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 PROGRAMME IN ELECTRONICS AND COMPUTER ENGINEERING

SPLIT, February 2022

1.1. List ofmandatory and elective courses

List ofcourses								
Year of study:1.								
Semester:I.								
STATUS	CODE	COURSE	HOURS IN SEMESTER*					ECTS
			L	S	AE	LE	DE	
	FELH02	Information theory and coding	45	0	0	15	0	6
	FELH38	Fields and waves in electronics	30	0	0	30	0	5
	FELG32	Telemedicine and biocybernetics	30	0	0	30	0	5
	FELJ28	Radars	30	0	0	30	0	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

List ofcourses								
Year of study:1.								
Semester:II.								
STATUS	CODE	COURSE	HOURS IN SEMESTER*					ECTS
			L	S	AE	LE	DE	
Mandatory	FELH05	Advanced computer architectures	30	0	0	30	0	5
	FELH06	Programming languages and compilers	45	0	0	15	0	5
	FELH07	Digital systems projecting	30	0	0	30	0	5
Elective	FELH35	Solar cells	30	0	0	30	0	5
	FELK16	Data warehouse	30	0	0	30	0	5
	FELK34	Computer games programming	30	0	0	30	0	5
	FELG33	Optoelectronic measurement methods	30	0	0	30	0	5
	FELJ14	Mobile communications	30	0	15	15	0	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

Module: **ELECTRONICS – 221**

List ofcourses								
Year of study:1.								
Semester:II.								
STATUS	CODE	COURSE	HOURS IN SEMESTER*					ECTS
			L	S	AE	LE	DE	
Mandatory	FELJ24	Bioelectromagnetics	15	0	15	30	0	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

List ofcourses								
Year of study:2.								
Semester:III.								
STATUS	CODE	COURSE	HOURS IN SEMESTER*					ECTS
			L	S	AE	LE	DE	
Mandatory	FELH12	Wireless communications	30	0	0	30	0	5
Elective	FELH40	Programming mobile robots and drones	30	0	0	30	0	5
	FELH41	Medical electronic devices	30	0	0	30	0	5
	FELJ36	Systems for wireless transmission of energy	30	0	0	30	0	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

Module: **COMPUTER ENGINEERING – 222**

List ofcourses								
Year of study:1.								
Semester:II.								
STATUS	CODE	COURSE	HOURS IN SEMESTER*					ECTS
			L	S	AE	LE	DE	
Mandatory	FELJ24	Bioelectromagnetics	15	0	15	30	0	5
	* L = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

List ofcourses								
Year of study:2.								
Semester:III.								
STATUS	CODE	COURSE	HOURS IN SEMESTER*					ECTS
			L	S	AE	LE	DE	
	FELJ20	Multimedia systems	30	0	0	30	0	5
	FELH40	Programming mobile robots and drones	30	0	0	30	0	5
	FELH41	Medical electronic devices	30	0	0	30	0	5
	*LL = lectures, S = seminars, AE = auditoryexcercise, LE = laboratoryexcercise, DE = design excercise							

1.2. Course description

NAME OF THE COURSE	**INFORMATION THEORY AND CODING**						
Code	FELH02	Year of study	1.				
Course teacher	Petar Šolić, Ph.D., AssistantProfessor	Credits (ECTS)	6				
Associate teachers		Type of instruction (number of hours)	L	S	AE	LE	DE
			45	0	0	15	0
Status of the course	Obligatory	Percentage of application of e-learning	0				
COURSE DESCRIPTION							
Course objectives	Training students for: - Understanding and applying the elementary principles in the field of information theory, coding and cryptography - Acquire and deepen the knowledge in the field of information theory, coding and cryptography						
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. Design efficient information source models by using acquired data from real information source 2. Develop simple Markov chains 3. Analyze simple information sources 4. Explain the role of cryptography in communication systems 5. Analyze crypted communication systems properties through simulations 6. Calculate capacity according the standard channel model 7. Choose appropriate decision concepts in communication systems by taking into account properties of communication channel and information source.						

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

Course content	L hours
Informationsourcemodels, ergodicinformationsource, memory-basedsources	3
Markov chain, Markov model, hidden Markov model, artificiallanguages	3
Informationmeasure, self-information, entropy	3
Joint sources, joint information, mutualinfromation, Venn diagrams	3
Cryptography	3
Detectionoferrorsanderrorcorrection	3
Redundantcoding, blockcodes	3
Dual codes, Cycliccodes	3
Convolutionalcodes, turbo codes	3
Noisechannel, binarysymetricchannel	3
Erasurechannel, channelcapacity, coding in noisychannels	3
Deterministicandrandomsignalsandsystems	3
MAP and ML decisions	3

List of laboratory exercises	LE hours
Markov information source	2
Entropy	2
Secret key cryptography	2
Public key cryptography	2
Block codes: Hamming code	2
Convolutional coedes	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	1,3	Research		Practical training	
	Experimental work		Report		Individual work	3,5
	Essay		Seminar essay		Laboratory exercises	0,5
	Tests	0,1	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	During the semester there are two mid-term exams and the final exam. Mid-term and final exams consist of questions and tasks. 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 (%) = 0,75 * (0.5 * M1 + 0,5 * M2) + 0,25 * L; M1, M2 - points at the mid-term expressed as a percentage, and L - points from the laboratory (with completed all lab. Exercises) expressed as a percentage. The final evaluation is determined as follows: percentage Rating 50% to 61% is sufficient (2) 62% to 74% good (3) 75% to 87% of very good (4) 88% 100% Excellent (5)

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	• N. Rožić: Informacije i komunikacije, script		e-learning

Optional literature (at the time of submission of study programme proposal)	• Rožić, N.: Informacije i komunikacije: kodiranje s primjenama, Zagreb, 1992. • Sinković, V.: Informacija, simbolika i semantika, Školska knjiga, Zagreb, 1997. • Cover, T. : ElementsofInformationTheory, J. Wiley&Sons., 1991.
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	**FIELDS AND WAVES IN ELECTRONICS**		
Code	FELH38	Year of study	1
Course teacher	Dragan Poljak, Ph.D., FullProfessor	Credits (ECTS)	5

			L	S	AE	LE	DE
Associate teachers	Anna Šušnjara, TeachingAssistant	Type of instruction (number of hours)	30	0	0	30	
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for: - Understandingandapplyfundamentalprinciplesandlawsofelectromagneticfieldtheory, - Formulatingandsolvesimplestatic, quasistaticanddynamicfields, - Applyingofanalyticalandnumericalmethods to solveproblemsinelectromagneticwavepropagationandradiation - Solvesimpleproblemsinelectromagneticcompatibilityandanalysisofsimpleantenna systems
Course enrolment requirements and entry competences required for the course	- Mathematics 2 and 3, Physics 1 and 2
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - Definefundamentalphenomena, quantitiesandlawsofelectromagneticwavepropagation, - Applyfundamentallawsofelectromagnetictheory to calculatebasicparametersofelectromagneticfields - Applymethodsandtechniques to solveproblemsofelectromagneticwavepropagationandradiationofthinwireantennas - Mathematicallyformulatesimplecasesofelectromagneticwaveandradiationfromthinwirestructures. - Analyzesimpletransmissionlines, groundingsystemsandantennas - Computequantitiesofsimplertransmissionlines, groundingelectrodesandantennas. - Developsimplecodesand use commercial software packages for solvingproblemsinpropagation, electromagneticcompatibilityandradiation.

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

Course content	L hours	AE hours
Introduction. Maxwell'sequationsindifferentialform. Maxwell'sequationsin integral form. Maxwell'sequations for movingmedia. Waveequations.	2	0
Continuityequation. Ohm'slaw. Poyintingtheorem. Electric propertiesofmaterial: isotropy, linearity, homogenity.	2	0
Continuityconditions. Electromagneticpotentials. Waveequations for potentials. Particularsolutions for potentials.	2	0
Maxwell'sequations for particularcases. Media classificationandapplicationofapproximationsdepending on frequencyrange. Fieldrepresentationby complex phasors.	2	0
Maxwellsequations, waveequations, potentialsandPoyntingvector for time-harmonicfields.	2	0
Electrostaticfield. Green'stheorems.GeneralsolutionofLaplaceandPoissonequations.	2	0
Magnetostaticfield. VectoranalogueofGreen'stheorem. Biot-Savartlaw.	2	0
Stationarycurrentfield.	2	0
Solutionmethodofstationaryproblems. Methodofseparationofvariables. FiniteDifferenceMethod.	2	0
Quasistationarymagneticfield. Eddycurrents. Selfandmutualinductance.	2	0
Transmissionlines.	2	0

<table>
<tr><td rowspan="14"></td><td>Electromagneticwaves. Solutionofwaveequations. Plane wavein free space. Reflectionanddiffractionof plane wave. Propagationof plane waveinfinitelyconductingmedia.</td><td>2</td><td>0</td></tr>
<tr><td>Electromagneticradiation. Hertz dipole. Introduction to linearantennatheory. Basicnotionsofelectromagneticcompatibilityandbioelectromagn etism.</td><td>2</td><td>0</td></tr>
<tr><td colspan="2">List oflaboratoryor design exercises</td><td>LE hours</td></tr>
<tr><td colspan="2">Fieldandpotentialinside a capacitor. (plate, cylindricalandsphericalcapacitor)</td><td>3</td></tr>
<tr><td colspan="2">Volumechargedistribution – Poissonequation.</td><td>3</td></tr>
<tr><td colspan="2">Fieldandpotentialofpointcharge.</td><td>3</td></tr>
<tr><td colspan="2">Magneticfieldofinfiniteconductorandshieldedcable.</td><td>3</td></tr>
<tr><td colspan="2">EM wavepropagationindielectricmediaandlossymedia.</td><td>3</td></tr>
<tr><td colspan="2">EM wavenormalincidence to perfectgroundand interface betweentwodielectricmedia.</td><td>3</td></tr>
<tr><td colspan="2">EM waveobliqueincidence to perfectgroundand interface betweentwodielectricmedia</td><td>3</td></tr>
<tr><td colspan="2">Total and zero reflection.</td><td>3</td></tr>
<tr><td colspan="2">EM obliqueincidence to lossymedia.</td><td>3</td></tr>
<tr><td colspan="2">Radiatedelectromagneticfieldfrom short dipole.</td><td>3</td></tr>
<tr><td colspan="3"></td></tr>
<tr><td>Format of instruction</td><td>☒lectures
☐seminars and workshops
☒exercises
☐on linein entirety
☐partial e-learning
☐field work</td><td colspan="2">☐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. Performed all required laboratory exercises.</td></tr>
</table>

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		(Other)	2,2
Essay		Seminar essay		(Other)	0,2
Tests	0,2	Oral exam		(Other)	0,2
Written exam	0,2	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. Each midterm test (120 min in duration) consists of 3 questions (each containing theoretical part and short numerical problem) and 2 longer numerical problems. The requirement for passing grade is the positive assessment of laboratory exercises and 50 % points on each midterm. Grade (in percentage) is formed according to the formula:

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

where M1 and M2 are the midterm test results, and is determined through following percentage score:

Percentage score:	Grade:
From 50% to 62%	sufficient (2)
From 63% to 75%	good (3)
From 76% to 88%	very good (4)
From 89% to 100%	excellent (5)

Students who do not pass midterm exams are obliged to pass final test (150 min in duration) in winter/fall examination period. Final test consists of 4questions(each

	containing theoretical part and short numerical problem) and 2 longer numerical problems. The requirement for passing grade is 50 % points.Final grade isformedaccording to thedescribed procedure.The midterm and final exams are carried out as written tests.		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	• D.Poljak, *Teorija elektromagnetskih polja s primjenama u inženjerstvu*, Šk. knjiga Zagreb, 2014.		
	• D.Poljak, V.Dorić, S.Antonijević,: Modeliranje žičanih antena primjenom računala . Zagreb, Kigen d.o.o., 2009.		
Optional literature (at the time of submission of study programme proposal)	1. D. Poljak, *AdvancedModelinginComputationalElectromagneticcompatibility*, WileyInterscience, New York 2007. 2. Z. Haznadar, Ž. Štih: *Elektromagnetizam*, Školskaknjiga, Zagreb 1997. 3. S. Ratnajeevan, H. Hoole, P. Ratnamahilan, P. Hoole: *AModernShortCoursein EngineeringElectromagnetics*, OxfordUniversityPress, 1996. 4. S.M.Wentworth: *Fundamentals of Electromagnetics with Engineering Applications*, Wiley, 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	**TELEMEDICINE AND BIOCYBERNETICS**						
Code	FELG32	Year of study	1.				
Course teacher	Mojmil Cecić, Ph.D., Full Professor Josip Musić, Ph.D., Assistant Professor	Credits (ECTS)	5				
Associate teachers	Tea Marasović, Ph.D., Assistant Professor	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:						

<table>
<tr><td></td><td colspan="2">- understanding basic principles and techniques in the area of telemedicine and biocybernetics.</td></tr>
<tr><td>Course enrolment requirements and entry competences required for the course</td><td colspan="2">None</td></tr>
<tr><td>Learning outcomes expected at the level of the course (4 to 10 learning outcomes)</td><td colspan="2">Students will be able to:
- explain computer and telecommunication basis for telemedicine.
- evaluate properties of algorithms for image processing in telemedicine.
- rate clinical application of telemedicine.
- choose sources of medical information in light of distant learning paradigm.
- evaluate systems for biomechanical human analysis.
- analyze joint forces and moments in correlation with muscle activity.
- experiment with measurement systems in biocybernetics based on EMG sensors, inertial sensors and optoelectronic sensors.
- evaluate measurement results in light of possible future application and system limitations.</td></tr>
<tr><td rowspan="14">Course content broken down in detail by weekly class schedule (syllabus)</td><td>Course content</td><td>L hours</td></tr>
<tr><td>Introduction to telemedicine. Historical development of telemedicine.</td><td>2</td></tr>
<tr><td>Computer and telecommunication basis for telemedicine.</td><td>2</td></tr>
<tr><td>Equipment and services in telemedicine.</td><td>2</td></tr>
<tr><td>Distant learning, searching through sources of medical information.</td><td>2</td></tr>
<tr><td>Image processing in telemedicine.</td><td>2</td></tr>
<tr><td>Ethics and telemedicine.</td><td>2</td></tr>
<tr><td>Clinical application.</td><td>2</td></tr>
<tr><td>Introduction to biocybernetics; overview of technical systems for measurement of human biomechanical parameters; measurement methods in biomechanics.</td><td>2</td></tr>
<tr><td>Human anthropometric parameter identification; gait analysis: terminology and measurements.</td><td>2</td></tr>
<tr><td>Gait parameter measurements; Kinematics and kinetics; Body position and balance during gate; measuring ground reaction forces during gait.</td><td>2</td></tr>
<tr><td>Electromyography, measuring muscle activity during human movement.</td><td>2</td></tr>
<tr><td>Inverse kinematics for muscle force identification.</td><td>2</td></tr>
<tr><td>Machine vision in biocybernetics.</td><td>2</td></tr>
<tr><td rowspan="10"></td><td>List of laboratory or design exercises</td><td>LE hours</td></tr>
<tr><td>Introductory lecture on laboratory safety procedures, laboratory measurement systems, and measurement procedures.</td><td>2</td></tr>
<tr><td>Measuring human anthropometric parameters using finite element method.</td><td>3</td></tr>
<tr><td>Measuring kinematic parameters during gait using fast cameras.</td><td>4</td></tr>
<tr><td>Measuring ground reaction forces during gait using force plate.</td><td>3</td></tr>
<tr><td>Measuring EMG muscle signals during gait.</td><td>4</td></tr>
<tr><td>Calculation of muscle forces and moments during gait based on measured kinematical parameters and floor reaction forces. Comparison with recorded EMG signals.</td><td>4</td></tr>
<tr><td>Measuring cervical spine range of motion using inertial motion sensors.</td><td>3</td></tr>
<tr><td>Application of machine vision in classification and automatic translation of Croatian signed alphabet.</td><td>4</td></tr>
<tr><td>Algorithms for image processing in telemedicine.</td><td>3</td></tr>
<tr><td rowspan="4">Format of instruction</td><td>☒ lectures</td><td>☐ independent assignments</td></tr>
<tr><td>☒ seminars and workshops</td><td>☒ multimedia</td></tr>
<tr><td>☐ exercises</td><td>☒ laboratory</td></tr>
<tr><td>☐ on line in entirety</td><td>☐ work with mentor</td></tr>
</table>

<table>
<tr><td></td><td colspan="3">☐ partial e-learning
☐ field work</td><td colspan="3">☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="6">The presence on lectures in the amount of at least 70 % of the times scheduled. Performed all required laboratory exercises.</td></tr>
<tr><td rowspan="5">Screening student work (name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)</td><td>Class attendance</td><td>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>Individual work</td><td>2</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>0,1</td><td>Oral exam</td><td></td><td>Preparation for laboratory exercises</td><td>0,3</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. The first midterm exam is after 7 weeks of lectures (in the area of biocybernetics) and the second one is after 13 weeks of lectures (in the area of telemedicine in a form of a project assignment). Each midterm test (as well as the final test) is carried out in a written format with duration of 90 minutes. It consists of both theoretical questions and numerical problems. In the final exams students that did not pass the midterm exams take part. The final exam test consists of 8 theoretical questions and numerical problems. 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(%) = 0,25L + 0,25M1 + 0,5M2

where:
• L – laboratory assessment,
• M1, M2 – midterm test results.

Final grade (based on percantages) 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)

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. In accordance with that student is required to solve and turn over for grading 100% of all 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.</td></tr>
<tr><td rowspan="4">Required literature (available in the library and via other media)</td><td colspan="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">• I. Klapan, I. Čikeš:; Telemedicina u Hrvatskoj, Medika, Zagreb, 2001.</td><td>3</td><td>teacher</td></tr>
<tr><td colspan="4">• R. J. Jagacinski, J. M. Flach: Control Theory for Humans: Quantitative Approaches to Modeling Performance, Lawrence Erlbaum Associates Inc., 2003</td><td></td><td>teacher</td></tr>
<tr><td colspan="4">• T. Marasović, Guidelines for laboratory exercises, FESB</td><td></td><td>e-learning portal</td></tr>
</table>

	• M. Cecić, J. Musić: Authorized lecture notes, FESB		e-learning portal
Optional literature (at the time of submission of study programme proposal)	1. Winter D.A.: The Biomechanics and Motor Control of Human Gait, University of Waterloo Press, Waterloo, 1991. 2. Zanchi V., Cecić M., Grujić T., Kuzmanić A., Papić V. : Laboratory for Identification of Human Movement with LaBACS Software Support, International Congress on Computational Bioengineering, ICCB'03, 24-26 September 2003., Zaragoza, Spain, p.p. 155-161 3.I. Kaplan, I Čikeš (editors): "Telemedicine", Telemedicine Association, Zagreb, 2005. 4. V. Štambuk: "Kibernetika s informatikom", 1989. 5. V. R. Milačić : "Tehnička kibernetika", 1981. 6. N. Wiener: "Kibernetika ili upravljanje i komunikacija kod živih bića i mašina", 1972.		
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	**RADARS**						
Code	FELJ28	Year of study	1				
Course teacher	Zoran Blažević, Ph.D., Full Professor	Credits (ECTS)	5				
Associate teachers	Maja Škiljo, Ph.D.	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	– explaining and increasing the knowledge about radiolocation principles, radar operation principle, and the role of all main radar subsystems. – calculating and estimating the basic radar signal parameters						

	– differentiating between specific radar types and perceiving their advantages and disadvantages – visualization of possibilities and characteristics of surveillance and targeting radar operation – considering and investigating modern solutions in radar technology	
Course enrolment requirements and entry competences required for the course	Finished the undergraduate study of Communications and Information Technology	
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: – develop competencies in individual and team work in analyzing and designing certain radar subsystems – estimate and calculate radar target parameters – recognize the relation between certain tactical and technical radar requirements – evaluate and perceive advantages and disadvantages of certain radar types – consider and analyze characteristics of surveillance and targeting radars	
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours
	Introduction to radar systems.	1
	Basic principles of radar systems.	2
	Parameters of radar signal.	2
	Radio wave propagation, radar equation and maximum range.	3
	Radar cross section.	3
	Estimation of target position parameters by radar signal.	2
	Basic radar hardware.	2
	Moving target indication (MTI) radar.	3
	Doppler impulse radar.	3
	Synthetic aperture radar (SAR).	2
	Meteorological radar.	2
	Ultra wideband (UWB) radar.	2
	Target tracking.	2
	Clutter cancelation in radar systems.	1

	List of laboratory exercises	LE hours
	Transmission and reflection measurements of devices using vector network analyzer.	2
	Radar principles- the measurement of target distance.	6
	Numerical simulation of target radar cross section.	2
	The measurement of bistatic radar cross section.	2
	SAR radar concept- simulation and measurements.	4
	MTI radar concept- simulation and measurements.	2
	UWB radar concept- simulation and measurements.	2
	Group visit to HRM (Croatian Navy) in Lora.	5
	Group visit to Naval centre of electronics (PCE) Split.	5

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

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	1.5	Research		Practical training	
	Experimental work		Report		Individual work	
	Essay		Seminar essay	2	Laboratory exercises	1
	Tests	0,5	Oral exam		Preparation for laboratory exercises	
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	There is one midterm test and seminar essay. The midterm test is after 7 weeks of lecturing and the seminar essays are presented during the next part of the semester. The midterm test consists of theoretical questions and numerical. Seminar essay includes individual work and work in groups, and the presentation of

<table>
<tr><td></td><td colspan="3">the results. The students that did not pass the test take part In the final exams and the presentation of the seminar essay is obligatory. The midterm test is carried out as written test. Grade (in percentage) is formed according to the formula:

Grade(%) = 0,1 NP + 0,1 LV + 0,4 (M + S)

the activities in percentage:
• NP - attendance at lectures,
• LV – laboratory assessment,
• M - test results,
• S- seminar essay</td></tr>
<tr><td rowspan="4">Required literature (available in the library and via other media)</td><td>Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td>• M. Škiljo:: Radari, predavanja</td><td></td><td>e-learning portal</td></tr>
<tr><td>• Skolnik, M: Introduction to Radar Systems, McGraw-Hill, 1990.</td><td>1</td><td></td></tr>
<tr><td>• Peebles, P. Z: "Radar Principles", John Wiley & Sons, 1998.</td><td>1</td><td></td></tr>
<tr><td>Optional literature (at the time of submission of study programme proposal)</td><td colspan="3">• Tait, P: "Introduction to Radar Target Recognition", IEE, 2005.
• Zentner, E.: Antene i radiosustavi, Graphis Zagreb, 2001.</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	**ADVANCED COMPUTER ARCHITECTURES**		
Code	FELH05	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	**PROGRAMMING LANGUAGES AND COMPILERS**						
Code	FELH06	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
			45	0	0	15	
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	Course content	L or S hours	AE hours
	Historyandelementsofprogramminglanguages	3	

class schedule (syllabus)	Lexical, syntaticandsemanticanalysis	3	
	Recursivedescentparser	3	
	Embeddingsemanticanalysis	3	
	Lexicalanalysisand DFA	3	
	Generatorsof LL and LR table drivenparsers	3	
	Attributedgrammar	3	
	Structures for semanticanalysis	3	
	Assemblerandrun-time structures	3	
	Introduction to codegeneration	3	
	Functionallanguages – Scheme	3	
	Logicallanguage – Prolog	3	
	Scriptlanguages	3	
	List oflaboratoryor design exercises		LE hours
	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	0.1
	Written exam	**0.1**	Project	0.3		

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.

	Title	**Number of copies in the library**	**Availability via other media**
Required literature (available in the library and 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. • 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	**DIGITAL SYSTEMS PROJECTING**						
Code	FELH07	Year of study	1				
Course teacher	Julije Ožegović, Ph.D., Full Professor	Credits (ECTS)	5				
Associate teachers	Vesna Pekić, Ph.D., Ante Kristic, Ph.D.	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: - Course provides advanced knowledge of digital system projecting using hardware definition languages, block synthesis methods and structural synthesis using complex programmable logic structures.		
Course enrolment requirements and entry competences required for the course	None		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - design digital systems using program definition of hardware - organize HDL modeling and synchronization - create a system using HDL syntax and functions libraries - evaluate results of simulation measurements - justify application of CPLD and FPGA architectures		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Approach to program specification of hardware. Verilog.	2	0
	Verilog basic syntax.	2	0
	Logic gate level modelling.	2	0
	Fields of logic gates.	2	0
	Bistables at the logic gate level.	2	0
	Delay, power and types of nets.	2	0
	Data flow level modelling.	2	0
	Behavioral level modelling.	2	0
	Behavioral level modelling techniques.	2	0
	Control structures on behavioral level.	2	0
	Functions and tasks. User defined elements.	2	0
	Transistor level modeling.	2	0
	Development system management.	2	0

	Advanced digital structures.	2	0
	CPLD and FPGA programmable structures architecture.	2	0
	List of laboratory or design exercises		LE hours
	Programmable logic development environment.		4
	Verilog language syntax applications.		4
	Signal power, fields of logic gates.		4
	Data flow level modelling.		4
	Behavioral level modeling.		4
	Functions and tasks. User defined elements.		4
	Advanced digital structures. Finite automata.		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	Attend all forms of teaching, pass ingress and egress tests, perform 100% laboratory exercises, pass preliminary exams or full exam (numeric and theory).	

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	1
	Experimental work		Report		Auditory exercises	0,5
	Essay		Seminar essay		Individual learning	2,5
	Tests		Oral exam		(Other)	
	Written exam		Project		(Other)	

Grading and evaluating student work in class and at the final exam	Continuous assessment: laboratory tests, practical tests, knowledge tests, preliminary exams. Exam: written and oral (numeric and theory) as unity.

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	1. T. R. Padmanabhan, B. Bala Tripura Sundari: "Design Through Verilog HDL", The IEEE Press - Willey Interscience, 2004.		Internet

Optional literature (at the time of submission of study programme proposal)	- Lecture notes: Ožegović, J., Projektiranjedigitalnihsustava, continuously upgraded - A. Kristić: Upute za laboratorijskevježbe, Internet
Quality assurance methods that ensure the acquisition of exit competences	- Lecture attending evidence - Annual exam passing analysis - Student feedback with teacher evaluation - Teacher self-evaluation - Graduated students feedback
Other (as the proposer wishes to add)	

NAME OF THE COURSE	**SOLAR CELLS**							
Code	FELH35	Year of study	1					
Course teacher	Tihomir Betti, Ph.D., Assistant Professor Ivan Marasović, 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						

COURSE DESCRIPTION

Course objectives	Training students for: - Understanding fundamental operating principles of solar cells. - Modeling solar cells using equivalent electrical circuits. - Calculating solar radiation on the plane of arbitrary tilt and orientation. - Understanding different PV technologies and comparison between them. - Designing simple stand-alone and grid-connected PV systems. - Calculating the electricity production of a photovoltaic system.
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: - Calculate the components of solar radiation on the plane of arbitrary tilt and orientation. - Explain the physical operating principles of a solar cell. - Compare different solar cell technologies. - Design simple grid-connected and stand-alone photovoltaic system. - Calculate the electricity production of a photovoltaic system.

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours
	Introduction. Solar radiation: irradiance and irradiation. Basic solar geometry parameters.	2
	Solar radiation components. Measurement of solar radiation. Calculating the beam, diffuse and reflected solar radiation.	2
	Physical principles of solar cell operation. Current-voltage characteristic and basic solar cell parameters. Series and shunt resistance.	2
	Solar cell models. Dependence of solar cell parameters on irradiance and temperature.	2
	Amorphous silicon solar cells.	2
	Crystalline silicon solar cells.	2
	High-efficiency III-V multijunction solar cells. Other semiconductor materials for solar cells.	2
	Organic solar cells.	2
	Third generation solar cells: concepts and perspective. Nanostructure-based solar cells.	2

<table>
<tr><td rowspan="14"></td><td colspan="5">Photovoltaic systems: stand-alone and grid-connected. Photovoltaic system components: inverters, charge regulators, batteries, mounting structures, cables.</td><td>2</td></tr>
<tr><td colspan="5">Design of grid-connected and stand-alone photovoltaic system. Shading and mismatch losses. Hot spot heating.</td><td>2</td></tr>
<tr><td colspan="5">Estimation of electricity production of a photovoltaic system.</td><td>2</td></tr>
<tr><td colspan="5">PV cell, module and system testing. Environmental impact of a photovoltaic system. Photovoltaics in the smart grid.</td><td>2</td></tr>
<tr><td colspan="5">List of laboratory or design exercises</td><td>LE hours</td></tr>
<tr><td colspan="5">Solar radiation. Measurement of solar radiation.</td><td>3</td></tr>
<tr><td colspan="5">Calculating global horizontal radiation from sunshine duration</td><td>3</td></tr>
<tr><td colspan="5">Estimation of solar radiation on surface of arbitrary tilt and orientation.</td><td>6</td></tr>
<tr><td colspan="5">Shade measurement and solar site assessment.</td><td>3</td></tr>
<tr><td colspan="5">Design of grid-connected photovoltaic system.</td><td>6</td></tr>
<tr><td colspan="5">Estimating electricity production of a photovoltaic system.</td><td>3</td></tr>
<tr><td colspan="5">Visiting photovoltaic system on the roof of the faculty building.</td><td>3</td></tr>
<tr><td colspan="5">Testing photovoltaic modules and systems. Photovoltaic system in the smart energy systems (smart home and smart grid).</td><td>3</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Format of instruction</td><td colspan="3">☒ lectures
☐ seminars and workshops
☒ exercises
☐on line in entirety
☐ partial e-learning
☒ field work</td><td colspan="3">☒ independent assignments
☒ multimedia
☒ laboratory
☐ work with mentor
☐ (other)</td></tr>
<tr><td>Studentresponsibilities</td><td colspan="6">At least 70% of lectures attendance. Completed all laboratory assignments and the presentation of two projects.</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>Individual work</td><td>2</td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td></td><td>Laboratory exercises</td><td>1</td></tr>
<tr><td>Tests</td><td>0.15</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>0.75</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">Students work in groups of two on two projects: the first project involves calculation of global solar radiation from sunshine duration, the evaluation of the model used and calculation of solar energy on slope of arbitrary tilt and orientation. The first project is presented during the first midterm exam (after 7 weeks of classes). The second project is design of a photovoltaic system and students must complete it and present the results during the second midterm exam (after the following 6 weeks of classes). Apart from presentation of student projects, there will be two midterm quizzes. The requirement for passing the course is to score at least 40% at each quiz, complete all laboratory work and successfully present the projects.. The final grade (in percentage) is formed using following formula:
Grade(%)=0.3(M1+M2)+0.4P,
where:
• M1, M2 – grade from midterm exams given in percentage,
• P – grade from projects given in percentage.
Students notpassingthemidtermexams take partinthefinalexams. For passingthefinalexam, students must score at least 50% as well as have a positiveassesmentofthelaboratoryexercises. The grade on finalexamsisdeterminedbythe formula:
Grade(%) = 0.65F+0.35P,
where:
• P – grade from projects given in percentage.</td></tr>
</table>

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	T. Betti, I. Marasović: Sunčanećelije – autoriziranapredavanja (prezentacije), FESB		E-learning portal
	P. Kulišić, J. Vuletin, I. Zulim: Sunčane ćelije, Školska knjiga, Zagreb, 1994.		
	PlanningandInstallingPhotovoltaic Systems, 2nd edition, Earthscan, 2010.		
Optional literature (at the time of submission of study programme proposal)	- T. Markvart, L. Castañer: Practical Handbook of Photovoltaics: Fundamentals and Applications, Elsevier, 2003. - M.A. Green: Solar cells: operating principles, technology, and system applications, Prentice-Hall, 1982. - A. Luque, S. Hegedus: Handbook of Photovoltaic Science and Engineering, Wiley, 2003. - S.M. Sze, K.K. Ng: Physics of Semiconductor Devices, Wiley, 2006. - M.A. Green: Third Generation Photovoltaics, Springer, 2006.		
Quality assurance methods that ensure the acquisition of exit competences	- Record of number of students attending the classes - Evaluation of results in accordance with expected learning outcomes - Feedback from students via student surveys - Teachers self-evaluation - 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 10 learning outcomes)	Students will be able to: - define the role, advantages and technologies of DW in information systems and business systems, - 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.

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction to Data Warehouse (DW)	2	
	DW technologies & environment	2	
	DW architecture. Concepts. Cube. OLAP. Data Mart	2	
	DW history and characteristics	2	
	Business processes (introduction)	2	
	ETL	2	
	Dimensional model. Star schema vs. snowflake schema	2	
	First midterm *pause*		
	Fact table. Examples	2	
	Dimensional table. Surrogate keys. Examples	2	
	DW projects and methodologies	2	
	OLAP tools and analysis. CubePlayer	2	
	Business Intelligence. Data Mining	2	
	DW projects examples	2	
	Second midterm *pause*		
	List of laboratory exercises		LE hours
	Introduction to the work method. Defining of project teams		2
	Installation and configuration of DW environment. Business process (BP) selection		4
	BP analysis – *short presentation*		2
	DW architecture design		2
	Dimensional model design – *logical design (short presentation)*		4
	DW physical design		2
	DW detailed design (with data)		4
	OLAP cube		4
	Reporting – *short presentation*		2

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

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	0,8	Practical training	1
	Experimental work		Report		Individual work	1
	Essay		Seminar essay		Laboratory exercises	0,2
	Tests		Oral exam	0,5	Preparation for laboratory exercises	
	Written exam		Project	0,5	(Other)	

Grading and evaluating student	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

work in class and at the final exam	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. 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*).		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	• S. Čelar: Authorised lectures, FESB		e-learning portal
	• William Inmon: Building the Data Warehouse (2005) John Wiley and Sons, ISBN 978-81-265-0645-3		
	• Kimball, R., Ross, M.: The Data Warehouse Toolkit, The Definitive Guide to Dimensional Modeling, Third Edition, John Wiley & Sohns, 2013		
	• S. Čelar: Authorised instructions for laboratory exercises, FESB		e-learning portal

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	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;						

10 learning outcomes	- 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	AEhours
	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		LEhours
	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
	3D puzzle game: The game manager.		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	Minimum of 70 percent lecture attendance. Completing all the 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
	Essay		Seminar essay		Laboratory exercises	1.5
	Tests	0.5	Oral exam		(Other)	
	Written exam	0.5	Project		(Other)	

Grading and evaluating student work in class and at the final exam	During semester, 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.		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	• T. Marasović, J. Marasović; Authorizedlectures		e-Learning portal
Optional literature (at the time of submission of study programme proposal)	• T. Miller; "Beginning 3D Game Programming", SamsPublishing, 2004, ISBN: 0-672-32661-2. • K. C. Finney; "3D Game Programming All in One", Premier Press, 2004. ISBN: 1-59200-136-X. • S. Blackman; "Beginning 3D Game Development withUnity", Apress, 2011, ISBN: 978-1-4302-3422-7		
Quality assurance methods that ensure the acquisition of exit competences	- 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		
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

<table>
<tr><td rowspan="2">Associate teachers</td><td rowspan="2"></td><td rowspan="2">Type of instruction (number of hours)</td><td>L</td><td>S</td><td>AE</td><td>LE</td><td>DE</td></tr>
<tr><td>30</td><td></td><td></td><td>30</td><td></td></tr>
<tr><td>Status of the course</td><td>Elective</td><td>Percentage of application of e-learning</td><td colspan="5">0</td></tr>
<tr><td colspan="8">COURSE DESCRIPTION</td></tr>
<tr><td>Course objectives</td><td colspan="7">Training students for:
- 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</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:
– 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</td></tr>
</table>

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

Course content	L hours	AE hours
Introduction to optoelectronics	2	
Machine visiona and computer vision	2	
Mathematical description of cameras and geometry of a space	4	
Lense optical system and distorsions	2	
Color system and photosensitive chips	2	
Inudstrial cameras, linear cameras, motion capture systems	2	
IR cameras and applications	2	
Stereovision systems	2	
3D scanners	2	
Laser range finders and LIDAR	2	
Night vision cameras and image intensifiers	2	
Future of optoelectronics	2	
Introduction to optoelectronics	2	

List of laboratory or 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

Format of instruction		
Format of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ *on line* in entirety ☐ partial e-learning ☐ field work	☒ independent assignments ☒ multimedia ☒ laboratory ☐ work with mentor ☐ (other)

<table>
<tr><td>Student responsibilities</td><td colspan="6"></td></tr>
<tr><td rowspan="5">Screening student work (name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)</td><td>Class attendance</td><td>1</td><td>Research</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Report</td><td></td><td>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="4">Title</td><td>Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="4">• Hartley, R., Zisserman, A.: ‘Multiple view geometry in computer vision’ (Cambridge University Press, 2003)</td><td></td><td></td></tr>
<tr><td colspan="4">• 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.
- Feedback from graduated students (or senior students) on course content relevance.</td></tr>
</table>

Other (as the proposer wishes to add)	/

NAME OF THE COURSE	MOBILE COMMUNICATIONS						
Code	FELJ14	Year of study	1.				
Course teacher	Zoran Blažević, Ph.D., Full Professor	Credits (ECTS)	5				
Associate teachers	Maja Škiljo, Ph.D.	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	15	15	0
Status of the course	Obligatory: 241 Elective: 242	Percentage of application of e-learning	0				

COURSE DESCRIPTION			
Course objectives	Training students for: - understanding and application of basic principles of radio-networks, - physical OSI layer of cellular radio-networks calculation and analysis, - mobile radio networks analysis.		
Course enrolment requirements and entry competences required for the course	Finished the undergraduate study of Communications and Information Technology		
Learning outcomes expected at the level of the course (4 to 10 learning outcomes)	Students will be able to: - Calculate optimal radio system configuration in sense of selecting digital modulation and coding, - model and perform basic calculation of cellular networks: base stations power and interference budget - calculate and analyse (narrow- and wide-band) radio-channel parameters, - conduct and analyse radio-channel measurements		
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction to Mobile Communications.	1	1
	Classification of digital radio-channels.	2	1

	Digital radio system performances.	2	2
	Systems with bandwidth limitation.	2	1
	Power limited systems.	2	1
	Power limited and bandwidth limited systems. Channel coding.	2	1
	Direct Sequence-Spread Spectrum Systems	2	1
	Cellular radio systems. Cochannel and adjacent channel interference.	2	1
	Path-loss law. Base station ling budget. Multipath reception.	2	2
	First midterm exam		
	Cell radio-coverage calculation.	2	1
	Mobile propagation channel analysis.	2	1
	Radio channel measurements.	2	1
	Propagation channel classification. Delay-spread and channel coherence bandwidth.	2	1
	Second midterm exam		
	List of laboratory exercises		LE hours
	Radio channel characterization by Vector Network Analyser measurements.		5
	Communication systems testing and simulating by Matlab and Simulink		2
	Analog and digital modulation simulations		2
	Multipath fading channels simulations		2
	Adjacent and co-channel interference in cellular systems simulations by Simulink		2
	COST 207 and GSM/EDGE channel models by Matlab		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 laboratory exercises required.					
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	2,0	Research		Practical training	
	Experimental work		Report		Individual work	1.5
	Essay		Seminar essay		Laboratory exercises	0,8
	Tests	0,5	Oral exam		Preparation for laboratory exercises	0,2
	Written exam		Project		(Other)	
Grading and evaluating student work in class and at the final exam	There are two midterms and final exams. The first midterm exam is after 7 weeks of lecturing and the second one is after the next 6 weeks. Each midterm test and final tests consist of theoretical questions and numerical. The students that did not pass the midterm exams take part In the final exams. The midterm and final exams are carried out as written tests. The requirement for passing grade is the positive assessment of laboratory exercises and 40 % points on each midterm exam or the final exam. Grade (in percentage) is formed according to the formula: Grade(%) = 0,1 NP + 0,1 LV + 0,4 (M1 + M2) the activities in percentage: • NP - attendance at lectures, • LV – laboratory assessment, • 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**
	• Z. Blažević: Mobilne komunikacije, predavanja, FESB		e-learning portal
	• I. Zanchi, Z. Blažević: Radiokomunikacije, predavanja, FESB		e-learning portal
	• David Parson.: The Mobile Radio Propagation Channel, Pentech Press Pub. London, 1992.	2	

Optional literature (at the time of submission of study programme proposal)	• R. Steele: "Mobile Radio Communications", Pentech Press, London, GB and IEEE Press, Piscataway, USA, 1992. • Vijag, K. Garg, Joseph, E. Wilkes: Wireless and Personal Communications Systems, Prentice Hall PTR, NY 1996.

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

NAME OF THE COURSE	**BIOELECTROMAGNETICS**						
Code	FELJ24	Year of study	1.				
Course teacher	Antonio Šarolić, Ph.D., Full Professor	Credits (ECTS)	5				
Associate teachers	Niko Ištuk, Teaching Assistant	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				

<table>
<tr><th colspan="4">COURSE DESCRIPTION</th></tr>
<tr><td>Course objectives</td><td colspan="3">Training students for:

- understanding the human electrophysiology
- acquiring knowledge on therapeutic and diagnostic methods
- application of specialized interdisciplinary knowledge in biomedical applications</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:

- describe the cell structure
- describe the electrophysiology of excitable cells and tissues
- apply the electrophysiology knowledge for understanding the brain and heart function
- analyze the electric activity of heart and brain with applications in diagnostics
- link the electrophysiology principles to the function of other bodily organs and to potential biomedical applications</td></tr>
<tr><td rowspan="13">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 and history.</td><td>2</td><td>0</td></tr>
<tr><td>Structure of neuron and muscle cells.</td><td>2</td><td>0</td></tr>
<tr><td>Membrane potential.</td><td>2</td><td>0</td></tr>
<tr><td>Axon as transmission line (cable).</td><td>2</td><td>0</td></tr>
<tr><td>Membrane activation.</td><td>2</td><td>0</td></tr>
<tr><td>Synapses, receptors and brain.</td><td>2</td><td>0</td></tr>
<tr><td>Heart.</td><td>2</td><td>0</td></tr>
<tr><td>Volume source. Volume conductor.</td><td>2</td><td>0</td></tr>
<tr><td>Electrocardiography (ECG).</td><td>2</td><td>0</td></tr>
<tr><td>Electroencephalograhpy (EEG).</td><td>2</td><td>0</td></tr>
<tr><td>Electrophysiology of the eye. Electrodermal reaction.</td><td>2</td><td>0</td></tr>
<tr><td>Other diagnostic and therapeutic methods based on applied electromagnetics. Magnetic resonance imaging (MRI).</td><td>2</td><td>0</td></tr>
</table>

	Visit to Medical School of the University of Split. Visit to companies related to the course topics.	2	0

	List of laboratory or design exercises	LE hours
	Membrane potential.	4
	Axon as transmission line (cable).	2
	Membrane activation.	4
	Synapses, receptors and brain.	2
	Electrocardiography (ECG).	2
	Electroencephalograhpy (EEG).	2
	Electrodermal reaction.	2
	Other diagnostic and therapeutic methods based on applied electromagnetics. Magnetic resonance imaging (MRI).	2
	Visit to Medical School of the University of Split. Visit to companies related to the course topics.	6

Format of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ *on line* in entirety ☐ partial e-learning ☒ field work	☐ independent assignments ☐ multimedia ☒ laboratory ☐ work with mentor ☐ (other)
Student responsibilities	Student is required to attend the lectures and auditory exercises in the amount of at least 70% of the schedule. Student is required to attend the laboratory exercises in the amount of 100% of the schedule and to complete all tasks associated with laboratory exercises.	

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal*	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)	

to the ECTS value of the course)						

Grading and evaluating student work in class and at the final exam	During the semester, two mid-exams will be held. The first mid-exam will be held in the middles of the semester, while the second will be held after the lectures and exercises are completed, schedules to be agreed with the students. The first mid-exam is based on the first half of the course material. The second mid-exam is based on the first second half of the course material. To pass at each mid-exam, min. 50% of points must be earned from the part of the exam containing numerical problems (material from auditory exercises) and min. 50% of points must be earned from the part of the exam containing theory (material from the lectures). To earn the right to approach the second mid-exam, min. 30% of points must be earned from the part of the first mid-exam containing numerical problems (material from auditory exercises) and min. 30% of points must be earned from the part of the first mid-exam containing theory (material from the lectures). If a student earns the positive grades on both mid-exams, he/she is considered to have passed the whole exam with the grade calculated as average from both mid-exams. At the first exam term, students may choose to take the exam containing only that half of the material that they haven't passed at mid-exams. At all other exam terms, students must take the whole exam, containing all the course material. Approaching the exams is subject to fulfilling the requirements on student responsibilities. The overall point percentage defining the overall grade is calculated as the average of points earned in all exam questions, corrected by the result of oral verification: Percentage -> Grade 50% - 62,4% -> sufficient (2) 62,5% - 74,9% -> good (3) 75% - 87,4% -> very good (4) 87,5% - 100% -> excellent (5) Final grade can be supplemented by performing practical project work involving individual and experimental work, in agreement with the teacher. Exam terms: according to the academic year calendar

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

NAME OF THE COURSE	WIRELESS COMMUNICATIONS						
Code	FELH12	Year of study	2.				
Course teacher	Antonio Šarolić, Ph.D., Full Professor	Credits (ECTS)	5				
Associate teachers	Niko Ištuk, mag. ing. el.		L	S	AE	LE	DE

		Type of instruction (number of hours)	30			30	
Status of the course	Obligatory	Percentage of application of e-learning	0				

COURSE DESCRIPTION

Course objectives	Training students for: - understanding the principles of radio signal propagation - understanding the principles of wireless signal transmission - understanding all the components of transmitters and receivers - understanding the important present and emerging wireless communication systems
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: - utilize antenna parameters as the basis for antenna application in ICT - elaborately assess the applicability of a certain antenna for specific purpose - characterize the frequency bands from the aspect of specific radio system features and needs - calculate the budget of a wireless link between the transmitter and the receiver - analyze the characteristics of modulation procedures - analyze and compare the characteristics of different radiocommunication systems

Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction and history of wireless communications. Radiation phenomena. Antennas – parameters and elementary radiation sources.	2	0
	Antennas – overview of types and frequency.	2	0
	Antenna systems.	2	0
	Radio spectrum.	2	0
	Radio signal propagation. Terrestrial and satellite links.	2	0
	Analog modulation procedures.	2	0
	Digital modulation procedures.	2	0
	Radiocommunication system configuration.	2	0
	Theoretical basis of radiocommunication systems. Radio channel. Broadcasting network operation principles.	2	0
	Mobile telephony network operation principles.	2	0
	Overview of presently operating and emerging systems: GSM, UMTS, LTE.	2	0
	Overview of presently operating and emerging systems: Wi-Fi, WIMAX, Bluetooth.	2	0
	Overview of presently operating and emerging systems: RFID, DVB, UWB, GPS, TETRA.	2	0

	List of laboratory or design exercises	LE hours
	Antennas – parameters and elementary radiation sources.	2
	Antennas – overview of types and frequency.	2
	Antenna systems.	2
	Radio spectrum.	2
	Radio signal propagation. Terrestrial and satellite links.	2
	Analog modulation procedures.	2
	Digital modulation procedures.	2
	Radiocommunication system configuration.	2
	Theoretical basis of radiocommunication systems. Radio channel.	2
	Mobile telephony network	2

	Presently operating and emerging systems: GSM, UMTS, LTE.	2
	Presently operating and emerging systems: Wi-Fi, Bluetooth.	2
	Presently operating and emerging systems: RFID, DVB.	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	Student is required to attend the lectures and auditory exercises in the amount of at least 70% of the schedule. Student is required to attend the laboratory exercises in the amount of 100% of the schedule and to complete all tasks associated with 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	0,5
Experimental work	0,5	Report		Laboratory exercises	0,5
Essay		Seminar essay		Individual work	0,5
Mid-exam	0,5	Oral exam		(Other)	
Written exam	0,5	Project	0,5	(Other)	

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

During the semester, two mid-exams will be held. The first mid-exam will be held in the middles of the semester, while the second will be held after the lectures and exercises are completed, schedules to be agreed with the students.
The first mid-exam is based on the first half of the course material. The second mid-exam is based on the first second half of the course material.
To pass at each mid-exam, min. 50% of points must be earned from the part of the exam containing numerical problems (material from auditory exercises) and min. 50% of points must be earned from the part of the exam containing theory (material from the lectures).
To earn the right to approach the second mid-exam, min. 30% of points must be earned from the part of the first mid-exam containing numerical problems (material from auditory exercises) and min. 30% of points must be earned from the part of the first mid-exam containing theory (material from the lectures).
If a student earns the positive grades on both mid-exams, he/she is considered to have passed the whole exam with the grade calculated as average from both mid-exams.
At the first exam term, students may choose to take the exam containing only that half of the material that they haven't passed at mid-exams.
At all other exam terms, students must take the whole exam, containing all the course material.

Approaching the exams is subject to fulfilling the requirements on student responsibilities.
The overall point percentage defining the overall grade is calculated as the average of points earned in all exam questions, corrected by the result of oral verification:

Percentage -> Grade
50% - 62,4% -> sufficient (2)
62,5% - 74,9% -> good (3)
75% - 87,4% -> very good (4)
87,5% - 100% -> excellent (5)

	Final grade can be supplemented by performing practical project work involving individual and experimental work, in agreement with the teacher. Exam terms: according to the academic year calendar		
Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	• E. Zentner: Antene i radiosustavi, Graphis, Zagreb 2001.		
	• David Tse andPramodViswanath: Fundamentals of Wireless Communication, Cambridge University Press, 2005.		
Optional literature (at the time of submission of study programme proposal)	- Ramjee Prasad: Technology Trends in Wireless Communications, Artech House, 2003. - Handbook of antennas in wireless communications, CRC Press, 2002.		
Quality assurance methods that ensure the acquisition of exit competences	Surveys providing student feedback		
Other (as the proposer wishes to add)			

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	None						

required for the course		
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*	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

<table>
<tr><td>equal to the ECTS value of the course)</td><td>Written exam</td><td>0,2</td><td>Project</td><td></td><td>(Other)</td><td></td></tr>
<tr><td>Grading and evaluating student work in class and at the final exam</td><td colspan="6">During the semester there are two midterm exams. The 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.</td></tr>
<tr><td rowspan="7">Required literature (available in the library and via other media)</td><td colspan="3">Title</td><td colspan="2">Number of copies in the library</td><td>Availability via other media</td></tr>
<tr><td colspan="3">• TSiegwart, R., Nourbakhsh, I. R., Scaramuzza D., Autonomous Mobile Robots, MIT Press, 2011.</td><td colspan="2"></td><td>teacher/Internet</td></tr>
<tr><td colspan="3">• Thomas Braunl, Embedded Robotics: mobile robot design and applications with embedded systems, Springer, 2006.</td><td colspan="2"></td><td>teacher/Internet</td></tr>
<tr><td colspan="3">• S. Thrun, W. Burgard, D. Fox, Probabilistic Robotics, MIT Press, 2006.</td><td colspan="2"></td><td>teacher/Internet</td></tr>
<tr><td colspan="3">• Saeed B. Niku: Introduction to Robotics: Analysis, Systems, Applications, Prentice Hall, 2001.</td><td colspan="2"></td><td>teacher</td></tr>
<tr><td colspan="3">• M. Bonković, J. Music, I Stančić: “Mikroregulatori i ugradbenimrežnisustavi u Arduino razvojnomokruženju”, faculty book, FESB</td><td colspan="2"></td><td>e-learning portal</td></tr>
<tr><td colspan="3">• J. Musić, M. Bonković: Authorised lecture notes, FESB</td><td colspan="2"></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. Tadej Bajd: Osnove robotike, Fakulteta za elektrotehniko, Univerza v Ljubljani, 2000.
2. Kovačić, Laci, Bogdan, Osnove robotike, Fakultet elektrotehnike i računarstva, Zagreb, 1999.</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.
- Feedback from graduated students (or senior students) on course content relevance.
- Periodic institutional evolution of course teachers.</td></tr>
</table>

Other (as the proposer wishes to add)	/

NAME OF THE COURSE	**MEDICAL ELECTRONIC DEVICES**							
Code	FELH41	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 - understanding and application of success criteria for medical device innovation and development							
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: - 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							
Course content broken down in detail by weekly	Course content	L hours	AE hours					
	Basics of human electrophysiology and electrophysiology	2	0					

class schedule (syllabus)	Measurement medical electronic devices	2	0
	Diagnostic medical electronic devices	2	0
	Therapeutic medical electronic devices	2	0
	Electronic circuits and components in medical devices	6	0
	Circuits and devices for electric and magnetic stimulation at low frequencies	2	0
	Circuits and devices for thermal procedures at high frequencies	2	0
	Electrical safety aspects and electromagnetic compatibility aspects of medical electronic devices	2	0
	Control and auxiliary medical electronic devices. E-Health. Theranostic medical electronic devices – unifying the therapeutics and diagnostics in innovative medical devices and methods	2	0
	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)	2	0
	Clinical studies: principles and implementation of clinical trials of medical devices	2	0
	List of laboratory or design exercises		LE hours
	Basics of human electrophysiology		2
	Amplifier circuits		4
	Electrostimulator circuits		4
	Noise and disturbance suppression in electronic devices		2
	Electromagnetic compatibility testing		2
	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.		
	JaakkoMalmivuo& Robert Plonsey: Bioelectromagnetism -		

	PrinciplesandApplicationsofBioelectricandBiomagneticFields, 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)			

NAME OF THE COURSE	**SYSTEMS FOR WIRELESS TRANSMISSION OF ENERGY**						
Code	FELJ36	Year of study	2				
Course teacher	Zoran Blažević, Ph.D., Full Professor	Credits (ECTS)	5				
Associate teachers	Maja Škiljo, Ph.D.	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 of basic principles of and problemacy of systems for wireless transmission of energy, - designing of radio system for near-field transmission of energy - design of radio system for far-field power transmission - calculation and analysis of wireless energy systems parameters						
Course enrolment requirements and entry competences required for the course	Finished the undergraduate study of Communications and Information Technology.						
Learning outcomes expected at the level of the course	Students will be able to: - analyse power and energy transmission techniques, - calculate and estimate wireless energy transmission system parameters, - designing basic transmission system schemes for given service						

(4 to 10 learning outcomes)			
Course content broken down in detail by weekly class schedule (syllabus)	Course content	L hours	AE hours
	Introduction. Historical perspective of radio and wireless transmission.	2	
	Principles and techniques for radio-transmission of energy. Transformers and resonant transformers (Tesla Coil), and electrically small antennas.	4	
	Antenna scattering matrix. Coupled-Mode Theory and Spherical Mode Theory-Antenna Model application to wireless transmission of energy systems.	4	
	Rectennas.	2	
	Near-field energy and power transmission. Resonant transformer.	4	
	Far-field power transfer.	4	
	Ground energy transfer by far-field systems concept	3	
	Satellite energy transfer system concept	3	
	Norms and standards for wireless energy transfer. Qi standard.	2	
	Electromagnetic Compatibility of wireless energy transfer systems.	2	
	Interference problem between radio-communications systems and radio systems for wireless energy transfer.	2	
	Midterm exam		
	List of laboratory exercises		LE hours
	Measurements and adjustments of inductively fed electrically small antennas		8
	Measurements of transfer performances by Spectrum Analyser, and by Oscilloscope		8
	Measurements of transfer performances by Vector Network Analyser		6
	Tesla Coil Measurements.		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)
Student responsibilities	The presence on lectures in the amount of at least 70 % of the times scheduled. Performed all laboratory exercises required.	

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	1.5	Research		Practical training	
	Experimental work		Report		Individual work	2
	Essay		Seminar essay		Laboratory exercises	0,8
	Tests	0,5	Oral exam		Preparation for laboratory exercises	0,2
	Written exam		Project		(Other)	

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

There are one midterm and one final exam. Both midterm test and final test consist of theoretical questions and numerical problems. The students that did not pass the midterm exams take part In the final exams. The midterm and final exams are carried out as written tests. The requirement for passing grade is the positive assessment of laboratory exercises, 40 % points on the midterm exam or the final exam, and the rest of the grade depends on the seminary work presented by the student. Grade (in percentage) is formed according to the formula:

$$Grade(\%) = 0{,}1\ NP + 0{,}1\ LV + 0{,}4\ (M + S)$$

the activities in percentage:

- NP - attendance at lectures,
- LV – laboratory assessment,
- M – test results.,
- S – seminary work results and presentation

Required literature (available in the library and via other media)	**Title**	**Number of copies in the library**	**Availability via other media**
	• Ki Young Kim (editor), “Wireless Power Transfer-Principles and Engineering Explorations”, InTech, January 2012.		e-learning portal

	• Volakis J., C. C. Chen and K. Fujimoto, “Small antennas: miniaturization techniques and applications”, New York, McGraw-Hill, 2010.		e-learning portal
	• Special issue „Solar Power Satellite and Wireless Power Transmission“, IEEE Microwave Magazine, Vol. 3, No. 4, December 2002.	1	
Optional literature (at the time of submission of study programme proposal)	• Lee J. and S. Nam, “Fundamental aspects of near-field coupling small antennas for wireless power transfer”, IEEE Trans. Antennas Propag., Vol. 58, No. 12, 3442-3449, 2010. • P. Sample, D. T. Meyer, J. R. Smith: Analysis, experimental results, and range adaptation of magnetically coupled resonators for wireless power transfer, IEEE Transactions on Industrial Electronics, Vol. 58, No. 2, 2010, p.p 544-554. • N. Tesla, A. Marinčić: Colorado Springs Notes, Nolit, Beograd, 1978. • Carol Gray Montgomery, Robert Henry Dicke and Edward M. Purcell, “Principles of microwave circuits”, McGraw-Hill Book Company, Inc.,USA, 1948.		
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	**MULTIMEDIA SYSTEMS**						
Code	FELJ20	Year of study	2.				
Course teacher	Mladen Russo, Ph.D., Assistant Professor	Credits (ECTS)	5				
Associate teachers	Jelena Čulić, Teaching Assistant Martina Bašić, Teaching Assistant	Type of instruction (number of hours)	L	S	AE	LE	DE
			30	0	0	30	0

Status of the course	Obligatory: 242 Elective: 241	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	2	0	

	color models (HSB, HLS, HSV). Gamma correction. Image signal (resolution, depth, memory requirements). Image formats (gif, tiff, jfif, ps, bmp).		
	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

<table>
<tr><td rowspan="5">Format of instruction</td><td colspan="3">☒ lectures
☐ seminars and workshops
☒ exercises
☐ *on line* in entirety
☐ partial e-learning
☐ field work</td><td colspan="3">☐ independent assignments
☐ multimedia
☒ laboratory
☐ work with mentor
☐ (other)</td></tr>
<tr><td>Student responsibilities</td><td colspan="6">The presence on lectures in the amount of at least 70 % of the times scheduled. Performed all required laboratory exercises.</td></tr>
</table>

Screening student work *(name the proportion of ECTS credits for each activity so that the total number of ECTS credits is equal to the ECTS value of the course)*	Class attendance	3	Research		Practical training	
	Experimental work		Report		Individual work	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: Multimedijski sustavi, internal script	1	e-learning portal
Optional literature (at the time of submission of study programme proposal)	• Steinmetz, Nahrstedt: "Multimedia Fundamentals: Media Coding and Content Processing", Prentice Hall, 2002 • Rao, Bojkovic, Milovanovic: "Multimedia Communication Systems: Techniques, Standards and Networks", 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)			