino development environment.	2
	Digital I/O – ultrasonic sensor.	3
	Motor control. Connection motors and sensors.	3

	Line following.	2
	Obstacle avoidance.	4
	Working on project assignments.	16

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	1,5	Research		Practical training	
	Experimental work		Report		Individual work	2
	Essay		Seminar essay		Laboratory exercises	1
	Tests	0,2	Oral exam		Preparation for laboratory exercises	0,1
	Written exam	0,2	Project		(Other)	

Grading and evaluating student work in class and at the final exam	During the semester there are two midterm exams. The first midterm exam is after 7 weeks of lectures and the second one is after 13 weeks of lectures (in a form of presentation and defense of the project assignment). Each midterm test (as well as the final test) is carried out in a written format with duration of 90 minutes. The requirement for passing grade is the positive assessment of laboratory exercises and 50 % points on average midterm exam ((M1 + M2)/2) or the final exam. Students are allowed to have at least 45% of total points on each midterm exams, as long as the final midterm average is at least 50% of total points. Grade (in percentage) is formed according to the formula: Grade(%) = 0,1L + 0,25M1 + 0,65M2 where: • L – laboratory assessment, • M1, M2 – midterm test results. According to Article 65. of Faculty's Bylaw, student is required to participate in all teaching activities attending at least 70% of lectures, and 100% of laboratory exercises. If student does not meet these criteria, she or he won't be able to take part in the final exam, and will be required to enroll in the course the next year.

	Title	**Number of copies in the library**	**Availability via other media**
Required literature (available in the library and via other media)	• TSiegwart, R., Nourbakhsh, I. R., Scaramuzza D., Autonomous Mobile Robots, MIT Press, 2011.		teacher/Internet
	• Thomas Braunl, Embedded Robotics: mobile robot design and applications with embedded systems, Springer, 2006.		teacher/Internet
	• S. Thrun, W. Burgard, D. Fox, Probabilistic Robotics, MIT Press, 2006.		teacher/Internet

	• Saeed B. Niku: Introduction to Robotics: Analysis, Systems, Applications, Prentice Hall, 2001.		teacher
	• M. Bonković, J. Musić, I Stančić: "Mikroregulatori i ugradbenimrežnisustavi u Arduino razvojnomokruženju", faculty book, FESB		e-learning portal
	• J. Musić, M. Bonković: Authorised lecture notes, FESB		e-learning portal
Optional literature (at the time of submission of study programme proposal)	1. Tadej Bajd: Osnove robotike, Fakulteta za elektrotehniko, Univerza v Ljubljani, 2000. 2. Kovačić, Laci, Bogdan, Osnove robotike, Fakultet elektrotehnike i računarstva, Zagreb, 1999.		
Quality assurance methods that ensure the acquisition of exit competences	- Keeping records of student attendance. - Annual analysis of course statistics in terms of midterm and finals exams. - Feedback from students via surveys. - Teacher self-evaluation. - Feedback from graduated students (or senior students) on course content relevance. - Periodic institutional evolution of course teachers.		
Other (as the proposer wishes to add)	/		

NAME OF THE COURSE	**MEDICAL DEVICES**						
Code	FELH18	Year of study	2.				
Course teacher	Antonio Šarolić, Ph.D., Full Professor Ivan Marinović, Ph.D., Full Professor	Credits (ECTS)	5				
Associate teachers	Niko Ištuk, mag. ing. el.	Type of instruction (number of hours)	L	S	AE	LE	DE
			30			30	
Status of the course	Elective	Percentage of application of e-learning	0				
COURSE DESCRIPTION							
Course objectives	- learning the types, realizations and application areas of electronic/communication/information technology in medical domain - knowledge on therapeutic, diagnostic and control medical electronic devices - understanding the specifics of functional and safety requirements for medical electronic devices						

<table>
<tr><td></td><td colspan="3">- understanding and application of success criteria for medical device innovation and development</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="3">None.</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:
- employ their knowledge on electronic/communication/information technology for analysis and development of medical devices
- use the knowledge of human physiology, especially electrophysiology, for analysis and development of medical devices
- analyze the components of medical electronic devices and their interaction with human body medical electronic devices
- conceive the electronic circuits for application in a medical device
- characterize a medical electronic device from the aspect of safety
- critically assess the success of innovation and development of a medical device</td></tr>
<tr><td rowspan="16">Course content broken down in detail by weekly class schedule (syllabus)</td><td>Course content</td><td>L hours</td><td>AE hours</td></tr>
<tr><td>Basics of human electrophysiology and electrophysiology</td><td>2</td><td>0</td></tr>
<tr><td>Measurement medical electronic devices</td><td>2</td><td>0</td></tr>
<tr><td>Diagnostic medical electronic devices</td><td>2</td><td>0</td></tr>
<tr><td>Therapeutic medical electronic devices</td><td>2</td><td>0</td></tr>
<tr><td>Electronic circuits and components in medical devices</td><td>6</td><td>0</td></tr>
<tr><td>Circuits and devices for electric and magnetic stimulation at low frequencies</td><td>2</td><td>0</td></tr>
<tr><td>Circuits and devices for thermal procedures at high frequencies</td><td>2</td><td>0</td></tr>
<tr><td>Electrical safety aspects and electromagnetic compatibility aspects of medical electronic devices</td><td>2</td><td>0</td></tr>
<tr><td>Control and auxiliary medical electronic devices. E-Health. Theranostic medical electronic devices – unifying the therapeutics and diagnostics in innovative medical devices and methods</td><td>2</td><td>0</td></tr>
<tr><td>Translational resaerch and development of medical devices from lab to clinics (from the workbench to the bedside). Assessment of clinical and economic efficacy of medical technology (Health Technology Assessment - HTA)</td><td>2</td><td>0</td></tr>
<tr><td>Clinical studies: principles and implementation of clinical trials of medical devices</td><td>2</td><td>0</td></tr>
<tr><td>List of laboratory or design exercises</td><td colspan="2">LE hours</td></tr>
<tr><td>Basics of human electrophysiology</td><td colspan="2">2</td></tr>
<tr><td>Amplifier circuits</td><td colspan="2">4</td></tr>
<tr><td>Electrostimulator circuits</td><td colspan="2">4</td></tr>
<tr><td>Noise and disturbance suppression in electronic devices</td><td colspan="2">2</td></tr>
<tr><td>Electromagnetic compatibility testing</td><td colspan="2">2</td></tr>
</table>

	Electrical safety testing	2
	Measurements of dielctric properties of tissues	2
	Measurement, diagnostic and therapeutic medical electronic devices – field trip (visit to medical establishments)	8

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	Student is required to attend the lectures and auditory exercises in the amount of at least 70% of the schedule.	

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	0,5	Report		Laboratory exercises	0,5
	Essay		Seminar essay	1	Individual work	1
	Mid-exam	0,5	Oral exam		(Other)	
	Written exam	0,5	Project		(Other)	

Grading and evaluating student work in class and at the final exam	Lectures are given in collaboration of prof. Šarolić (2/3 of lecture hours) and prof. Marinović (1/3 of lecture hours). Exam: presentation and defense of the seminar essay

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	Ante Šantić: Biomedicinska elektronika, Školska knjiga, Zagreb, 1995.		
	Jaakko Malmivuo & Robert Plonsey: Bioelectromagnetism - Principles and Applications of Bioelectric and Biomagnetic Fields, Oxford University Press, New York, 1995.		

Optional literature (at the time of submission of study programme proposal)	- Handbook of biological effects of electromagnetic fields (third edition): Bioengineering and Biophysical Aspects of Electromagnetic Fields, Ed. Frank S. Barnes and Ben Greenebaum, CRC Press, 2007. - Handbook of biological effects of electromagnetic fields (third edition): Biological and Medical Aspects of Electromagnetic Fields, Ed. Frank S. Barnes and Ben Greenebaum, CRC Press, 2007. - The Biomedical Engineering Handbook (Second Edition), Ed. Joseph D. Bronzino, CRC Press, 2000.
Quality assurance methods that ensure the acquisition of exit competences	Surveys providing student feedback
Other (as the proposer wishes to add)	