Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	DSP Algorithms and Programming		
Lecturer (for lectures)	Nikolić R. Tatjana		
Lecturer/associate (for exercises)	Nikolić R. Tatjana		
Lecturer/associate (for OFE)	Nikolić R. Tatjana		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	The goal of this course is to introduce students with the theoretical and practical knowledge required for implementation of the basic algorithms from the domain of digital signal processing using DSP processors.
Course outcomes	The students are able to use DSP processor for digital signal processing using high-level programming languages and modern development tools to implement complex DSP algorithms.
Course outline	
Theoretical teaching	Review of the theory of digital signal processing. Digitization of analog signals. Sampling, quantization and work with the codec. A/D and D/A converters. Specificity and DSP processor architectures. Representation of the data using fixed and floating point format and arithmetic; the effect of finite length words. Instruction set. Development and implementation of computationally efficient algorithms on the DSP platform: convolution, correlation, digital filters (IIR, FIR, LMS, DFT, FFT, IFFT). Audio signal processing using DSP processors. Image processing using DSP processors. Programming the DSP processors in assembly language and higher programming language. Development kits and tools: assembler, linker, simulator, debugger. Writing an efficient code: compiler optimization, effect of data types and memory map. Code optimization.
Practical teaching (exercises, OFE, study and research work)	It is planned that students individually do the following exercises: 1) Manipulation with numbers of fixed- and floating-point format, 2) Getting to know the possibilities of modern development tools for design, 3) Implementation of FIR and IIR filters using MATLAB and FDATool, 4) Practical application of FFT, 5) Generation of sinusoidal and noise signal, DTM (dual-tone multifrequency) generator and tone detector; 6) Audio signal processing, sound source location, and application in speech recognition, 7) Echoes cancelation, 8) Techniques for channel coding and application in communications, 9) Digital image processing, histogram, filtering, application of standard JPEG and DCT, 10) Medical image processing, filtering electrocardiogram (ECG) and electroencephalogram (EEG) signals. Exercises are carried out using software tools MATLAB and Code Composer Studio, and DSP development system.
Textbooks/references	
1	DSP algorithms and programming, Script and PowerPoint presentations for all lectures, available on the website of the course
2	Kuo, S., Lee, B., Tian, W., Real-Time Digital Signal Processing: Fundamentals, Implementations and Applications, Second Edition, John Wiley & Sons Ltd., 2013.
3	Kuo, S., Gan, W. S., Digital Signal Processors: Architectures, Implementations, and Applications, Pearson Educaton Inc., 2005.
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Number of classes of active education per week during semester/trimester/year

Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1		

Teaching methods	Lectures, exercises, labs, homeworks, colloquia, projects, consultations

Grade (maximum number of points 100)

Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	20
Exercises	20	**Oral exam**	20
Colloquia	20		
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Embedded Systems Design		
Lecturer (for lectures)	Đošić M. Sandra		
Lecturer/associate (for exercises)	Jovanović D. Milica		
Lecturer/associate (for OFE)	Stojanović Z. Igor		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	The course aims to provide students with a fundamental knowledge of methods and tools for modeling, specification, partitioning, synthesis (hardware, software and interface), validation, verification and design of embedded system.
Course outcomes	By the end of the course a student should be able to: a) model and specify embedded systems at high level of abstraction; b) analyze hardware/software tradeoffs, algorithms and architectures to optimize the embedded systems based on requirements and implementation constraints.
Course outline	
Theoretical teaching	Introduction to embedded system design: application areas and examples, common characteristics, and challenges in embedded systems; traditional design flow, platform-based design. Specifications and modeling: requirements, models of computation, communicating finite state machines, data flow models, process networks, discrete-event based languages, levels of hardware modeling; comparison of models of computation. Evaluation and validation: performance evaluation, energy and power models, simulation, emulation, formal verification. Application mapping: problem definition, scheduling in real-time systems, hardware/software partitioning, mapping to heterogeneous multi-processors.
Practical teaching (exercises, OFE, study and research work)	Practical classes cover work with the FPGA development platforms. Several laboratory exercises and small-scale projects focus on unified designing of hardware and software as well as performance evaluation. Practical classes include the following activities: a) designing a complete microprocessor based on the available IP core of standard peripheral units, b) developing software under the operating system using available device drivers, c) designing a dedicated IP core, and d) developing a software driver for the projected IP core and its integration into the microprocessor system.
Textbooks/references	
1	P. Marwedel, Embedded System Design: Foundations of Cyber-Physical Systems, and the Internet of Things, Springer, 2018.
2	M. Wolf, High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing, Morgan Kaufmann, 2014.
3	L. H. Crockett, R. A. Elliot, M. A. Enderwitz, R. W. Stewart, The Zynq Book : Embedded Processing with the Arm Cortex-A9 on the Xilinx Zynq-7000 All Programmable SoC, Strathclyde Academic Media, 2014
4	Embedded System Design, Notes and PowerPoint presentation for all lectures, available online.
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1		

Teaching methods	Lectures, exercises, labs, homework, colloquia, consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	25
Exercises	30	Oral exam	25
Colloquia			
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Advanced Microprocessor Architectures		
Lecturer (for lectures)	Nikolić R. Tatjana		
Lecturer/associate (for exercises)	Nikolić R. Tatjana		
Lecturer/associate (for OFE)	Nikolić R. Tatjana		
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	
Prerequisites			
Course objectives	Introducing students with current trends and future directions for the development of microprocessor architectures. The study material refers to a high-performance processor and various techniques of parallelism that are implemented at the thread-level and process-level.		
Course outcomes	a) Acquiring knowledge of modern multicore on-chip microprocessor, b) Ability to design and program homogeneous and heterogeneous multiprocessor systems-on-chip, c) Creating multithread programs, performance evaluation using code profiler and debugging code, d) Architecture and software design of application-specific processor.		
Course outline			
Theoretical teaching	Trends in scaling technology. Techniques to improve performance. Reducing energy consumption. Operating modes for saving energy in a microprocessor. Throughput increasement. Multiprocessor systems. Physical and logical connection of computer resources. Basic concepts of parallel programming. Parallelism at different levels. Concurrent and distributed systems. Process. Thread. Data communication and synchronization. Forms of parallel programming. Structure of the program. Multicore processor architectures. Multicore system programming. Manycore processors. Characteristics of symmetric and asymmetric multiprocessor architectures. Application specific processors. Data level parallelism with SIMD and GPU architecture. Programming manycore systems using OpenCL, OpenMP and MPI.		
Practical teaching (exercises, OFE, study and research	During implementation of the plan and program the students need independently to do the following exercises: 1) performance evaluation of the system with parallel execution of program sections, 2) creating a thread, 3) creating parallel-sequential programs, 4) usage of parallel library program for multicore machines, 5) creating a code with threads by modification of the serial code, 6) creating complex multithread parallel programs.		
Textbooks/references			
1	Advanced microprocessor architectures, PowerPoint presentations for all lectures, available on the website of the course		
2	Mile Stojčev, Emina Milovanović, Tatjana Nikolić, Multi- and many-core system on chip, Faculty of Electronic Engineering Niš, in Serbian, 2012.		
3	J. L. Hennessy, D. A. Patterson, Computer Architecture: A Quantitative Approach (5th Edition), Morgan Kaufmann, 2012.		
4	Barbara Chapman, Gabriele Jost, Ruud van der Pas, Using OpenMP, Portable Shared Memory Parallel Programming, The MIT Press, Cambridge, MA, 2008.		
5	Michel Dubois, Murali Annavaram, Per Stenstrom, Parallel Computer Organization and Design, Cambridge University Press, 2012.		

Number of classes of active education per week during semester/trimester/year

Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1		

Teaching methods	Lectures, exercises, labs, homeworks, colloquia, projects, consultations

Grade (maximum number of points 100)

Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	20
Exercises	20	**Oral exam**	20
Colloquia	20		
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Adaptive Signal Processing		
Lecturer (for lectures)	Stančić Z. Goran		
Lecturer/associate (for exercises)	Cvetković S. Stevica		
Lecturer/associate (for OFE)	Cvetković S. Stevica		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Acquiring basic knowledge of adaptive processing of digital signals. Introduction to the methods of practical implementation of the adaptive filter transfer function. Introduction to Matlab commands for analyzing and processing of digital signals. Theoretical and practical knowledge of the methods for the design of adaptive filters. Mastering the techniques of nonrecursive adaptive filters design.
Course outcomes	Collecting of theoretical and practical knowledge of the methods for the design of adaptive filters. Mastering the techniques of nonrecursive adaptive filters design.
Course outline	
Theoretical teaching	Least-squares approximation. Correlation. Discrete Fourier transform. Random signals. Spectral estimation. Power density spectrum. Signal energy. Properties of the power spectrum. Power spectral estimation. Wiener filter. Kalman filter. Least-squares system design. Linear predictor realization. System identification. Channel equalization. Interference canceling. Adaptive notch filters. MSE function. Covariance. Convergence time constants. Ideal condition convergence. Steepest-descent algorithm. LMS algorithm. Modified LMS algorithms. RLS algorithm. Measures of adaptive system performance. Learning curve.
Practical teaching (exercises, OFE, study and research	Least-squares approximation calculations in Matlab for analog signals. Least-squares approximation calculations in Matlab for digital signals.Orthogonality. The discrete Fourier series. Correlation. Covariance. Realization of linear predictor, system identification, channel equalization and interference canceling in Matlab.
Textbooks/references	
1	Samuel D. Stearns, Digital signal processing with examples in Matlab, CRC Press Washington, 2003.
2	Ed. Vijay K. Madisetti and Douglas B. Williams, Introduction to Adaptive Filters, Digital Signal Processing Handbook, 1999
3	
4	
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Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1		

Teaching methods	Lectures, auditory exercises, consultation

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		**Written exam**	30
Exercises		**Oral exam**	40
Colloquia			
Projects	30		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Open Source Operating Systems		
Lecturer (for lectures)	Dimitrijević A. Marko		
Lecturer/associate (for exercises)	Dimitrijević A. Marko		
Lecturer/associate (for OFE)	Dimitrijević A. Marko		
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	
Prerequisites			
Course objectives	Acquiring the necessary knowledge for advanced using open source operating systems: Linux/Unix.		
Course outcomes	Mastering the knowledge and skills of using and administering open source operating systems (OOS), application installation on OOS and OOS networking. Learning user interface (shell) and script programming.		
Course outline			
Theoretical teaching	The history of open source system (OOS) development. OOS architectures. Kernel. Working with files and file systems. Shell and shell script programming (regular expressions, variables). Processes and jobs. Working with users and security models. Working with hardware and hardware diagnostics. Working with text files, standard I/O, pipes. Installing and maintaining software on OOS. Computer networks and network services. Graphical user interface.		
Practical teaching (exercises, OFE, study and research work)	The login procedure. General purpose commands (passwd, cal, clear, date, man, find, grep,...). Working with files and directories (commands: cat, chmod, umask, chown, chgrp, cmp, diff, cp, more, mv, rm, ln, ...). Working environment and corresponding commands (env, set). Archiving (tar, gzip, bzip,...). Process control (jobs, ps, top, kill, killall,...). Text editors (VI editor). Shell (bash, tcsh, zsh) and script programming. Regular expressions. Working with a file system (commands df, du, dd, fdisk, gdisk). Graphical user interface. System administration basics. Applications installation and maintenance (rpm, make,...). Basic network services and commands for working in the computer network environment (ping, traceroute, arp, netstat, nslookup,...).		
Textbooks/references			
1	P. P. Silvester, "UNIX user manual" (in Serbian), Mikro Knjiga, 1992.		
2	Z. Jelić, "UNIX User Manual" (in Serbian), Beograd 1989.		
3	A short introduction to UNIX (in Serbian), http://leda.elfak.ni.ac.rs/?page=education/unix/html/sadrzaj.html		
4			
5			

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	2		

Teaching methods	lectures, excercises, laboratory work, consultations

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	
Exercises	30	Oral exam	70
Colloquia			
Projects			

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Character Animation		
Lecturer (for lectures)	Pavlović D. Vlastimir		
Lecturer/associate (for exercises)	Pavlović D. Vlastimir		
Lecturer/associate (for OFE)	Pavlović D. Vlastimir		
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	
Prerequisites			
Course objectives	Presentation of modeling techniques for characters and skeletal systems in 3D animation.Description of character animation techniques.Recording and editing movements in 3D animation.		
Course outcomes	Students will be trained for character and skeletal systems modelling in 3D animation. They shall master character animation techniques, as well as recording and editing of movements.		
Course outline			
Theoretical teaching	Polygonal modelling of a simple character. Making of a simple skeletal system. Making of controls. Character set. Character animation. "Motion capture" systems using Kinect. Programs for editing files with "captured motions".		
Practical teaching (exercises, OFE, study and research	Modelling of characters and skeletal systems. Making of controls. Character set. Character animation. Motion capture using Kinect. Introduction to programs for editing files with "captured motions".		
Textbooks/references			
1	Peter Ratner, "3-D Human Modeling and Animation", John Wiley & Sons, 2003.		
2	Steve Roberts, "Character Animation in 3D", Focal Press, 2004.		
3	Morgan Robinson and Nathaniel Stein, "Maya 8 - Visual QuickStart Guide", Peachpit Press, 2007.		
4			
5			

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1		

Teaching methods	Lectures, exercises, consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	20	Written exam	
Exercises	20	Oral exam	40
Colloquia			
Projects	20		

Specification for the book of courses

Study program			Electronics and Microsystems	
Module			Electronics and Microsystems	
Type and level of studies			Master studies	
The name of the course			RF Systems	
Lecturer (for lectures)			Jovanović S. Goran	
Lecturer/associate (for exercises)			Jovanović S. Goran	
Lecturer/associate (for OFE)			Jovanović S. Goran	
Number of ECTS		5	**Course status (obligatory/elective)**	Elective
Prerequisites				
Course objectives	Analysis of modern radio systems, operating principles and characteristics. Design of radio links. Principle of antenna design. Usage of electromagnetic simulation in a design procedure.			
Course outcomes	Introducing students with the process of planning and designing radio links. Training for practical application of electromagnetic simulation.			
Course outline				
Theoretical teaching	Radio waves propagation. Antennas, properties and basic types. Electromagnetic simulation. Compact planar antennas. Software and cognitive radio. Radio Frequency Identification RFID. Readers and tags. Global positioning systems and systems for ground / sea navigation. Ultra wide band (UWB) radio transmission. Radars. Metal detectors. 4G networks.			
Practical teaching (exercises, OFE, study and research	Radio links design. The impact of terrain's topology to signal attenuation. Tools for electromagnetic simulation. Antenna design. Example of compact planar antenna. Basic building blocks in RFID systems. Implementation of RFID readers for frequency ranges 125 kHz and 13.56 MHz. Metal detectors. Doppler radar.			
Textbooks/references				
1	David Parsons, The Mobile Radio Propagation Channel, Pentech Press, 1992.			
2	Constantine A. Balanis, Antenna Theory Analysis and Design, John Wiley & Sons, 2005.			
3	G. Jovanović, Manuals, textual and video tutorials for laboratory exercises and individual projects (available on the website of the course).			
4				
5				
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	1		
Teaching methods	Lectures, exercises, laboratory exercises, consultations.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures		10	**Written exam**	
Exercises		10	**Oral exam**	50
Colloquia				
Projects		30		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Mixed Signal Integrated Circuit Design		
Lecturer (for lectures)	Petković M. Predrag, Andrejević-Stošović V. Miona		
Lecturer/associate (for exercises)	Mirković D. Dejan		
Lecturer/associate (for OFE)	Mirković D. Dejan		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Adopting and systematizing knowledge related to electronic circuits with digital and analog signals with particular emphasis on the parts in which conversion from one signal to another occurs.
Course outcomes	Acquiring competencies for designing integrated circuits with mixed signals. Students are expected to learn to use HDL-AMS, to dimension transistors in analog and digital parts of mixed-signal circuits, use software tools for verification and physical design of integrated circuits as well as to learn how to write and present the result of the work.
Course outline	
Theoretical teaching	Basics of the HDL-AMS language for the description of hardware. A/D and D/A converter models. Converters performances. Effective number of bits. Improving the signal/noise ratio using feedback. Noice shaping. Improving the signal/noise ratio by averaging. A signal sampling. SC-circuits. SI-circuits. Programmable Gain Amplifiers (PGA). Architecture and design of A/D converters. SD modulator. MASH architecture. Decimator filters for A/D converters. Architecture and designing D/A converters. Effects of signal crosstalk. Clock signals. Thermal effects. Effects of the substrate. Impact of tolerances and maching. Application of integrated A/D and D/A converters.
Practical teaching (exercises, OFE, study and research	Acquired knowledge in lectures is deepen through set of hands-on sessions with professional CAD/EDA tools for mixed-signal IC design (Cadence, Mentor Graphics).
Textbooks/references	
1	Dokić B., Petković P., Analysis and design of CMOS digital integrated circuits (in Serbian), Academic Mind, Belgrade, 2017, ISBN 978-86-7466-696-8
2	Barr K., ASIC Design in the Silicon Sandbox: A Complete Guide to Building Mixed-Signal Integrated Circuits 1st Edition, McGraw-Hill Education; 1 edition (December 22, 2006) ISBN-10: 0071481613.
3	Baker J. R., CMOS: Mixed-Signal Circuit Design, Second Edition 2nd Edition, Wiley-IEEE Press; (December 10, 2008), ISBN-10: 0470290269
4	
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	2		

Teaching methods	Lectures; Auditory exercises; Laboratory exercises on computer; Consultations; Individual and group projects.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	
Exercises	20	**Oral exam**	30
Colloquia			
Projects	40		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Electronic Control Circuits for Converters		
Lecturer (for lectures)	Mančić D. Dragan		
Lecturer/associate (for exercises)	Jovanović D. Igor		
Lecturer/associate (for OFE)			
Number of ECTS 5		**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Acquiring the fundamental knowledge about the control principles for power converters, methods of their realisation and practical application.
Course outcomes	Theoretical knowledge on the control of power converters. Mastering the techniques of development, realisation and application of the various control methods for power converters.
Course outline	
Theoretical teaching	Driver circuits for power electronic components (thyristor, bipolar transistor, MOSFET, IGBT, GTO). Control circuits with phase control. Control circuits for AC voltage controllers. Control circuits for rectifiers. Control circuits for choppers. Control circuits for inverters. Control circuits for cycloconverters. Professional systems in power electronics. Electromagnetic compatibility of power electronic devices.
Practical teaching (exercises, OFE, study and research	Drivers. Control of rectifiers. Control of choppers. Control of inverters. Control of a system for speed regulation of an asynchronous motor.
Textbooks/references	
1	N.Mohan, T.M.Undeland, W.P.Robbins, "Power electronics: Converters, Applications, and Design", John Wiley & Sons., New York, 2007.
2	R.W.Erickson, D.Maksimovic, "Fundamentals of Power Electronics, Second Edition", Kluwer Academic Publishers, New York, 2004.
3	M.H.Rashid, "Power Electronics Handbook", Elsevier Science, 2017.
4	S.Manias, Power Electronics and Motor Drive Systems", Academic Press, 2016.
5	L.A.Kumar, A.Kalaiarasi, Y.U.Maheswari, “Power Electronics with MATLAB”, Cambridge University Press, Cambridge, 2018.

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	0		

Teaching methods	Lectures; Auditorial exercises; Laboratory exercises; Computer exercises; Consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	20
Exercises	15	**Oral exam**	20
Colloquia	20		
Projects	15		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Medical Electronic Systems		
Lecturer (for lectures)	Milić Lj. Miljana		
Lecturer/associate (for exercises)	Jovanović D. Borisav		
Lecturer/associate (for OFE)	Jovanović D. Borisav		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	Basics of Electronics
Course objectives	Adoption of knowledge related to the electronics in medicine, the usage of electrical signals in medicine and the main characteristics of medical devices: the reliability and safety.
Course outcomes	Acquiring knowledge related to the electronic medical system design and gaining competence for designing the electronic systems used in medical diagnostics and physical therapy.
Course outline	
Theoretical teaching	Membrane and action potential, transmission of electrical impulses. Medical devices for electrotherapy. Stimulation of nerves and muscles. Electro-muscle stimulation (EMS). Transcutaneous electrical nerve stimulation (TENS). Stimulation by interferential currents. Stimulation with electromagnetic fields. Construction of a pacemaker devices. Impedance plethysmography. Defibrillator design and defibrillator cardioverter design. System for monitoring the operation of the human cardiovascular system. System for real time monitoring vital vital parameters of patients. Remote patient monitoring system.
Practical teaching (exercises, OFE, study and research work)	Laboratory exercises and project design. The knowledge acquired in lectures is deveolped during laboratory exercises and the realization of the students project. Exercises include simulation of analog electronic circuits and design of a complete system for pulse plethysmography and measurement of the percentage of oxygen in the blood. The projects include practical tasks of programming PIC microcontrollers and ANDROID mobile devices in the realization of real-time systems for monitoring vital parameters, realization of holter devices, realization of advanced telemetry systems based on ANDROID mobile devices.
Textbooks/references	
1	M. Damnjanovic, B. Jovanovic, The medical electronics (in Serbian), script
2	D. Prutchi, M. Norris, Design and Development of Medical Electronic Intrumentation, John Willey and Sons, Inc. 2005
3	B. MIhajlovic, The physical Therapy, Obodsko slovo, 2002.
4	
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1		

Teaching methods	Lectures supported by usage of projectors, auditory exercises, laboratory exercises on computer, consultations, individual projects.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	
Exercises	20	**Oral exam**	30
Colloquia	20		
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Simulation and Optimization of Electronic Circuits		
Lecturer (for lectures)	Milić Lj. Miljana		
Lecturer/associate (for exercises)	Milić Lj. Miljana		
Lecturer/associate (for OFE)	Milić Lj. Miljana		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Adoption and systematization of knowledge about algorithms for analysis and optimization of analog and simulation of digital and circuits with mixed signals.
Course outcomes	Acquiring competencies for implementing optimization procedures in electronic circuits to the extent that qualifies them to develop their own programs for simulation of analogue, digital and mixed signal circuits.
Course outline	
Theoretical teaching	Analog circuit simulation: The domains of abstraction: DC, AC, time domain. Simulation algorithms. Simulation of linear resistant and reactive circuits. Non-linear resistant circuits simulation. A simulation of nonlinear reactive circuits. Models of basic passive and active components of electronic circuits. Simulation of digital circuits (principle of selection of paths and subsequent events). A simulation of discreet events. A mix of circuits with mixed signals. Methods for evaluating the power and delays. An electronic circuits optimization. The importance of a weight function. Optimization algorithms. Simulated annealing. Evolutionary algorithms. Optimization with limitations. Deterministic and statistical analysis of tolerances. Optimisation procedures in mechanical learning.
Practical teaching (exercises, OFE, study and research	Algorithms for analysis of linear and nonlinear circuits in different domains. Algorithms for simulation of digital circuits. Optimizing electronic circuits without using computer programs. This course provides laboratory exercises based on the application of Spice simulator and Optimizer from the OrCAD package.
Textbooks/references	
1	V. Litovski, Electronic circuit design (in Serbian), Нова Југославија Врање, 2000, ISBN 86-7369-015-3
2	
3	
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5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1		

Teaching methods	Lectures with application of the projector; Practical exercises; Laboratory exercises on computer; Consultations; Individual projects

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	
Exercises		**Oral exam**	30
Colloquia			
Projects	60		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Microelectromechanical Systems (MEMS)		
Lecturer (for lectures)	Paunović V. Vesna, Pešić M. Biljana		
Lecturer/associate (for exercises)	Đorđević D. Miloš		
Lecturer/associate (for OFE)	Đorđević D. Miloš		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Introducing the students in the structure, operating principle and application of various microelectromechanical systems (MEMS).
Course outcomes	Necessary knowledge on the operating principles, realization and application of MEM devices.Working with certain types of pressure, acceleration and temperature sensors. Calculation and construction of simple electronic systems. Realization of wireless communication systems for information transmission
Course outline	
Theoretical teaching	Basic elements of MEM systems: sensors, actuators, passive structures and electronic circuits. Techniques for sensing and actuation. Operation and application of following MEM devices: acceleration sensors and gyroscopes, pressure sensors and fluid flow sensors, gas sensors and biochemical sensors, microelectrodes, microphones, micromotors, microelectromechanical valves and micropumps, microelectromechanical resonators, optical and RF switches, digital micromirrors and optical displays, thermomechanical memories, integrated MEM devices.
Practical teaching (exercises, OFE, study and research	Practical work with specific types of pressure sensors, acceleration sensors and temperature sensors. Computer simulations and corresponding lab measurements. Design and realization of simple electronic systems. Realization of wireless communication systems for information transmission, acquaintance and work with accelerometers made in MEMS technology, realization of Data Logger microsystems based on various sensing techniques and storage of data on various media.
Textbooks/references	
1	V. Lindroos, M. Tilli, A.Lehto and T.i Motooka, Handbook of Silicon Based MEMS Materials and Technologies, 2010, Elsevier
2	J. Gardner, V. Vardan and O. Awadelkarim, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley, 2006.
3	V. Vardan, K. Vinoy and S. Gopalakrishnan, RF MEMS and Their Applications, John Wiley, 2003
4	N, Maluf, K. Williams, An Introduction to Microelekctromechanical Systems Engineering, Artech House, Inc. 2004
5	S. E. Lyshevski, MEMS and NEMS: Systems, Devices, and Structures, CRC Press, 2002

Number of classes of active education per week during semester/trimester/year

Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1		

Teaching methods	Power Point presentation for theoretical teaching. Computer simulations and lab measurements for practice teaching. Students within the seminar work individually or teamally solve the practical problem of applying one of the available MEM systems.

Grade (maximum number of points 100)

Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	25
Exercises	20	**Oral exam**	25
Colloquia	15		
Projects	10		

Specification for the book of courses

Study program		Electronics and Microsystems		
Module		Electronics and Microsystems		
Type and level of studies		Master studies		
The name of the course		Laser Electronics		
Lecturer (for lectures)		Paunović V. Vesna, Aleksić M. Sanja		
Lecturer/associate (for exercises)		Đorđević D. Miloš		
Lecturer/associate (for OFE)		Đorđević D. Miloš		
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites				
Course objectives	Introduction to the laser light sources, their excitation and structures, and applications in various fields of technology, medicine and consumer products.			
Course outcomes	Detailed knowledge of laser devices and systems. Knowing the working principle of certain types of lasers. Use of lasers and their control in various systems.			
Course outline				
Theoretical teaching	Laser techniques as part of optoelectronics and its role in electronics.Emission and absorption of light. Spontaneous and stimulated emission. Laser light sources, modulators, optical transmitters and detectors. Laser diodes. Gas, liquid and solid lasers. Semiconductor lasers. Laser spectroscopy. Holography. The characteristics and limitations of the laser. Quantum optoelectronics. Sources and transmissions of light. Complex optical and electro-optical structure of telecommunications systems.			
Practical teaching (exercises, OFE, study and research	Exercises on computer and microcontroller development bord, for design and simulation of laser and communication systems. Use of lasers and their control in various alarm systems, introduction and operation with RF communication protocols, introduction and operation with Bluetooth protocols, operation with ultrasonic modules.			
Textbooks/references				
1	W. Silfvast, Laser fundamentals, Cambridge, 2004			
2	Anil K. Maini, Lasers and Optoelectronics, John Wiley and Sons Ltd 2013			
3	Chartier, G., Introduction to Optics, Springer, 2005.			
4	J. T. Verdeyen, Laser Electronics, Prentice Hall, 1994			
5	M. J. Weber, Handbook of Lasers, CRC Press, 2000			
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	1		
Teaching methods	Classical lectures, consultations, laboratory exercises (exercises on a computer in microcontroller development borads)			
Grade (maximum number of points 100)				
Pre-exam duties	**Points**	**Final exam**	**Points**	
Activity during lectures	10	**Written exam**	25	
Exercises	25	**Oral exam**	25	
Colloquia				
Projects	15			

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Materials for Advanced and Alternative Energy Sources		
Lecturer (for lectures)	Mitić V. Vojislav		
Lecturer/associate (for exercises)	Mitić V. Vojislav		
Lecturer/associate (for OFE)	Mitić V. Vojislav		
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	
Prerequisites			
Course objectives	Gaining academic knowledge on advanced materials for energy sources, the ability to interlink multidisciplinary knowledge. Gaining knowledge about the latest developments in advanced materials research and their application in new and alternative energy sources. Studying the structure – properties – applications and energy – materials – information relationship.		
Course outcomes	Students develop the capacity to deal with scientific, development and technological problems either alone or as members of a team, as well as to organize scientific research. They should also be able to take part in research projects owing to the experience gained through the research during studies.		
Course outline			
Theoretical teaching	Energy as a global priority issue. Materials for new and alternative energy sources. Solar energy and materials for solar cells. Electrochemical properties of materials. Electrical energy based on electrochemical processes. Batteries and micro-batteries based on ceramic materials for electronic applications. Batteries and battery systems for specific purposes (portable devices and electric or hybrid vehicles). Solid-oxide fuel cells (SOFC). Alternative energy sources (based on fluid motion: wind energy (wind generators), energy of electrical discharge in the atmosphere, water energy (mini hydropower plants), energy of underground gas sources, energy of lithosphere plate deformation (earthquakes, volcanoes) and new materials. Electronic power components and systems for the energy transformation. Microelectronic power sources for highly integrated electronic circuits and systems. Components and systems for space technology. Fusion power generation materials and mini-reactors. Electronic materials, components and systems for the management and control of climate change and earthquakes. Engineering in the design and installation of components and systems of different energy sources.Global strategy of research and development of new materials for new and alternative energy sources.□		
Practical teaching (exercises, OFE, study and research	Lectures, laboratory excercises, consultations. Seminar paper. Colloquia and tests.		
Textbooks/references			
1	Vojislav V. Mitić, Materials for new and alternative energy sources, (in the process of issuing publishing, in Serbian)		
2	Vojislav V. Mitić, Momčilo M. Ristić, Electrical materials, (in the process of publishing, in Serbian)		
3	Donald J. Bray, New Applications of Advanced Ceramics and the Path to Commercialization, Morgan AM&T, Daytona Beach, 2008.		
4	Steven J. Zinkle, Materials for Next Generation Nuclear Energy, Oak Ridge Nat. Laboratory, Daytona Beach, 2008.		
5	European White Book of Fundamenral Research in Materials Science Max-Planck-Institut fur Metallforschung Stuttgart Publishers: Max-Planck-Institut fur Metallforschung Stuttgart M.Ruble, H.Dosch, E.J.Mitemeijer, M.H.van de Voorde, 2001.		

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1		

Teaching methods	Lectures, consultations, computational and laboratory exercises

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	20	**Oral exam**	20
Colloquia	20		
Projects	10		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Nanoelectronics		
Lecturer (for lectures)	Davidović S. Vojkan, Golubović M. Snežana		
Lecturer/associate (for exercises)	Davidović S. Vojkan		
Lecturer/associate (for OFE)			
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	The objective of the course is providing the students with the necessary level of knowledge oncurrent trends in the field of the latest nanoelectronic devices and systems, their development, new principles of device operation, advanced materials used for realization of nano-devices, technological processes that implement the nano-devicess and models describing their operatin. By acquiring knowledge in this subject, a student should be able to easyer fit in with modern semiconductor industry and understand new achievements in the field of information technology.
Course outcomes	The student is familiar with scaling rules and trends in the development of nanodevices. He knows the specificities of technological processes for the realization of very thin and well-controlled layers of materials, material removal techniques and adequate measuring methods. He understands the application of high-k dielectric materials, strained silicon, metal gates, understands the structure and operation of the FD and SOI transistors, as well as FinFET model. He understands the ferroelectric FET, the principle of RTD and Single electron transistors. He understands the superconductivity and its application in electronics, the potentials of carbon nanotubes for the realization of devices, devices based on organic molecules, memory components for RAM or HDD and sensor devices. In general, his thinking is shifted from the macrolevel to the level of very thin layers, the interaction of a small number of molecules, the significance of the interface phenomena and new materials.
Course outline	
Theoretical teaching	Scaling theory, Moore law. Materials in nanoelectronics (semiconductors, dielectrics, ferroelectrics, organic molecules). Quantum effects - tunneling. Technological methods of thin layers of material deposition. Lithography. Materials removal techniques - etching and chemo-mechanical polishing. Measuring techniques in nanotechnology. Silicon MOSFET transistors - new materials and alternative concepts (high-k dielectrics, strained silicon). FinFETs, structures and modeling. Ferroelectric FET transistors. Resonant tunneling devices. Single-electron transistors. Superconducting electronics. Quantum computing based on a superconductors. Graphene and carbon nanotubes and devices. Nanoelectronic devices based on organic molecules. Nanoelectronic RAM. Ferroelectric RAM devices. The concept of high density memory disks - AFM. Sensor nanodevices.
Practical teaching (exercises, OFE, study and research	Defining and solving a certain number of tasks related to physical phenomena and the operating of nanoelectronic devices, modeling and computer simulation. In the form of consultations, a number of scientific papers (selected in accordance to the affinity of the student himself) in the field of nanoelectronic devices will be analyzed.
Textbooks/references	
1	Rainer Waser (Ed.), NANOELECTRONICS AND INFORMATION TECHNOLOGY, Advanced Electronic Materials and Novel Devices, Wiley-VCH, 2003, ISBN 3-527-40363-9
2	Brajesh Kumar Kaushik, NANOELECTRONICS, Devices, Circuits and Systems, Elsevier, 2018, ISBN 9780128133538
3	K. Goel, NANOELECTRONICS AND NANOSYSTEMS, From Transistors to Molecular Quantum Devices, Springer 2004, ISBN 978-3-662-05421-5
4	
5	

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	0		

Teaching methods	Lectures using PowerPoint presentations, problem solving, consulting classes.
Grade (maximum number of points 100)	

Pre-exam duties	Points	Final exam	Points
Activity during lectures	20	Written exam	20
Exercises		Oral exam	30
Colloquia	10		
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	RF Microelectronics		
Lecturer (for lectures)	Prijić D. Zoran, Danković M. Danijel		
Lecturer/associate (for exercises)	Danković M. Danijel, Prijić D. Zoran		
Lecturer/associate (for OFE)	Danković M. Danijel, Prijić D. Zoran		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Acquiring the knowledge needed for understanding the principles of operations and applications of RF microelectronics circuits
Course outcomes	Student training for capacity to sucesfully design the functional blocks of RF microelectronic circuits using the dedicated state-of-art software packages.
Course outline	
Theoretical teaching	Introduction to RF and wireless technology. Basic concepts of RF design: effects of non-linearity, noise, sensitivity and dynamic range, transformation of passive impedance, scattering parameters. Communication concepts: analog and digital modulations, mobile RF communications, standards of wireless transmittion. Architectures of transmitters and receisivers , Low-noise amplifiers (LNAs). Frequency mixers. Integrated passive components. Oscillators. Phase detectors. Phase-Lock-Looped oscillators (PLL). Frequency oscillators. RF power amplifiers.
Practical teaching (exercises, OFE, study and research	Laboratory exercises include the use of dedicated software package for designing RF integrated circuits. Each student obtains a final project assignment that aims to verify that the student can design and check the functionality of some practical RF circuit block .
Textbooks/references	
1	Behzad Razavi, "RF Micorelectronics", 2nd Edition, Prinmtence Hall PTR, 2011, ISBN: 978-0-13-713473-1.
2	Sorin Voinigescu, "High-Frequency Integrated Circuits", Cambridge University Press, 2013, ISBN: 978-0-521-87302-4.
3	John W. M. Rogers, Calvin Plett, "Radio Frfequency Integrated Circuit Design", 2nd Edition, Artech House, 2010, ISBN: 978-1-60783-979-8.
4	Behzad Razavi, "Fundamentals of Micorelectronics", 2nd Edition, Wiley, 2014, ISBN: 978-1118156322.
5	"RF Basic Technology Guide", Rigol Technologies, 2016.

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1		

Teaching methods	Auditorial teaching. Laboratory exercise. Consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	
Exercises	20	Oral exam	50
Colloquia			
Projects	30		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Microsensors and Microsystems		
Lecturer (for lectures)	Vračar M. Ljubomir		
Lecturer/associate (for exercises)	Vračar M. Ljubomir		
Lecturer/associate (for OFE)	Vračar M. Ljubomir		
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	
Prerequisites			
Course objectives	Acquiring the knowledge needed to understand the application of modern sensors in measuring and controlling systems.		
Course outcomes	Students became capable of understanding the microsytem principals and independently be able to connect sensors with microcontrollers forming a basic microsystem.		
Course outline			
Theoretical teaching	Introduction to microsensors technologies. Integrated microsensors: thermal, optical, magnetic, velocity and accelerometer sensors, chemical sensors, biosensors. Microsystems design and operation. Microsensors and microcontrollers. Interface circuits. Analog to digital conversion. Data processing in time domain. Microcontroller programming. Standards and protocols.		
Practical teaching (exercises, OFE, study and research	Practical teaching refers to student training for independent programming the microcontrollers. Students will be assigned with final project including the independently design of basic microsystem and verification of its proper operation.		
Textbooks/references			
1	Gardner J., Varadan V., Awadelkarim O. "Microsensors, MEMS and smart devices: technology, applications & devices ", Wiley, UK (2001)		
2	Fraden J., Handbook of modern sensors: Physics, designs and applications,Springer-Verlag, (2004)		
3			
4			
5			

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1		

Teaching methods	Auditorial teaching, Laboratory exercise, student tutorials

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	Written exam	
Exercises	20	Oral exam	50
Colloquia			
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems			
Module	Electronics and Microsystems			
Type and level of studies	Master studies			
The name of the course	Integrated Microsystems			
Lecturer (for lectures)	Prijić P. Aneta			
Lecturer/associate (for exercises)	Prijić P. Aneta, Stojković S. Aleksandra			
Lecturer/associate (for OFE)	Stojković S. Aleksandra			
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites				
Course objectives	Objectives of the course are focused on: - Introduction to the structure of integrated microsystems; - Introduction to the concept of integrated microsystems based on Programmable System on Chip (PSoC); - Understanding the specific characteristics of individual families of PSoC chips (PSoC3, PSoC4, PSoC5LP); - Possibilities for realization of various applications with PSoC chips; - Mastering the software development tool PSoC Creator; - Mastering work with different development kits with PSoC.			
Course outcomes	Learning outcomes allow a student to: - Describe the architecture of integrated microsystems based on a Programmable System on Chip (PSoC); - Explan the reconfiguration property of PSoC chips; - Distinct the particularities of individual families of PSoC chips (PSoC3, PSoC4, PSoC5LP); - Demonstrate the principle of creating projects within the PSoC Creator software development tool; - Design a variety of applications using different PSoC development kits.i			
Course outline				
Theoretical teaching	Introduction. Characteristics of PSoC architecture. Central subsystem. PSoC3 chip with an 8-bit processor. PSoC4 chip with 32-bit ARM Cortex M0 processor. PSoC5 chip with 32-bit ARM Cortex M3 processor. Analog subsystem. Digital Subsystem. System wide resources. Subsystem for communication with the environment. Communication between the subsystems. Specific PSoC modules (SC/CT, LCD driver, CapSense driver). Built-in components. Software development environment of the PSoC (PSoC Creator). Development kits with PSoC. Rules from practice for work with PSoC.			
Practical teaching (exercises, OFE, study and research	Laboratory exercises using PSoC development kits: work with acceleration, capacitive, temperature and proximity sensors; state indication and peripheral management; communication with PC; working with capacitive sliders and buttons; digital logic; generation of precise analog signals.			
Textbooks/references				
1	W. Weidinger, "System Investigation of Programmable Systems on Chip (PSoC)", VDM Verlag Dr. Mueller e.K., 2008.			
2	A. R. Kansal, "A Study on Programmable System on Chip", IOSR Journal of VLSI and Signal Processing, Vol. 4, No. 5, 2014.			
3	R. Ashby, "My First Five PSoC3 Designs", Cypress Semiconductor Corporation, 2010-2012, Online available: https://www.cypress.com/documentation/other-resources/my-first-five-psoc-3-designs.			
4	DVK - Development kits guides			
5				
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1		
Teaching methods	Theoretical lectures - using slides; Practical demonstration of typical projects; Laboratory exercises with development kits and PC.			
Grade (maximum number of points 100)				
Pre-exam duties	**Points**	**Final exam**	**Points**	
Activity during lectures	20	**Written exam**	40	

Exercises	40	**Oral exam**	
Colloquia			
Projects			

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Basics of Photovoltaic conversion		
Lecturer (for lectures)	Aleksić M. Sanja		
Lecturer/associate (for exercises)	Aleksić M. Sanja		
Lecturer/associate (for OFE)	Aleksić M. Sanja		
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	

Prerequisites	No
Course objectives	The objective of the course is for students of master studies to learn more about the characteristics of solar radiation and the principles of solar energy conversion in order to understand the principle of solar cell operation and to acquire basic knowledge about the materials used in the production of solar cells.
Course outcomes	After fnishing the course, the student fully understands the characteristics of solar radiation and the principle of photovoltaic conversion, the basics of semiconductor physics and photovoltaic cells, the processes of generation and recombination of carriers in the semiconductor, as well as the characteristics of the pn-bond in equilibrium and under the influence of light. Also, knowledge about different types of solar cells (mc-Si, GaAs, a-Si, thin-film, organic), methods of solar cell design and techniques for increasing their efficiency are acquired.
Course outline	
Theoretical teaching	Introduction to renewable energy sources. Solar energy, solar radiation, solar radiation spectrum, solar constant, average solar radiation, direct, reflected and diffused radiation. Sun-Earth geometry, relative motion and determination of the position of the Sun relative to the defined location. Radiation of the black body, Plankov law, spectral distribution of extraterrestrial and radiation on the surface of the Earth. Properties of a semiconductor, crystal structure, energy zones, dynamics of the electron and cavities in the crystal structure, the density of the energy states, the concentration of electrons and cavities. Light absorption, direct and indirect semiconductors, light absorption coefficient, reflection and reflection losses. Absorption of light in the function of photon energy, surface states and defects. Recombination processes, carrier transport. Density of donors and acceptors, system of basic semiconductor equations. pn-connection, spatial charge region, impoverishment region, built-in potential, concentrations of minority and majority charge carriers, carrier injection, current-voltage characteristic of unexposed and illuminated joints. The principle of solar cell work. Basic structure of the solar cell. Speed of generation and recombination of bearers, current of darkness, current generated by the light, current-voltage characteristic. Electrical parameters of the solar cell, open circuit voltage, short circuit current, maximum power, fill factor, efficiency. The influence of geometry on the characteristics of the solar cell, maximum thermodynamic efficiency. Equivalent solar cell. Practical efficiency constraints, short circuit currents, open circuit voltage, fill factor and efficiency. The influence of temperature on the characteristics of the solar cell, the influence of parasitic resistances. Spectral response and quantum efficiency. Measurement of current-voltage characteristics and solar cell efficiency. Optimal design of the solar cell based on the minimization of optical and recombination losses. Simulation of electrical characteristics of different types of solar cells.
Practical teaching (exercises, OFE, study and research work)	Modeling of extraterrestrial solar radiation. Modeling global solar radiation. Modeling the position of the Sun relative to the defined location. Modeling the electrical characteristics of the solar cell under standard test conditions. Determination of open circuit voltage VOC and short-circuit current of the ISC solar cell, depending on the intensity of solar radiation. Measurement of open circuit voltage VOC and short-circuit current of the ISC solar cell, depending on the incident angle of the solar air. Measurement of open circuit voltage VOC and short circuit current of ISC solar cell, depending on temperature. Simulation of the technological array for the production and electrical characteristics of the mc-Si solar cell. Simulation of the technological array for the production and electrical characteristics of high-efficiency Si solar cells.
Textbooks/references	
1	Photovoltaic Devices, Systems and Applications CD-ROM, C. Honsberg and S. Bowden, (free online resource)
2	Solar Cell Device Physics, Stephen Fonash, Academic Press, 2010.
3	Physics of Solar Cell, Peter Würfel, WILEY-VCH Verlag GmbH & Co., 2005.

4	The Physics of Solar Cell, Jenny Nelson, Word Scientific, 2003.			
5	Lectures and exercises (http://mikro.elfak.ni.ac.rs/osnove-fotonaponske-konverzije/)			
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1		
Teaching methods	Lectures, independent studio research work, computational exercises, laboratory exercises, consultations. Lectures are conducted in combination. The lectures present the theoretical part of the material, supported by characteristic examples for easier understanding of matter. Through student research work, a student studying available literature, doing a seminar work or a team project. Practical examples of semiconductor and solar cell physics are used in computational exercises, and in laboratory exercises, using computer and available software, simulate and model electrical characteristics of different types of solar cells and optimize their geometries in order to increase their efficiency.□			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures		5	**Written exam**	25
Exercises		15	**Oral exam**	25
Colloquia		30		
Projects				

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Solar Technologies and Devices		
Lecturer (for lectures)	Pantić S. Dragan, Mančić D. Dragan		
Lecturer/associate (for exercises)	Aleksić M. Sanja		
Lecturer/associate (for OFE)	Aleksić M. Sanja		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	No
Course objectives	The objective of the course is to give students detailed knowledge of the technologies used for the production of solar cells, types of solar cells, electrical characteristics, as well as methods of optimal design of solar cells in order to maximize their efficiency. Students also get acquainted with basic elements of photovoltaic systems and their basic characteristics.
Course outcomes	After the course, student acquired knowledge about all the most commonly used technologies for the production of solar cells, as well as about the different types of solar cells and their electrical characteristics.
Course outline	
Theoretical teaching	Introduction. Preparation of silicon used for the production of solar cells. MG silicon, SG polysilicon and the Czochral method for the production of monocrystalline (c-Si) silicon. The process of obtaining Si wafers from the ingot. Types of solar cells: s-Si, mc-Si, thin-layer solar cells, amorphous silicon (a-Si), cadmium telluride (Cd-Te) solar cells, Cu (inGa) Se2 solar cells, organic and polymer solar cells. Commercial technology of Si solar cell production. Solar cell production process. Structures and production of highly efficient solar cells. Commercial technologies for the production of thin layer solar cells. Advantages and disadvantages of thin-layer solar cells. Materials used in production of thin-layer solar cells, thin layer deposition techniques. Reliability of characteristics and production costs. CdTe solar cells and solar cells on amorphous silicon (a-Si). Heterojunction (HIT) and CIGS solar cells. Advanced technology of new generation solar cells. Electrical characteristics of solar cells, current-voltage characteristics. Electrical parameters (open circuit voltage, short circuit current, maximum power, fill factor, efficiency), characterization of the solar cell. Simulation of the technology flow for the production and electrical characteristics of solar cells. Solar cells with concentrators. Types of concentrators, overview of CSP and CPV systems, Frensel's lenses and reflectors. Operation of solar cells in conditions of large incident radiation. Production of photovoltaic modules. Connections of solar cells, processes of encapsulation and lamination. Electrical and optical properties of the PV module. The effects of local shading and the formation of hot spots. Characterization of photovoltaic module. Types and components of photovoltaic systems. Independent, hybrid and network-connected systems. Inverters (DC / DC, DC / AC), MPPT algorithms, energy storage, batteries. Cables, connectors, monitoring equipment. Design and optimization of photovoltaic systems.
Practical teaching (exercises, OFE, study and research work)	Simulation of the technology flow for the production and electrical characteristics of the mc-Si solar cell. Simulation of the technology flow for the production and electrical characteristics of IBC-SHJ solar cells. Simulation of the technology flow for the production and electrical characteristics of the CIGS solar cell. Simulation of the technology flow for the production and electrical characteristics of thin-layer tandem solar cells. Simulation of the technology flow for the production and electrical characteristics of organic solar cells. Measurement of the current-voltage characteristics of the illuminated and unexposed solar cells. Measurement of open circuit voltage VOC and short-circuit ISC, regular, parallel and combined solar cells. Measurement of electrical characteristics of photovoltaic modules. Configuration of a stand-alone photovoltaic system and measurement of its characteristics with I / V photovoltaic PVCHECK tester.
Textbooks/references	
1	Photovoltaic Devices, Systems and Applications CD-ROM, C. Honsberg and S. Bowden, (free online resource)
2	Photovoltaic Science and Engineering Handbook, Second Edition, Antonio Luque and Steven Hegedus, John Wiley and Sons, 2012.
3	Thin film Solar Cells, Jeff Poortmans and Vladimir Arkhipov (Ed.), John Wiley and Sons Ltd. 2006.
4	Lectures and Exercises (http://mikro.elfak.ni.ac.rs/predmeti/solarne-tehnologije-i-komponente/)

5				
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	2		
Teaching methods	Lectures, independent studio research work, computational exercises, laboratory exercises, consultations. The lectures present the theoretical part of the material, supported by characteristic examples for easier understanding of matter. Through student research work, a student studying available literature, doing a seminar work or a team project. Practical examples of calculation and design of concrete photovoltaic systems are used in calculation exercises. Practical knowledge is acquired in laboratory exercises.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures		5	**Written exam**	25
Exercises		15	**Oral exam**	25
Colloquia		30		
Projects				

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Gas discharge devices –characterization and application		
Lecturer (for lectures)	Živanović N. Emilija, Golubović M. Snežana		
Lecturer/associate (for exercises)	Živanović N. Emilija		
Lecturer/associate (for OFE)	Živanović N. Emilija		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Theoretical knowledge is acquired, necessary for understanding the operating principles of gas devices, as well as their characterization and application.
Course outcomes	Introduction of theoretical and practical knowledge of physical processes in gases. Introduction to the operation principle of gas photocell and photomultiplier, gas surge arresters, gas light sources, gas sensors of ionized radiation, gas lasers, gas electrical switches.
Course outline	
Theoretical teaching	Introducing students with the operating principle of different types of gas components and systems. Gas photocells and photomultipliers, gas surge arresters, gas light sources, gas sensors of ionized gases, gas lasers, gas electric switches.
Practical teaching (exercises, OFE, study and research	Practical classes take place at the Laboratory for Applied Physics and Laboratory for Gas and Vacuum Engineering. It implies demonstration and practical presentation of the operation principle of gas systems.
Textbooks/references	
1	Momčilo Pejović, „Uvod u električna gasna pražnjenja. Gasne elektronske komponente“, 2008.
2	Emilija Živanović, „Procesi inicirani električnim probojem i pražnjenjem odgovorni za memorijski efekat u azotu i vazduhu“, doktorska disertacija, Elektronski fakultet, Univerzitet u Nišu, 2014.
3	Emilija Živanović, „Fizičko-hemijski procesi koji dovode do iniciranja električnog proboja u azotu na niskim pritiscima“, magistarska teza, Elektronski fakultet, Univerzitet u Nišu, 2004.
4	Y. P. Rayzer, „Gas Discharge Physics“, Berlin: Springer, 1991.
5	

Number of classes of active education per week during semester/trimester/year

Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1		

Teaching methods	Teaching takes place through lectures, auditory and laboratory exercises and consultations.

Grade (maximum number of points 100)

Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	25
Exercises	10	**Oral exam**	25
Colloquia	20		
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Study and Research Work		
Lecturer (for lectures)			
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS 5	**Course status (obligatory/elective)**	Obligatory	
Prerequisites			
Course objectives	Application of basic, theoretical-methodological, scientific-professional and applied knowledge and methods to solve concrete problems. The student studies the problem, its structure and complexity, and on the basis of the conducted analysis, concludes the possible ways of solving it. By studying literature students are introduced to methods and engineering practice for solving similar tasks.		
Course outcomes	Training students to independently apply previously acquired knowledge from different areas they have studied, in order to examine the structure of the given problem and to analyze it in a systematic way, with the final goal to make conclusions about possible solutions. Through self-use of literature, students expand their knowledge by studying various methods and papers related to similar issues. In this way, students develop the ability to conduct analyzes and to identify problems within the given issues. By the practical application of acquired knowledge, students develop the ability to see the place and role of engineers in the selected area, as well as the need for cooperation with other professions and for the teamwork.		
Course outline			
Theoretical teaching	It is formed individually in accordance with the needs of a concrete graduate-master work, its complexity and structure. According to his affinities and preferences, the student chooses the field of study work or the subject teacher from the list of teachers in the study program, which defines the specific task. The student studies professional literature, professional and scientific papers dealing with similar topics, performs analyzes in order to find a solution for a concrete task, or perform certain experiments in the laboratory. The study includes active monitoring of primary knowledge, organization and performance of experiments, numerical simulations and statistical data processing, preparation of seminar work from the narrow scientific-scientific field, which is the topic of independent research work.		
Practical teaching (exercises, OFE, study and research			
Textbooks/references			
1			
2			
3			
4			
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
			10	
Teaching methods				

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises		**Oral exam**	50
Colloquia			
Projects	50		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Real Time Operating Systems		
Lecturer (for lectures)	Petrović D. Branislav		
Lecturer/associate (for exercises)	Nikolić S. Goran		
Lecturer/associate (for OFE)	Nikolić S. Goran		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Knowledge of the basic concepts and principles of modern operating systems, as well as their structure, functions and components. Getting to know the importance of time warranties in executing programs in real-time systems.
Course outcomes	Theoretical and practical knowledge of concepts, internal design and implementation of modern operating systems that are applied in embeded applications. Practical application of the Real Time Linux operating system API functions. Detailed knowledge of the Linux kernel and its upgrade capabilities.
Course outline	
Theoretical teaching	History of embeded Linux, Embeded Linux distribution. Architecture embeded Linux, Linux kernel architecture, User space, Start-up sequences, Boot loader interface, Mapping memory, interrupt management. Timers, UART, power management. Embeded storage memory: Flash memory card, Memory device technologies. File systems: Ramdisk, JFFS, NFS, PROC file system. Optimize the memory space. Optimize kernel memory. Embeded drivers: serial port driver, ethernet driver, I2C, USB. Porting applications: Programming threads, operating system porting level, kernel API drivers. Real-Time Linux as an operating system for real-time operation: interruption delay, delay and duration of panners. Planning process, memory lock, POSIX memory sharing, waiting queues, traffic lights, signals, clock and timer, asynchronous I / O. Building and Debuging: building kernel, building applications, root file system. IDE: Eclipse, Kdevelop, CodeBlocks. Example of design: Design and development of board computer cars using mirror and RT Linux.
Practical teaching (exercises, OFE, study and research	Working with files from the command line, Command Interpreter (shell). Copy, move, and delete files. Work with directories. Working with text files. Shell programming. Basics of shell programming. Structures in shell programming. Network environment. Introduction to TCP / IP Linux as a network server. Process administration. Basic techniques of process and thread management. Process synchronization. Synchronizing threads. Booting (boot). Configuring the Linux system core. Work with modules. Translation of the kernel.
Textbooks/references	
1	Stalling William, "Operating Systems 6th Edition, Pearson Education, ISBN 978-81-317-2528-3.
2	Andrew S. Tanenbaum ,Modern Operating Systems, 3/E, ISBN-13: 9780136006633.
3	Christopher Hallinan, "Embedded Linux Primer: A Practical Real-World Approach (2nd Edition)", Prentice Hall, 2010, ISBN-13: 978-0-137-01783-6.
4	Teacher's handwriting (in Serbian) : Linux in embeded systems
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1		

Teaching methods	Auditory instruction using computers and projectors. Lectures. Practical exercises. Laboratory exercises. Homework. Colloquiums. Seminary work. Consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	20
Exercises	15	**Oral exam**	20
Colloquia	20		
Projects	15		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Digital Signal Controllers		
Lecturer (for lectures)	Petrović D. Branislav		
Lecturer/associate (for exercises)	Nikolić S. Goran		
Lecturer/associate (for OFE)	Nikolić S. Goran		
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	

Prerequisites	
Course objectives	Introducing students with architecture and basic features of digital signal controllers with fixed and mobile commas, assembler programming methods and linking to programming in higher programming languages. Also, the goal is to implement digital signal processing algorithms.
Course outcomes	Knowledge that enables the design and implementation of algorithms for digital signal processing. Practical application of DSC in systems for the realization of inverters and motions of electric motors of different types.
Course outline	
Theoretical teaching	Definition of digital signal controller - DSC. Characteristics and differences in relation to the classical microprocessor. Basic architecture of the DSC Texas Instruments family of C2000. Core (data ALU, address generator, program control, patch program logic, PLL generator, JTAG, peripherals). Memory mapping, development tools. Basic types of operations, macro commands and subroutines. Connection to programming in C language. Format Presentation Number. Arithmetic operations, addressing methods. Structures for implementing digital filters. Realization of the FFT algorithm. DSC with moving gates, standard IEEE-754. Application of DSC in digital audio processing. Application of DSC in Invertites for the Initiative of Asynchronous and DC Motors.
Practical teaching (exercises, OFE, study and research	Getting to know the development system. Audio signal processing programs, benchmark programs, loaders, routine codecs, DMTF routines, encoders, data-driven data in a mobile comma, FFT algorithms, matrix work, sorting, speech synthesis. Inverter for DC motor.
Textbooks/references	
1	"DSP processors, architecture and programming", manuscript of the teacher(in Serbian).
2	Selected Articles, Documentation Texas Instruments C2000 Microcontrollers Development Tool.
3	
4	
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1		

Teaching methods	Auditory instruction using computers and projectors. Lectures. Practical exercises. Laboratory exercises. Homework. Colloquiums. Seminary work. Consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	20
Exercises	15	**Oral exam**	20
Colloquia	20		
Projects	15		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Distributed Embedded Systems		
Lecturer (for lectures)	Đorđević Lj. Goran		
Lecturer/associate (for exercises)	Jovanović D. Milica		
Lecturer/associate (for OFE)	Stojanović Z. Igor		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The goal of the course is for students to acquire knowledge about the role and importance of communications and networking in the field of embedded systems, with an emphasis on the study of basic concepts and methods inherent in wireless sensory networks.		
Course outcomes	The outcome of this course is the adoption of theoretical knowledge necessary for: a) understanding the principles of design, analysis and realization of distributed embeded systems; b) designing and developing real embeded applications based on wireless sensor networks; c) understanding advantages and disadvantages of different technologies used in the design and realization of wireless sensor networks.		
Course outline			
Theoretical teaching	Introduction to distributed embedded systems: common characteristics, classification, typical fields of application. Wireless sensor networks: application areas and application examples, common features and challenges; sensor node architecture: sensor, processor, communication and power supply subsystem; network architecture: classification, optimization goals and design principles; communication protocols: physical level: characteristics of the wireless communication channel and low-power transmitters; MAC level: contention based protocols and time-based protocols, multi-channel protocols, 802.15.4 and ZigBee; routing protocols: flooding and gossiping, protocols for proactive, geographic and on-demand routing; time synchronization; localization: techniques for direct and indirect localization; programming wireless sensor networks: operating systems (TinyOS) and programming languages (nesC).		
Practical teaching (exercises, OFE, study and research	Several laboratory exercises and mini-projects will be assigned with focus on wireless sensor network programming, sensory data collection, data delivery and communication, and interfacings between the user and the deployed wireless sensor network.		
Textbooks/references			
1	H. Karl and A. Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley, 2007.		
2	Additional course materials, such as lecture notes and tutorial documents, will be available on the faculty website.		
3			
4			
5			

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1		

Teaching methods	Lectures, exercises, laboratory exercises, homework, seminar work, consultations

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		**Written exam**	35
Exercises	30	**Oral exam**	35
Colloquia			
Projects			

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Visual Design		
Lecturer (for lectures)	Pavlović D. Vlastimir		
Lecturer/associate (for exercises)	Pavlović D. Vlastimir		
Lecturer/associate (for OFE)			
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Introduce students to the visual arts, as it accrues, which are the basics and an introduction to aesthetics. What is the trash, and what are the real visual values, a sense of beauty. Introduce students with the basics of logos, typography, photography, complete visual identity and its creation. Design to photography, film and television, print, and web. The use of colors, lines, shapes and letters. Total design and visual communications.
Course outcomes	Students are able to independently create logos and other visual elements for the diverse needs in web design, television, movies, billboards, advertisements, but only as part of the overall design with a specific message to the visual communication and better visual experience. Independently designing a logo placement in a specific format, with complete follow-up design, set design, lighting, graphics on television, and with all the visual elements on the web and other formats.
Course outline	
Theoretical teaching	Practical classes will be carried out continuously throughout the whole semester, students will make logos, typography and complete visual design on the given topics. Designing a complete total design for a company, firm, from a logo, to a complete first website and a trademark. Design on TV spots and jigsaws, design for printing in large and small formats, design for mobile telephony, icons and applications.
Practical teaching (exercises, OFE, study and research	Practical classes will be carried out continuously throughout the whole semester, students will make logos, typography and complete visual design on the given topics. Designing a complete total design for a company, firm, from a logo, to a complete first website and a trademark. Design on TV spots and jigsaws, design for printing in large and small formats, design for mobile telephony, icons and applications.
Textbooks/references	
1	Mike Monteiro, Design is a job, A book a part, 2012.
2	Jil Butler, William Lindwell, Universal Principles of Design, Mate, 2014.
3	
4	
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	0		

Teaching methods	Lectures, laboratory exercises.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	Written exam	
Exercises	20	Oral exam	40
Colloquia			
Projects	30		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Video Signals Processing		
Lecturer (for lectures)	Nikolić V. Saša		
Lecturer/associate (for exercises)	Cvetković S. Stevica		
Lecturer/associate (for OFE)	Cvetković S. Stevica		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Present the basic algorithms for digital video processing: video enhacement, sharpening, filtering, segmentation, object detection etc.. Using of mathematical algorithms for operation in digital video processing. Software implementation of presented algorithms in Matlab.		
Course outcomes	To enable students to understand and implement alone the basic operations of digital video processing in MATLAB.		
Course outline			
Theoretical teaching	Removing noise in the video signal. Superresolution - improving the resolution of video. Stabilization of video sequences. Creating of panorama images based on video. Automatic detection and tracking of moving objects. Detection and extraction of key frames. Content based video browsing. Video watermarking.		
Practical teaching (exercises, OFE, study and research	Exercises on the computer in the MATLAB. The practical implementation of algorithms for digital video processing presented in lectures.		
Textbooks/references			
1	Oge Marques, Practical image and video processing using Matlab, Wiley, 2011.		
2	Y. Wang, J. Ostermann, Y. Zhang, Video Processing and Communications, Prentice Hall, 2002.		
3	Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 3rd edition, Prentice-Hall, 2008		
4			
5			

Number of classes of active education per week during semester/trimester/year

Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	1		

Teaching methods	Lectures, exercises, laboratory exercises, homework, course project, consultations

Grade (maximum number of points 100)

Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	15	**Oral exam**	20
Colloquia	20		
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	System on Chip		
Lecturer (for lectures)	Dimitrijević A. Marko, Andrejević-Stošović V. Miona		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)	Dimitrijević A. Marko, Andrejević-Stošović V. Miona		
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	

Prerequisites	
Course objectives	Acquiring knowledge about basic characteristics, architecture and methods of system on chip design.
Course outcomes	Mastering design of integrated circuits that contain all elements of an entire system. Students will learn the basic characteristics of the system on chip, design procedures, methods of solving fundamental and specific problems for the realization and production of such systems.
Course outline	
Theoretical teaching	Modeling and specification of the system at a high level of abstraction. System performance analysis at an early stage of the design process. Analysis of the relationship between the hardware and software components of the system on chip, algorithms and architectures in order to optimize the system based on the requirements (specifications) and limitations. System on chip architectures (control, real-time systems, data processing). Hardware, software and interface synthesis. System simulation and verification, hardware/software (HW/SW) cosimulation. Network-on-chip. Examples of high-level applications and development environments for system on chip implementation (Chisel, Magma). Reuse of blocks, codesign.
Practical teaching (exercises, OFE, study and research work)	The methodology and design tools at the system level. HW/ W co-design: analysis, partitioning, real-time operation, hardware acceleration. Virtual platform models, cosimulation, system prototyping on FPGA. Transaction-Level Modeling (TLM), SystemC, SystemVerilog, Electronic System-Level (ESL) languages. High-Level Synthesis (HLS): allocation, scheduling, binding, resource sharing. Integration of the system on the chip, verification and testing. The system on chip design using Chisel tools, realization of the prototype on the FPGA platform.
Textbooks/references	
1	D. Black, J. Donovan, SystemC: From the Ground Up, Springer, 2004
2	M. Zwolinski, Digital System Design with SystemVerilog
3	M. J. Flynn, W. Luk, Computer System Design: System-on-Chip, Wiley, 2011
4	
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	0	2		

Teaching methods	Lectures, laboratory work, consultations, projects

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	25	**Written exam**	
Exercises	25	**Oral exam**	50
Colloquia			
Projects			

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Ultrasonic Technique		
Lecturer (for lectures)	Mančić D. Dragan		
Lecturer/associate (for exercises)	Jovanović D. Igor		
Lecturer/associate (for OFE)	Jovanović D. Igor		
Number of ECTS 5		**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Acquiring the fundamental knowledge about ultrasonic technique, methods of realisation and practical applications of ultrasonic devices.
Course outcomes	Theoretical knowledge on ultrasonic technique. Mastering the techniques of development, realisation and application of ultrasonic transducers and generators.
Course outline	
Theoretical teaching	Introduction to ultrasonic technique. Application areas of ultrasound. Theoretical aspects on application of ultrasound. Generation and propagation of ultrasonic waves. Ultrasonic waveguides and transducers. Detection and measurement of ultrasound. Nondestructive testing of materials. Application of ultrasound in signal processing and measurements. Ultrasound in medicine. Methods of ultrasonic scanning. Application of power ultrasound.
Practical teaching (exercises, OFE, study and research	Measurement of the parameters of piezoelectric ceramics. Construction and measurement of the parameters of ultrasonic sandwich transducers. Construction and measurement of the parameters of ultrasonic sonotrode. Ultrasonic generator. System for ultrasonic cleaning.
Textbooks/references	
1	M.Radmanovic, D.Mancic, "Design and modelling of power ultrasonics transducers", MP Interconsulting, Le Lockle, Switzerland, 2004.
2	D.Ensminger, L.J.Bond, "Ultrasonics: Fundamentals, Technologies, and Applications", CRC Press, 2011.
3	J.David, N.Cheeke, "Fundamentals and Applications of Ultrasonic Waves", CRC Press, 2012.
4	D.Mancic, V.Paunovic, “Application of impedance spectroscopy for electrical characterization of La doped BaTiO3-ceramics” (in Serbian), Faculty of Electronic Engineering Nis, Edition: Monographies, Nis, 2012.
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1		

Teaching methods	Lectures; Auditorial exercises; Laboratory exercises; Computer exercises; Consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	Written exam	20
Exercises	15	Oral exam	20
Colloquia	20		
Projects	15		

Specification for the book of courses

Study program	Electronics and Microsystems			
Module	Electronics and Microsystems			
Type and level of studies	Master studies			
The name of the course	Metodology in Verification			
Lecturer (for lectures)	Dimitrijević A. Marko, Andrejević-Stošović V. Miona			
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)	Dimitrijević A. Marko, Andrejević-Stošović V. Miona			
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites				
Course objectives	Systematization of knowledge from functional verification and mastering verification methodologies: e Reuse Methodology (eRM) and Universal Verification Methodology (UVM).			
Course outcomes	Acquiring knowledge and competence for applying standard methodologies (eRM and UVM) in functional verification.			
Course outline				
Theoretical teaching	Basics of e Reuse Methodology (eRM). Fundamentals of Universal Verification Methodology (UVM). Phases of the UVM methodology. Classes in UVM methodology. UVM macros. Verification component parts – environment, tests, test agent, agent, driver, sequencer, monitor, sequences, scoreboard, BFM (Bus Functional Model), synchronizer. Realization of the verification component.			
Practical teaching (exercises, OFE, study and research	Verification component design in the UVM methodology for: 1. FIFO register, 2. Serial protocol (I2C, SPI, UART), 3. Parallel (bus) protocol.			
Textbooks/references				
1	Cadence, "Universal Verification Methodology (UVM) e User Guide", 2015.			
2	S. Iman, S. Joshi, The e hardware verification language, Kluwer Academic Publishers, New York, 2004.			
3				
4				
5				
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	0	2		
Teaching methods	Lectures, laboratory work, consultations, project			
Grade (maximum number of points 100)				
Pre-exam duties	**Points**	**Final exam**	**Points**	
Activity during lectures	25	**Written exam**		
Exercises	25	**Oral exam**	50	
Colloquia				
Projects				

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Medical Physics		
Lecturer (for lectures)	Ristić S. Goran		
Lecturer/associate (for exercises)	Živanović N. Emilija		
Lecturer/associate (for OFE)			
Number of ECTS 5		**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Introduction to application of the ionizing and non-ionizing radiation in medicine, as well as the principle of basic methods of medical diagnostics.
Course outcomes	Knowledge of diagnostic and therapeutic methods in medicine that are based on the ionizing and non-ionizing radiation, and the equipment is used in that purpose
Course outline	
Theoretical teaching	Medical diagnostics. X-rays and X-ray characteristics and their application in medicine. Radiography and fluoroscopy, mammography, X-ray, computer tomography. Digital Flat Panel X-ray Appliances. The production and the characteristics of ultrasound and its application in medicine. Principle of magnetic resonance, and its application in medical diagnostics. Use of radioisotopes in medical diagnostics and radiotherapy. PET diagnostics. Electrocardiography, Laser application in medicine. Application of radiofrequency and optical radiation in medical diagnostics and therapy. Radiotherapy devices.
Practical teaching (exercises, OFE, study and research	Practical classes take place through computational exercises. Concrete problems are solved during computational tutorials in order to make students more easily and successfully master certain areas that are covered in theoretical classes.
Textbooks/references	
1	G. S. Ristic, Medical Physics, Script, Faculty of Electrical Engineering Nis (in Serbian)
2	
3	
4	
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	0		

Teaching methods	Lectures, computational exercises and consultations

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	30
Exercises		Oral exam	30
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Technologies of Organic Semiconductor Materials and Devices		
Lecturer (for lectures)	Paunović V. Vesna, Pantić S. Dragan		
Lecturer/associate (for exercises)	Aleksić M. Sanja		
Lecturer/associate (for OFE)			
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	

Prerequisites	
Course objectives	The basic knowledge of organic semiconductors, components and technologies that are based on these materials.
Course outcomes	The student becomes familiar with the properties and technologies of organic semiconductor materials. Also, acquires knowledge about the components that are based on organic semiconductors, and is capable of independently using commercial Silvaco software tools for simulation of technological process and the electrical characteristics of the components
Course outline	
Theoretical teaching	Introduction. Organic semiconductors. Transport carriers in the crystal, polycrystalline and amorphous organic semiconductors. Luminescence in organic materials, films and crystals. Spontaneous and stimulated emission. Energy transfer and excitation. Photo conduction, photo-induced charge transfer. Photovoltaic components, solar cells and photodiodes. Organic LEDs, the basic structure and charge injection. Organic LED displays, active and passive matrix displays. Organic transistors. Circuits and systems based on organic components. Photo excitation organic lasers.
Practical teaching (exercises, OFE, study and research	As part of a planned seminar and defend an independent project in the final exam, as well as the planned exercises that are performed on a computer, the student shall be met with organic semiconductors and components, as well as electronic circuits and systems that are based on organic components.
Textbooks/references	
1	Handbook of Organic Materials for Electronic and Photonic Devices, ed Oksana Ostroverkhova, Woodhead Publishing, 2018
2	M.Petty, Organic and Molecular Electronics: From Principles to Practice, Wiley and sons, 2019
3	H.S. Nalwa, Ed., Organic electroluminescent materials and devices, Amsterdam.
4	Hagen Klauk, Organic Electronics: Materials, Manufacturing and Applications, Wiley VCH , 2006
5	Handbook of Flexible Organic Electronics, Materials, Manufacturing and Applications, ed: Stergios Logothetidis, Woodhead Publishing, 2014

Number of classes of active education per week during semester/trimester/year

Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	0		

Teaching methods	Lectures, consultations, exercises, exercises on the computer, the project

Grade (maximum number of points 100)

Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	25
Exercises	20	**Oral exam**	25
Colloquia			
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Multi-Layer Printed Circuit Boards Design		
Lecturer (for lectures)	Prijić D. Zoran, Danković M. Danijel		
Lecturer/associate (for exercises)	Stojković S. Aleksandra		
Lecturer/associate (for OFE)	Marjanović B. Miloš		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Learning objectives are defined so that the student will: - Learn the technology of producing multilayer printed circuit boards; - Learn the process of designing multilayer printed circuit boards; - Learn the sources of parasitic effects that may appear on the multilayer printed circuit board; - Understand ways to reduce the impact of parasitic effects; - Know techniques for the realization of planar components on the printed circuit board; - Know techniques for interconnecting integrated circuits on the multilyer printed circuit board; - Be able to use the ECAD package for the design of multilayer printed circuit boards of medium complexity.
Course outcomes	Learning outcomes are defined so that the student will: - Distinguish the elements of the structure of multilayer printed boards and the technology of their production; - Explain the procedure for designing multilayer printed boards using the given example; - Distinguish grounding topologies and ways of partitioning the ground level, according to the given examples; - Identify sources of parasitic effects and propose ways to minimize them, according to the given examples; - Design planar components on the printed circuit board according to the given technical specifications, using the ECAD package; - Arrange and interconnect on the printed circuit board an integrated circuit with a large number of copies, using ECAD package; - Identify heat sources on the printed circuit board and design appropriate structures for heat removal.
Course outline	
Theoretical teaching	Technology of production of multilayer printed boards. Buried and the blind vias. Distribution of signal type by layers. Ground loops, grounding topology, partitioning the ground level. Power and current flows. Signal integrity. Impact of noise, guard rings. Influence of parasitic components between and within layers. Effects of high frequencies. Electromagnetic interference and crosstalk. Arrangement and ways of connecting integrated circuits with a large number of pins. Planar components on the printed circuit board (sensors, transformers, antennas). Distribution of temperature inside the board structure. The influence of connected peripheral components.
Practical teaching (exercises, OFE, study and research	Using the ECAD package. Laboratory exercises. Research work related to a given or self-proposed subject.
Textbooks/references	
1	https://www.nxp.com/files-static/training_pdf/WBNR_PCBDESIGN.pdf
2	https://www.analog.com/media/en/training-seminars/design-handbooks/Basic-Linear-Design/Chapter12.pdf
3	D. Brooks, "Signal Integrity Issues and Printed Circuit Board Design", Prentice Hall, 2003.
4	D. Brooks, "PCB Currents: How They Flow, How They React", Prentice Hall, 2013.
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1		

Teaching methods	Active teaching; Lectures; Exercises on the computer; Exercises in the laboratory; Consultations.		
Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	25
Exercises	20	**Oral exam**	25
Colloquia			
Projects	20		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Design of Photovoltaic Systems		
Lecturer (for lectures)	Pantić S. Dragan, Mančić D. Dragan		
Lecturer/associate (for exercises)	Jovanović D. Igor		
Lecturer/associate (for OFE)	Jovanović D. Igor		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	Basic of Photovoltaic, Solar Technologies and Devices
Course objectives	The objectives of this course are reflected in: acquiring basic knowledge about photovoltaic (PV) systems; methods of designing and realization of electric power converters used in PV systems; methods of designing and realization of PV systems; getting acquainted with the standards of PV systems and electric power converters for PV systems; meeting the relevant economic aspects, both for autonomous (off-grid) PV systems and for grid connected PV systems.
Course outcomes	After completion of the course, students will, based on the acquired theoretical and practical knowledge, be able to: identify different types of solar modules and components used in PV systems; determine the optimum orientation (optimum tilting angles) of PV panels in relation to the geographic position of the system; calculate the expected production of electricity PV systems; analyze different methods of monitoring maximum power; compare the different topology of the PV system; design PV systems and evaluate the costs of system implementation; follow the trends of further development of the PV system.
Course outline	
Theoretical teaching	Types and characteristics of solar panels. Basic characteristics of topology of electric power converters and criteria for selecting the optimal topology of converters in the design of PV systems: selection of electric power converters depending on the power of the photovoltaic system, single-mode converters and inverters. Control and protection functions of the PV system: methods for monitoring the maximum power point (MPP tracker) and overall system efficiency; control of electric power converters; synchronization with network voltage and network voltage monitoring; detection of network failure, protection against overheating. Types of PV system (fixed and rotating, standalone and network connected). Estimation of the expected energy using software packages for analyzing, estimating and simulating the operation of the PV system. Calculation of the power losses of the PV system due to shading, dust accumulation and increase of the temperature of the module. Principles of design of PV system and accompanying control, protective, measuring and monitoring equipment. Connecting the PV system to the distribution network and monitoring the performance of the PV system.
Practical teaching (exercises, OFE, study and research work)	Introduction to the Matlab / Simulink software package. Modeling the electrical characteristics of the solar cell under standard test conditions. Measurement of open circuit voltage VOC and short-circuit current ISC of regular, parallel and combined solar cells. Modeling of the MPPT algorithm: direct methods and indirect methods. Configuration of a stand-alone photovoltaic system and measurement of its characteristics I / V photovoltaic PVCHECK tester. Introduction to PVGIS and RETScreen software packages. Measuring the effect of shading on the electrical characteristics of photovoltaic modules. Viziting the realized modular rotating photovoltaic system of 5kW power. Measurement of characteristics of network-connected (grid-on) photovoltaic system I / V photovoltaic PVCHECK tester.
Textbooks/references	
1	Photovoltaic Devices, Systems and Applications CD-ROM, C. Honsberg and S. Bowden, (free online resource)
2	Photovoltaic Science and Engineering Handbook, Second Edition, Antonio Luque and Steven Hegedus, John Wiley and Sons, 2012.
3	Applied Photovoltaic 2nd ed., S. Wenham, M. Green, et. al., ARC Centre for Advance Silicon Photovoltaics and Photons, 2007.
4	Lectures and Exercises (http://mikro.elfak.ni.ac.rs/predmeti/projektovanje-fotonaponskih-sistema/)
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1		

Teaching methods	Lectures, independent studio research work, computational exercises, laboratory exercises, consultations. Through study research, a student is studying available literature through seminar work or team project. Practical examples of calculation and design of concrete PV systems are used in calculating and laboratory exercises.		
Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	10	**Oral exam**	30
Colloquia			
Projects	30		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Energy, Environment and Sustainable Development		
Lecturer (for lectures)	Pantić S. Dragan, Aleksić M. Sanja		
Lecturer/associate (for exercises)	Pantić S. Dragan, Aleksić M. Sanja		
Lecturer/associate (for OFE)			
Number of ECTS 5	**Course status (obligatory/elective)**	Elective	

Prerequisites	
Course objectives	The objectives of this course are reflected in: understanding of the environmental impact of electricity, i.e. why they should be taken into consideration when it comes to production and the open electricity market; prioritizing the impact and understanding of their physical properties that leave the consequences for the environment; the study of the best methods for quantification and the implementation of a comparative analysis of the harmful effects on the environment; getting acquainted with the concepts of Microeconomics characterized by market imperfections; learning the basic elements, advantages and disadvantages of various regulatory instruments that control the impact of electricity on the environment; analysis of best practices in the use of regulatory instruments for the purpose of reducing pollution, i.e. increasing the presence of renewable resources, with a focus on regulatory policy at the level of the European Union and beyond; analysis of different case studies, which points students to trends in the development and application of sustainable technologies for the production and consumption of electricity.
Course outcomes	The student should, after successful completion of the course, be able to: distinguish the various harmful effects that the production of electricity has on the environment, both in cases when using "dirty" energy sources, and in cases of renewable sources; uses different methodologies for quantifying significant environmental impacts and their mutual comparison; be familiar with the basic concepts of Microeconomics that define market imperfections; understand and conduct comparative analysis of various regulatory instruments for controlling the impact of the energy sector on the environment; and follows trends in further development of the energy sector and the application of sustainable technologies.
Course outline	
Theoretical teaching	Energy: past, present and future. Mechanical energy. Wind Energy. Hydro energy, Biomass energy. Energy derived from fossil fuels. Nuclear energy. Geothermal energy. Solar energy. Electricity and environment. The impact of emissions of harmful gases from thermal power plants to the atmosphere, the environment and human health. The greenhouse effect and global climate change. Assessment and evaluation of the impact of climate change on the environment. Instruments of ecological regulation of the energy sector. Alternative instruments for energy and slime regulation. Public policy on climate change. Energetic efficiency. Analyzes of best practice in the use of regulatory instruments for the purpose of reducing pollution, i.e. increasing the presence of renewable resources, with a focus on regulatory policy at the level of the European Union and beyond. Regulatory policy related to the use of renewable energy sources in the Republic of Serbia.
Practical teaching (exercises, OFE, study and research	Analyzes of various studies and cases in developed countries, which aim to familiarize students with the trends of development and application of sustainable technologies for the purpose of production and consumption of electricity.
Textbooks/references	
1	Reza Toossi, Energy and the Environment: Resources, Technologies, and Imapct, second edition, VerVe Publishers, Inc., Los Angeles, USA, 2008.
2	Robert A. Ristinen, Jack J. Kraushaar, Energy and the Environment, Wiley, 2nd edition, 2008.
3	Efstathios E. Michaelides, Energy, the Environment, and Sustainability, CRC Press, 2018.
4	Michel Andre, Zissis Samaras, Energy and Environment, Volume 1, ISTE Ltd 2016.
5	Lectures and Exercises (http://mikro.elfak.ni.ac.rs/predmeti/energija-okolina-i-odrzivi-razvoj/)

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	0		

Teaching methods	Lectures, independent studio research work, consultations. Through study research, a student is studying available literature through seminar work or team project.		
Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises		**Oral exam**	50
Colloquia			
Projects	40		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Professional Practice		
Lecturer (for lectures)	Head of study programme		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory

Prerequisites	
Course objectives	Getting to know the process of work in the company in which the professional practice is carried out, its goals and organizational units. Getting to know the team and the project where the student is involved, which is selected in accordance with the student's study program. Understanding the process of work in the company, business processes, understanding of work risks, participation in design, documentation preparation or quality control, in accordance with the work process and organizational possibilities of the company.
Course outcomes	Improving students' ability to get involved in the work process after completion of studies. Developing responsibility, professional approach to work, communication skills in the team. Complementing the theoretical knowledge acquired within the study program with practical knowledge of the issues that have been studied. Using the experience of professionals working in the enterprise where the practice is carried out to expand the practical knowledge and motivation of students. To gain a clear insight into the possibility of applying the acquired knowledge and skills covered by the study program in practice.
Course outline	
Theoretical teaching	
Practical teaching (exercises, OFE, study and research work)	The content of the professional practice is in full compliance with the objectives of the practice. The student learns the structure of the company and the goals of its business, adjusts his/her own engagement to the corresponding study area and duly fulfills his/her work obligations in accordance with the duties of the employees in the company. The student describes his own engagement during the professional practice and gives a critical insight in his/her own experience, knowledge and skills gained in practice.
Textbooks/references	
1	
2	
3	
4	
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
				6

Teaching methods	As a rule, the student chooses a company from the state, private or public sector in which he/she will perform the professional practice. Professional practice can also be done abroad, which offers opportunity for improving student's language proficiency. Following the student's proposal, the head of the study program approves the practice in the chosen company, and a written referral for professional practice is issued to a person in charge in the company. After completing the practice, on the basis of the student's report and the confirmation of the responsible person who confirms that the practice has been performed, the student is awarded 3 ESPB points.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	
Exercises	70	Oral exam	30
Colloquia			
Projects			

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Master Thesis – Study and Research Work		
Lecturer (for lectures)			
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS 2	**Course status (obligatory/elective)**	Obligatory	

Prerequisites	
Course objectives	Application of basic, theoretical-methodological, scientific-professional and applied knowledge and methods to solve concrete problems. The student studies the problem, its structure and complexity, and on the basis of the conducted analysis, concludes the possible ways of solving it. By studying literature students are introduced to methods and engineering practice for solving similar tasks.
Course outcomes	Training students to independently apply previously acquired knowledge from different areas they have studied, in order to examine the structure of the given problem and to analyze it in a systematic way, with the final goal to make conclusions about possible solutions. Through the self-use of literature, students expand their knowledge by studying various methods and papers related to similar issues. In this way, students develop the ability to conduct analyses and to identify problems within the given issues. By the practical application of acquired knowledge, students develop the ability to see the place and role of engineers in the selected area, as well as the need for cooperation with other professions and for the teamwork.
Course outline	
Theoretical teaching	The study work is formed individually in accordance with the needs of a concrete master work, its complexity and structure. According to his/her affinities and preferences, the student chooses the field of study work and the teacher (from the list of teachers of the study program), who defines the specific task. The student studies professional literature, professional and scientific papers dealing with similar topics, performs the analysis in order to find a solution for a concrete task, or perform some experiments in the laboratory. The study includes active monitoring of primary knowledge, organization and performance of experiments, numerical simulations and statistical data processing, as well as the preparation of seminar work from the chosen scientific area.
Practical teaching (exercises, OFE, study and research	
Textbooks/references	
1	
2	
3	
4	
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
			4	

Teaching methods	

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	
Exercises		Oral exam	50
Colloquia			
Projects	50		

Specification for the book of courses

Study program	Electronics and Microsystems		
Module	Electronics and Microsystems		
Type and level of studies	Master studies		
The name of the course	Master Thesis		
Lecturer (for lectures)			
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS	15	**Course status (obligatory/elective)**	Obligatory
Prerequisites			
Course objectives	The work at Master Thesis is aimed at consolidating, validating and practical application of acquired knowledge during Master Academic Studies. The student is given the opportunity to demonstrate the ability to independently perform a project, which can be practical, theoretical-methodological or research-oriented. The student also acquires experience in presenting his work through written form as well as oral presentation during the Thesis defense.		
Course outcomes	Ability to lead a standalone project, the ability to formulate and analyze problems, critically review possible solutions, review the literature in a particular area. Application of acquired engineering and design knowledge and problem solving skills, taking into account the complexity, cost, reliability and efficiency of the solution. Ability to write work in a given form. Ability to clearly explain the project through an oral defense of the Thesis.		
Course outline			
Theoretical teaching	Master Thesis is the independent research, practical or theoretical-methodological work of the student in accordance with the level of studies, in which he/she becomes acquainted with a certain area through a literature review and adopts methodology of research, necessary for the work realization. By work on the Thesis, the student applies the practical and theoretical knowledge acquired during the studies. As a rule, the Master Thesis contains an introductory chapter, definition of the problem, overview of the areas and existing solutions, proposal and description of the solution, conclusion and literature. A public oral defense of the Thesis is organized in the presence of a commission of three members, one of which is a mentor of Thesis. During the oral defense, the candidate explains the results of his work, and then answers the commission's questions, whereby the candidate demonstrates the ability for the oral presentation of his/her project.		
Practical teaching (exercises, OFE, study and research			
Textbooks/references			
1			
2			
3			
4			
5			

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes

Teaching methods	

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	70
Exercises		Oral exam	30
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Power Engineering
Module	Electrical Power Engineering
Type and level of studies	Master studies
The name of the course	Methods of optimization
Lecturer (for lectures)	Marinković D. Slađana
Lecturer/associate (for exercises)	Jovančić S. Vladan
Lecturer/associate (for OFE)	

Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Gaining basic mathematical knowledge of optimization and different optimization methods. Developing skills of mathematical modelling of real problems of practice, as well as solving them.
Course outcomes	Students' competence to put the gained knowledge into practice. Competence to identify and define the optimization problems of practice, develop mathematical models, choose the appropriate methods for their solving and the application of methods.
Course outline	
Theoretical teaching	Defining the general optimization problem. Theoretical basis of optimization. Elements of convex analysis. Linear programming. Duality. Simplex method. Nonlinear programming. Unconstrained optimization. Searching methods. Gradient methods. Constrained optimization. Kuhn-Tucker conditions. Lagrange multipliers method. Penalty functions methods. Quadratic programming. Basis of multiobjective optimization. Overview of heuristic methods.
Practical teaching (exercises, OFE, study and research	Exercises of knowledge gained in the lectures. Impementation of optimization algorithms by the appropriate software.
Textbooks/references	
1	Lj. M. Kocić, G. V. Milovanović, S. Marinković, Operational research, University of Niš, Faculty of Electronic Engineering, 2007.(Serbian)
2	G.V. Milovanović, P.S. Stanimirović: Symbolic Implementation of Nonlinear Optimization, University of Niš, Faculty of Electronic Engineering, Niš, 2002 (Serbian).
3	K. Y. Lee and M. A. El-Sharkawi, Modern Heuristic Optimization Techniques: Theory and Applications to Power Systems, Wiley, 2008.
4	
5	

Number of classes of active education per week during semester/trimester/year

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	0		

Teaching methods	Lectures, exercises consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	40
Exercises		Oral exam	20
Colloquia			
Projects	40		