Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Basics of Electronics		
Lecturer (for lectures)	Dimitrijević A. Marko, Milić Lj. Miljana		
Lecturer/associate (for exercises)	Mirković D. Dejan, Đorđević D. Srđan, Radivojević S. Novak, Đorđević Z. Ivana		
Lecturer/associate (for OFE)	Đorđević Z. Ivana, Radivojević S. Novak, Panić D. Aleksandar, Milić Lj. Miljana		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Acquiring basic knowledge of electronics, amplifier technology, linear oscillators, linear sources, and power supply voltage regulation.
Course outcomes	Students will be able to recognize an electrical scheme, understand the principle of operation, and grasp the application of basic electronic circuits, such as amplifiers, linear oscillators, and DC voltage sources.
Course outline	
Theoretical teaching	Physical basics of electronics, semiconductors, semiconductor doping and electric current in semiconductors. Diodes and diode circuits. Bipolar transistor, DC load line and operating point. Model of a bipolar transistor. MOSFET transistor, DC load line and operating point. Model of a MOSFET. Basic amplifier stages with bipolar and MOSFET transistors. Multistage amplifiers. Direct-coupled amplifiers. Differential and operational amplifier. Applications of operational amplifiers. Amplifier frequency response. Negative feedback. Linear oscillators. Large-signal amplifiers. Linear sources and supply voltage regulation.
Practical teaching (exercises, OFE, study and research work)	Basic amplifier stages, applications of operational amplifiers, negative feedback, oscillators, large-signal amplifiers, rectifiers and voltage regulators.
Textbooks/references	
1	B. Razavi, Fundamentals of Microelectronics, 3rd edition, Wiley, 2021, ISBN: 978-1-119-69514-1
2	A. Sedra, K. Smith, Microelectronic Circuits, 8th edition, Oxford University Press, 2020, ISBN: 978-0-190-85346-4
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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
3	2	1	0	0

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**	20
Exercises	10	**Oral exam**	20
Colloquia	40		
Projects	0		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Mathematics 3		
Lecturer (for lectures)	Milošević M. Dušan, Marjanović M. Zvezdan, Ranđelović M. Branislav		
Lecturer/associate (for exercises)	Stanković M. Hranislav, Rajković P. Jovan, Denić Z. Anđa		
Lecturer/associate (for OFE)			
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Mastering basic mathematical knowledge from theory and applying it through examples.
Course outcomes	Students' capability to solve complex engineering and physical problems using advanced mathematical apparatus.
Course outline	
Theoretical teaching	Numerical series. Functional series and series. Potential and trigonometric series. Differential equations of first order. Equations that separate variables, homogeneous euqation, linear equation and Bernoulli equation. Differential equations of second order. Real functions of several real variables. Limits and continuity. Partial derivatives and differentials. Tangent plane. Taylor's formula. Directional derivative and gradient. Extreme values. Double, triple and curvilinear integrals. Complex functions. Cauchy-Riemann conditions. Complex integration. Laplace transform. Inverse transform.
Practical teaching (exercises, OFE, study and research work)	Numerical series. Functional series and series. Potential and trigonometric series. Differential equations of first order. Equations that separate variables, homogeneous euqation, linear equation and Bernoulli equation. Differential equations of second order. Real functions of several real variables. Limits and continuity. Partial derivatives and differentials. Tangent plane. Taylor's formula. Directional derivative and gradient. Extreme values. Double, triple and curvilinear integrals. Complex functions. Cauchy-Riemann conditions. Complex integration. Laplace transform. Inverse transform.
Textbooks/references	
1	J. J. Duistermaat, J. A. C. Kolk, Multidimensional Real Analysis II. 978-0511616723, Cambridge University Press, UK, 2004.
2	Pugh, C.C. Real Mathematical Analysis. 9780387216843, https://books.google.rs/books?id=Rs7iBwAAQBAJ, Springer New York, 2013.
3	Zill, D. G., Advanced Engineering Mathematics, 7th ed., Jones & Bartlett Learning, 2021.
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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
3	2	0	0	0

Teaching methods	Lectures and exercises.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Electronics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital Electronics		
Lecturer (for lectures)	Đorđević Lj. Goran, Đošić M. Sandra, Jovanović D. Milica		
Lecturer/associate (for exercises)	Jovanović D. Milica, Đošić M. Sandra		
Lecturer/associate (for OFE)	Jovanović D. Milica, Veljković J. Milijana		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Acquisition of fundamental knowledge in the field of digital electronics and the integration of theoretical knowledge with practical aspects of analyzing and designing combinational and sequential digital circuits using programmable digital components and hardware description languages. Understanding the principles of memory circuit construction, programmable digital components, and data converters.
Course outcomes	The outcome of the course is the student's ability to: (a) analyze and design combinational and sequential digital circuits by applying formal minimization methods and fundamental principles of digital engineering; (b) develop and behavioral and structural hardware description language models for low-complexity digital subsystems. (c) synthesize, optimize, and implement low-complexity digital systems onto modern field-programmable gate array (FPGA) platforms.
Course outline	
Theoretical teaching	Logic Circuits and Combinational Networks: Elementary logic circuits, logic expressions and combinational networks, Boolean algebra. Implementation Technologies: MOSFET transistor as a switch, CMOS inverter and logic circuits, programmable logic components (PLA, PAL, ROM). Standard Combinational Circuits: Decoder, multiplexer, encoder, demultiplexer. Arithmetic Circuits: Full adder, ripple-carry adder, carry-lookahead adder, multipliers. Latch Circuits and Flip-Flops: Latches, master-slave flip-flops, edge-triggered flip-flops. Register Components: Data and shift registers, counter synthesis (asynchronous and synchronous). Sequential Circuits: Analysis and synthesis, algorithmic state machines. Memory Circuits: RAM (SRAM, DRAM), ROM. D/A and A/D Conversion: Basic architectures of digital-to-analog and analog-to-digital converters.
Practical teaching (exercises, OFE, study and research work)	Practical instruction consists of a cycle of six laboratory exercises. Each exercise represents an independent engineering design task in which students apply theoretical principles using specialised electronic design automation software and programmable logic platforms. The practical programme is structured as follows: 1) Introduction to the digital system design environment and the stages of implementation using programmable logic devices. 2) Implementation and structural modelling of medium-scale integration combinational modules. 3) Hardware implementation of basic arithmetic circuits (a full adder and a binary adder). 4) Hardware implementation of complex arithmetic circuits (a binary multiplier). 5) Design and implementation of basic asynchronous and synchronous sequential circuits (latches, flip-flops, and registers). 6) Design and hardware implementation of synchronous counter registers.
Textbooks/references	
1	R.J. Tocci, N. S.Widmer, G. L. Moss, Digital Systems: Principles and Applications, 11th ed., Pearson, July 17, 2010.
2	S.Brown, Z.Vranesic, Fundamentals of Digital Logic with VHDL Design, 3th ed.,McGraw-Hill Education, April 14, 2008.
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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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, consultations, quizzes, and midterm exams.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points

Activity during lectures		**Written exam**	30
Exercises	10	**Oral exam**	30
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Signals and Systems		
Lecturer (for lectures)	Nikolić V. Saša		
Lecturer/associate (for exercises)	Stančić Z. Goran		
Lecturer/associate (for OFE)	Đorđević Z. Ivana		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Acquisition of basic knowledge about signals and systems. Introduction to methods of system analysis in the time domain. Laplace transform and its application to system analysis. Fourier series. Convolution and calculation of system output for arbitrary excitation. Acquisition of basic knowledge for studying Digital Signal Processing.		
Course outcomes	Theoretical and practical knowledge of signal and system properties. Knowledge of procedures for system analysis in the time and frequency domains.		
Course outline			
Theoretical teaching	The concept of signals and systems, signal types, classification. Stability. Impulse response. Characterization of continuous systems by differential equations. Fourier series. Discretization of continuous signals. Real and idealized measurement of time-continuous signals. Measurement theorem. Impulse response in the time domain. Convolution. Laplace transform. Relationship between Laplace and Fourier transforms. Application of Laplace transform to solving linear differential equations. Transfer function of a linear system. System stability. Response of linear continuous systems to arbitrary input signals.		
Practical teaching (exercises, OFE, study and research work)	Transformations of independent variables: operations of shift, reflection and scaling. Even and odd functions. Analysis of first and second order circuits. Elementary signals. Representation of functions through elementary signals. Laplace transform. Inverse Laplace transform and its calculation. Convolution. Computing convolution in the time domain. Computing convolution using the Laplace transform. Fourier series. Expanding periodic functions into the Fourier series. Determining the output of a system for a given input using the Laplace transform.		
Textbooks/references			
1	Steven T. Karris: Signal ans systems with Matlab applications, Orchard publications, Fremont, California, 2003.		
2	F. Cohen: Signals, Systems and Transforms: Concise Coverage from Theroy to Application, Willey, 2025		
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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	1	2	0	0

Teaching methods	Lectures, Audition exercises, Laboratory exercises, 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	Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Telecommunications		
Lecturer (for lectures)	Đorđević T. Goran		
Lecturer/associate (for exercises)	Đorđević T. Goran		
Lecturer/associate (for OFE)	Đorđević T. Goran		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	The objective of the course is to provide students with fundamental knowledge in the field of analog and digital telecommunications, as well as an understanding of the operating principles of modern telecommunication systems and networks.		
Course outcomes	After passing the exam, the student will: 1) be able to perform spectral analysis of deterministic and random signals; 2) understand the basic principles of analog modulation; 3) understand the process of digitization of analog signals and know the principles of digital signal transmission in both baseband and passband frequency ranges; 4) know the elementary methods of compression, error correction coding, and cryptography.		
Course outline			
Theoretical teaching	Spectral analysis of deterministic and random signals. Signals transmission through linear and non-linear systems. Analog modulation. Signal digitalization. Impulse coded modulation and differential impulse coded modulation. Multiplexing. Digital signals transmission in baseband. Intersymbol interference. Transmission of digital signals in the passband (ASK, FSK, PSK, QAM - process of modulation and demodulation). Entropy of information sources and channel capacity. Introduction to compression, error correction coding and cryptography. Signal transmission through fiber optic and wireless media. Public mobile and satellite systems. Cable distributed systems. The importance of telecommunication techniques for Internet-of-Things (M2M, autonomous vehicles, smart cities).		
Practical teaching (exercises, OFE, study and research work)	Problem-solving sessions and laboratory exercises will be organized for all methodological units covered in the lectures. During problem-solving sessions, students solve numerical problems and practical tasks that are closely aligned with the theoretical course content. Laboratory exercises are conducted in both the laboratory and the computer classroom. Students acquire practical laboratory skills through teamwork in the implementation of functional parts of telecommunication systems using basic electronic components, as well as through the use of soldering irons, oscilloscopes, pulse generators, spectrum analyzers, network analyzers, various antenna systems, and optical fibers. In the computer classroom, students are trained to perform Monte Carlo simulations and to master fundamental signal processing techniques.		
Textbooks/references			
1	S. Haykin, M. Moher, Communication Systems, 5th edition, John Wiley & Sons, Inc., NY, USA, 2009.		
2	B. Sklar, F. Harris, Digital Communications: Fundamentals and Applications, Pearson, 2020.		
3	J. Proakis, M. Salehi, G. Bauch, Contemporary Communication Systems Using MATLAB, 3rd Edition, Cengage Leraning, USA, 2013.		
4	B. Razavi, RF Microelectronics, 2nd ed., Prentice Hall, NJ, USA, 2011.		
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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	0	0

Teaching methods	Lectures. Exercises. Laboratory exercises. Preparation and presentation of seminar papers. Consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	15
Exercises	10	**Oral exam**	15
Colloquia	30		
Projects	20		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Metrology of Electrical Quantities	
Lecturer (for lectures)			Denić B. Dragan, Simić M. Milan	
Lecturer/associate (for exercises)			Ranđelović S. Ivana	
Lecturer/associate (for OFE)			Stojanović S. Milica	
Number of ECTS	6	**Course status (obligatory/elective)**		Obligatory / Elective
Prerequisites	None			
Course objectives	Education and introduction of students to basic theoretical and practical knowledge in the field of metrology and measurement of electrical quantities.			
Course outcomes	Students' training and ability to solve practical problems in the field of measuring electrical quantities, based on a good knowledge of measurement methods and techniques, with the proper use of modern instruments and equipment for measuring electrical quantities. In addition, an important segment is the training of students for the later application of acquired knowledge in measurement techniques in engineering professions in the field of electrical engineering and computer science.			
Course outline				
Theoretical teaching	Introduction to metrology. Definition and materialization of the measurement units of amperes, ohms and volts of the MKSA system. Functional diagrams of the process of measuring electrical quantities. Methods of measuring electrical quantities. Processing of measurement results and measurement uncertainty. Determination of measurement uncertainty in more complex modern measurement systems. Analog and digital measuring instruments and their basic measurement errors. Virtual instrumentation. Expansion of the measurement range of ammeters, voltmeters and ohmmeters. Working with modern measuring instruments. Oscilloscopes.			
Practical teaching (exercises, OFE, study and research work)	Computational, laboratory and demonstration exercises: training students to solve computational problems in the field of measuring electrical quantities, as well as for the practical application of measurement methods and measuring instruments through engagement in laboratory and demonstration exercises. The basic areas covered in laboratory exercises are: calibration of measuring devices, analysis of measurement results and assessment of measurement uncertainty, expansion of the measurement range of ammeters and voltmeters, resistance measurement, work with modern digital measuring instruments, as well as the application of analog and digital oscilloscopes. According to the Practicum for working on laboratory exercises, students submit an appropriate report on each completed laboratory exercise.			
Textbooks/references				
1	J. G. Webster, "Measurement, Instrumentation and Sensors Handbook", CRC Press, 2014.			
2	S. Tumanski, “Principles of Electrical Measurements”, Taylor & Francis Group, 2006.			
3	W. Nawrocki, Measurement Systems and Sensors. London, Artech House, 2005.			
4	P. Sydenham, “Handbook of Measurement Science“, John Wiley & Sons, Ltd., 1982			
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	0	0

Teaching methods	Lectures (theoretical teaching) with graphical presentation of material in the form of slides. Computational exercises with solving problems in the field of electrical measurements. Practical teaching in the form of laboratory and demonstration exercises. Daily student consultations with teachers or associates. Individual work of students in the form of homework assignments.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	Written exam	20
Exercises	10	Oral exam	20
Colloquia	40		
Projects	0		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Numerical Mathematics	
Lecturer (for lectures)			Marjanović M. Zvezdan, Marinković D. Slađana, Rančić Z. Lidija	
Lecturer/associate (for exercises)			Denić Z. Anđa	
Lecturer/associate (for OFE)				
Number of ECTS		6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None			
Course objectives	Mastering basic concepts in numerical mathematics.			
Course outcomes	Students' capability to apply numerical algorithms for solving equations and systems of equations, function approximation, numerical differentiation and integration, and solving differential equations in the profession.			
Course outline				
Theoretical teaching	Numerical methods for solving systems of linear equations. Direct methods. Iterative methods. Ill-conditioned systems. Nonlinear equations and systems of nonlinear equations. Newton's method and its modifications, secant method, bisection method. Solving algebraic equations. Newton-Kantorovich method for systems of nonlinear equations. Approximation of functions. Interpolation (Lagrange and Hermite). The least squares problem. Numerical differentiation and integration. Newton-Cotes and Gaussian quadrature. Basic methods for the approximate solution of ordinary differential equations and systems of differential equations.			
Practical teaching (exercises, OFE, study and research work)	Practical teaching is implemented through solving tasks that cover the content of theoretical teaching, with the aim of the student turning previously presented theoretical considerations into their own functional knowledge.			
Textbooks/references				
1	Richard L. Burden, J. Douglas Faires, Numerical Analysis, Boston, MA : Brooks/Cole, Cengage Learning, 2011.			
2	L. Ridgway Scott, Numerical Analysis, Princeton University Press, 2011.			
3	K. Atkinson, An Introduction to Numerical Analysis, John Wiley & Sons, 1989.			
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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**
3	2	0	0	0

Teaching methods	Lectures, computational exercises, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	40
Exercises	10	**Oral exam**	10
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microprocessor Systems		
Lecturer (for lectures)	Nikolić R. Tatjana		
Lecturer/associate (for exercises)	Nikolić R. Tatjana		
Lecturer/associate (for OFE)	Nikolić R. Tatjana		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Introducing students to the fundamental components, operating principles, and design of modern microprocessor systems. Special emphasis is placed on ARM processor architecture and the interaction between hardware and software. Through theoretical and practical work, students will develop the ability to analyze, understand, design, and program components of microprocessor systems.		
Course outcomes	The knowledge acquired in this course will enable the student to: a) explain the fundamental concepts of microcomputer architecture and organization, b) understand the principles of hardware design, data path, and microprocessor control unit, c) differentiate and analyze the structure and operation of ARM processors, d) understand the relationship between hardware and machine code, i.e., assembly language, e) explain memory and input/output device operation and management, f) apply basic software concepts necessary for programming microprocessor-based systems, and g) apply acquired knowledge in the simulation and design of simple microprocessor systems.		
Course outline			
Theoretical teaching	Definition of microcomputer architecture and organization, components and levels of abstraction. Performance of microprocessor systems. Overview of ARM architecture, ARM ISA, instruction set, and registers. Instruction formats, operation types, addressing modes, programming in assembly and C language. Simple central processing unit – single-cycle, multi-cycle, and pipelined. Data path – arithmetic logic unit, register file. Control unit – hardwired and microprogrammed control. Memory hierarchy: cache, main, secondary, and virtual memory. Input-output subsystem, buses, arbitration. Interrupts and exceptions. General principles of performance enhancement techniques – pipelining, parallelism, superscalar architecture, VLIW, and multiprocessor systems-on-chip.		
Practical teaching (exercises, OFE, study and research work)	1) Simulation and analysis of ARM processor operation, 2) Working with registers and basic instructions, 3) Branching and conditional instructions, 4) Stack and subroutines – function call mechanism, 5) Using a debugger, 6) Memory manipulation – reading and writing, 7) Real-time interrupt handling, 8) Creating programs in assembly and C, 9) Speed comparison and optimization.		
Textbooks/references			
1	David A. Patterson, John L. Hennessy, Computer Organization and Design: The Hardware/ Software Interface, ARM Edition, Elsevier Inc., 2017.		
2	Sarah L. Harris, David Money Harris, Digital Design and Computer Architecture, ARM Edition, Elsevier Inc., 2016.		
3	Jean-Loup Baer, Microprocessor Architecture: From Simple Pipelines to Chip Multiprocessors, Cambridge University Press, 2009.		
4	Andrew Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Morgan Kaufmann, 2004.		
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	0	0

Teaching methods	Lectures; classroom exercises; laboratory exercises; homework assignments; colloquia; consultations

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	Written exam	30
Exercises	15	Oral exam	30
Colloquia	20		

Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Digital Signal Processing	
Lecturer (for lectures)			Nikolić V. Saša	
Lecturer/associate (for exercises)			Stančić Z. Goran	
Lecturer/associate (for OFE)			Đorđević Z. Ivana	
Number of ECTS	6	**Course status (obligatory/elective)**		Obligatory
Prerequisites	None			
Course objectives	Acquiring basic knowledge about analysis, synthesis and processing of digital signals. Getting to know the methods of practical realization of the transfer function. Getting to know Matlab next for analysis and processing of digital signals. Acquisition of basic knowledge related to the design of digital filters.			
Course outcomes	Theoretical and practical knowledge of discrete systems and their implementation. Mastering the techniques of designing recursive and non-recursive digital filters.			
Course outline				
Theoretical teaching	Z transform. Inverse z transform. Discrete Fourier transform. Short-time Fourier transform. Discrete networks. Linear differential equations with constant coefficients. Block diagram for representing discrete networks. Discrete network transfer function. Frequency response. Continuous discrete transforms. Derivative transform. Impulse invariant transformation. Bilinear transformation. Nonrecursive digital filters. Networks with linear phase characteristic. Design of nonrecursive filters. Window functions. Design of a nonrecursive filter in the frequency domain. Hilbert transformer.			
Practical teaching (exercises, OFE, study and research work)	Derivative transformation. Impulse invariant transformation. Calculation of z transform based on Laplace transform. Bilinear transformation. Modified z transform. Relations LT- FT-ZT. Structures for implementing digital filters. Direct implementation. Cascade implementation. Parallel implementation. Ladder implementation. Lattice implementation. Allpass realization. Binary arithmetic. Effect of coefficient quantization on the filter function. Limit cycles. Product quantization and limit cycle effects. Limit cycles as a consequence of overrange during addition. Digital-to-continuous conversion.			
Textbooks/references				
1	S. Mitra, Digital signal processing A computer based approach, McGraw-Hill, 2006.			
2	L. Tan, J. Jiang, Digital Signal Processing: Fundamentals, Applications and Deep Learning, Academic Press, 2025			
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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	0	0

Teaching methods	Lectures; Audition exercises; Laboratory exercises; 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	Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Multimedia Systems		
Lecturer (for lectures)	Nikolić V. Saša		
Lecturer/associate (for exercises)	Cvetković S. Stevica		
Lecturer/associate (for OFE)	Cvetković S. Stevica		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	To impart theoretical and practical knowledge about the basic concepts of multimedia systems. Analyze the procedures of creation, compression, presentation and processing of multimedia information. Present image, video and sound compression algorithms in detail.		
Course outcomes	Knowledge of the basic concepts of creating, compressing, presenting and processing multimedia information. Understanding and implementation of image, video and audio signal compression algorithms.		
Course outline			
Theoretical teaching	The concept of digital multimedia information and systems. Digital data acquisition, measurement and quantization. Formats for recording and displaying image, video and audio information. Colorimetry - color spaces (RGB, rg, HSV, YCbCr, CMYK, etc.). Basics of information theory - compression ratio, entropy. Introduction to compression - lossless and lossy compression. VLC coding - Huffman process. Arithmetic and binary-arithmetic coding. Dictionary coding - LZW. Predictive coding - DPCM. Image compression - GIF and JPEG. Audio signal compression - MP3. Video signal compression MPEG-2 and MPEG-4.		
Practical teaching (exercises, OFE, study and research work)	Computer exercises in the Matlab and Python programming environments. Practical implementation of coding algorithms (Huffman, arithmetic, LZW). Example of JPEG image compression algorithm. Using the FFmpeg software library and video compression tools.		
Textbooks/references			
1	P. Havaldar, G. Medioni: Multimedia Systems: Algorithms, Standards, and Industry Practices, Course Technology, Cengage Learning, 2010		
2	Shi Yun Q. Image and video compression for multimedia engineering, CRC Press, 2008		
3	Z. Li, M.S. Drew, J. Liu: Fudamentals of Multimedia, Springer 2025		
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	0	0

Teaching methods	Lectures,

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	40
Exercises	5	**Oral exam**	30
Colloquia	10		
Projects	10		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Animation 1		
Lecturer (for lectures)	Nikolić V. Saša		
Lecturer/associate (for exercises)	Stojanović V. Nikola		
Lecturer/associate (for OFE)	Stojanović V. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to 3D modeling programs. Acquisition of basic knowledge of polygonal modeling, primitive geometry, introduction to polygons.		
Course outcomes	Acquiring the knowledge needed to create complex 3D models, manipulate 3D objects, and learn the basics of animation		
Course outline			
Theoretical teaching	Introduction to 3D modeling programs. Overview of current software (Maya) and their functions. User interface, 3D camera view and orthogonal views, coordinate system, object manipulation. Basics of polygonal modeling, primitive geometry, moving pivot objects, introduction to polygons, hierarchy. NURBS modeling.Object mapping. Camera. Lights. Rendering, shadow mesh, optimizations. Working with timeline, keyframes and object and camera animation techniques.		
Practical teaching (exercises, OFE, study and research work)	3D modeling. 3D camera and orthogonal views, coordinate system, object manipulation. Polygonal modeling, primitive geometry, pivot object movement, polygons, hierarchy. NURBS modeling. Object mapping. Camera. Lights. Rendering, shadow mesh, optimizations, animation. Studio research paper: Photography, modeling and visualization of a building in Niš		
Textbooks/references			
1	Lee Lanier, "Maya - Professional Tips and Techniques", Wiley, 2007		
2	K. Roberts: Real-Time Character Animation: Principles and Practice with Unreal Engine, CRC Press, 2025		
3	S. Thornton: The Digital 2D Animation Handbook: From Traditional Principles to Modern Workflow, Routledge, 2024		
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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	1	2	0	0

Teaching methods	Lectures, auditory exercises, 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	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Analog Electronics		
Lecturer (for lectures)	Andrejević-Stošović V. Miona		
Lecturer/associate (for exercises)	Andrejević-Stošović V. Miona, Đorđević D. Srđan		
Lecturer/associate (for OFE)	Đorđević D. Srđan		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Application of ideal and real operational amplifiers, stability analysis of circuits with operational amplifiers, frequency compensation of operational amplifiers, integrated operational amplifier circuits, analog function generators and active filters.		
Course outcomes	Using the knowledge acquired from the above methodological units in the analysis and synthesis of analog electronic circuits with ideal and real discrete and integrated components.		
Course outline			
Theoretical teaching	Application of ideal and real operational amplifiers. Analysis of circuits with operational amplifiers. Characteristics of real operational amplifiers. Stability of circuits with feedback. Frequency compensations of operational amplifiers: compensation by reducing input impedance, differential compensation, integral compensation. Integrated circuits of operational amplifiers: cascode amplifiers and current mirrors, differential amplifiers. Output stages. Analog function generators. Active filters - Butterworth and Chebyshev approximation.		
Practical teaching (exercises, OFE, study and research work)	In computational exercises, problems from all areas that have been theoretically studied are solved. In practical exercises, students implement circuits that have been theoretically studied on models and measure their characteristics.		
Textbooks/references			
1	B. Razavi, "Fundamentals of Microelectronics", Wiley, ISBN: 978-1-118-15632-2, 2013.		
2	B. Razavi, "Design of Analog CMOS Integrated Circuits", McGraw-Hill Internationsl Edition, ISBN: 0-07-118815-0, 2001.		
3			
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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**
3	1	1	0	0

Teaching methods	Lectures; Laboratory exercises; Consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	30
Exercises	5	**Oral exam**	30
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electronic Circuits and Embedded systems		
Lecturer (for lectures)	Milić Lj. Miljana, Đorđević Lj. Goran		
Lecturer/associate (for exercises)	Milić Lj. Miljana, Đošić M. Sandra		
Lecturer/associate (for OFE)	Milić Lj. Miljana, Veljković J. Milijana		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The aim of the course is to introduce our students to contents and principles of design of electronic circuits and embeded systems, through mastering the basic design techniques and appropriate development tools		
Course outcomes	The ability of a student to analyise, optimize and simulate an electronic circuit and design a printed circuit board. Upon successful completion of this course, the student will be able to: apply the fundamental design principles of embedded systems to develop low-complexity applications; design, write, and debug efficient embedded software solutions in a high-level programming language; integrate and control external hardware components, such as sensors, actuators, and displays with a microcontroller platform; implement, test, and troubleshoot fully functional low-complexity embedded firmware projects through hands-on laboratory prototyping.		
Course outline			
Theoretical teaching	Aspects of electronic circuits design (technology, hardware / software, legal, economic and environmental aspects). Design styles, criteria for selecting the suitable style. Domains of project description. Phases of design process. Hardware description languages: PSpice, VHDL. Simulation and optimization of electronic circuits. Basics of physical design - design of printed boards. Types and elements of printed circuit boards. Materials for PCBs. Processes of PCB design and manufacturing. Verification. Introduction to embeded systems: 1) Introduction to the ESP32 development platform and the Arduino IDE, and development and testing of simple programs for working with digital inputs and outputs. 2) Interfacing and software control of a buzzer, an ultrasonic sensor, and an LED display, and their integration into a functional embedded system. 3) Acquisition and processing of signals from digital and analogue sensors, and implementation of a simple automatic control system. 4) Application of hardware and timer interrupts for event processing, time measurement, and button contact debouncing. 5) Modelling the behaviour of a reactive embedded system using a state diagram and its implementation as a finite-state machine. 6) Analysis of the timing diagram of a serial communication protocol and implementation of a driver for communication with a sensor module as a C++ class.		
Practical teaching (exercises, OFE, study and research work)	Knowledge gained in lectures, students deepen through practicing of electronic circuits design skills and the development of embedded systems with the application of available tools and programme environments. Laboratory part of the course consists of one cycle of laboratory exercises and a final project. Students are expected to complete 12 laboratory exercises, divided into two main parts: a) Simulation and optimization of analog electronic circuits, and VHDL simulation of digital circuits; b) Fundamentals of embedded programming. As part of the final project, students will design, implement, and program a low-complexity embedded system. This includes the independent design and fabrication of a printed circuit board (PCB) required for the system's hardware.		
Textbooks/references			
1	Vanco Litovski, Mark Zwoliński, VLSI Circuit Simulation and Optimization, Springer, 1996.		
2	Mark Zwoliński, Digital System Design with VHDL, 2004.		
3	J. Blum, Exploring Arduino: Tools and Techniques for Engineering Wizardry, Welly, 2019.		
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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
1	2	2	0	0

Teaching methods	Lectures utilizing multimedia projectors; classroom-based practical exercises; computer laboratory sessions; academic consultations; individual project work.		
Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	40	**Oral exam**	30
Colloquia	20		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Software Engineering in Electronics		
Lecturer (for lectures)	Cvetković S. Stevica		
Lecturer/associate (for exercises)	Radivojević S. Novak, Špeletić M. Matija		
Lecturer/associate (for OFE)	Radivojević S. Novak, Špeletić M. Matija		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	To provide students with practical knowledge of essential software engineering methodologies, tools, and best practices aimed at improving code quality, increasing productivity, and enhancing collaboration in development projects related to electronics. The course prepares students for modern professional environments where software engineering competencies are essential.		
Course outcomes	Upon completion, students will be able to use version control systems, apply software design patterns to engineering problems, write well-documented and maintainable code that adheres to industry standards, implement automated testing and continuous integration, select appropriate software tools for specific engineering challenges, and collaborate effectively in multidisciplinary teams.		
Course outline			
Theoretical teaching	Lectures cover fundamental software engineering concepts relevant to applications in electronics. Topics include version control with Git, code quality and conventions, tools for code analysis and improvement, software testing methodologies, code documentation, software design patterns, basics of UML diagrams, continuous integration, and project management systems. The theoretical foundation is aimed at enabling students to apply software tools and concepts within real-world development workflows in the domain of electronics.		
Practical teaching (exercises, OFE, study and research work)	Students gain hands-on experience with standard software development tools used in electronics. Exercises include practical work with version control systems (Git), implementation of software design patterns in C/C++ and Python, code formatting and documentation, design and implementation of automated tests, creation of UML diagrams, CI pipeline setup, and basic work with local databases.		
Textbooks/references			
1	Robert C. Martin, Clean Code: A Handbook of Agile Software Craftsmanship, Pearson, 2008.		
2	D. Thomas and A. Hunt, The Pragmatic Programmer, Addison-Wesley Professional, 1999.		
3	Ron Patton, Software testing, 2nd edition, SAMS Publishing, 2005.		
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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	1	1	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Audio and Music Signal Processing		
Lecturer (for lectures)	Stančić Z. Goran		
Lecturer/associate (for exercises)	Đorđević Z. Ivana		
Lecturer/associate (for OFE)	Đorđević Z. Ivana		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Introduction to the Methods of Designing and Implementing Analog Filters for Audio Signal Processing. Design of Crossovers with Specified Attenuation. Notch Filters for Compensation of Audio Driver Characteristics. Phase Analysis and Compensation. Digital Music Signal Processing. Introduction to Methods for Implementing Echo and Reverberation. Equalizers		
Course outcomes	Mastery of Techniques for the Design and Implementation of Analog Audio Filters. Understanding of Digital Music Signal Processing Techniques. Offline Digital Signal Processing in MATLAB.		
Course outline			
Theoretical teaching	Design of Butterworth and Chebyshev Filters. Linkwitz-Riley Filter and Phase Analysis. Crossovers up to 24 dB/oct. Characteristics of Loudspeakers/Drivers and Selection of Crossover Frequencies. Frequency Response Compensation. Design of Compression, Bass-Reflex, and Transmission Line Speaker Enclosures. Normalization. Frequency Transformations. Fundamentals of Digital Music Signal Processing. Implementation of Echo. Implementation of Reverberation Using Various Digital Filters. Chorus and Flanging Effects. Equalizers for Music Signal Processing.		
Practical teaching (exercises, OFE, study and research work)	Demonstration of the Calculation and Implementation of Inductors for Analog Filters in Audio Signal Processing. Processing of Digital Music Signals in MATLAB and Their Playback on an Audio System.		
Textbooks/references			
1	Julius O. Smith: Physical audio signal processing, CCRMA, Stanford, https://ccrma.stanford.edu/~jos/pasp/		
2	Julius O. Smith: Introduction to digital filters, CCRMA, Stanford,https://ccrma.stanford.edu/~jos/filters/		
3	Udo Zolzer: DAFX - Digital audio effects, John Wiley & Sons, Hamburg, Germany, 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	1	1	0	0

Teaching methods	Lectures and problem-solving classes, exercises, homeworks, 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			
Projects	40		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Microprocessor Technique		
Lecturer (for lectures)		Đošić M. Sandra, Jovanović D. Milica		
Lecturer/associate (for exercises)		Đošić M. Sandra		
Lecturer/associate (for OFE)		Veljković J. Milijana		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	The goal of the course is to familiarize students with: a) microarchitecture and fundamental techniques for improving the performance of modern microprocessors; b) the role and significance, structure, and basic concepts of operating systems.			
Course outcomes	The student is able to apply the principles of designing modern pipelined and superscalar microprocessors in the analysis and design of high-performance microprocessor systems, critically analyze microprocessor architectures and evaluate their performance and limitations, integrate knowledge of operating systems into the development of simple embedded applications under Linux, and independently develop and test embedded solutions using modern tools and techniques.			
Course outline				
Theoretical teaching	Pipelined and superscalar microprocessor architectures: pipelined CPU organization, dynamic instruction execution flow, register renaming, branch prediction and speculative execution, instruction-level parallelism. Memory system: cache organization and cache consistency issues in uni- and multiprocessor systems. Input/output system: system bus and interconnection networks. Overview of parallel microprocessor architectures. Introduction to operating systems: concept, role, structure, and types of operating systems. Core concepts: processes and threads, memory and I/O management, file system organization.			
Practical teaching (exercises, OFE, study and research work)	Practical instruction consists of a cycle of six laboratory exercises focused on the development of less complex embedded applications in the C/C++ programming language using the basic services of the Linux operating system. The content of the exercises includes: familiarization with the Linux environment and basic system calls, programming with peripherals (GPIO, timers), implementation of simple control algorithms, multitasking and processes in Linux, communication via serial interfaces, and the development and testing of embedded applications.			
Textbooks/references				
1	J. P. Shen, M. H. Lipasti, Modern processor design: Fundamentals of Superscalar Processors, Waveland Press, Inc, July 30, 2013.			
2	J. L. Hennessy, D. A. Patterson, Computer Architecture: A Quantitative Approach, 6th ed., Morgan Kaufmann, December 7, 2017.			
3	Mishra, B.K., Dhiman, G., Kasturiwale, H., Alegavi, S. and Yadav, K. eds.,Industrial Internet of Things for Responsible Technology, CRC Press, 2025			
4	Pakdel, M., Digital Control of Power Converters Using Arduino and an STM32 Microcontroller, CRC Press, 2024			
5	Microprocessor Technology, course notes and PowerPoint presentations for lectures, problem-solving sessions, and laboratory exercises, available on the course website.			
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	1	0	0
Teaching methods	Lectures, tutorial sessions, laboratory exercises, homework assignments, mini-projects, and 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	20			
Projects				

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Analog Integrated Circuits		
Lecturer (for lectures)	Đorđević D. Srđan, Andrejević-Stošović V. Miona		
Lecturer/associate (for exercises)	Đorđević D. Srđan		
Lecturer/associate (for OFE)	Đorđević D. Srđan		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The course will enable students to understaned the structure, opeation and applications of different types of linear integrated circuits. Lectures are partially devoted to the analysis and design of analog circuits consisting of linear integrated circuits.		
Course outcomes	Upon successful completion of the course, students will get knowledge about application of anaog integrated circuits in various circuits. They will be able to select circuit topology, select appropriate integrated circuits and dimension an analog circuit based on a given specification.		
Course outline			
Theoretical teaching	Non-linear applications of operational amplfiers. Integrated voltage comparators. Sample/hold amplifiers. Lock-in amplifiers. Instrumentation amplifier. Operational Transconductance Amplifier (OTA). Current feedback amplifiers. Switched capacitor circuits. Voltage-Controlled Oscillator (VCO). Inegrated-circuit timers. Relaxation oscillators. Phase-Locked Loops (PLL). Voltage reference circuits. IC voltage regulators. Switching regulators.		
Practical teaching (exercises, OFE, study and research work)	Calculation exercises are organized according to the topic of the respective lecture, and follow its content. By solving the problems presented in the exercises, students gain knowledge of the operating principles of linear circuits as well as the limitations and non-idealities of integrated circuits. Homeworks and design projects assigned to students are focused on the practical aspects of circuit design and design trade-offs.		
Textbooks/references			
1	S. Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 4th ed., McGraw-Hill Education, 2015, ISBN: 978-0-07-802816-8		
2	R. Coughlin, F. Driscoll, Operational Amplifiers & Linear Integrated Circuits, 6th ed., Prentice Hall, 2014, ISBN: 9788120320963		
3	Horowitz, Paul, and Winfield Hill. “The Art of Electronics”, 3rd ed., Cambridge University Press, 2015., ISBN: 978-0521809269		
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	0	0

Teaching methods	Lectures, laboratory exercises, consultations, project assignment

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Computer Networks		
Lecturer (for lectures)	Nikolić R. Tatjana		
Lecturer/associate (for exercises)	Nedeljković N. Jelena		
Lecturer/associate (for OFE)	Nedeljković N. Jelena		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Introducing students to the architecture and functioning of computer networks. Presentation of the basic principles of data transmission, network hierarchy, communication protocols, and the structure of the Internet, including network layers from the physical to the application layer. Special emphasis is placed on the TCP/IP protocol stack, routing algorithms, and traffic management mechanisms.		
Course outcomes	By acquiring knowledge from this course, the student will be able to: a) understand the principles of computer communications and the components of computer networks, b) distinguish the layers and functions of the ISO/OSI and TCP/IP models, c) analyze the operation and interaction of protocols across different layers, d) identify and configure protocols at the network layer, and e) apply tools for network traffic analysis and simulation.		
Course outline			
Theoretical teaching	Data transmission and networking. Network components. Layered communication model, ISO-OSI model, TCP/IP protocol stack. Physical layer – signal transmission, interfaces, digital and analog transmission, modulation techniques, multiplexing, error detection and correction. Data link layer – addressing, link layer management, medium access control protocols. Random access, Ethernet. Characteristics of wireless transmission, 802.11xx standards. Network layer – IP addressing, IPv4/IPv6, fragmentation, network address translation (NAT), subnetting. Routing algorithms: distance vector, link state. Mobile IP. Transport layer – ports, UDP and TCP, segmentation, flow control, congestion control. Application layer – client-server architecture, DNS, FTP, HTTP, email, Web protocols.		
Practical teaching (exercises, OFE, study and research work)	1) Familiarization with network simulation and analysis tools – Packet Tracer and Wireshark, 2) Simulation of LAN and IP configurations, 3) Analysis of TCP/IP model layers through packet monitoring at each communication layer, 4) Data link layer protocols, MAC address analysis, 5) IP address configuration, subnetting, DHCP protocol, 6) Monitoring TCP connection establishment, 7) Network traffic analysis by tracking HTTP, FTP, DNS, and ICMP protocols.		
Textbooks/references			
1	Andrew S. Tanenbaum, Nick Feamster, David J. Wetherall, Computer Networks, 6th ed., Pearson Education, 2021.		
2	James F. Kurose, Keith W. Ross, Computer networking: a top-down approach, 8th ed., Pearson Education, 2021.		
3	Behrouz A. Forouzan, Data Communications and Networking, 5th ed., McGraw Hill, 2012.		
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	0	0

Teaching methods	Lectures; classroom exercises; laboratory exercises; homework assignments; colloquia; consultations

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	Written exam	30
Exercises	15	Oral exam	30
Colloquia	20		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital Image Processing		
Lecturer (for lectures)	Nikolić V. Saša, Cvetković S. Stevica		
Lecturer/associate (for exercises)	Cvetković S. Stevica		
Lecturer/associate (for OFE)	Špeletić M. Matija, Cvetković S. Stevica		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Present basic algorithms for digital image processing: quality improvement, sharpening, filtering, segmentation, etc. Master the mathematical apparatus for applying operations in digital image processing. Implement the acquired knowledge about image processing algorithms in software.		
Course outcomes	To enable students to understand and independently implement basic digital image processing operations in Matlab or Python.		
Course outline			
Theoretical teaching	"Components of an image processing system. Photometry, image acquisition and digitization. Image enhancement in the spatial domain. Image histogram. Linear filtering in the spatial domain - image sharpening. Fast image filtering in the frequency domain - convolution theorem. Nonlinear image filtering - an example of a median filter. Image restoration in the presence of noise. Image segmentation - comparison with a threshold. Morphological operations on an image. Color image processing.		
Practical teaching (exercises, OFE, study and research work)	Computer exercises in the Matlab and Python software packages. Practical program implementation of digital image processing algorithms presented in lectures. Working with matrices, scripts, functions and flow control. Loading and displaying images, pixel analysis and data types. Techniques for improving image quality are covered - contrast, gamma correction and histogram. Spatial and frequency filtering, as well as edge detection methods. Segmentation, morphological operations, and color image processing are also covered. The goal is to master the most important image processing algorithms in Matlab and Python.		
Textbooks/references			
1	Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 3rd edition, Prentice-Hall, 2008.		
2	R. Gonzales, R. Woods: Digital Image Processing: A Modern Approach Using Deep Learning, Pearson, 2025		
3	S. Day: Hands-on Digital Image Processing with Python, Packt Publishing, 2025		
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	0	0

Teaching methods	Lectures, laboratory exercises, individual projects

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	
Exercises	5	**Oral exam**	40
Colloquia	50		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Animation 2		
Lecturer (for lectures)	Nikolić V. Saša		
Lecturer/associate (for exercises)	Stojanović V. Nikola		
Lecturer/associate (for OFE)	Špeletić M. Matija		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to using visual effects on 3D models. Introduction to particle dynamics techniques for simulating fabrics, fibers, fluids, and more.		
Course outcomes	Acquiring the knowledge necessary to create complex visual effects on 3D models using the particle system dynamics technique.		
Course outline			
Theoretical teaching	Principles of basic visual effects, with an emphasis on 3D visual effects. Compositing techniques and compositing software. Introduction to dynamic simulations. Fundamentals of particle systems and techniques for simulating the dynamics of particle systems. Fabric dynamics. Fiber Dynamics. Fluids and Fluid Dynamics. 2D Fluids. 3D Fluids. Caching and Rendering Techniques for Dynamic Simulations in Virtual Environments. Basic Principles of MEL Scripting.		
Practical teaching (exercises, OFE, study and research work)	2D and 3D visual effects. Compositing and compositing software. Dynamic simulations. Particle systems. Particle system dynamics. Fabric dynamics. Dynamic fibers. Fluids and fluid dynamics. 2D and 3D fluids. Caching and rendering of dynamic simulations. MEL scripting. Studio research paper: Add special effects to video material recorded with a camera and perform post-production in compositing software.		
Textbooks/references			
1	Morgan Robinson, “Maya 8 - A Visual Quick Guide”, Computer Library, 2007.		
2	Lee Lanier, "Advanced Maya Texturing and Lighting", Wiley, 2008.		
3	K. Roberts: Real-Time Character Animation: Principles and Practice with Unreal Engine, CRC Press, 2025		
4	S. Thornton: The Digital 2D Animation Handbook: From Traditional Principles to Modern Workflow, Routledge, 2024		
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	0	0

Teaching methods	Lectures, auditory exercises, computer laboratory exercises, 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**	40
Colloquia			
Projects	30		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Acoustics		
Lecturer (for lectures)		Ćirić G. Dejan		
Lecturer/associate (for exercises)		Vučić J. Nikola		
Lecturer/associate (for OFE)		Vučić J. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Mastering basic theoretical and practical knowledge about the nature of sound, generating and transmitting sound, sound perception, sound sources, transducers, room acoustics, sound recording and reproduction. Gaining knowledge about audio signals and systems, their characteristics and applications.			
Course outcomes	Theoretical knowledge in the field of sound. Application of theoretical knowledge aimed at acquiring skills in the use of acoustic devices, audio equipment, studio facilities, and relevant software tools. Skills in sound recording and signal processing. Competencies in assessing the basic acoustic characteristics of systems and environments, and in carrying out simple sound recording and processing tasks in accordance with specified requirements.			
Course outline				
Theoretical teaching	Physical characteristics of sound (generation and transmission of sound waves). Electro-acustical transducers: microphones, speakers, headphones. Standard microphones and special-purpose microphones (high directivity microphones and microphone arrays). Psycho-physiological acoustics: sound perception; subjective perception of sound, equal loudness curves, binaural localization, effects of masking. Spatial dimensions of the sound image (stereo techniques, binaural technique, multi-channel formats). Room acoustics - sound in enclosed space. Acoustical design of rooms. Standards of sound recording and sound reproduction in analog and digital domain. Formats and compression of audio signals. Time and frequancy analysis of audio signals. Speech intelligibility. Features of music signals. Features of ambient sounds.			
Practical teaching (exercises, OFE, study and research work)	Problem solving in computational exercises (Sound transmission and sound sources. Electro-acustical transdusers. Input and output acoustical environment. Psychological acoustics. Sound recording and reproduction). Use of standard procedures and software tools for sound processing (Sound Forge, Praat, Adobe Audition, WaveLab). Computer simulations (Room acoustics). Practical lab and studio exercises (Characteristics of electro-acoustical transducers (speakers, cross-overs, and headphones). Room impulse response and objective parameters of room acoustics. Sound recording and reproduction. Microphone techniques).			
Textbooks/references				
1	T. D. Rossing: Springer handbook of acoustics, Springer, New York, 2007.			
2	J. H. Ginsberg: Acoustics - A textbook for engineers and physicists, Volume I: Fundamentals, Springer and ASA Press, Cham, Switzerland, 2018.			
3	J. Blauert, N. Xiang: Acoustics for engineers - Troy lectures, 2nd edition, Springer, Berlin, 2009.			
4	D. R. Raichel: The science and applications of acoustics, 2nd edition, Springer, New York, 2006.			
5	L. E. Kinsler, A. R. Frey, A. B. Coppens, J. V. Sanders: Fundamentals of acoustics, 4th edition, John Wiley & Sons, New York, 2000.			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

Teaching methods	Lectures; Computational exercises; Laboratory sessions; Studio exercises; Consultations.

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	25		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital System Architecture		
Lecturer (for lectures)	Đorđević Lj. Goran, Jovanović D. Milica		
Lecturer/associate (for exercises)	Jovanović D. Milica, Veljković J. Milijana		
Lecturer/associate (for OFE)	Veljković J. Milijana		
Number of ECTS 5	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	Digital electronics		
Course objectives	The course objective is to teach students with basic principles of digital systems design with emphasis on a hardware description language approach.		
Course outcomes	Upon completion of the course, students will be able to analyse the specification of a digital system and develop its synthesizable VHDL model; model combinational and sequential circuits using concurrent and sequential statements; design control units in the form of finite-state machines; apply hierarchical and parameterized design methods to develop more complex and reusable hardware modules; develop a testbench and verify the functional correctness of the design through simulation; and perform the synthesis, implementation, and functional verification of a digital system on an FPGA development platform using modern computer-aided design tools.		
Course outline			
Theoretical teaching	Introduction to principles of digital circuits and systems design: implementation technologies and design principles. Programmable devices FPGA architecture, design flow and development tools. Introduction to VHDL: VHDL code structure, design styles, VHDL design units. Lexical elements and objects: data types, signals, variables and arrays, data conversion, operators and attributes. Concurrent statements: WHEN, SELECT, and GENERATE, conceptual diagrams, optimization and synthesis of concurrent code. Sequential code: process, sequential statements IF, CASE, and LOOP, synthesis of sequential code, sequential code for combinational and sequential circuits. Finite state machines. Package and components: statements PACKAGE and COMPONENT, structural and hierarchical design. Functions and procedures.		
Practical teaching (exercises, OFE, study and research work)	Ten problem sets regarding digital system design using VHDL will be assigned during the semester: 1) understanding FPGA design flow, VHDL simulation and synthesis; 2) basic lexical constructions; 3) using concurrent statements; 4) concurrent statements optimization 5) using sequential statements; 6) designing registers; 7) VHDL design of finite state machines; 8) structural design in VHDL; 9) using packages and libraries; 10) using functions and procedures.		
Textbooks/references			
1	V. A. Pedroni, „Circuit Design with VHDL“, MIT Press, Cambridge, Massachusetts, 2004.		
2	P.P. Chu, „RTL Hardware Design Using VHDL, Coding for Efficiency, Portability, and Scalability“, John Wiley & Sons, Inc. Hoboken, New Jersey, 2006		
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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	1	1	0	0

Teaching methods	Lectures, exercises, laboratory exercises, homework, 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	20		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Pulse and Digital Electronic Circuits		
Lecturer (for lectures)	Stančić Z. Goran		
Lecturer/associate (for exercises)	Stančić Z. Goran		
Lecturer/associate (for OFE)			
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to the Characteristics of Logic Circuits (TTL, ECL, CMOS, etc.) and Operational Amplifiers Used in the Implementation of Pulse Generators. Understanding of Ideal and Real Systems for Generating Square and Sawtooth Waveforms. Mastery of Analysis Techniques for Bootstrap and Miller Integrators, Start-Stop, Astable and Monostable Pulse Generators, Timers. The Influence of Parasitic Capacitances and Resistances as well as the Non-ideal Transfer Function of Inverters on the Frequency of Output Pulses. Voltage-to-Frequency Converters.		
Course outcomes	Successful Analysis of Pulse Circuits Implemented with Inverters, Logic Circuits, and Operational Amplifiers. Understanding the Operation of Operational Amplifiers and Transistors in Saturation. Mastery of Design Techniques for Comparators With and Without Hysteresis. Analysis and Design of Square Wave Generators and Linear Time Base Generators.		
Course outline			
Theoretical teaching	Characteristics of Diodes. Fast, Schottky, and Zener Diodes. Transistor Models in Active Mode and Saturation. Integrator and Differentiator. CMOS Inverter — Transfer Characteristics and Application in Pulse Circuit Implementation. Inverter Power Consumption. Astable Multivibrator as a Square Wave Generator. Positive Feedback. Implementation of Voltage Comparator Using CMOS Inverter. Hysteresis Transfer Function and Its Impact on Noise. Monostable Multivibrators as Precise Pulse Duration Generators. Retriggerable Monostable Multivibrator and Practical Applications. Characteristics and Transfer Function of Operational Amplifiers. Miller Integrator. Bootstrap Integrator. Voltage-to-Frequency Converter. 555 Timer Circuit. Application of Timers for Pulse Circuit Implementation. SPICE and Analysis of Pulse Circuits. A		
Practical teaching (exercises, OFE, study and research work)	Operating Conditions of the Transistor in Active and Saturation Modes. Integrator and Differentiator. Determination of the Voltage Transfer Characteristic of a CMOS Inverter. Calculation of the Operating Frequency of Astable Multivibrators. Calculation of the Threshold Voltage of a Voltage Comparator. Calculation of a Retriggerable Monostable Multivibrator. Miller Integrator. Bootstrap Integrator. Voltage-to-Frequency Converter. 555 Timer. Application of the Timer for Pulse Circuit Realization.		
Textbooks/references			
1	A. Anand Kumar, Pulse and Digital Circuits, Second edition, PHI Learning Private Learning,2014		
2	Millman and Taub, Pulse, digital switching waveforms, International student edition, McGraw-Hill, 1965		
3	Phillip E. Allen, Douglas R. Holberg, CMOS analog circuit design, Second edition, New York Oxford university press, 2002		
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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	0	0	0

Teaching methods	Lectures and problem-solving classes, consultations, demonstrations in PSpice

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		Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Digital System Design		
Lecturer (for lectures)		Jovanović D. Milica		
Lecturer/associate (for exercises)		Jovanović D. Milica, Veljković J. Milijana		
Lecturer/associate (for OFE)		Veljković J. Milijana		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	Digital System Architecture			
Course objectives	The course objective is to teach students with principles and techniques of digital system design at register transfer level (RTL) of abstraction including: RTL design methodology, building blocks of digital systems, basics of high-level synthesis and synchronization.			
Course outcomes	Upon successful completion of the course, the student is able to apply contemporary techniques, methodologies, engineering tools, and CAD environments for the design of medium- and large-scale digital systems; to design the datapath and control unit of a system based on specified functional requirements; to design and analyze combinational and sequential arithmetic circuits; to transform algorithmic specifications into appropriate hardware architectures; to integrate existing IP cores into more complex digital systems; and to apply fundamental techniques for signal synchronization and communication within complex digital systems.			
Course outline				
Theoretical teaching	RTL design: control/datapath model of digital system, datapath organization, control unit design techniques, ASM representation of algorithm, optimization of ASM diagram, VHDL description of RTL system. RTL design for low-power. Clocking methodologies and synchronization. High-Level Synthesis: data-flow graph and transformations; architecture synthesis (allocation, resource sharing, register sharing, bus sharing, pipelining, area and performance optimization), scheduling (time-constrained scheduling, resource constrained scheduling, heuristic scheduling algorithms). Introduction to system on-chip design and IP core based design.			
Practical teaching (exercises, OFE, study and research work)	Four laboratory exercises will be assigned with focus on RTL design and using FPGA EDA tools: 1) design and optimization of datapath; 2) VHDL-based design of large-size standard digital components; 3) design and performance evaluation of various types of arithmetic circuits; 4) design and implementation of a simple RTL system according to a stated functional behavior. In addition, a larger RTL design project will be assigned as the course project.			
Textbooks/references				
1	P.P. Chu, „RTL Hardware Design Using VHDL, Coding for Efficiency, Portability, and Scalability“, John Wiley & Sons, Inc. Hoboken, New Jersey, 2006.			
2	D. Gajski, Principles of Digital Design, Prentice-Hall, Inc. Upper Saddle River, NJ, 1997.			
3	P. P. Chu, FPGA Prototyping by VHDL Examples: Xilinx MicroBlaze MCS SoC, 2nd ed. Hoboken, NJ, USA: John Wiley & Sons, 2017.			
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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	1	1	0	0

Teaching methods	Lectures, exercises, laboratory exercises, homework, 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	20		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electronic Systems Design	
Lecturer (for lectures)			Milić Lj. Miljana, Jovanović D. Borisav	
Lecturer/associate (for exercises)			Jovanović D. Borisav	
Lecturer/associate (for OFE)			Jovanović D. Borisav	
Number of ECTS	5	**Course status (obligatory/elective)**		Obligatory / Elective
Prerequisites	None			
Course objectives	Acquisition and consolidation of knowledge related to system design, with emphasis on hardware design—from defining user requirements to final implementation on a printed circuit board and microcontroller programming.			
Course outcomes	Acquiring competencies in the design of electronic systems through familiarity with the necessary software and hardware tools. Students develop confidence and the skills required for their future professions. The knowledge gained is practical and applicable, regardless of the choice of platform, programming language, or microcontroller type.			
Course outline				
Theoretical teaching	Types of electronic systems. System design: levels and phases of the design process, specification development, modeling, top-down design methodology, modularization. Compilers: machine language, assembly language, and high-level programming languages. Source code analysis, error detection, and code optimization. Basics of operating systems: programs and processes, basic process states, OS operations related to processes, system calls. Practical PCB design. Power supply design considering non-ideal connections. Techniques for routing ground and power signals. Sources of radio-frequency interference on PCBs and noise minimization strategies. Basic loop configurations on PCBs. PCB design for electromagnetic compatibility.			
Practical teaching (exercises, OFE, study and research work)	The knowledge acquired during lectures is deepened through exercises involving development boards and the Microchip software development environment. Students use the C programming language applied to PIC microcontrollers. Communication protocols such as RS232/485, SPI, I2C, and Ethernet are utilized. For the purpose of these exercises, custom printed circuit boards have been developed, which students use in projects aimed at solving technical challenges related to data acquisition, system control, and data transfer between system components and a host computer. Emphasis is placed on programming PIC microcontrollers. The exercises also include practical PCB design.			
Textbooks/references				
1	Tocci R., Widmer N.and MossG. Principles and applications (10th edition), Prentice Hall 2006			
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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	1	1	0	0

Teaching methods	Lectures with projector presentations, audio-supported exercises, computer-based laboratory sessions, consultations, and individual project work.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	10	**Oral exam**	30
Colloquia			
Projects	50		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Analog Integrated Circuits Design		
Lecturer (for lectures)	Mirković D. Dejan		
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	Acquiring the knowledge necessary for the design and verification of CMOS analog integrated circuits at the transistor level.		
Course outcomes	Students acquire the competencies to: design and dimension analog electronic circuits at the transistor level in CMOS technology, verify the project at the functional and technological level using CAD/EDA software, become familiar with working in the LINUX/UNIX operating system, and acquire skills in writing reports and presenting results.		
Course outline			
Theoretical teaching	CMOS process. Challenges in the process of analog circuit integration in CMOS technology. MOS structure and PN junction. Passive components and basic building blocks of analog electronics in CMOS technology. Noise sources in integrated circuits. Selection of analog circuit topology for a given application. Trade-off between speed, power consumption and area. Sizing transistors in submicron CMOS processes. Analog integrated circuit design flow. Manufacturer support in integrated circuit design (Process Design Kit). Physical implementation (layout). Extraction of parasitic components from the layout. Characterization after implementation (post-layout simulation). Development of project documentation, writing reports.		
Practical teaching (exercises, OFE, study and research work)	Students deepen the knowledge acquired in lectures by acquiring the skill of designing analog integrated circuits using professional software packages for designing integrated circuits, such as Cadnece and Mentor Graphics (Siemens EDA).		
Textbooks/references			
1	Behzad Razavi, Design of Analog CMOS Integrated Circuits Second Edition, McGraw Hill Education, 2017, 782 pp., ISBN: 978-0-07-252493-2		
2	P. Allen and D. Holdberg, CMOS Analog Circuit Design Third Edition, OXFORD UNIVERSITY PRESS, 2012, 725 pp., ISBN 978-0-19-976507-2		
3	Jacob Baker, CMOS Circuit Design, Layout, and Simulation Third Edition, Wiley-IEEE Press, 2010, 1173 pp., ISBN 978-0-470-88132-3		
4	T. C. Carusone, D. A. Johns and K. W. Martin, ANALOG INTEGRATED CIRCUIT DESIGN, John Wiley & Sons, Inc., 2012, 794 pp., ISBN: 978-0-470-77010-8		
5	P. R. Gray, P. J. Hurst, S. H. Lewis, R. G. Mayer, Analysis and Design of Analog Integrated Circuits, Fifth Edition, John Wiley & Sons, Inc, 2009, ISBN: 978-0-470-24599-6		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	2	0	0

Teaching methods	Lectures, auditory exercises, computer laboratory exercises, 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	0		
Projects	40		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Data Acquisition and Conversion Techniqes		
Lecturer (for lectures)	Nikolić S. Goran		
Lecturer/associate (for exercises)	Nedeljković N. Jelena		
Lecturer/associate (for OFE)	Nedeljković N. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The course on data acquisition and conversion techniques covers the principles and methods of converting real-world signals into digital data for further processing, storage, or transmission via communication networks. Its goal is to familiarize students with the principles of converting signals from the analog to the digital domain and vice versa, as well as to provide practical knowledge about modern circuits designed for these purposes. It includes an introduction to basic methods of acquiring electrical and non-electrical quantities, understanding the role of sensors, transducers, and the challenges in processing their signals. The course also examines the fundamental principles of integrating data acquisition systems.		
Course outcomes	The student acquires basic theoretical and practical knowledge in the field of data acquisition and conversion. They understand the architecture and operating principles of analog-to-digital and digital-to-analog converters, as well as sensor systems. They are capable of independently applying the acquired knowledge to the implementation of simple data acquisition and processing systems in modern electronic devices.		
Course outline			
Theoretical teaching	Definition and basic structures of data acquisition systems. General measurement principles, data domains. Types of acquisition systems. Basic building blocks of the system. Sensors and transducers. Calibration and linearization techniques. Analog multiplexers, signal conditioning. Encoding and quantization. Sampling theory. Converter errors. Converter architecture (ADC, DAC, Sigma-Delta). Converter testing. Coupling circuits. Reference sources, clock signal generators. Examples of applications of data acquisition and signal conversion systems.		
Practical teaching (exercises, OFE, study and research work)	Working with basic types of analog and digital sensors (temperature, pressure, force) Application of analog and digital filters Practical exercises with DA converters: weighted, ladder, capacitive Working with different types of ADCs: SAR, flash, sigma-delta Writing programs for the C8051Fxxx microcontroller in the Keil uVision IDE software environment and simulating the operation of built-in AD and DA converters Designing and implementing data acquisition systems, including interfacing with microcontrollers and computers Implementation of wireless systems for measuring physical parameters		
Textbooks/references			
1	The Data Conversion Handbook, Edited by Walt Kester, Newnes, 2005, ISBN 0-7506-7841-0. Also published as Analog-Digital Conversion, Analog Devices, Inc. 2004, ISBN 0-916550-27-3. https://www.analog.com/en/resources/technical-books/data-conversion-handbook.html		
2	Practical Data Acquisition for Instrumentation and Control Systems, John Park and Steve Mackay, ISBN-10:0750657960, ISBN-13:978-0750657969, Newnes, 2003		
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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	1	1	0	0

Teaching methods	Auditory and interactive instruction using computers and a projector Laboratory exercises with real sensors and converters Homework assignments and seminar papers Midterm exams 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	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Virtual Instruments		
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)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Introduction to the concept of virtual instrumentation, data-flow data processing and implementation of systems for measuring, analyzing and visualizing signals on a computer.		
Course outcomes	Students will be able to implement systems for measuring, analyzing, and visualizing signals (virtual instruments) on various platforms using the LabVIEW development environment, and acquire competencies for performing measurements, analyzing, and visualizing the obtained data.		
Course outline			
Theoretical teaching	The concept of a virtual instrument and the advantages of virtual instruments over traditional instruments. Basic concepts of data acquisition - resolution, sampling rate, and A/D conversion. The integration of hardware and software in a virtual instrument. The concept of data-flow processing and graphical programming. Analysis of the acquired data, documentation, and visualization. Advanced programming techniques: the event-driven model, producer-consumer pattern, finite state machine, error control, multithreaded applications, process and thread synchronization, and an object-oriented approach. Virtual instruments for measuring and analyzing signals in real-time systems. Signal analysis on the FPGA platform.		
Practical teaching (exercises, OFE, study and research work)	Introduction to the LabVIEW development environment (front panel, block diagram, palettes with elements), implementation of a virtual instrument in the LabVIEW environment. Data-flow programming concept and modular programming. Loops. Arrays. Working with files, displaying signal waveforms (Waveform Graphs). Strings, clusters, error control, case structures, and sequences. Data acquisition in the LabVIEW environment. Documenting results. Connecting and transferring data over the network. Basic programming architectures - implementation of virtual instruments with events (event-driven) and error control, finite state machine, multithreaded application, synchronization.		
Textbooks/references			
1	Richard Jennings, Fabiola De La Cijeva, LabVIEW Graphical Programming, 5th edition, McGraw Hill, 2019, ISBN: 978-1-260-13526-8		
2	Behzad Ehsani, Data Acquisition Using LabVIEW, Packt Publishing, 2016, ISBN: 978-1-782-17216-1		
3	Julio Cesar Rodriguez-Quinonez, Oscar Real-Moreno, Graphical Programming Using LabVIEW™: Fundamentals and advanced techniques (Computing and Networks), The Institution of Engineering and Technology, 2022, ISBN: 978-1-839-53460-7		
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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	1	1	0	0

Teaching methods	Lectures, exercises, laboratory exercises, consultations, project assignment

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	
Exercises	20	**Oral exam**	70
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microcontrollers		
Lecturer (for lectures)	Nikolić S. Goran		
Lecturer/associate (for exercises)	Nikolić S. Goran		
Lecturer/associate (for OFE)	Nedeljković N. Jelena		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Introducing students to the architecture and fundamental operating principles of the C8051 microcontroller family, as well as acquiring basic knowledge necessary for their practical application in embedded systems. Enabling students to write programs in assembly and C language using available IDE software tools. Mastering the design and implementation of simple embedded devices in laboratory conditions.
Course outcomes	Upon achieving the course objectives, students will possess a basic understanding of the C8051 microcontroller architecture and will be able to independently write programs to solve simple tasks, such as peripheral control, data processing, and basic process control.
Course outline	
Theoretical teaching	Difference between microcontrollers and microprocessors Application of microcontrollers in industry and everyday life Architecture of the MCS-51 microcontroller family, with a special focus on the Silicon Labs C8051Fxxx series Overview of built-in microcontroller interfaces and memory model Input/Output lines (I/O pins and ports), timers, serial interfaces Interrupt system Instruction set and programming in A51 assembly language Basics of C programming for microcontrollers: memory models, variable types, pointers Program organization: modules, linking, directives
Practical teaching (exercises, OFE, study and research work)	Introduction to development systems and software tools, assembly and compilation processes, and program uploading Programming in assembly and C language Number conversion Converting uppercase and lowercase letters presented in ASCII format Automatic climate control (a simple embedded system) Working with a seven-segment display Communication with a PC – establishing a serial connection via RS232 standard or VCOM port System simulation examples and real-time operation Working with a keypad Working with timers
Textbooks/references	
1	C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie, https://www.amazon.com/Programming-Language-2nd-Brian-Kernighan/dp/0131103628
2	Embedded C by Michael Pont, https://www.amazon.com/Embedded-C-Michael-J-Pont/dp/020179523X
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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	0	0

Teaching methods	Auditory and interactive instruction using computers and a projector Examples of embedded systems in a simulator and on real hardware Laboratory exercises, midterm exams, homework assignments, seminar papers 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	Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electronics for Multimedia Systems		
Lecturer (for lectures)	Andrejević-Stošović V. Miona, Mirković D. Dejan, Jovanović D. Igor		
Lecturer/associate (for exercises)	Andrejević-Stošović V. Miona, Jovanović D. Igor		
Lecturer/associate (for OFE)	Mirković D. Dejan		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Devices used for recording and playing multimedia content are predominantly digital, but their operation would also be impossible without the appropriate analog blocks. The aim of the course is to introduce students to the parts of multimedia devices based on analog electronic circuits.		
Course outcomes	This course enables students to aquire the basics of analog, high-frequency and power electronics, to understand the working principle of selected analog electronic circuits, to recognize their main characteristics, as well as the basic principles of their design. Through practical exercises, they are trained in the use of measurement equipment and software for simulating analog electronic circuits.		
Course outline			
Theoretical teaching	Small-signal amplifiers for audio and video, based on operational amplifiers, analog multipliers, analog filters, power amplifiers. Amplifier properties: noise figure, harmonic and intermodulation distortion. Electromagnetic waves, lines, scattering parameters (S parameters), Smith chart, matching networks, principles of operation of RF amplifiers and phase-locked loops (PLL). Power electronics components, power converters, linear power supplies, drivers (LED lighting, DC/BLDC/step motors), uninterruptible power supply systems and components for storing electrical energy.		
Practical teaching (exercises, OFE, study and research work)	Operational amplifier circuits, analog filters, power amplifiers. Numerical examples of tasks (RF amplifiers, matching networks and phase-locked loops (PLL)). Basic power electronics circuits, rectifiers, linear voltage regulator, switching voltage regulator, uninterruptible power supply system.		
Textbooks/references			
1	B. Razavi, "Fundamentals of Microelectronics", Wiley, ISBN: 978-1-118-15632-2, 2013.		
2	R.W.Erickson, D.Maksimovic, "Fundamentals of Power Electronics, Third Edition", Springer, Charm., 2020.		
3	Michael Steer, Fundamentals of Microwave and RF Design Third Edition, NC State University, 2019, 229 pp., ISBN: 978-1-4696-5688-5		
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	1	0	0

Teaching methods	Lectures, exercises, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Web Technologies		
Lecturer (for lectures)		Cvetković S. Stevica		
Lecturer/associate (for exercises)		Špeletić M. Matija		
Lecturer/associate (for OFE)		Špeletić M. Matija		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Acquiring the knowledge necessary to understand the basic protocols, standards, and application services commonly used on the Web today. Understanding the client-server architecture of web applications. Implementing web pages using HTML5, CSS3, and JavaScript.			
Course outcomes	The course aims to equip students with the ability to develop the client-side of web applications using HTML5, CSS3, and JavaScript.			
Course outline				
Theoretical teaching	Understanding the HTTP protocol, methods of communication between client and server, and the basic methods and headers. This is followed by working with HTML5, where students learn about the semantic structure of documents, forms, links, multimedia content, and page formatting elements. For the CSS, students cover both basic and advanced styling, the box model, positioning, layout techniques (Flexbox, Grid), and responsive design for different devices. The course then introduces JavaScript—its syntax, variables, functions, object model, and event handling. The course concludes with work on the DOM structure, HTML element manipulation, and object-oriented programming techniques on the client side.			
Practical teaching (exercises, OFE, study and research work)	Students acquire practical, applicable skills by developing web pages and interactive components. The exercises begin with the HTTP protocol, where students analyze requests and responses using tools like Curl and Postman. Through HTML5, they create semantically correct page structures, forms with validation, and multimedia content integration. CSS3 exercises include designing components using the box model, classes, selectors, and pseudo-classes, as well as arranging elements using Flexbox and Grid systems. Special attention is given to responsive design and media query techniques. Practical JavaScript tasks cover basic programming structures, working with forms, timing functions, and events, followed by DOM tree manipulation. The exercises conclude with a mini-project where students apply their knowledge to develop a dynamic web application.			
Textbooks/references				
1	T. Felke-Morris: Web Development and Design Foundations with HTML5, 9th edition, AddisonWesley, 2018.			
2	The Architecture of the World Wide Web, Volume One – W3C Recommendation https://www.w3.org/TR/webarch			
3	MDN Web Docs – https://developer.mozilla.org			
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	40
Exercises	10	**Oral exam**	20
Colloquia			
Projects	20		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Photography and Graphic Design	
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)**		Obligatory
Prerequisites	None			
Course objectives	Introducing students to the values of photography, how it is created, what are the basic principles of creation, processing photography through photography tools. Introducing students to the basic genres of photography, documentary, fashion, art, information, journalism. Photo formats, application in the Internet environment, photos produced with a mobile phone and use through applications on a mobile phone. Study of photo processing tools from the Adobe suite. Introducing students to graphic design, which are the basic principles of creation, use in film and television, print, packaging, promotional material, billboards, the Internet, web design and design for mobile devices, application and icon design. Logo design in various formats. Iconography, color and typography as basic elements of a graphic solution.			
Course outcomes	Students are trained to independently take their own photographs while respecting the basic rules and principles of photography. They will be able to recognize the moment and method of creating a photograph, how and why to process it in post-production in order to improve the visual experience, and how to intervene with graphics with or without photography. The use of photography in film, television, print, outdoor, the Internet, and the telephone. Students are trained to independently create various forms of logos, icons, web pages, billboards, respecting the basic rules and principles of design. Working in Adobe PhotoShop, Illustrator. Independently designing logos and saving them in a specific format. Using tools to improve the visual experience of graphic solutions and how to intervene in the restyling of old solutions. Combination with or without photography. Branding and corporate identity.			
Course outline				
Theoretical teaching	Basic concepts of fine arts in photography, the origin and development of photography, light, light analysis by wavelength, light sources, color temperature. Photographic camera, emulsion, lenses, DoF, exposure, aperture. Cameras, professional, prosumer and phones. Frame and plans, composition of photography. Digital photography, post-production photography. Photography in the media as part of total design. Basic concepts and application of fine arts in design. History of design, use of form, color and typography and their combination to the final solution. Aesthetic principles and artistic value. Evoking emotions through the use of color in design. Design through time and styles. A good solution as a subconscious communication between you and the user. Wide application of design and aesthetics in the media, mass communications, but also to individuals. Application in marketing.			
Practical teaching (exercises, OFE, study and research work)	Practical lectures will be conducted continuously throughout the semester, students will photograph and create photographs on given topics through practical work with the camera: architecture, documentary, news and information, and artistic photography. This is followed by the process of analyzing photographs, editing in PhotoShop and Lightroom, correction, and post-production. Photography in indoor and outdoor media, posters, billboards, etc. Practical lectures will be conducted continuously throughout the semester, students will work on designing various formats, graphic design with and without photography, television credits, animations, teleplays, posters, billboards, web design, design for mobile phone applications and icons, and creating business cards and websites through practical work with Adobe suite tools. Work on composition, rehearsals, alignments, evoking movement. Preparing solutions for print, but also for electronic media.			
Textbooks/references				
1	Scott Kelby, Photoshop CS: A Digital Photography Book			
2	T. Inglis: The Graphic Design Bible: Story, Theory and Practice, Chronicle Books, 2025			
3	T. Paglen: How to See Like a Machine: Images After AI, Verso, 2026			
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	0	0
Teaching methods	Lectures, auditory exercises, 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	Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Fundamentals of Power Electronics		
Lecturer (for lectures)	Mančić D. Dragan, Jovanović D. Igor		
Lecturer/associate (for exercises)	Jovanović D. Igor, Panić D. Aleksandar		
Lecturer/associate (for OFE)	Panić D. Aleksandar		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquiring the fundamental knowledge about power electronics, components of power electronics and the fundamental circuits in which they are applied.		
Course outcomes	Theoretical knowledge on fundamentals of power electronics. Mastering the techniques of development, realisation and application of the basic circuits of power electronics.		
Course outline			
Theoretical teaching	Introduction to power electronics. Components of power electronics (power diode, bipolar power transistor, thyristor, power MOSFET, IGBT, GTO, integrated power circuits). Application technique of power components (cooling, protection, joint operation of components). Basic circuits with diodes and thyristors. AC voltage controllers. Natural and forced commutation. Sources of DC voltage (diode rectifiers, thyristor rectifiers).		
Practical teaching (exercises, OFE, study and research work)	Basic circuits of power electronics; Single-phase voltage regulator; Three-phase voltage regulator; Single-phase diode rectifier; Three-phase diode rectifier.		
Textbooks/references			
1	N.Mohan, T.M.Undeland, W.P.Robbins, "Power electronics: Converters, Applications, and Design", John Wiley & Sons., New York, 2007.		
2	M.H.Rashid, "Power electronics, Circuits, Devices and Applications", Pearson Education, Inc., New Jersey, 2013.		
3	M.H.Rashid, "Power Electronics Handbook", Elsevier Science, 2017.		
4	L.A.Kumar, A.Kalaiarasi, Y.U.Maheswari, “Power Electronics with MATLAB”, Cambridge University Press, Cambridge, 2017.		
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	0	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	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital Integrated Circuits Design		
Lecturer (for lectures)	Andrejević-Stošović V. Miona, Mirković D. Dejan		
Lecturer/associate (for exercises)	Mirković D. Dejan		
Lecturer/associate (for OFE)	Radivojević S. Novak		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Systematization of knowledge related to the design of digital integrated circuits and fully custom-designed circuits.		
Course outcomes	Acquiring competence in designing digital integrated circuits at the transistor level and at the register-transfer level (RTL). Students are expected to learn to dimension transistors in digital circuits, use description and simulation programs, become familiar with programs for automatic synthesis and implementation of digital integrated circuits, and learn how to write and present the results of their work.		
Course outline			
Theoretical teaching	Description of digital integrated circuits using Verilog HDL. Basic syntax and equivalence with VHDL. Metrics for evaluating the performance of a designed, digital, integrated circuit. CMOS integrated circuit manufacturing process. MOS transistor, PN junction and wiring (connections), digital, integrated circuit. Layout and connection. Connection models. CMOS inverter. Complex gates. Combinational and sequential CMOS gates. Delay and power models. Analysis and design of standard, digital, cells (gates) at the transistor level. Symbolic design (stick diagram). Physical design (layout).		
Practical teaching (exercises, OFE, study and research work)	Students deepen the knowledge acquired in lectures by acquiring design skills using professional software packages for designing integrated circuits, such as Cadence and Mentor Graphics (Siemens EDA).		
Textbooks/references			
1	David Harris and Sarah Harris. Digital Design and Computer Architecture, Second Edition (2nd. ed.). Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2012.		
2	Jan M. Rabaey, Anantha P. Chandrakasan, and Borivoje Nikolic. Digital integrated circuits: a design perspective. Vol. 2. Englewood Cliffs: Prentice hall, 2002.		
3	Neil HE Weste and David Harris. CMOS VLSI design: a circuits and systems perspective. Pearson Education India, 2015.		
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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	1	2	0	0

Teaching methods	Lectures, auditory exercises, computer laboratory exercises, 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	0		
Projects	40		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Machine Learning in Embedded Systems		
Lecturer (for lectures)	Đorđević Lj. Goran, Đošić M. Sandra, Jovanović D. Milica		
Lecturer/associate (for exercises)	Đošić M. Sandra, Veljković J. Milijana		
Lecturer/associate (for OFE)	Veljković J. Milijana		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Study of the principles of machine learning (ML) and its application in resource-constrained embedded systems, including: fundamental machine learning algorithms, model optimization techniques for efficient implementation on modern microcontrollers, and development of ML applications for embedded systems.		
Course outcomes	Upon completion of the course, students will be able to prepare and process data for the application of machine learning in embedded systems; select, develop, train, and evaluate an appropriate machine learning model; analyse the constraints of the target hardware platform in terms of memory, computational resources, energy consumption, and execution time; apply model quantisation, compression, and optimisation techniques; deploy and execute a model on a microcontroller-based platform using appropriate development tools, such as TensorFlow Lite for Microcontrollers and Edge Impulse; and develop, test, and evaluate a complete machine learning application tailored to the requirements of an embedded system.		
Course outline			
Theoretical teaching	Introduction to Machine Learning and Embedded Systems: differences between traditional and embedded machine learning; applications in Edge AI, IoT, and robotics. Fundamental Machine Learning Concepts: supervised and unsupervised learning, key ML algorithms. Data Preprocessing for Embedded Systems: feature extraction and selection, quantization, and normalization. Hardware Platforms for Machine Learning in Embedded Systems: microcontrollers, FPGAs, AI accelerators. Software Platforms for Developing and Deploying ML Models on Embedded Systems: an overview of TinyML platforms (TensorFlow Lite, TensorFlow Micro, and Edge Impulse). Case Studies and Practical Projects. Optimization of ML Models for Embedded Systems: fixed-point arithmetic, low-power inference strategies, model compression techniques.		
Practical teaching (exercises, OFE, study and research work)	Practical classes comprise a cycle of seven laboratory exercises: 1. Data collection and preparation; 2. Feature extraction and selection; 3. Application of basic machine learning algorithms for classification and regression using prepared datasets; 4. Development of a neural network model tailored for implementation in an embedded system; 5. Model optimisation for an embedded platform; 6. Model deployment on a microcontroller; 7. Development of a complete TinyML application.		
Textbooks/references			
1	P. Warden, D. Situnayake, TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, O'Reilly Media, 2019.		
2	D. Situnayake, J. Plunkett, AI at the Edge: Machine Learning with Edge Impulse, TensorFlow Lite, and LoRa, O'Reilly Media, 2023.		
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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	1	1	0	0

Teaching methods	Lectures, tutorial exercises, laboratory exercises, homework assignments, midterm exams, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electronic Circuits Testing	
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	None			
Course objectives	The aim is to familiarize students with the fundamental principles of electronic circuit testing, with a focus on integrated components and circuits			
Course outcomes	Acquiring competencies in the field of electronic circuit testing. Students are expected to learn how to approach the testing of an electronic circuit, which methods are used during the preparation and design phases, and what hardware and software tools are employed for testing electronic circuits in both laboratory settings and industrial environments.			
Course outline				
Theoretical teaching	Introduction to defects and their effects in electronic circuits. Fundamental concepts of electronic circuit testing Inductive fault analysis and the defect dictionary. Functional vs. structural testing approaches. Testing of analog circuits. Fault models in analog and digital circuits. Test pattern generation techniques. Digital circuit testing methodologies. Delay fault testing and timing-related issues. IDDQ testing for digital circuits. Testing of circuits with regular topologies. Fault simulation in digital circuits. Design for testability (DFT) principles. Decision-making criteria in test evaluation. Testing of mixed-signal systems (analog + digital). Overview of automated test systems and tools			
Practical teaching (exercises, OFE, study and research work)	Principles of digital circuit testing. Minimal test sets and their significance. Algorithms for automatic test pattern generation (ATPG) for combinational circuits. Test generation techniques for sequential circuits. Delay fault testing in digital systems. IDDQ test generation for digital circuits. Fault simulation algorithms for digital circuits. Cost analysis and optimization in digital test generation.			
Textbooks/references				
1	Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen: VLSI TEST PRINCIPLES AND ARCHITECTURES, Elsevier, 2006.			
2	SAMIHA MOURAD, YERVANT ZORIAN: Principles of testing electronic systems, JOHN WILEY & SONS, 2000.			
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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	0	0

Teaching methods	Lectures utilizing multimedia projectors; classroom-based practical exercises; computer laboratory sessions; academic consultations; individual project work.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	30
Exercises	20	**Oral exam**	40
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies			
Type and level of studies	Undergraduate Academic Studies			
The name of the course	Automotive Electronics			
Lecturer (for lectures)	Nikolić S. Goran			
Lecturer/associate (for exercises)	Nikolić S. Goran			
Lecturer/associate (for OFE)	Nedeljković N. Jelena			
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective	

Prerequisites	None
Course objectives	Introduction to the operating principles of vehicles with internal combustion engines, electrical devices in automobiles, and engine control principles. Familiarization with modern electric and hybrid vehicles and methods for vehicle diagnostics. Combining theoretical knowledge with practical skills.
Course outcomes	The student acquires basic knowledge in the field of electrical and electronic systems in vehicles, understands the operation of components and communication protocols, and is capable of independently analyzing and applying the acquired knowledge to solve fundamental problems in automotive electronics.
Course outline	
Theoretical teaching	Covers the basic principles of motor vehicle operation, with a particular focus on electronic monitoring and control systems. ECU units are explained as central components of engine and system electronic control. The course addresses types of sensors and actuators in vehicles and their integration into the system through CAN, LIN, FLEXRAY, and Ethernet/LAN communication protocols. It explores the structure and logic of in-vehicle network communication, as well as the analysis and interpretation of DTC (Diagnostic Trouble Codes). The instruction also includes an overview of modern vehicle motion control systems such as ABS, ESP, electronic suspension systems, and electronic steering. Topics on electric vehicles are introduced—battery types, motors, and drive electronics—as well as the basics of hybrid systems, energy management, and regeneration.
Practical teaching (exercises, OFE, study and research work)	Introduction to the C8051F500DK development system Introduction to the Keil uVision IDE software tool Creating C programs for monitoring signal values generated by a potentiometer and/or analog temperature sensor Creating C programs for monitoring data values generated by a digital accelerometer via the I2C interface Creating C programs for basic use of CAN and LIN communication protocols Creating C programs for controlling various types of motors through appropriate interfaces
Textbooks/references	
1	Robert Bosch GmbH (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive 5th Edition
2	Understanding Automotive Electronics An Engineering Perspective Eighth edition William B. Ribbens, Department of Electrical Engineering and Computer Science, University of Michigan, USA
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	0	0

Teaching methods	Lectures using presentations, video demonstrations, and simulations Laboratory and auditory exercises Homework assignments, seminar papers, 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		Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Mobile Devices Programming		
Lecturer (for lectures)		Jovanović D. Milica		
Lecturer/associate (for exercises)		Jovanović D. Milica		
Lecturer/associate (for OFE)		Veljković J. Milijana		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	Object oriented programming			
Course objectives	The course objective is to provide students with a fundamental understanding of mobile device programming. The aim is to introduce students to the basics of the mobile device programming and elements of the hardware and software platforms, with emphasis on Kotlin programming for Android platforms.			
Course outcomes	Upon successful completion of the course, the student is able to use mobile hardware and software platforms, develop and deploy mobile applications, utilize mobile platform services and functionalities, evaluate the limitations of mobile devices with respect to available resources, and apply methods for enhancing the energy efficiency and performance of mobile applications.			
Course outline				
Theoretical teaching	Introduction to mobile devices. Hardware platform overview. Operating systems for mobile devices. Introduction to mobile application development (developing environments and programming languages). Application architecture. New project and new window (Activity) creation. Introduction to basic standard GUI interface elements. Access to the peripherals. Mobile service development: Android Activity and Android Intent. Android fragments. Android threads and connection to the network and internet. Data storage: synchronization, work with Content provider. Data protection. Work with multimedia content. Energy-efficiency of the applications.			
Practical teaching (exercises, OFE, study and research work)	Twelve laboratory exercises with focus on Android programming: 1) Android studio and Kotlin for mobile application; 2) design flow for Android application; 3) GUI development (Linear layout); 4) Android Activity (Constraint layout); 5) Android intent; 6) Android Fragments, Navigation; 7) Application lifecycle; 8) Application architecture (UI system); 9) Application architecture (data storage); 10) Android Threads and connection to the Internet; 11) Android applications based on content providers and broadcast receivers 12) Recycler view.			
Textbooks/references				
1	B. Sills, B. Gardner, K. Marsican and C. Stewart, "Android Programming: The Big Nerd Ranch Guide", Big Nerd Ranch LLC, 5th edition, 2022			
2	A. Bailey, D. Greenhalgh and J. Skeen, Kotlin Programming: The Big Nerd Ranch Guide", Big Nerd Ranch LLC, 2nd edition, 2021.			
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	0	0

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

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	20
Exercises	40	**Oral exam**	20
Colloquia	20		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Power Electronic Converters	
Lecturer (for lectures)			Mančić D. Dragan, Jovanović D. Igor	
Lecturer/associate (for exercises)			Panić D. Aleksandar	
Lecturer/associate (for OFE)			Panić D. Aleksandar	
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	None			
Course objectives	Acquiring the fundamental knowledge about power electronic converters, the methods of their realisation and practical application.			
Course outcomes	Theoretical knowledge on power electronic converters. Mastering the techniques of development, realisation and application of the power electronic converters.			
Course outline				
Theoretical teaching	Types of power electronic converters (AC/DC, DC/DC, DC/AC, AC/AC). DC converters (DC/DC). One-quadrant and multi-quadrant converters. Realisation methods of converters. Thyristor converters. Inverters (DC/AC). Types of inverters. Voltage inverters (single-phase and polyphase). Current inverters. Resonant inverters. AC converters (AC/AC). Cycloconverters. Matrix converters. Application of convertors in powering of DC and AC motors. Application of converters in production, transmission and distribution of electricity.			
Practical teaching (exercises, OFE, study and research work)	Single-phase thyristor rectifier; Three-phase thyristor rectifier; Chopper; Single-phase inverter; Three-phase bridge inverter.			
Textbooks/references				
1	N.Mohan, TMUndeland, WPRobbins, "Power electronics: Converters, Applications, and Design", John Wiley & Sons., New York, 2007.			
2	M.H.Rashid, "Power electronics, Circuits, Devices and Applications", Pearson Education, Inc., New Jersey, 2013.			
3	M.H.Rashid, "Power Electronics Handbook", Elsevier Science, 2017.			
4	L.A.Kumar, A.Kalaiarasi, Y.U.Maheswari, “Power Electronics with MATLAB”, Cambridge University Press, Cambridge, 2017.			
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	0	0

Teaching methods	Lectures; Audition 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			Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Sensors and Measurement of Non-Electrical Quantities in Industry	
Lecturer (for lectures)			Dinčić R. Milan	
Lecturer/associate (for exercises)			Pešić T. Miroljub, Đorđević-Kozarov R. Jelena	
Lecturer/associate (for OFE)			Pešić T. Miroljub, Đorđević-Kozarov R. Jelena	
Number of ECTS		5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None			
Course objectives	Acquiring fundamental knowledge essential for using sensors to measure non-electrical quantities via electrical methods.			
Course outcomes	Comprehensive theoretical and practical knowledge essential for developing measurement systems. Proficiency in utilizing appropriate sensors and electronic circuits.			
Course outline				
Theoretical teaching	Definition of sensors. Classification of sensors. Trends in sensor development. Static and dynamic characteristics of sensors. Resistive, capacitive, magnetic, inductive, and optical sensors. Sensors for strain, force, displacement, position, velocity, acceleration, pressure, flow, level, humidity, and temperature. Integrated Hall sensors. MEMS sensors. Connecting sensors with measurement bridges and amplifiers. Wireless sensors. Application of Hall sensors for current measurement. Application of sensors in predictive maintenance in industry.			
Practical teaching (exercises, OFE, study and research work)	Tutorials, problem-solving exercises and laboratory exercises, as well as project assignments, aimed at mastering the use of sensors and actuators and the development of measurement systems.			
Textbooks/references				
1	Ambarish Paul, Mitradip Bhattacharjee, Ravinder Dahiya, “Solid-State Sensors”, IEEE Press, Wiley Blackwell, 2024.			
2	Ekbert Hering, Gert Schönfelder, “Sensors in Science and Technology: Functionality and Application Areas”, Springer, 2022.			
3	Walter Lang, “Sensors and Measurement Systems”, River Publishers, 2021.			
4	Patrick F. Dunn, “Fundamentals of Sensors for Engineering and Science”, CRC Press, 2019.			
5	John Webster, „The Measurement, Instrumentation and Sensors Handbook“, CRC Press, 2014.			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	2	0	0

Teaching methods	Lectures, Tutorials, Problem-solving exercisesLaboratory exercises, Project assignments, Consultations

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	Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Audio Production		
Lecturer (for lectures)	Ćirić G. Dejan		
Lecturer/associate (for exercises)	Ćirić G. Dejan		
Lecturer/associate (for OFE)	Ćirić G. Dejan		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Mastering theoretical and practical knowledge of sound, editing and sound processing software, audio devices and systems, sound recording and audio production. Focus is on forming audio contents for multimedia applications, computer games as well as accompanying content of video materials.		
Course outcomes	Theoretical and practical knowledge in the field of audio systems and audio production, including audio signal analysis and interpretation of audio content quality criteria. Skills in applying techniques for sound recording, processing, mixing, and mastering, as well as in the use of studio audio equipment and specialized software tools for audio production. Competencies in independently carrying out simple audio production projects and evaluating the quality of produced audio content from both technical and production perspectives.		
Course outline			
Theoretical teaching	Audio signals (types and characteristics of audio signals). Audio information recording, transmission, and storage formats. Software for recording, processing and production of sound (AVID - Pro Tools, Steinberg - Cubase, Steinberg – WaveLab, Adobe Audition). Basic processing of audio signals. De-noising of audio signals. Audio devices (systems). Studio audio technique - audio interface/mixer. Sound recording (input acoustical environment and microphone concept). Virtual spatial sound (3D sound recording, 3D spatial processing of sound, coding and decoding). Audio processors (frequency, dynamic and time processors). Parallel and serial processing of audio signals. Mixing and mastering of audio signals. Audio production (pre-production, production and post-production). Sound design, sound effects.		
Practical teaching (exercises, OFE, study and research work)	Application of software tools for sound recording, editing and processing of audio signals. Sound recording in diverse environments (open and closed spaces, controlled and uncontrolled environments) and for different purposes (multimedia contents, movies, computer games). Usage of different types of microphones and audio equipment. Audio production.		
Textbooks/references			
1	Y. Huang, J. Benesty: Audio signal processing for next-generation multimedia communication systems, Kluwer Academic Publishers, Boston, 2004.		
2	D. O. McDaniel, R. C. Shriver, K. Ray Collins: Fundamentals of audio production, Pearson/A&B, 2008.		
3	S. Savage: The art of digital audio recording, Oxford University Press, New York, 2011.		
4	B. Katz: Mastering audio - The art and the science, 3rd edition, Focal press, 2014.		
5	R. Izhaki: Mixing audio - Concepts, practices and tools, Focal press (Elsevier), Oxford, 2008.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures; Practical exercises; Studio exercises; Consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	Written exam	
Exercises	30	Oral exam	40
Colloquia	25		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Applied Electromagnetics		
Lecturer (for lectures)	Cvetković N. Nenad, Jovanović B. Dejan		
Lecturer/associate (for exercises)	Cvetković N. Nenad, Jovanović B. Dejan		
Lecturer/associate (for OFE)			
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The objective of the course is to deepen knowledge in the field of electromagnetics, with a particular emphasis on the analysis of electric and magnetic fields, wave propagation, transmission lines, and the fundamentals of electromagnetic compatibility of electronic systems, as well as to enable students to apply analytical and numerical methods in modeling and analyzing electromagnetic phenomena in electronic devices and systems.		
Course outcomes	Upon successful completion of the course, the student is qualified to analyze basic electromagnetic phenomena in electronic systems using Maxwell's equations and appropriate analytical methods, calculate wave propagation parameters along transmission lines, analyze standing waves and reflections, determine characteristics of plane electromagnetic waves in different media, analyze basic antenna parameters, and apply fundamental concepts of electromagnetic compatibility in assessing the operation and mutual compatibility of electronic devices.		
Course outline			
Theoretical teaching	Electric and magnetic fields. Static and time-varying fields. Transmission lines: Wave propagation. Lossless transmission lines. Reflection coefficient. Standing waves. Electrostatics: Maxwell's equations. Electric scalar potential. Poisson's equation. Boundary conditions. Method of images. Magnetostatics: Biot–Savart law. Magnetic fields of surface and volume currents. Ampère's law. Magnetic vector potential. Boundary conditions. Plane wave propagation: Polarization of plane waves. Phase and group velocity. Snell's laws. Fresnel reflection and transmission coefficients. Metamaterials. Radiation and antennas: Short dipole. Far-field region. Radiated power. Radiation pattern. Antenna gain. Electromagnetic compatibility.		
Practical teaching (exercises, OFE, study and research work)	Analysis of electric and magnetic fields using Maxwell's equations. Wave propagation along transmission lines: lossless lines, reflection coefficient, and standing waves. Electrostatics and magnetostatics: electric and magnetic scalar and vector potentials, Poisson's equation, Biot–Savart and Ampère's laws. Application of boundary conditions in field analysis. Plane electromagnetic waves: polarization, phase and group velocity, Snell's laws, and Fresnel coefficients. Fundamentals of antenna parameter analysis and electromagnetic compatibility.		
Textbooks/references			
1	F. T. Ulaby, "Fundamentals Applied Electromagnetics", Pearson, Prentice Hall, New York, 2010.		
2	J. Vanderlinde, "Classical Electromagnetic Theory", Kluwer Academic Publishers, 2004.		
3	H. Neff, "Introductory Electromagnetics", John Willey & Sons, 1991.		
4	D. M. Veličković, F. H. Uhlmann, K. Brandisky, R. D. Stancheva, H. Brauer, "Fundamentals of Modern Electromagnetics for Engineering", TU Ilmenau, Germany, 2005.		
5	E. Rothwell, M. Cloud, "Electromagnetics", CRC Press, 2001.		

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

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

Teaching methods	Lectures, classroom (practical) exercises, homeworks, and consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Game Development		
Lecturer (for lectures)	Cvetković S. Stevica		
Lecturer/associate (for exercises)	Cvetković S. Stevica		
Lecturer/associate (for OFE)	Špeletić M. Matija		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Equip students with the skills required for creating multimedia 3D computer games for different platforms. The course integrates knowledge of image, sound, and video processing, 3D modeling and animation, with game programming.		
Course outcomes	Students will combine previously acquired knowledge in image, sound, and video processing, as well as in 3D modeling and animation, with programming and application development. The course prepares students to develop multimedia computer games that operate across a wide range of hardware platforms and major operating systems.		
Course outline			
Theoretical teaching	Game development process. Basics of the C# programming language and an overview of Unity classes. Creating and rendering scenes, terrains, and environments. Loading or creating 3D objects, models, textures, and materials. Setting up scene lighting and cameras. Handling user input (controllers, keyboard, joystick, touchscreen, etc.). Built-in commands and scripts for object manipulation. C# scripts for game control. Programming object physical properties, colliders, collision detection, raycasting, etc. Graphical user interface – menus, dropdowns, textures. Particle systems. Navigation. Animation and object control. Sound programming. Extending functionality with plugins.		
Practical teaching (exercises, OFE, study and research work)	Examples of rendering terrain and environments in scenes. Loading 3D models, textures, and materials. Assigning colliders and rigid body properties to objects. Setting up lighting and cameras. Game development using visual scripting – graphs, finite state machines, transitions. Object-oriented programming in C#, writing C# scripts, using built-in Unity class libraries. Examples of scripting for objects, programming collision detection, raycasting, and object physics. Programming input commands and handling input devices. Graphical user interface – buttons, menus, text messages. Object control. Visual effects systems with particles. Examples of sound and navigation programming. Examples of complete 2D and 3D game projects in Unity.		
Textbooks/references			
1	Paris Buttfield-Addison, Jon Manning, Tim Nugent, Unity Development Cookbook: Real-Time Solutions from Game Development to AI, 2nd edition, O'Reilly, 2023.		
2	Nicolas Alejandro Borromeo, IconJuan Gabriel Gomila Salas, Hands-On Unity Game Development, 4th edition, Packt Publishing, 2023.		
3	Joseph Hocking, Unity in Action - Multiplatform Game Development in C#, 2nd edition, Manning, 2018.		
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Camera and Editing		
Lecturer (for lectures)	Nikolić V. Saša		
Lecturer/associate (for exercises)	Špeletić M. Matija		
Lecturer/associate (for OFE)	Špeletić M. Matija		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory

Prerequisites	None
Course objectives	Introducing students to the basic functions of the camera and editing. Explaining to them all the basic information about live images in film and television, introducing them to how images are created and how they can be used for informative, artistic and entertaining purposes. The evolution of film and television through formats from film to high-resolution images via HDTV, to 4K resolution. The use of film and TV images on television and the Internet and the telephone. The telephone as a super device, camera and editing on a mobile phone
Course outcomes	Students are trained to think creatively with images, to shoot thematic films, videos, jingles and other TV forms, using all the rules of film and TV schools, to use pre-recorded footage meaningfully through editing in order to tell a logical story to viewers, using a camera and TV image editing programs. The emergence of MOJO (mobile journalism), and its use in rapid reporting. Advantages of MOJO on the Internet compared to classic television.
Course outline	
Theoretical teaching	Introducing students to the camera, camera optics, prisms, basic camera functions, camera electronics. CCD and CMOS chips, image processing. Introducing different camera systems and formats, the emergence of HD and 4K formats. The emergence of 3D images, recording and broadcasting. From camera to mobile phone, phone as camera. Amount of light and its effect on exposure. Introduction to camera functions. Plan, shot and framing, frame composition, camera movement, scene framing. Film and television punctuation. Linear and nonlinear editing. Cut, frame, shot in editing and its duration, ellipse, parallel editing. Frame dynamics, motion connection. Nonlinear systems, Adobe, Avid, Final Cut, DaVinci resolve.
Practical teaching (exercises, OFE, study and research work)	Students shoot and edit their own films and videos based on their own ideas, so that each student has two works for the exam, a short feature film or a TV spot. Practical classes take place through visits to TV studios, director's and master's rooms. Students participate in the production of individual live or recorded shows at a TV station under the supervision of teachers and television people. They take turns in key positions, such as video mixer, sound engineer, cameraman, editor, producer, etc. They actively participate in the production of a specific TV program in live studio broadcasts, combined broadcasts, live broadcasts of sports and cultural events by reporting cars, slow-motion recordings of TV reports, documentaries, etc. They are trained to create their own video clips using only a mobile phone, with recording and editing applications.
Textbooks/references	
1	Daniel Erridgen, Grammar of Film Language, Faculty of Dramatic Arts, Belgrade, 1982.
2	Peter Jones, Television Cameraman Technique, Radio Television Belgrade, 1975.
3	M. Harrison: The Cinematic Lens: Physics, Art and the Craft of Camera, Focal Press, 2025
4	E. Rostova, S. Gallagher: The Digital Video Editor's Guide: Mastering Aesthetics and Software Workflows, CRC Press, 2025
5	Marko Babac - Film in your hands, 1979.

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, 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**	40
Colloquia			
Projects	30		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Character Animation	
Lecturer (for lectures)			Nikolić V. Saša	
Lecturer/associate (for exercises)			Stojanović V. Nikola	
Lecturer/associate (for OFE)			Stojanović V. Nikola	
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Introducing character modeling techniques and the skeletal system in 3D animation. Description of character animation techniques. Recording and processing of movements in 3D animation.			
Course outcomes	Students will be trained in character and skeletal modeling in 3D animation. They will master character animation techniques, motion capture, and processing.			
Course outline				
Theoretical teaching	Topics for creating a simple skeletal system will be covered, including skeleton construction, geometry binding, and basic parameter settings. Special emphasis is placed on building animation controls and organizing character sets, which allows for efficient movement management within a scene. Character animation techniques such as creating keyframe animation, walk cycle, facial expressions and basic emotional expressions. Introduction to motion capture systems, their working principles, equipment types and basic application methods.			
Practical teaching (exercises, OFE, study and research work)	Character and skeletal modeling. Creating controls. Character set. Character animation. Motion capture. Introduction to a program for processing “motion capture” files.			
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, “Maya 8 - A Visual Quick Guide”, Computer Library, 2007.			
4	K. Roberts: Real-Time Character Animation Handbook: From Traditional Principles to Modern Workflow, Routledge, 2024			
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	0	0

Teaching methods	Lectures, exercises, consultations.

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	Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	VLSI Design		
Lecturer (for lectures)	Jovanović D. Borisav		
Lecturer/associate (for exercises)	Jovanović D. Borisav		
Lecturer/associate (for OFE)	Jovanović D. Borisav		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquisition and consolidation of knowledge related to the design of highly integrated circuits.		
Course outcomes	Gaining competence in the design of highly integrated circuits, from VHDL-based description to layout implementation.		
Course outline			
Theoretical teaching	VLSI technology. Structure of VLSI systems. VLSI architecture design. High-level synthesis, RTL-level synthesis. Design of high-speed adders. RTL-level multiplier design. System design using IP blocks. VLSI microprocessor circuit design. Architectural partitioning into controller and datapath. Timing constraints in synchronous circuits. Clock signal. Setup and hold timing constraints, minimum clock period. Positive and negative skew and jitter. Clock tree design. Design of power and ground distribution networks in integrated circuits. Low-power circuit design. Sources of VLSI power consumption: dynamic and static power. Sources of leakage currents in VLSI circuits. Low-power design strategies. Techniques for power gating of inactive circuits.		
Practical teaching (exercises, OFE, study and research work)	The knowledge acquired through lectures is deepened as students develop design skills using Cadence tools for automated integrated circuit design. The integrated circuit projects include: a 16-bit Carry Look Ahead adder, a combinational multiplier, a sequential Booth multiplier, a sequential Shift/Add multiplier, and an IIR filter. Timing constraints specification using modern circuit implementation tools. Circuit synthesis using the Genus tool. Practical back-end IC design: placement, routing, and clock tree design using Cadence Innovus. Layout-level logic verification. Design of a simple RISC microprocessor up to layout implementation.		
Textbooks/references			
1	K.C. Chang, Digital Systems Design with VHDL, An Integrated Approach, IEEE Computer Society, ISBN 0-7695-0023-4		
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	1	1	0	0

Teaching methods	Lectures with projector presentations, audio-assisted exercises, computer-based laboratory sessions, consultations, and individual student projects.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	10	**Oral exam**	30
Colloquia			
Projects	50		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	RF Electronics		
Lecturer (for lectures)	Mirković D. Dejan		
Lecturer/associate (for exercises)	Mirković D. Dejan		
Lecturer/associate (for OFE)	Mirković D. Dejan		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introducing students to the principles of wireless data transmission. Studying the architecture of transmitters and receivers as well as the basic blocks and circuits that make up the high-frequency part of radio devices. Acquiring knowledge about the process of designing RF circuits.		
Course outcomes	Students should acquire knowledge about the functioning and properties of RF circuits and systems. They should also master the process of designing RF circuits. Training in the use of specialized software tools is provided during the design process.		
Course outline			
Theoretical teaching	Principles of wireless data transmission, radio transmitter and receiver architectures, oscillator/selective circuits, passive and active elements in RF circuits, transmission lines, Smith chart, S parameters, design of RF power amplifiers, matching circuits, amplifier stability in the RF domain, design of RF filters, oscillators and frequency synthesizers (PLL), circuits for changing the frequency/phase of signals - mixers, amplitude modulation, frequency/phase modulation.		
Practical teaching (exercises, OFE, study and research work)	Students practice the application of theoretical principles and techniques of RF circuit design using professional/free software packages AWR Microwave Office/QucsStudio and MATLAB/GNU-Octave.		
Textbooks/references			
1	R. Ludwig, P. Bretchko, RF Circuit Design: Theory and Applications, Prentice Hall, 2000, 636 pp., ISBN: 0-13-075323-7		
2	Michael Steer, Fundamentals of Microwave and RF Design Third Edition, NC State University, 2019, 229 pp., ISBN: 978-1-4696-5688-5		
3	F. Fornetti, Conquer Radio Frequency, Explore RF Ltd, 2013, 228 pp., ISBN: 978-0-9576635-2-7		
4	D. M. Pozar, Microwave Engineering, Fourth Edition, John Wiley & Sons, Inc, 2012, 756 pp., ISBN: 978-0-470-63155-3		
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	0	0

Teaching methods	Instructions, text and video tutorials for lab exercises and individual projects (available via the Microsoft Teams platform)

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	10	**Oral exam**	30
Colloquia	10		
Projects	40		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Embedded hardware and operating systems		
Lecturer (for lectures)	Nikolić S. Goran		
Lecturer/associate (for exercises)	Nedeljković N. Jelena		
Lecturer/associate (for OFE)	Nedeljković N. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The aim of the course is for students to acquire fundamental knowledge and practical skills in the field of embedded systems design and programming, with a focus on the architecture of modern microcontrollers and their application in real-time systems. Students will become familiar with software development for embedded devices using Assembly, C, and C++ programming languages, as well as with principles of hardware control, handling of asynchronous and synchronous events, and the implementation of real-time operating systems.		
Course outcomes	Students will be trained to analyze the architecture of modern microcontrollers (such as ARM Cortex-M), program embedded systems using Assembly, C, and C++ languages, and apply real-time system concepts including synchronous and asynchronous events, interrupts, timers, and peripheral interfacing. They will be able to use real-time operating systems (RTOS) for task management, inter-process communication, and synchronization, as well as to model and implement practical systems. Students will also be capable of diagnosing and debugging hardware and software issues in embedded systems using appropriate development and debugging tools.		
Course outline			
Theoretical teaching	The course covers the architecture of ARM Cortex-M3/M4/M7 microcontrollers: registers, operating modes, NVIC, memory map, interrupts, MMU, debug support, system timer, and power management. It includes programming in Assembly, C, and C++, working with memory, semaphores, bit-banding techniques, interrupt handling, and multiprocessor communication. The course analyzes the peripherals of the STM32F7 microcontroller (CAN, USB, TCP/IP, and graphical environments), and tools such as STM32CubeMX, STM32CubeIDE, MDK-ARM, uVision, and CMSIS. Special emphasis is placed on real-time operating systems, including FreeRTOS. Topics include fundamental characteristics of real-time systems, design, programming, reliability, failure models, multitasking, scheduling, synchronization, task communication, kernel architecture, and the basics of distributed systems.		
Practical teaching (exercises, OFE, study and research work)	The course is implemented using the STM32F7508 Discovery development board, providing students with hands-on experience in real-time embedded system programming using CMSIS-OS v2.x and FreeRTOS. Exercises include task creation and management, semaphores, inter-process communication, timers, and interrupt handling. Applications are developed with multiple tasks, synchronization, and communication through queues, buffers, and protected objects. The course covers concepts such as priorities, scheduling, timing constraints, and resource management. By working with peripherals (GPIO, UART, ADC, VCOM port, sensors), students implement real-time data measurement and display systems. STM32CubeIDE, STM32CubeMX, and tools for debugging and RTOS task execution analysis are used throughout the course.		
Textbooks/references			
1	The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Newnes, https://community.nxp.com/pwmxy87654/attachments/pwmxy87654/kinetis/39396/1/The%20definitive%20guide%20to%20the%20ARM%20CORTEX-M3%202nd.pdf		
2	FreeRTOS documetations, https://github.com/FreeRTOS/FreeRTOS-Kernel-Book/blob/main/toc.md		
3	"Cortex-M programming: starts with a smart Mbed" by Hee Jae Park, Chibum Lee, https://www.amazon.com/Cortex-M-programming-starts-smart-Mbed/dp/B09HG7G141		
4	"Embedded System Design with ARM Cortex-M Microcontrollers Applications with C, C++ and MicroPython", Cem Ünsalan, Hüseyin Deniz Gürhan and Mehmet Erkin Yücel, https://www.amazon.com/Embedded-System-Design-with-ARM-Cortex_M-Microcontrollers_-Applications-with-C_-C__-and-MicroPython/dp/3030884384		
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	0	0
Teaching methods	Lectures supported by the use of computers and projectors. Basic examples of system simulation. Practical demonstrations of implemented real-time embedded systems. Lectures. Auditory exercises. Laboratory exercises. Homework assignments. Midterm exams. Seminar paper. 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	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Wireless Networks and Devices		
Lecturer (for lectures)	Đorđević Lj. Goran, Đošić M. Sandra, Jovanović D. Milica		
Lecturer/associate (for exercises)	Đošić M. Sandra, Veljković J. Milijana		
Lecturer/associate (for OFE)	Veljković J. Milijana		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Mastery of fundamental theoretical principles in the areas of data transmission, networking, protocols, and embedded programming, along with the acquisition of engineering skills necessary for designing and implementing wireless embedded devices and sensor networks. Understanding the advantages and limitations of various wireless technologies used in the design and implementation of practical wireless embedded systems.
Course outcomes	Upon completion of the course, students will be able to analyse the fundamental characteristics and limitations of wireless data transmission; explain the architectures, topologies, and operating principles of modern wireless networks and their protocols; compare wireless technologies in terms of communication range, data rate, energy consumption, reliability, and implementation complexity, and select a technology appropriate to the requirements of a specific application; develop and test network applications and BLE devices on a microcontroller-based platform; and design and implement a simple wireless embedded system while taking into account the limitations of communication and computational resources.
Course outline	
Theoretical teaching	Introduction to Wireless Transmission: transmission medium, antennas, modulation, error control. Smart Devices: sensors, actuators, MEMS. RFID and NFC. Wireless Network Architectures: classification, topologies, protocol stack. MAC Protocols: classification, MAC protocols with static resource allocation, MAC protocols with contention. WLAN: physical layer, 802.11 network architecture, Access Point, MAC. WPAN: IEEE 802.15.4, ZigBee. Bluetooth Low Energy: architecture, topologies, protocols, physical layer, link layer, Attribute Protocol, Advertising and Connections Profile, Generic Attribute Profile. WWAN: WWAN and IoT, LPWAN, NB-IoT and LTE-M, LoRa, LoRaWAN.
Practical teaching (exercises, OFE, study and research work)	Practical classes are conducted using the ESP32 development platform, which supports Wi-Fi and Bluetooth Low Energy (BLE), through a cycle of five laboratory exercises: 1. Development of UDP network applications and implementation of an NTP client for time synchronisation; 2. Implementation of an SMTP client for sending email over a wireless network; 3. Development of an MQTT system based on the publish–subscribe model, comprising clients and a message broker; 4. Implementation of a BLE peripheral device, including advertising, definition of GATT services and characteristics, and data exchange; 5. Implementation of a BLE client for device scanning, connection establishment, service and characteristic discovery, and data exchange with a peripheral device.
Textbooks/references	
1	C. Beard, W. Stallings, Wireless Communication Networks and Systems, Pearson. Higher Education, Inc., 2015
2	H. Karl, A. Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley, 2007.
3	
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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	1	1	0	0

Teaching methods	Lectures, tutorial exercises, laboratory exercises, homework assignments, midterm exams, consultations.

Grade (maximum number of points 100)

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

Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Medical Electronics		
Lecturer (for lectures)	Jovanović D. Borisav		
Lecturer/associate (for exercises)	Jovanović D. Borisav		
Lecturer/associate (for OFE)	Jovanović D. Borisav		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Acquiring knowledge of the fundamentals of electronics in medicine, the use of electrical signals in medical applications, and the most important characteristics of medical electronic devices: reliability and safety.
Course outcomes	Acquiring competence in the design of electronic circuits and systems found in diagnostic medical devices, in particular, in ECG machines, pulse oximeters, and patient monitors.
Course outline	
Theoretical teaching	Sources of bioelectric potential. Electrical conduction system of the heart. Standard ECG leads. Devices for recording ECG, EMG, and EEG signals. Biopotential amplifiers. Instrumentation biopotential amplifier. Bandwidth of biopotential amplifiers. Biopotential signal filtering (design of low-pass filters, construction of active and passive filters, harmonic suppression circuits). Pacemaker impulse detection, signal slew-rate limiting circuits. Hardware for digital processing of biopotential signals. Design of digital filters for biopotential signal processing. Reliability and safety of medical electronic devices. Isolation between analog and digital signals. Design of power supply systems for medical devices.
Practical teaching (exercises, OFE, study and research work)	The knowledge gained in lectures is reinforced through laboratory exercises. These exercises include simulations of analog circuits for amplification and filtering of ECG, EEG, and EMG signals, as well as hands-on programming of PIC microcontrollers. Circuit simulations are performed using the PSpice simulator, which is part of the KiCad toolset. In the ECG device design lab, students write microcontroller code that converts analog signals from the ECG amplifier into digital form, and then transfers the data to a computer for visualization and further processing. Through this, students gain practical knowledge in digital ECG signal processing and digital filter design. One of the exercises involves the practical implementation of a Holter ECG device, with emphasis on writing firmware for the PIC microcontroller used in the device. For the lab sessions, custom printed circuit boards have been developed that replicate real medical devices. Additionally, a dedicated application has been created to run under the Linux operating system, providing most of the functions of a patient monitor.
Textbooks/references	
1	D. Prutchi, M. Norris, Design and Development of Medical Electronic Intrumentation, John Willey and Sons, Inc. 2005
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	1	1	0	0

Teaching methods	Lectures using a projector, audio-based exercises, computer-based laboratory sessions, consultations, and 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			Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Thermovision	
Lecturer (for lectures)			Mančić D. Dragan, Jovanović D. Igor	
Lecturer/associate (for exercises)			Panić D. Aleksandar	
Lecturer/associate (for OFE)			Panić D. Aleksandar	
Number of ECTS	5	**Course status (obligatory/elective)**		Obligatory / Elective
Prerequisites	None			
Course objectives	Acquiring the fundamental knowledge about thermovision and practical application of a thermal imaging camera.			
Course outcomes	Theoretical knowledge on the fundamentals of thermovision. Mastering the technique of recording and interpretation of the results of thermal imaging inspections.			
Course outline				
Theoretical teaching	Introduction to thermal imaging. Theory of infrared radiation. Detection of infrared radiation and temperature measurement. Devices for temperature measurement. Operation principle and types of thermal imaging cameras. Practical aspects of thermal imaging cameras. Application of thermal imaging in a preventive maintenance and testing in various areas. Processing and analysis of thermal images.			
Practical teaching (exercises, OFE, study and research work)	Thermal imaging camera Varioscan 3021ST. Thermal imaging inspection of electronic devices. Thermal imaging inspection of energy efficiency of buildings. Thermal imaging inspection of the power grid. Thermal imaging inspection of a thermal pipeline system. Thermal imaging inspection of patients in medicine. Processing of thermal images using Irbis software.			
Textbooks/references				
1	M. Vollmer, KPMöllmann, "Infrared Thermal Imaging: Fundamentals, Research and Applications", Wiley – VCH, 2018.			
2	D. Lanzoni, "Infrared Thermography: electrical and industrial applications", CreateSpace Independent Publishing Platform, 2015.			
3	W. Minkina, S. Dudzik, "Infrared Thermography – Errors and Uncertainties", Wiley, 2009.			
4	V. Vavilov, B. Douglas, "Infrared Thermography and Thermal Nondestructive Testing", Springer, 2020.			
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	0	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	Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Internet of Things		
Lecturer (for lectures)	Nikolić R. Tatjana		
Lecturer/associate (for exercises)	Nikolić R. Tatjana		
Lecturer/associate (for OFE)	Nedeljković N. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Understanding the architecture and software solutions for connecting devices to the Internet network across various application domains. The focus is on the Internet of Things (IoT) paradigm, covering system architecture, device selection, communication protocols, data processing, security, and integration into cloud and edge environments.		
Course outcomes	After completing the course, the student will be able to: a) design and implement IoT systems, b) select and apply appropriate communication protocols according to the application requirements, c) integrate sensors and microcontrollers into a network of connected devices, d) connect devices to cloud platforms and manage data, e) develop client-server solutions.		
Course outline			
Theoretical teaching	The concept of the Internet of Things (IoT), its architecture, and application areas. Devices and things in the IoT environment: sensors, actuators, microcontrollers (STM32, Raspberry Pi). The physical layer of IoT and M2M communication. Internet in IoT: addressing and routing. IoT protocol stack and comparison with the traditional Internet protocol stack. Data link layer protocols: IEEE 802.15.4, 802.11ah, ZigBee, LoRaWAN, LTE-M, NB-IoT. Network layer protocols: 6LoWPAN, 6TiSCH. Application layer protocols: MQTT, CoAP, AMQP, HTTP. Fog computing and edge computing: integrated systems and network services. Cloud and PaaS platforms: architecture, APIs, and development tools for IoT applications. IoT platforms: components, architecture, and examples of cloud-based solutions. Data processing: stream processing, edge AI.		
Practical teaching (exercises, OFE, study and research work)	1) Introduction to the development environment and basic sensors. 2) Creating software for sensor data acquisition and processing. 3) Creating and configuring an MQTT broker and establishing connections. 4) Integration with a cloud IoT platform and data visualization. 5) Implementation of a simple IoT system – generating control signals based on sensor data.		
Textbooks/references			
1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, IoT Fundamentals, Cisco Press, 2017.		
2	B. K. Mishra, A. V. Salunkhe, Internet of Things: Technological Advances and New Applications, 1st Edition, CRC Press, 2023.		
3	Ammar Rayes, Samer Salam, Internet of Things From Hype to Reality, Springer, 2019.		
4	Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, VPT, 2014.		
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	0	0

Teaching methods	Lectures; classroom exercises; laboratory exercises; homework assignments; colloquia; project work; consultations

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Video Production		
Lecturer (for lectures)	Nikolić V. Saša		
Lecturer/associate (for exercises)	Stojanović V. Nikola		
Lecturer/associate (for OFE)	Špeletić M. Matija		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Acquiring knowledge and skills in the field of multimedia design and technology. Training on video and audio post-production tools is provided. Presentation of the capabilities of these tools in the creation of multimedia content in video and audio format, multimedia presentations and video tutorials.		
Course outcomes	Students should master basic and advanced techniques for video and audio production. This includes processing of recorded materials, editing, and special effects. They should be able to create multimedia content in video and audio format, as well as video tutorials.		
Course outline			
Theoretical teaching	Images in video production. Editing tools. Keyframes. In and out points. Static and dynamic subtitles. Video and audio effects and transitions. Types and properties of layers in video effects. Image animation techniques, automatic orientation, motion drawing. Drawing in a video clip: brushes, erasers, cloning. Text layer animation, kinetic typography. Mask animation. Layers in 3D space. Virtual camera in 3D space. Virtual light in 3D space. Image stabilization and object tracking. Tracking the movement of a real camera in space. Animated 3D models and inserting them into video clips. Special video effects. Tools for animating puppets. Time mapping. Erasing the background using the key color technique. Recording video tutorials.		
Practical teaching (exercises, OFE, study and research work)	Images in video production. Video editing tool. Creating videos from animated images. Using the source window, editing complex video and audio projects. Effects with sound. Image effects. Transitions. Subtitles. Tools for creating special video effects. Examples of image, text and video animation. Using 3D layers. Image stabilization. Tracking motion in an image. Time mapping. Erasing key color. Particle tricks. Using 3D models. Recording video tutorials.		
Textbooks/references			
1	Maxim Jago, Adobe Premiere Pro CC Classroom in a Book, Adobe, 2015.		
2	Brie Gyncild & Lisa Fridsma, Adobe After Effects CC Classroom in a Book, Adobe, 2016.		
3	M. Brindle, S. Schenk: The Digital Filmmaking Handbook, Quercus Publishing, 2025		
4			
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	1	1	0	0

Teaching methods	Lectures, exercises, independent work on video production

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	10	**Oral exam**	40
Colloquia			
Projects	40		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Virtual Reality	
Lecturer (for lectures)			Cvetković S. Stevica	
Lecturer/associate (for exercises)			Stojanović V. Nikola	
Lecturer/associate (for OFE)			Stojanović V. Nikola	
Number of ECTS	5		**Course status (obligatory/elective)**	Obligatory
Prerequisites	None			
Course objectives	The goal of this course is for students to acquire comprehensive knowledge in the field of Virtual Reality and apply this knowledge in developing practical applications for virtual reality devices.			
Course outcomes	Students will be trained to develop and implement complete applications for use in virtual reality systems.			
Course outline				
Theoretical teaching	Introducing students to the latest research in modeling and animation for virtual reality (VR) systems. VR devices – headsets, virtual glasses, haptic devices. Models of virtual environments. Computer animation and computer visualization. Development and implementation of 2D and 3D models and creation of virtual environments. Game modeling for VR environments. VR applications in industrial production. VR applications in the arts. Development of virtual prototypes. Applications in science, education, business, and other domains.			
Practical teaching (exercises, OFE, study and research work)	3D modeling and animation for virtual reality applications. Types and forms of virtual objects. Visual appearance of objects. Proper object positioning and hierarchy. Scene optimization for virtual reality. Touch and overlap detection in virtual space. Haptic feedback. Example of developing a complete application for execution on virtual reality headsets.			
Textbooks/references				
1	William R. Sherman, Alan B. Craig: Understanding Virtual Reality: Interface, Application, and Design, 2nd edition, 2018.			
2	Doug A. Bowman, Ernst Kruijff, Joseph J. LaViola Jr., Ivan Poupyrev: 3D User Interfaces: Theory and Practice, 2nd edition, Addison-Wesley, 2021.			
3	William R. Sherman, VR Developer Gems, CRCPress, 2019.			
4				
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	1	1	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	20	**Written exam**	
Exercises	30	**Oral exam**	30
Colloquia			
Projects	20		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Embedded Systems		
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)**	Obligatory / Elective
Prerequisites	None		
Course objectives	To enable students to understand the architecture, operation, and development of embedded systems, as well as to independently create and run simple Linux-based systems on embedded platforms such as the BeagleBone Black.		
Course outcomes	Upon successful completion of this course, the student will be able to: a) explain the architecture and components of embedded systems, b) select and apply appropriate development tools and compilers (toolchains) for cross-compiling programs intended for embedded environments, c) understand and configure the system boot process, d) customize and compile the Linux kernel for an embedded platform, e) install and use a Linux SDK and libraries for embedded application development, f) create and test a simple kernel driver.		
Course outline			
Theoretical teaching	Introduction to embedded systems: hardware components, software. Architecture: CPU, memory, peripherals, I/O interfaces. BeagleBone Black platform: AM335x SoC (ARM Cortex-A8 processor). Operating systems: types, selection criteria. Programming tools and toolchain: cross-compilation, GCC, binutils, make. Boot process: U-Boot bootloader. Linux Kernel: source tree structure, configuration, compilation. Device Tree: structure, compilation. File system: directories, minimal rootfs. Build systems: OpenEmbedded, Yocto, Buildroot. Flash memory and storage: eMMC, NAND/NOR Flash, file systems. Scripts: bootable SD cards. Linux SDK and libraries: OpenEmbedded SDK, glibc, uClibc. Linux device drivers: device classes and modules, user-space drivers, writing kernel-space drivers.		
Practical teaching (exercises, OFE, study and research work)	1) Working in the Linux environment – basic commands, file system structures; 2) Introduction to the BeagleBone Black development board, connection and setup; 3) Installation of the development environment, toolchain, cross-compilation; 4) Writing and using Makefile scripts, project organization; 5) Serial communication and system preparation – working via UART; 6) Preparing the SD card for booting Linux on the embedded system; 7) U-Boot source code – U-Boot configuration; 8) Linux kernel source code – configuration and compilation; 9) Setting boot parameters, hardware description (Device Tree); 10) Creating the rootfs; integrating the rootfs, kernel, and DTB into the SD image; 11) Running Embedded Linux on the BeagleBone Black; 12) Using the Linux SDK (OpenEmbedded SDK); 13) Creating and loading a simple Linux Kernel module; 14) Development of a simple character device driver.		
Textbooks/references			
1	Frank Vasquez, Chris Simmonds, Mastering Embedded Linux Programming, Packt Publishing, 2021.		
2	Derek Molloy, Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux, Wiley, 2019.		
3	Changyi Gu, Building Embedded Systems, Programmable Hardware, Apress, 2016.		
4			
5			

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	1	1	0	0

Teaching methods	Lectures; classroom exercises; laboratory exercises; homework assignments; colloquia; consultations

Grade (maximum number of points 100)

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

Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Functional Verification		
Lecturer (for lectures)	Andrejević-Stošović V. Miona		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)	Radivojević S. Novak		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Systematization of knowledge related to functional verification of integrated circuits, verification at the module and block level.		
Course outcomes	Acquisition of competence for functional verification at the block level. Students acquire the competence to use software tools for verification, create a verification plan, define a verification environment and verify simpler blocks of digital systems.		
Course outline			
Theoretical teaching	Verification as part of the digital system design flow. Directed and randomized testing. Communication protocols, interfaces, and transactions. Fundamentals of the SystemVerilog language - basic data types and structures and basic program structures. Object-oriented programming in SystemVerilog. Generating random values with constraints. Introduction to the Universal Verification Methodology (UVM). Universal Verification Components (UVC). Modeling UVC subcomponents. Integrating UVC and verification components into the verification environment. Progressing the verification flow from the block level to the system level. Coverage analysis and coverage-driven design testing.		
Practical teaching (exercises, OFE, study and research work)	Students are introduced to the SystemVerilog language and UVM through a series of practical examples using professional tools and software packages for electronic design (Cadence). Through the examples, students have the opportunity to apply the acquired knowledge from object-oriented programming to create an abstract model of a digital system, and then to develop a UVC according to the universal methodology for simpler protocols based on the valid-ready handshake concept.		
Textbooks/references			
1	Chris Spear, Greg Tumbush: SystemVerilog for Verification - A Guide to Learning the Testbench Language Features, 3rd edition, Springer, 2012, ISBN: 978-1-4614-0714-0		
2	IEEE Standard for Universal Verification Methodology Language Reference Manual, in IEEE Std 1800.2-2020 (Revision of IEEE Std 1800.2-2017) , vol., no., pp.1-458, 14 Sept. 2020, doi: 10.1109/IEEESTD.2020.9195920.		
3	IEEE Standard for SystemVerilog-Unified Hardware Design, Specification, and Verification Language, in IEEE Std 1800-2017 (Revision of IEEE Std 1800-2012) , vol., no., pp.1-1315, 22 Feb. 2018 doi: 10.1109/IEEESTD.2018.8299595		
4			
5			

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	0	2	0	0

Teaching methods	Lectures, auditory exercises, computer laboratory exercises, consultations, individual and group 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		Electrical Engineering and Computer Science / Communications and Information Technologies		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Fundamentals of Telecommunications		
Lecturer (for lectures)		Milošević D. Nenad		
Lecturer/associate (for exercises)		Anastasov A. Jelena		
Lecturer/associate (for OFE)		Panajotović S. Aleksandra		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Enabling students to analyze deterministic signals in the time and frequency domains, as well as their transmission through telecommunication systems. Developing engineering competencies necessary for the practical application of various analog modulation techniques, as well as for implementing analog-to-digital conversion procedures in the design and analysis of modern communication systems.			
Course outcomes	Upon successful completion of the course, the student is qualified to mathematically model and analyze the spectral characteristics of deterministic signals using Fourier analysis. The student possesses the skills to calculate the response of linear and non-linear systems to a given excitation and to evaluate the impact of distortion on transmission quality. The student is capable of analytically determining the parameters of systems with analog amplitude and angle modulations, including the calculation of bandwidth and signal power. The student is able to practically apply sampling, quantization, and coding procedures when designing systems for the digitization of analog signals, as well as to evaluate the performance of basic pulse modulation techniques.			
Course outline				
Theoretical teaching	Signal theory: analysis of periodic and aperiodic deterministic signals in the time and frequency domains. Signal transmission through linear systems: spectral analysis, amplitude, and phase characteristics of the system. Effects of non-linearity in telecommunication systems and their impact on signal transmission. Analog modulation techniques: amplitude modulations and angle modulations. Principles of pulse modulation: pulse amplitude, pulse width, and pulse position modulation. Procedures for the digitization of analog signals: the sampling theorem, quantization, and coding of digital signals.			
Practical teaching (exercises, OFE, study and research work)	Computational exercises include the mathematical solving of engineering problems in signal spectral analysis using the Fourier transform. Calculation of the response of linear networks to harmonic and impulse excitation. Analytical determination of modulated signal parameters, frequency spectrum, and required transmission power. Solving practical problems from the digitization process: determining the minimum sampling frequency, calculating the quantization signal-to-noise ratio (SNR), and digital signal bitrate. Laboratory exercises include: instrumental measurement and software spectral analysis of signals using oscilloscopes and spectrum analyzers; recording the frequency characteristics of filters; practical implementation and waveform analysis of analog amplitude modulators; experimental analysis of the sampling and signal reconstruction process along with the visualization of the aliasing effect.			
Textbooks/references				
1	B. Sklar and F. J. Harris, Digital Communications: Fundamentals and Applications (3rd Edition). Prentice Hall, New Jersey, 2019.			
2	I. A. Glover and P. M.Grant, Digital Communications. Prentice Hall Europe, London, 2009.			
3	U. Madhov, Introduction to Communication Systems. Cambridge University Press, 2014.			
4	R. L. Freeman, Fundamentals of Telecommunications, John Wiley & Sons, New York, USA, 1999.			
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	0	0

Teaching methods	Teaching is conducted through interactive theoretical lectures using multimedia presentations and the analysis of concrete engineering examples from practice. In classroom auditory exercises, a deductive approach is applied through independent and group solving of mathematical and practical problems in spectral analysis and modulation techniques. Practical teaching is realized through laboratory exercises involving students' independent work on hardware telecommunication modules, handling standard measuring instruments, and applying software simulation tools. Continuous monitoring of student progress and additional support in mastering the material are provided through regular individual consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	10	**Oral exam**	20
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electric Circuits and Signals		
Lecturer (for lectures)	Dončov S. Nebojša		
Lecturer/associate (for exercises)	Stošić P. Biljana		
Lecturer/associate (for OFE)	Perić S. Nemanja		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Development of fundamental competencies for the analysis of analogue and digital electric circuits as parts of the infrastructure of information and communication systems. Training the student to apply theoretical methods, software tools and measuring equipment in the analysis, simulation and practical implementation of basic electric circuits.		
Course outcomes	Understanding the methods and techniques of analyzing the fundamental electric circuits in solving practical problems. Ability to use software and measurement devices for analyzing analog and digital electric circuits and signals. Understanding the performance of electric circuits.		
Course outline			
Theoretical teaching	Basic terms, concepts and models of electric circuits as part of the infrastructure of an information and communication system. Signal types. Passive components and their applications. Analog circuits of the first and second order. Response calculation in electric circuits: time and frequency response. Relationship between responses. Application in analysis and design of communication circuits. Recursive and non-recursive discrete networks. Proof of concept of functionality of analog electric circuits with ideal elements by simulation and implementation. Measurement of circuit characteristics. Signal analysis and problem detection in communication devices. Optimization of electric circuits in communication systems.		
Practical teaching (exercises, OFE, study and research work)	Solving practical problems in exercises. Circuit analysis in communication systems by using software packages. Introduction to electric components, measurement devices and measurement procedures. Use of data acquisition device (NI myDAQ) in electric circuits (digital multimeter, function generator, oscilloscope, vector network analyzer).		
Textbooks/references			
1	John Bird, Bird's Electrical Circuit Theory and Technology, Routledge, 2022.		
2	James W. Nilsson, Susan A. Riedel, Electric Circuits, eleventh edition, Global Edition, 2015.		
3	B. P. Lathi, Linear Systems and Signals, second edition, Oxford University Press, Oxford, New York, 2005.		
4	Charles K. Alexander, Matthew N. O. Sadiku, Fundamentals of Electric Circuits, McGraw-Hill, New York, 2009.		
5	F. T. Ulaby, M. M. Maharbiz, NI myDAQ and MULTISIM Problems for Circuits, National Technology and Science Press, 2011.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, exercises, practical work on computers, practical work in laboratory, homework, consultations

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Applied Electromagnetics		
Lecturer (for lectures)	Raičević B. Nebojša, Perić T. Mirjana		
Lecturer/associate (for exercises)	Živaljević U. Dragana		
Lecturer/associate (for OFE)	Perić T. Mirjana		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The objective of the course is to deepen knowledge in the field of electromagnetics and to enable students to apply analytical and numerical methods in solving electromagnetic field problems, as well as to use modern software tools for the analysis and modeling of practical electromagnetic problems.		
Course outcomes	Upon successful completion of the course, the student is qualified to analyze and solve engineering problems in electromagnetics using analytical and numerical methods. The student is able to apply Maxwell's equations and boundary conditions in the analysis of electromagnetic fields, as well as to analyze the propagation of plane electromagnetic waves in different media. The student also uses software tools for numerical simulation and analysis of electromagnetic phenomena. The student is able to interpret simulation results and assess their significance in the context of engineering applications and device safety.		
Course outline			
Theoretical teaching	Maxwell's equations in integral and differential form. Maxwell's equations in the complex domain. Electromagnetic properties of media. Boundary conditions. Electrostatics. Stationary and time-varying electromagnetic fields. Analytical methods for calculating EM fields – the method of separation of variables, the method of images. Electromagnetic field potentials in homogeneous media. Poynting's theorem. Plane electromagnetic waves (in vacuum, dielectrics, imperfect conductors, ferrites, and layered media). Field polarization. Electromagnetic wave propagation. Fresnel coefficients. Electromagnetic compatibility.		
Practical teaching (exercises, OFE, study and research work)	Computational exercises: Curvilinear coordinate systems. Application of Maxwell's equations in integral and differential forms. Time-harmonic and complex vectors. Continuity equation. Electromagnetic properties of media and application of boundary conditions. Analytical methods for solving electromagnetic fields (separation of variables method, image theorem in different coordinate systems). Electromagnetic field potentials (Laplace and Poisson equations, retarded potentials). Plane electromagnetic waves and Fresnel coefficients. Laboratory exercises: numerical methods in electromagnetics and application of FEMM 4.2 software for the analysis of electrostatic and magnetostatic problems, including simulation of various geometries and systems.		
Textbooks/references			
1	F. T. Ulaby, "Fundamentals Applied Electromagnetics", Pearson, Prentice Hall, New York, 2010.		
2	J. Vanderlinde, "Classical Electromagnetic Theory", Kluwer Academic Publishers, 2004.		
3	H. Neff, "Introductory Electromagnetics", John Willey & Sons, 1991.		
4	D. M. Veličković, F. H. Uhlmann, K. Brandisky, R. D. Stancheva, H. Brauer, "Fundamentals of Modern Electromagnetics for Engineering", TU Ilmenau, Germany, 2005.		
5	E. Rothwell, M. Cloud, "Electromagnetics", CRC Press, 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	0	0

Teaching methods	Lectures, auditory exercises, homework, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Data Structures and Algorithms		
Lecturer (for lectures)	Stoimenov V. Leonid		
Lecturer/associate (for exercises)	Davidović P. Nikola		
Lecturer/associate (for OFE)	Davidović P. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Mastering the basic concepts of basic data structures and algorithms, as well as the knowledge necessary for the design, implementation and use of basic algorithms and the use of adequate data structures in order to design effective algorithms for the observed problem.		
Course outcomes	Theoretical and practical knowledge of the concepts, internal design and implementation of basic data structures in programming languages C. Knowledge of algorithmic paradigms and the ability to choose the best data structure and appropriate algorithm for optimal problem solving		
Course outline			
Theoretical teaching	Definition and overview of data structures and their use in software engineering programming, categorization of data structures, pseudocode. Concept of efficiency and complexity of algorithms. Evaluation of algorithm complexity. Paradigms for generating algorithms. Classification of algorithms. Arrays: definition of arrays, operations with arrays, operations with matrices, string data types. Linked lists: definition of structure, types of linked lists - singly linked, doubly linked, cyclic, basic operations (traversal, addition, deletion), advanced operations, static and dynamic implementation of linked lists. Queue, Stack, Deck: definition of structure, static and dynamic implementation of queue, stack and deck, basic operations (traversal, addition, deletion) in static and dynamic implementation. Hash tables: definition of structure, definition of terms (hash function, collision and synonyms), collision resolution (open addressing, synonym chaining), hash table implementation, basic operations (search, read/delete). Trees: basic concepts, binary and general trees, operations (traversal, addition and deletion of nodes), ordered binary trees, static and dynamic implementation of trees. Graphs: definition of terms, static (adjacency matrices, incidence matrices) and dynamic representation of graphs (chain structures), operations for static and dynamic implementation, breadth-first and depth-first traversal of graphs, shortest path in a graph for static and dynamic representation Dynamic programming. Grid algorithms. FFT and FFT-like algorithms.		
Practical teaching (exercises, OFE, study and research work)	1. Introduction: Introduction to the development environment for development and preparation for the implementation of exercises. Refreshing knowledge about user data types, pointers and dynamic memory allocation. 2. Arrays: implementation of arrays in a programming language, Sorting and sorting algorithms. 3. Linked lists: Implementation of linked lists, static and dynamic, implementation of operations. 4. Queue, Stack, Deck: Implementation of stack, queue and deck in a programming language, static and dynamic. 5. Hash tables: Implementation of Hash tables in a programming language. 6. Binary trees: Implementation of binary trees in a programming language, implementation of special types of trees (Heap). 7. Graphs: Implementation of graphs in a programming language, static and dynamic, operations for working with graphs.		
Textbooks/references			
1	M.T.Goodrich, R.Tamassia, D. Mount, Data Structures and Algorithms in C++, second edition, John Wiley, 2011, ISBN 978-1118136645		
2	M.T.Goodrich, R.Tamassia, M. Goldwasser, Data Structures and Algorithms in Java, 6th edition, John Wiley, 2014, ISBN-13: 978-1118803165		
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	0	0
Teaching methods	Lectures, auditory exercises, laboratory exercises, independent work of students on homework and projects			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures			**Written exam**	
Exercises		20	**Oral exam**	40
Colloquia		40		
Projects				

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Probability and Statistics		
Lecturer (for lectures)	Milošević M. Dušan, Džunić S. Jovana		
Lecturer/associate (for exercises)	Denić Z. Anđa		
Lecturer/associate (for OFE)			
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Mastering basic knowledge of probability theory and statistics.		
Course outcomes	Students' capability to draw conclusions under conditions of uncertainty and to analyze real-world data.		
Course outline			
Theoretical teaching	Random events. Definition of probability. Conditional probability and independence of events. Total probability and Bayes' formula. Random variables. Distribution function. Numerical characteristics of random variables. Mathematical expectation, moments, dispersion, standard deviation. Chebyshev's inequality. Characteristic function. Distributions of discrete and continuous random variables. Limit theorems. Basic concepts of statistics. Population and random sample. Measures of central tendency. Measures of dispersion. Central theorem of mathematical statistics. Some distributions important in statistics.		
Practical teaching (exercises, OFE, study and research work)	Random events. Definition of probability. Conditional probability and independence of events. Total probability and Bayes' formula. Random variables. Distribution function. Numerical characteristics of random variables. Mathematical expectation, moments, dispersion, standard deviation. Chebyshev's inequality. Characteristic function. Distributions of discrete and continuous random variables. Limit theorems. Basic concepts of statistics. Population and random sample. Measures of central tendency. Measures of dispersion. Central theorem of mathematical statistics. Some distributions important in statistics.		
Textbooks/references			
1	Arak M. Mathai, Hans J. Haubold, Probability and Statistics, De Gruyter, Berlin/Boston, 2017.		
2	Murray R. Spiegel, John J. Schiller, R. Alu Srinivasan, Probability and Statistics, McGraw-Hill, 2009.		
3	Joseph K. Blitzstein, Jessica Hwang, Introduction to Probability, Chapman & Hall, 2019.		
4			
5			

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	2	0	0	0

Teaching methods	Lectures, computational exercises, computer exercises, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Software Tools		
Lecturer (for lectures)		Pronić-Rančić R. Olivera, Marinković D. Zlatica		
Lecturer/associate (for exercises)		Atanasković S. Aleksandar, Dimitrijević Ž. Tijana		
Lecturer/associate (for OFE)		Dimitrijević Ž. Tijana, Mladenović M. Ksenija		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Training students to work with MATLAB and LabVIEW software packages.			
Course outcomes	Students are expected to independently use the specified software packages - to run programs, define and execute simulations, and present results.			
Course outline				
Theoretical teaching	MATLAB programming environment - mathematical calculations, modeling and simulations, data analysis and processing, data visualization and algorithm development. Working in the command window. Data representation. Mathematical operations with arrays. Script and function files. 2D and 3D graphs. Programming in MATLAB. MATLAB applications in numerical analysis. Symbolic mathematics. Toolboxes. LabVIEW programming environment. Basics of graphical programming. Signal generation. Data acquisition, processing and presentation. Instruments' control. Software tools for simulation, modeling, design and optimization of information and communication systems.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises. Laboratory exercises on defined problems.			
Textbooks/references				
1	Amos Gilat, MATLAB –an introduction with applications, Fourth Edition, John Wiley & Sons, 2011.			
2	D.M. Etter, D.C. Kuncicky, H. Moore, Introduction to MATLAB®7, Pearson Education, Inc,2004			
3	O. Pronić - Rančić, Softverski alati - skripta, 2024.			
4	Julio César Rodríguez-Quiñonez, Oscar Real-MorenoGraphical, Programming Using LabVIEW: Fundamentals and advanced techniques, IET, 2022.			
5	LabVIEW Operational Manual, National Instruments, http://www.ni.com/pdf/manuals/320999e.pdf			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	2	0	0

Teaching methods	Lectures. Auditory exercises. Laboratory exercises. 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	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Communication Acoustics		
Lecturer (for lectures)	Ćirić G. Dejan		
Lecturer/associate (for exercises)	Vučić J. Nikola		
Lecturer/associate (for OFE)	Ćirić G. Dejan		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Mastering basic theoretical and practical knowledge about the nature of sound, generating and transmitting sound, sound sources, transducers, effects of environment (closed and open space), sound perception and consequences. Practical knowledge is related to abilities and skills of application of technology based on sound (e.g., devices for sound acquisition, basic processing and sound signal storage).		
Course outcomes	Theoretical knowledge in the field of sound with a particular emphasis on communication technologies: analysis of sound fields and acoustic systems, understanding the role of acoustic components in communication systems, and interpretation of the fundamental principles of acoustic design. Skills in applying methods for sound field analysis and modeling, using acoustic measurement equipment, and conducting acoustic measurements. Competencies in assessing the acoustic characteristics of simple systems and spaces and proposing solutions in the field of acoustic design.		
Course outline			
Theoretical teaching	Physical characteristics of sound (generation and transmission of sound waves, sound sources, sound field quantification). Electro-acoustical transducers (principles and characteristics). Standard microphones and special purpose microphones (microphone arrays and digital (MEMS) microphones). Speakers and headphones. Psychological-physiological acustics: physiology of hearing and the consequences on the perception of sound; aspects of perception - intensity, pitch and timber, subjective perception of sound, equal loudness curves, localization, effects of masking. Sound in enclosed space. Room acustics. Objective measurements and subjective evaluation of parameters of the sound field. Sound recording and reproduction. Characteristics of speech, musical, and ambiental sounds. Sound applications in the industry and medicine.		
Practical teaching (exercises, OFE, study and research work)	Problem solving in computational exercises (Sound transmission and sound sources. Analogies. Electro-acustical transducers. Room acoustics. Psychological acustics. Software tools for sound processing (Sound Forge, Adobe Audition, WaveLab). Computer simulations (Design of electro-acustical transdusers. Room acoustics). Practical lab and studio exercises (Characteristics of electro-acustical transducers (speakers, cross-overs and headphones). Room impulse response. Objective measurements and subjective evaluation of parameters of the sound field. Characteristics of speech and music. Sound recording and reproduction).		
Textbooks/references			
1	J. Blauert: Communication acoustics, Springer, Berlin, 2005.		
2	F. A. Everest, K. C. Pohlmann: Master Handbook of Acoustics, 5th ed., McGraw Hill, New York, USA, 2009.		
3	T. D. Rossing: Springer handbook of acoustics, Springer, New York, 2007.		
4	J. Blauert, N. Xiang: Acoustics for engineers - Troy lectures, 2nd edition, Springer, Berlin, 2009.		
5	G. Ballou: Handbook for sound engineers, 4th edition, Elsevier, Focal Press, Burlington, 2008.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures; Computational exercises; Laboratory sessions; Studio exercises; Consultations.

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	25		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Introduction to Digital Communications		
Lecturer (for lectures)	Perić H. Zoran, Nikolić R. Jelena		
Lecturer/associate (for exercises)	Vučić J. Nikola		
Lecturer/associate (for OFE)	Vučić J. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites			
Course objectives	Acquire fundamental knowledge of digital signal processing and transmission, with an emphasis on quantization techniques and quantizer design methods.		
Course outcomes	Knowledge necessary for designing various models of scalar quantizers. Practical experience in quantizer design and application in PCM and APCM systems.		
Course outline			
Theoretical teaching	Statistical characteristics of signals (signal distributions, amplitude dynamics of signals). Analog-to-digital signal conversion. Optimal Lloyd-Max quantizer. Uniform quantizers. Logarithmic companding quantizers. Optimal companding quantizers. Piecewise uniform quantizers. Piecewise linear companding quantizers. Adaptive quantizers. Pulse Code Modulation (PCM) and Adaptive Pulse Code Modulation (APCM). Delta modulation. Adaptive delta modulation. Delta-sigma modulation.		
Practical teaching (exercises, OFE, study and research work)	Auditory exercises are conducted for all thematic units. Through problem solving during auditory exercises, theoretical knowledge is reinforced, and it is demonstrated that when choosing and designing a quantizer model, it is necessary to take into account the statistical characteristics of the processed signal. During laboratory exercises, students design various quantizer models and apply them in PCM and APCM systems.		
Textbooks/references			
1	M. Safak, Digital Communications, Wiley, 1st edition, 2017.		
2	D. Salomon, Data Compression: The Complete Reference, Springer, 2007.		
3	N.S. Jayant, P. Noll, Digital Coding of Waveforms, Prentice-Hall, New Jersey, 1984		
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	0	0

Teaching methods	Lectures, auditory exercises, practical computer-based classes, homework assignments, 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	40		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Internet of Things		
Lecturer (for lectures)		Milić N. Dejan, Milošević D. Nenad		
Lecturer/associate (for exercises)		Anastasov A. Jelena		
Lecturer/associate (for OFE)		Anastasov A. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Introduction to concept of internet of smart objects and its significance within a wider context of future objects interconnection technologies. Considering the implications of internet of things expansion, as well as potential problems and solutions. Practical experience in relaiyation of modules and system elements for intelligent objects.			
Course outcomes	- Students will be able to briefly explain functioning of the internet as the global network, as well as the concept and working principles behind internet of smart things - Understanding role and significance of the internet of smart things at economic and social level. - Realization of hardware and software for smart devices that are able to interact with their environment. - Choice and design of architecture and technologies required to implement smart devices.			
Course outline				
Theoretical teaching	Introduction, Standards and architecture. Difference between M2M paradigm and IoT. Protocols, Applications. Context. Smart houses/homes. Smart cities. Digitalization and national level. IoT modules. Limited capabilities devices. Distributed signal processing. Processing of large data quantities. Sensor networks. Usage models in healthcare system. Data security issues. Communication technologies for IoT.			
Practical teaching (exercises, OFE, study and research work)	Practical teaching is conducted using micro controller platforms and computing resources available in the laboratory. Study and research engagement is realized via team projects with thematic relating to the course content. Consultations about practical realizations are available during work on the projects.			
Textbooks/references				
1	P. Raj, A. Raman, "The Internet of Things, Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017			
2	A. Gilchrist, "Industry 4.0, The Industrial Internet of Things", Apress, 2016			
3	S. C. Mukhopadhyay, "Internet of Things: Challenges and Opportunities, Smart Sensors, Measurement and Instrumentation", Springer, 2014			
4	O.Hersent, D.Boswarthick, O.Elloumi, "The Internet of Things: Key Applications and Protocols", Willey, 2012			
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	0	0

Teaching methods	Lectures. Individual study work. Consultations, Laboratory excercises.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	30	**Oral exam**	30
Colloquia	10		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Programming on development platforms		
Lecturer (for lectures)	Milić N. Dejan, Ćirić G. Dejan, Milošević D. Nenad		
Lecturer/associate (for exercises)	Anastasov A. Jelena, Eferica M. Predrag		
Lecturer/associate (for OFE)	Anastasov A. Jelena, Eferica M. Predrag		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Qualifying students to work with the most widely used development boards in order to be able to use them for realization of more complex projects.		
Course outcomes	- Students will be qualified to choose an appropriate development platform suitable for a specific task according to specified requirements - They will have an insight and develop ability to choose a software part for the development system - Students will gain practical experience in programming of widely used platforms, such as Arduino and Raspberry Pi (R-Pi) - Students will practice on abilities and limitations of development platforms.		
Course outline			
Theoretical teaching	Introduction to Arduino. Connecting and communicating with a computer. Integrated development environments; installation and settings. Arduino language dialect. Structure and execution of the program. Groups of commands and their purpose. Libraries and the usage of thereof. Basics of R-Pi, construction, functions, connections. Operating system. Python programming. Language structure, variables, commands, Visualisation. Application of platforms in digital signal processing. DSP algoritms implementation and basic blocks realisation. Limitations of hardware and software conserning the digital processing. Practical implementation of platforms in communications and signal processing context.		
Practical teaching (exercises, OFE, study and research work)	Practical exercises related to programming of development platforms (Arduino and R-Pi) - specific characteristics, syntax, examples. Pracitcal work and programming of development boards from their connection to a computer to realisation of real-life mini projects.		
Textbooks/references			
1	A. Dennis, Raspberry Pi Home Automation with Arduino, Pack Publishing, 2013		
2	J. Blum: Exploring Arduino - Tools and techniques for engineering wizardry, Willey, 2013.		
3	B. Evans: Beginning Arduino programming - Writing code for the most popular microcontroller boards in the world, Apress, 2011.		
4	M. Geddes: Arduino project handbook, No Starch Press, 2016.		
5	W. Donat: Learn Raspberry Pi programming with Python, Apress, 2014.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	2	0	0

Teaching methods	Lectures. Consultations. Student research projects.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		M2M Communications		
Lecturer (for lectures)		Milić N. Dejan		
Lecturer/associate (for exercises)		Anastasov A. Jelena		
Lecturer/associate (for OFE)		Anastasov A. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Provide the necessary theoretical and practical knowledge of M2M architecture, protocols and applications.			
Course outcomes	Comprehensive insight into M2M architecture and standards, from concept to implementation.			
Course outline				
Theoretical teaching	M2M communication and application. Local communication between devices and components. Components in the M2M structure: devices, gateway, M2M network, communication network, application. Logical levels and adjusting the levels to required standards. M2M architectures: 3GPP MTC architecture; ETSI M2M architecture; Architecture of the EXALTED system. Standards and protocols in M2M communications: ZigBee, Bluetooth, 6LoWPAN, NFC standard.			
Practical teaching (exercises, OFE, study and research work)	Realization of M2M communication by connecting the Raspberry Pi platform with the M2M device. Programming and implementation of Python application on Raspberry Pi.			
Textbooks/references				
1	D. Ibrahim, Android App Development for Electronics Designers, Elektor International Media, 2018.			
2	D. Boswarthick, O. Elloumi, O. Hersent, M2M Communications: A Systems Approach, Wiley, 2012.			
3	C. Anton-Haro, M. Dohler, Machine-to-machine (M2M) Communications: Architecture, Performance and Applications, Elsevier, 2014.			
4	D. Ibrahim, Raspberry Pi 3 -Raspberry Pi 3 - Basic to Advanced Projects, Elektor International Media, 2018.			
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	0	0

Teaching methods	Lectures, practical and laboratory exercises, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	50	**Oral exam**	20
Colloquia			
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Wireless Communication Technologies		
Lecturer (for lectures)		Panajotović S. Aleksandra, Milović M. Daniela, Milić N. Dejan		
Lecturer/associate (for exercises)		Panajotović S. Aleksandra		
Lecturer/associate (for OFE)		Panajotović S. Aleksandra		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	To enable students to learn about the principles, technologies and applications of wireless communication systems.			
Course outcomes	Students' ability to understand different wireless network technologies and standards, and make adequate design choises to use them most effectively.			
Course outline				
Theoretical teaching	Introduction. Multilevel modulation schemes. Time division multiplex. Frequency division multiplex. Pseudo-random carrier modulation. Pseudorandom sequnces and their properties. Modulation with direct sequence (DS) and frequency hopping (FH). Principles of synhronization. Fundamental principles of OFDM technique. Synhronization and channel estimation in OFDM systems. Wireless communication systems and networks. Coding schemes for OFDM systems. Evolution of mobile networks. GSM, UMTS, LTE, 5G, WiFi, Bluetooth, ZigBee, Z wave, NFC, Lora, Sigfox. IEEE 802.x standards. Security problems and current standards.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises are carried out from following topics: multilevel modulation schemes, time-division multiplexing, frequency-division multiplexing, spread-spectrum systems, coding techniques for OFDM systems, and modern wireless communication technologies and standards. Laboratory exercises are related to digital modulation, direct sequence modulation and OFDM.			
Textbooks/references				
1	N. Morinaga, R. Kohno, S. Sampei, Wireless Communication Technologies: New Multimedia Systems, Springer, 2020.			
2	M. Vaezi, Z. Ding, H. V. Poor, Multiple Access Techniques for 5G Wireless Networks and Beyond, Springer International Publishing, 2019.			
3	D. Torrieri, Principles of Spread-Spectrum Communication Systems, Springer, 2022.			
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Signal Processing		
Lecturer (for lectures)	Dončov S. Nebojša		
Lecturer/associate (for exercises)	Stošić P. Biljana		
Lecturer/associate (for OFE)	Stošić P. Biljana		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Development of basic competencies for signal processing, with a particular focus on the application of filters in signal processing. Training the student for the design and implementation of basic types of analogue and digital filters.		
Course outcomes	Understanding basic concepts of signal processing. Designing analog and digital filters. Understanding the basics of software and hardware implementation of fundamental types of digital filters.		
Course outline			
Theoretical teaching	Signal processing in key trends of the modern technological revolution: Internet of Things (IoT), cloud computing, software-defined radio, robotics, autonomous vehicles, etc. Classification of discrete signals and systems. Analysis of discrete systems using z- and Fourier transforms. Application of filters in signal processing. Design of analog networks. Amplitude and phase spectra. Design of digital filters with infinite (IIR) and finite (FIR) impulse response. Design of wave digital filters. Analysis of the characteristics of the designed circuits.		
Practical teaching (exercises, OFE, study and research work)	Software implementation of designed filters in MATLAB/Simulink environment. Hardware implementation of digital filters on FPGA board. Use of data acquisition device (NI myDAQ) in analysis of passive and active filters.		
Textbooks/references			
1	Lars Wanhammar, Tapio Saramäki, Digital Filters Using MATLAB, Springer Nature Switzerland AG, 2020.		
2	Wai-Kai Chen, The Circuits and Filters Handbook, Passive, Active and Digital Filters, CRC Press, 2009.		
3	Paolo Prandoni, Martin Vetterli, Signal Processing for Communications, CRC Press, 2008.		
4	Stefan Bilbao, Wave and Scattering Methods for Numerical Simulation, John Wiley & Sons Ltd, 2004.		
5	David Baez-Lopez, Felix E. Guerrero-Castro, Circuit Analysis with Multisim, in Synthesis Lectures on Digital Circuits and Systems, by Mitchell Thornton, Morgan and Claypool Publisher, 2011.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures, exercises, practical work on computers, practical work in laboratory, homework, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital Communications		
Lecturer (for lectures)	Perić H. Zoran, Jovanović Ž. Aleksandra, Panajotović S. Aleksandra		
Lecturer/associate (for exercises)	Panajotović S. Aleksandra, Vučić J. Nikola		
Lecturer/associate (for OFE)	Panajotović S. Aleksandra, Vučić J. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites			
Course objectives	To deepen knowledge of analog-to-digital signal conversion based on differential coding. To provide the necessary understanding of digital signal transmission in baseband and passband, with special focus on line coding, digital modulation, and digital signal detection.		
Course outcomes	The student will fully master techniques for analog-to-digital signal conversion. They will understand the basic principles of digital signal transmission in both baseband and passband. They will become familiar with the advantages and disadvantages of line codes and various modulation techniques. Finally, they will complete their understanding of digital transmission by acquiring fundamental knowledge of signal detection and digital signal processing at the receiver.		
Course outline			
Theoretical teaching	Multistage delta modulation. Analog-to-digital signal conversion based on differential coding: DPCM and ADPCM. Transmission of signals in the baseband frequency range: error probability in binary transmission; multilevel amplitude pulse MPAM modulation and error probability. Line coding. Equalization. Transmission of digital signals in the passband, basic concepts. Introduction to classical digital modulation schemes (ASK, FSK, PSK and its variants, multilevel modulations (MFSK, MQAM, MPSK), MSK, DPSK). Coherent and non-coherent demodulation. Performance of communication systems in the passband. Modern digital modulation techniques for new generation wireless, satellite, and wired communications (OFDM and its variants, CPM and FTN).		
Practical teaching (exercises, OFE, study and research work)	During auditory and laboratory exercises, knowledge acquired in theoretical lessons is reinforced through analytical problem-solving and software implementation of practical examples.		
Textbooks/references			
1	J. Proakis, M. Salehi, Digital Communications, McGraw-Hill Education, 5th edition, 2007.		
2	M.Safak, Digital Communications, Wiley, 1st edition, 2017.		
3			
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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	0	0

Teaching methods	Lectures, classroom exercises, practical computer-based training, homework assignments, 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	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Telecommunications Theory		
Lecturer (for lectures)	Đorđević T. Goran		
Lecturer/associate (for exercises)	Đorđević T. Goran		
Lecturer/associate (for OFE)	Đorđević T. Goran		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Acquisition of fundamental knowledge in Telecommunications Theory and its application to the performance evaluation of telecommunication systems.		
Course outcomes	Upon passing the exam, students will: 1) be able to generate random variables with a given arbitrary distribution; 2) be able to determine the autocorrelation function and power spectral density of random signals; 3) be able to apply both analytical and simulation approaches to estimate the error probability in digital signal detection; 4) understand the principles of optimal, matched, and adaptive filtering.		
Course outline			
Theoretical teaching	Model of a telecommunication system from the perspective of Telecommunications Theory. Random variables. Basic types of probability distributions in telecommunication systems. Transformation of the probability density function. Generation of random variable values with a given distribution. Principle of Monte Carlo simulations. Autocorrelation function and power spectral density of a random signal. Wideband and narrowband Gaussian noise. Analytical and simulation-based estimation of error probability in digital signal detection in both baseband and passband. Intersymbol interference. Determining error probability in a channel with intersymbol interference. Viterbi algorithm and its application in mitigating intersymbol interference. Concepts of optimal, matched, and adaptive filtering. Introduction to probabilistic decision theory.		
Practical teaching (exercises, OFE, study and research work)	Tutorial classes and laboratory exercises will be organized for all topics covered in the lectures. During tutorial sessions, students solve problems and practical tasks that are closely aligned with the theoretical course content. Laboratory exercises are conducted both in the laboratory and in the computer classroom. In the laboratory, students perform experiments using pulse generators, noise generators, and bit-error-rate measurement equipment, as well as oscilloscopes and training platforms for illustrating intersymbol interference. In the computer classroom, students gain proficiency in random number generation methods, the application of Monte Carlo simulations for system performance evaluation, and the simulation of the Viterbi algorithm for intersymbol interference mitigation.		
Textbooks/references			
1	A. Papoulis, S. U. Pillai, Probability, random variables and stochastic processes, 4th edition, McGraw-Hill Europe, 2001.		
2	B. Sklar, F. Harris, Digital Communications: Fundamentals and Applications, Pearson, 2020.		
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	0	0

Teaching methods	Lectures. Problem-solving sessions. Laboratory work. Individual consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	5	**Oral exam**	30
Colloquia	20		
Projects	20		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Networks and Protocols		
Lecturer (for lectures)	Milošević D. Nenad		
Lecturer/associate (for exercises)	Anastasov A. Jelena		
Lecturer/associate (for OFE)	Eferica M. Predrag		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Enabling students to analyze, design, and practically implement telecommunication networks. Developing engineering competencies necessary for configuring network devices, analyzing network traffic, and applying standard communication protocols at different layers of the OSI and TCP/IP reference models, with a specific focus on local and industrial networks.		
Course outcomes	Upon successful completion of the course, the student is qualified to independently analyze functions and protocols within the layered OSI network architecture. The student possesses the skills to practically apply error detection and correction techniques and analyze the efficiency of medium access control algorithms in LAN and MAN networks. The student is capable of designing IP addressing schemes, performing subnetting, configuring basic routing parameters, and diagnosing issues through TCP/IP network traffic analysis. Additionally, the student is trained to evaluate the parameters of industrial communication networks and apply CAN protocol concepts.		
Course outline			
Theoretical teaching	Basic concepts and architecture of telecommunication networks. Layered network architecture and detailed analysis of the OSI reference model. Data link layer functions: medium access control, methods for transmission error detection and correction, architecture and application of the HDLC protocol. Network layer: IP addressing schemes, subnetting, and data routing principles. Multiple access techniques to network resources: static and dynamic protocols (Aloha, CSMA mechanisms). Network and transport layer analysis through detailed study of IPv4/IPv6 and TCP/UDP protocols. Industrial telecommunication networks: architectural specifics, real-time operation requirements, and detailed analysis of the CAN protocol.		
Practical teaching (exercises, OFE, study and research work)	Computational exercises include calculating the efficiency of data link layer protocols and the mathematical performance analysis of multiple access algorithms. Practical engineering problem-solving in network design through IP addressing and subnetting techniques. Calculation of network delay and throughput parameters. Laboratory exercises are carried out in a computer lab and include: working with software network simulators to design network topologies; practical configuration of network interfaces and routing tables; capturing, filtering, and deep-dive analysis of network traffic using software packet analyzers (Wireshark) to understand the operation of the TCP/IP stack; software simulation of operations and analysis of frame formation on an industrial CAN bus.		
Textbooks/references			
1	T. Saadawi, M. Ammar, A. El Hakeem, Fundamentals of Telecommunication Networks, John Wiley&Sons, NY, 1994		
2	A. Tanenbaum, D. Wetherall, Computer Networks, 6th ed, Prentice Hall Press, NJ, USA, 2021		
3	J. Kurose, K. Ross, Computer Networking: A Top-Down Approach, 8th ed., Pearson, Boston, 2021.		
4	B. Forouzan, Data Communications and Networking with TCP/IP Protocol Suite, 6th ed., McGraw-Hill Education, New York, 2021.		
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	0	0

Teaching methods	Teaching is carried out through interactive lectures using multimedia tools, during which theoretical concepts of network architectures and protocols are directly linked with modern practical examples. Classroom auditory exercises are based on independent and team problem-solving of concrete engineering problems, such as designing addressing schemes and calculating network performance. Laboratory exercises are conducted in a specialized computer lab, where students acquire specific professional skills through practical work in network simulators and the use of network traffic analysis software. Regular individual consultations serve to continuously monitor student progress, clarify more complex concepts, and provide additional professional support in mastering the material.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	10	**Oral exam**	20
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microwave Technique		
Lecturer (for lectures)	Maleš-Ilić P. Nataša, Pronić-Rančić R. Olivera, Joković J. Jugoslav		
Lecturer/associate (for exercises)	Mladenović M. Ksenija		
Lecturer/associate (for OFE)	Mladenović M. Ksenija		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory

Prerequisites	None
Course objectives	Acquiring basic theoretical and practical knowledge in the field of microwave techniques.
Course outcomes	Acquire knowledge of the theory of EM wave propagation by transmission lines, Ability to use Smith chart in analysis / design of microwave circuits, Acquire knowledge of the wave parameters and ability to use them in the analysis and design of microwave circuits, Understand the most important planar structures for guiding microwaves. Ability to analyse, synthesize, and implement transmission lines in microwave devices. Understanding the operation of semiconductor components and the basic principles of designing active microwave circuits.
Course outline	
Theoretical teaching	Microwaves, specifics and areas of application. Propagation of electromagnetic waves along transmission lines - mechanisms, basic characteristics and parameters. Smith chart and applications in the analysis of microwave circuits. Techniques for solving impedance matching networks. Microstrip lines - characteristics, discontinuities, analysis and synthesis. Determination of S and T parameters of networks and circuits. Microwave semiconductor components - diodes and transistors. Introduction to microwave amplifiers. Examples of microwave amplifier design.
Practical teaching (exercises, OFE, study and research work)	Auditory exercises. Practical work in laboratory.
Textbooks/references	
1	Hans L. Hartnagel, Rüdiger Quay, Ulrich L. Rohde, Matthias Rudolph, Fundamentals of RF and Microwave Techniques and Technologies, Springer, 2023
2	Mouqun Dong, RF Circuits and Applications for Practicing Engineers, Artech House, 2021
3	David Pozar, Microwave Engineering, third edition, John Wiley and Sons, Inc., 2005
4	Les Besser, Rowan Gilmore, Practical RF Circuit Design for Modern Wireless Systems Volume I - Passive Circuits and Systems, Artech House, 2003
5	Rowan Gilmore, Les Besser, Practical RF Circuit Design for Modern Wireless Systems Volume II Active Circuits and Systems, Artech House, 2003

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures. Computational exercises. Laboratory work. Homeworks. 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	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Wireless Communication Systems		
Lecturer (for lectures)	Maleš-Ilić P. Nataša, Stanković Ž. Zoran, Joković J. Jugoslav		
Lecturer/associate (for exercises)	Dimitrijević Ž. Tijana, Mladenović M. Ksenija		
Lecturer/associate (for OFE)	Perić S. Nemanja		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquiring theoretical and practical knowledge of transmission of information by wireless communication systems.		
Course outcomes	The students acquire knowledge of the basic architectures and components of wireless communication systems and knowledge of the basic principles and mechanisms of wireless information transmission. They are trained to calculate wireless transmission parameters in order to determine the reliability and capacity of the connection and to know the specifics of various wireless technologies. The students are trained to independently engineer the planning of elementary wireless communication connections while respecting technical and standardization requirements, as well as to monitor the development of modern wireless technologies through understanding their fundamental physical and system principles.		
Course outline			
Theoretical teaching	Basic architectures, components and frequency ranges of wireless communication systems. Antennas in microwave communication systems - basic topologies and parameters. Propagation of electromagnetic waves through the atmosphere - mechanisms, effects, Friis transmission equation, Fresnel zone. Phenomena in wireless communication systems - fading, thermal noise, nonlinear effects of microwave circuits. Microwave fixed links - structure, architecture of transceivers and repeaters, frequency plan. Microwave link budget. Overview and basic specifics of modern wireless systems - mobile systems, broadcasting, satellite communications and navigation, computer and sensor networks.		
Practical teaching (exercises, OFE, study and research work)	Auditory exercises: solving practical problems related to the transmission of signals over the air, and analysis of components of wireless systems. Labs: Characterization of wireless system components by measurements and analysis of the components by software tools.		
Textbooks/references			
1	A. F. Molisch, Wireless Communications, John Wiley and Sons, 2010.		
2	A. Osseiran, J. F. Monserrat, P. Marsch, 5G Mobile and Wireless Communications Technology, University Press, 2016.		
3	Randy L. Haupt, Wireless Communications Systems: An Introduction, John Wiley & Sons, Inc., 2020		
4	Andreas F. Molisch, Wireless Communications: From Fundamentals to Beyond 5G, 3rd Edition, Wiley-IEEE Press, 2022		
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	0	0

Teaching methods	Lectures; Practical exercises; Laboratory exercises; Consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	5	**Oral exam**	20
Colloquia	40		
Projects	10		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Software-hardware Interface in Communication Platforms		
Lecturer (for lectures)		Milić N. Dejan		
Lecturer/associate (for exercises)		Anastasov A. Jelena		
Lecturer/associate (for OFE)		Milić N. Dejan		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	

Prerequisites	None
Course objectives	Aim of this course is getting the srudents familiar with hardware and software aspects of interconnecting modulesin the systems that require data interchange and M2M communication. Presentation of the concept of modern short range wireless communications platforms as a base for implementing internet of things
Course outcomes	Acquiring knowledge about modern ways of communication between electronic modules and devices, as well as between the endpoints in communications links. Students that choose this course will be able to: - identify main challenges associated with modern M2M communications - know the most important standards, protocols, algorithms and research activities related to the aforementioned challenges - describe ways in which these standards, protocols and algorithms resolve the specified problems - identify limitations that exist in M2M communications - combine different concepts and approaches inside a system and identify potential weaknesses regarding the system performance - search, find, evaluate, and present the research results, as well as relevant documents regarding international standardization - implement an M2M system with sensors, actuators and controllers
Course outline	
Theoretical teaching	The course considers following subjects: •Introduction to M2M communications •Industrial communication systems - Wired networks and their interfaces (HART, CAN, Industrial Ethernet) - Industrial wireless networks (Wireless HART, ISA100.11a) •M2M and capillary networks - Wireless sensor networks, Bluetooth, 802.11ah, Wireless M-bus - Requirements regarding power and traffic in M2M applications •M2M and mobile networks - Solutions for existing and perspective networks •Internet of Things - 6LowPAN, CoAP, IP, energy consumption and efficiency •Vehicle networks - Security requirements for applications - Vehicle-X communication, possible solutions and performance
Practical teaching (exercises, OFE, study and research work)	Practical topics/tasks are going to be performed in the laboratory
Textbooks/references	
1	J. A. Dell, "Digital Interface Design and Application", Willey, 2015
2	M. Schleicher, F. Blasinger, "Digital Interfaces and Bus Systems for Communication, Practical Fundamentals", JUMO, 2001
3	D. Boswarthick, O. Elloumi, O. Hersent , "M2M Communications - A System Approach", Willey, 2012
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	0	0
Teaching methods	Course includes lectures, auditory excercises, homework, seminar papers and practical project			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures			**Written exam**	30
Exercises		30	**Oral exam**	20
Colloquia				
Projects		20		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Machine Learning 1		
Lecturer (for lectures)	Perić H. Zoran, Ćirić G. Dejan, Nikolić R. Jelena		
Lecturer/associate (for exercises)	Vučić J. Nikola		
Lecturer/associate (for OFE)	Vučić J. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introducing students to the fundamental principles of machine learning, different types of learning, methods of data analysis, and prediction models. Understanding the essence of engineering problems in modern communications that are solved by applying supervised machine learning algorithms.		
Course outcomes	Students will be able to: understand the basic principles of machine learning and types of learning, prepare and process data for machine learning, implement regression and classification methods, apply various optimization algorithms and regularization techniques, evaluate models using appropriate performance metrics, develop and test machine learning algorithms for solving practical problems.		
Course outline			
Theoretical teaching	Introduction to machine learning and types of learning (supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning). Types of features and their normalization. Dataset splitting and K-fold cross-validation. Preprocessing of incomplete data. Univariate, bivariate, and multivariate feature analysis. Regression and performance measures of regressors. Linear and polynomial regression. Regularization techniques (Ridge, Lasso, and Elastic Net). Optimization methods and learning algorithms (Gradient Descent, Stochastic Gradient Descent). Classification and performance measures of classifiers. Logistic regression. Support Vector Machines (SVM). Linear SVM, polynomial and RBF kernel. Application of supervised learning methods in solving industrial and communication problems.		
Practical teaching (exercises, OFE, study and research work)	At the exercises, theoretical knowledge is reinforced and skills in the field of machine learning are acquired through the analysis of Python codes, from data preparation to model implementation and evaluation.		
Textbooks/references			
1	F. Chollet, Deep Learning with Python, 2nd Edition, MANNING PUBLICATIONS, 2021.		
2	A. Geron, Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems, O'Reilly Media, 2021.		
3	S. Raschka and V. Mirjalili, Python Machine Learning, Packt Publishing, 2020.		
4	S. Raschka, V. Mirjalili, and Y. Liu, Machine Learning: PyTorch and Scikit-Learn, Kompjuter Library, 2022.		
5	I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	1	1	0	0

Teaching methods	Lectures, PowerPoint presentations, auditory exercises, practical computer-based lessons, homework assignments, consultations.

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	25		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Fourier Analysis and Applications		
Lecturer (for lectures)		Rančić Z. Lidija		
Lecturer/associate (for exercises)		Rajković P. Jovan		
Lecturer/associate (for OFE)		Damnjanović G. Ivan		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Mastering the general principles and techniques of applying Fourier analysis.Training students to apply acquired knowledge to solve engineering problems, especially problems in signal theory, information-communication techniques.			
Course outcomes	Developed ability to identify problems in the field of interest and their solving by the methods of Fourier analysis. The ability to use acquired knowledge and skills in further education and practice. The ability of students to solve problems from their profession by using a software package.			
Course outline				
Theoretical teaching	Signals. Linear Systems. Fourier series. Fourier integral, Fourier transform and inverse Fourier transform. Distributions.Convolution and correlation. Discrete Fourier transform.Fast Fourier transform. Cosinous Fourier transform, continuous and discrete. Multidimensional Fourier transform and application in image processing. Window functions. Applications in solving practical engineering and scientific problems.MatLab implementation.			
Practical teaching (exercises, OFE, study and research work)	Identifying and solving problems that follow the theoretical part of the course. Through laboratory exercises, it is possible to see the true nature of the proposed algorithms and their implementation.			
Textbooks/references				
1	Brad Osgood, Lectures on the Fourier Transform and Its Applications (Pure and Applied Undergraduate Texts) , American Mathematical Society, 2019			
2	Russell L. Herman, An Introduction to Fourier Analysis, Chapman & Hall, 2023			
3	David W. Kammler, A First Course in Fourier Analysis, Cambridge University 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	2	0	0

Teaching methods	Lectures, auditory exercises, consultations

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	20	**Written exam**	20
Exercises		**Oral exam**	20
Colloquia	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Data Analysis and Compression	
Lecturer (for lectures)			Perić H. Zoran, Jovanović Ž. Aleksandra, Nikolić R. Jelena	
Lecturer/associate (for exercises)			Jovanović Ž. Aleksandra, Nikolić R. Jelena	
Lecturer/associate (for OFE)				
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites				
Course objectives	To study methods for signal and data analysis, along with fundamental techniques and standards for both lossless and lossy data compression. To develop students' skills in critical thinking, analytical problem-solving, and the ability to apply acquired theoretical knowledge to processing various types of real-world signals and data.			
Course outcomes	Acquired theoretical and practical knowledge in the field of lossless and lossy data compression. Ability to apply compression techniques in processing various real signals and data, as well as to modify existing methods to find improved solutions.			
Course outline				
Theoretical teaching	Introduction to data compression and Shannon's noiseless coding theorem. Lossless compression methods: Huffman coding, Golomb-Rice coding, arithmetic coding, run-length coding, and dictionary-based codes (both static and adaptive dictionaries). Lossy compression techniques: scalar quantization (including entropy-coded quantization), transform coding, subband coding, wavelet-based compression, and compressed sensing.			
Practical teaching (exercises, OFE, study and research work)	Studying and solving selected problems in the field of compression during practical lessons will contribute to a deeper understanding of theoretical concepts as well as the acquisition of applied knowledge.			
Textbooks/references				
1	K. Sayood, Introduction to Data Compression, Elsevier, Morgan Kaufmann; 5th edition, 2018.			
2	D. Salomon, Data Compression: The Complete Reference, Springer, 2007.			
3				
4				
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	2	0	0	0

Teaching methods	Lectures, PowerPoint presentations, classroom exercises, homework assignments, seminar papers, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises		**Oral exam**	20
Colloquia	35		
Projects	20		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Speech Communications		
Lecturer (for lectures)	Ćirić G. Dejan, Nikolić R. Jelena		
Lecturer/associate (for exercises)	Vučić J. Nikola		
Lecturer/associate (for OFE)	Nikolić R. Jelena, Ćirić G. Dejan		
Number of ECTS 6	**Course status (obligatory/elective)**	Elective	
Prerequisites			
Course objectives	Introduction to basic speech communication elements and speech technologies, which includes speech generating, speech characteristics, analysis and processing of speech signals in time and frequency domain as well as perception and modelling of speech. Mastering software tools application for processing and analysis of speech signals. Speech signal characterization. Understanding algorithms for speech signal processing.		
Course outcomes	Theoretical knowledge in the field of speech, including speech production and perception mechanisms, speech signal analysis, and understanding the principles of speech technologies. Skills in applying software tools for speech signal analysis and processing, as well as in using basic methods for speech parameter extraction and analysis. Practical application of theoretical knowledge from speech technologies in elementary speech and speaker recognition tasks. Competencies in assessing the applicability of various speech processing methods and carrying out simple speech and speaker recognition tasks.		
Course outline			
Theoretical teaching	Articulation, transmission and perception of speech, the nature and characteristics of speech (acoustical aspects, modelling of speech production and listening - linguistic modelling of speech,, acoustical modelling of speech). Articulatory and acoustical phonetics. Speech perception. Pre-processing of speech signals and extraction of relevant characteristics (features). Prosodical speech features. Time and frequency analysis of speech signals. Spectrogram analysis and LPC analysis. Acoustical and statistical characteristics of speech signals (vocals and consonants). Formant field application for identification of vocals. Speech intelligibility (objective measurements and subjective evaluations of acoustical characteristics of voice). Speech technologies: the chronology of development, terminology, perspectives. Speech technology applications.		
Practical teaching (exercises, OFE, study and research work)	The use of standard software tools for handling speech signals (Praat, Sound Forge,Adobe Audition). Modelling of speech generation. Speech acquisition in diverse environments, and analysis of environment efects. Pre-processing nad processing of speech signals. Speech signal analysis and extraction of fundamental features. Speech features applications, for instance in speech recognition. Practical work with speech automated devices.		
Textbooks/references			
1	G. Fant: Speech acoustics and phonetics, Kluwer Academic Publishers, Dordrecht, Netherlands, 2004.		
2	J. Benesty, M. M. Sondhi, Y. Huang: Springer handbook of speech processing, Springer, Berlin, 2008.		
3	I. McLoughlin: Speech and audio processing: A Matlab based approach, Cambridge University Press, Cambridge, 2016.		
4	D. Yu, L. Deng: Automatic speech recognition: A deep learning approach, Springer, London, 2015.		
5	L. R. Rabiner, R. W. Schafer: Introduction to digital speech processing, Now Publishers Inc, Hanover, USA, 2007.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	2	0	0

Teaching methods	Lectures; PowerPoint presentations; Calculation exercises; Laboratory exercises; Consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	Written exam	20
Exercises	30	Oral exam	30
Colloquia			

Projects	15		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Mobile Communication Systems		
Lecturer (for lectures)	Marinković D. Zlatica		
Lecturer/associate (for exercises)	Mladenović M. Ksenija		
Lecturer/associate (for OFE)	Stošić P. Biljana		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Mastering the knowledge and skills in mobile communication systems. Introduction to the basic principles and techniques of mobile communications, as well as the specifics of current and future mobile systems and services that they offer.		
Course outcomes	Upon successful completion of the course, the student is able to explain the basic principles of mobile communications and the evolution of mobile communication systems from the first to the fifth generation, describe different types of radio wave propagation in various scenarios and to apply signal propagation models, explain the architecture of modern mobile communication systems and the operating principles of their main components, analyze key characteristics of 5G systems and their role in IoT applications, and apply methods for evaluating the quality of service (QoS) in mobile communication networks.		
Course outline			
Theoretical teaching	Evolution of the standards of mobile communication systems. Principles of mobile communications. Cellular approach. Signal propagation in mobile communications. User equipment. GSM, GPRS and UMTS systems. Multiple access, handover and roaming. Packet data transfer. Power control. HSPA and HSPA + systems. TE and LTE Advanced system. 5G mobile systems. Quality of services tests in mobile networks (benchmarking). Mobile communications applications in IoT and smart systems. Mobile IoT (MIoT). Towards new generations of mobile systems.		
Practical teaching (exercises, OFE, study and research work)	Examples of calculations related to the following areas: signal propagation in mobile communications; propagation models; cellular approach; traffic theory; planning of mobile communication systems. Introduction to practical methods for EM field monitoring and testing the quality of mobile services. Introduction to mobile applications development. Visits to mobile operators.		
Textbooks/references			
1	J. Schiller, Mobile Communications, Addison-Wesley, 2000		
2	D.P.Agrawal, Q.A.Zeng, Introduction to Wireless and Mobile Systems, Thomson, 2006		
3	J. Rodriguez, “Fundamentals of 5G Mobile Networks”, Wiley, ISBN: 978-1-118-86752, 2015		
4	International (ETSI) Standards for Quality of Service Testing in Mobile Networks		
5	Selected book chapters and articles on the most recent applications of mobile communication systems		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, exercises, laboratory exercises, consultations

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	5	**Oral exam**	20
Colloquia	50		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Broadcasting systems and digital television		
Lecturer (for lectures)	Joković J. Jugoslav, Pronić-Rančić R. Olivera		
Lecturer/associate (for exercises)	Atanasković S. Aleksandar, Perić S. Nemanja		
Lecturer/associate (for OFE)	Perić S. Nemanja		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Introduction to basic principles of production, transmission and reception of TV signals in broadcasting systems.
Course outcomes	Knowledge of the broadcasting systems architecture. Understanding of standards for satellite, cable and terrestrial transmission, as well as network planning for TV signal distribution. Knowledge of the basic technical details and functionality of equipment for TV signals production, transmission and reception.
Course outline	
Theoretical teaching	Broadcasting systems – types, frequency ranges, DTV system architecture. TV studio production – generating TV signal, additional services, TS, interfaces, TV programs multiplexing. Digital TV transmission (DVB) – satellite/cable/terrestrial - primary and secondary distribution, microwave links, transmitter architecture, parameters of TV transmission. Terrestrial broadcasting network planning - MFN and SFN, gap fillers, calculation of EM field level and service area of digital TV transmitter. Reception of digital TV signals - receiver architecture, quality of service and measurement of TV signal parameters.
Practical teaching (exercises, OFE, study and research work)	Auditory exercises.
Textbooks/references	
1	E. P. J. Tozer, Broadcast Engineer's Reference Book, Focal Press, Oxford, 2004.
2	J.C. Whitaker, Standard Handbook of Broadcast Engineering, McGraw-Hill, NY 2005.
3	U. Reimers, DVB - The Family of International Standards for Digital Video Broadcasting, Springer, 2005.
4	H. Benoit, Digital Television - Satellite, Cable, Terrestrial, IPTV, Mobile TV in the DVB Framework, Focal Press 2008.
5	W. Ficher, Digital Video and Audio Broadcasting Technology, Springer, 2010

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures, exercises, practical work in the laboratory.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microwave Circuit Design		
Lecturer (for lectures)	Pronić-Rančić R. Olivera, Maleš-Ilić P. Nataša		
Lecturer/associate (for exercises)	Atanasković S. Aleksandar		
Lecturer/associate (for OFE)	Stošić P. Biljana		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquiring theoretical and practical knowledge in the analysis and design of passive and active microwave circuits using modern CAD tools.		
Course outcomes	The student understands the operating principles of modern passive and active microwave circuits and is trained to use specialized software tools for the design, analysis, and optimization of microwave circuits.		
Course outline			
Theoretical teaching	CAD, analysis and optimization of microwave circuits in modern communication systems. Design of planar microwave subsystems (matching circuits, impedance transformers, couplers and power dividers, microwave filters). Microwave integrated circuits. Design of circuits for efficient use of microwave radiation energy and nonlinear tags. Design of linear microwave transistor amplifiers. Design of microwave control circuits (switches, phase shifters, limiters, attenuators).		
Practical teaching (exercises, OFE, study and research work)	Solving selected problems in computational exercises. Practical work in the laboratory. Analysis and optimization of microwave circuits and components using specialized software packages.		
Textbooks/references			
1	Charles E. Free, Colin S. Aitchison: RF and Microwave Circuit Design: Theory and Applications, John Wiley & Sons Ltd, 2021.		
2	Les Besser, Practical RF Circuit Design for Modern Wireless Systems Volume I - Passive Circuits and Systems, Artech House, 2003.		
3	Rowan Gilmore, Practical RF Circuit Design for Modern Wireless Systems Volume II - Active Circuits and Systems, Artech House, 2003.		
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory work, homework, 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	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Short Range Wireless Systems		
Lecturer (for lectures)	Pronić-Rančić R. Olivera, Maleš-Ilić P. Nataša, Stanković Ž. Zoran		
Lecturer/associate (for exercises)	Perić S. Nemanja		
Lecturer/associate (for OFE)	Atanasković S. Aleksandar		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquiring theoretical and practical knowledge about information transmission in short range wireless communication systems.		
Course outcomes	Knowledge of short range wireless system architecture and component operation principles. Understanding of core information transmission techniques in short range wireless systems.		
Course outline			
Theoretical teaching	Basic characteristics of short-range wireless systems. Technology overview. Infrared wireless communication (IrDA). BLE (Bluetooth Low Energy). Z-Wave. ZigBee: system architecture, data exchange protocols, physical and logical channels. UWB (Ultra-wideband) systems. RFID (Radio Frequency Identification) systems. NFC (Near Field Communication) systems. Patient monitoring systems in medicine based on BSN (Body Sensor Network), WBAN (Wireless Body Area Network) and MBAN (Medical Body Area Network). Integration of short-range wireless system technologies into IoT systems.		
Practical teaching (exercises, OFE, study and research work)	Computational exercises: solving problems concerning data transmission in short-range wireless systems and component performance analysis. Laboratory exercises: practical implementation of short-range wireless systems.		
Textbooks/references			
1	Walid Saad, Mehdi Bennis, Wireless Communications and Networking for Unmanned Aerial Vehicles, Springer, 2020.		
2	M. Ghavami, L. B. Michael, R. Kohno, Ultra Wideband Signals and Systems in Communication Engineering, John Wiley & Sons, Ltd, 2007.		
3	Albert Lozano-Nieto, RFID Design Fundamentals and Applications, CRC Press, 2018.		
4	Mehmet R. Yuce, Jamil Khan, Wireless Body Area Networks: Technology, Implementation, and Applications, CRC Press, 2012.		
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	0	0

Teaching methods	Lectures, computational exercises, laboratory work, consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	
Exercises	30	**Oral exam**	50
Colloquia			
Projects	15		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Control Systems		
Lecturer (for lectures)	Veselić R. Boban		
Lecturer/associate (for exercises)	Đorđević D. Anđela		
Lecturer/associate (for OFE)	Đorđević D. Anđela		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to the basic idea of automatic control, components of control systems, systems modeling, as well as control systems analysis and design.		
Course outcomes	Systematic approach to modeling of automatic control systems. Structural block diagram algebra. Characteristic transfer functions derivations. System analysis in time, frequency and complex domain. Controller design and tuning. Practical implementations of automatic control systems in industry.		
Course outline			
Theoretical teaching	Overview of the automatic control systems (ACSs) development. ACSs classification. Modeling of linear analog and digital ACSs. ACS structure. Structural block diagrams of control systems. Linear systems analysis in time, frequency and complex domain. System stability. Stability analysis methods in frequency and complex domains. System performance rating and design criteria. Continuous-time ACSs synthesis. Digital control systems analysis. Discrete-time transfer functions. Digital control systems stability. Digital control systems design. Computer simulation of ACSs. Industrial controllers. PID controller design.		
Practical teaching (exercises, OFE, study and research work)	The Laplace transformation, definition, properties and applications. Signal flow graph and Mason's rule in structural block diagram analysis. Electromechanical analogies and electrical circuits transfer functions derivation. State space approach. State space models determination of electrical networks. State space model transformation into transfer function. Direct, series and parallel programming. Time and frequency responses. Stability of linear systems. Routh stability method. Nyquist stability criterion. Root locus. Compensator design using root locus method. z-transformation and inverse z-transformation. Discrete-time transfer functions of digital systems. Stability of digital control systems. Jury's stability test and bilinear transformation.		
Textbooks/references			
1	B.C. Kuo, Automatic Control Systems, Prentice-Hall, 1975.		
2	R.C. Dorf , R.H. Bishop, Modern Control Systems, Prentice-Hall, 2010.		
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	0	0

Teaching methods	Lectures; Auditory and computer exercises; 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	40		
Projects	0		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Information Theory and Applications		
Lecturer (for lectures)	Đorđević T. Goran		
Lecturer/associate (for exercises)	Đorđević T. Goran		
Lecturer/associate (for OFE)	Đorđević T. Goran		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Acquisition of fundamental knowledge in Information Theory and its applications in data compression, error-control coding, and cryptography, as well as developing students' ability to analyze and design information transmission and storage systems.
Course outcomes	After passing the exam, students will: 1) be able to estimate the capacities of certain telecommunication channels; 2) be capable of developing their own programs for source code analysis, such as Huffman and Ziv-Lempel algorithms; 3) be able to implement coding and decoding algorithms of convolutional and cyclic codes; 4)understand the principles of iterative decoding; 5) know the basic encryption methods.
Course outline	
Theoretical teaching	Overview of information transmission and storage systems. Discrete and continuous information sources. Source entropy. Basics of compression. Compression algorithms – Shannon-Fano procedure, Huffman code, Lempel-Ziv code. Information transmission channels. Mutual information. Channel capacity. Arimoto-Blahut algorithm. Error-control coding. Linear block codes. Cyclic codes. Cyclic Redundancy Check (CRC). Convolutional codes. Viterbi algorithm for convolutional code decoding. Software implementation of block and convolutional coding and decoding. Code gain estimation using Monte Carlo simulations. Principles of iterative decoding. Information storage on hard disks and flash memory. Data centers. Introduction to cryptology. Examples of interdisciplinary applications of Information Theory.
Practical teaching (exercises, OFE, study and research work)	Problem-solving sessions and laboratory exercises will be organized for all methodological units covered in the lectures. During problem-solving sessions, students solve numerical problems and practical tasks that are closely aligned with the theoretical course content. Laboratory exercises are conducted in both the laboratory and the computer classroom. Students are trained for laboratory work through teamwork using the EMONA telecommunications training platform. In the computer laboratory, students are trained to use MATLAB to illustrate the topics covered in lectures. Laboratory exercises are organized in the areas of data compression, error-control coding, and the application of decoding algorithms. Furthermore, during laboratory sessions, students acquire the skills necessary to simulate telecommunication systems employing data compression and error-control coding, as well as to numerically calculate channel capacity.
Textbooks/references	
1	P. Ivanis, D. Drajic, Information Theory and Coding - Solved Problems, Springer, 2017.
2	T. M. Cover, J. A. Thomas, Elements of Information Theory, 2nd edition, John Wiley & Sons, Inc., New Jersey, 2006.
3	S. Lin, J. Li, Fundamentals of Classical and Modern Error-Correcting Codes, 1st Edition, Cambridge University Press, 2022.
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	0	0

Teaching methods	Lectures. Exercises. Laboratory exercises. Consultations. Preparation and presentation of seminar papers.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	Written exam	10

Exercises	10	**Oral exam**	20
Colloquia	30		
Projects	20		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Optical Communications	
Lecturer (for lectures)			Milić N. Dejan, Milović M. Daniela	
Lecturer/associate (for exercises)			Anastasov A. Jelena	
Lecturer/associate (for OFE)			Milović M. Daniela	
Number of ECTS	5	**Course status (obligatory/elective)**		Obligatory / Elective
Prerequisites	None			
Course objectives	Discussing optical communication system details, and the priciples of typical systems that use optical data transfer techniques.			
Course outcomes	Acquired knowledge can be used for finding and practical implementation of engineering solutions in optical telecommunications. Students will be able to analyze perfromance of analogue and digital optical systems, asses the link reach and bandwidth, i.e. maximal bitrate, as well as to make a power budget in an optical link.			
Course outline				
Theoretical teaching	History of optical communications. Geometrical and wave optics, Types and characteristics of optical fibers, waveguiding, modes. Coupling with light sources and detectors. Attenuation and disperssion, fiber bandwidth. Fabrication of optical fibers. Devices and measurement techniques. Generating and modulation of optical carrier. Signal detection. Optical amplifiers. Link noise, quantum limit, and performance. Criteria of power and bandwidth. Coherent receivers and superquantum limit.			
Practical teaching (exercises, OFE, study and research work)	Auditory excersises that include detailed solutions of practical problems, including the problems required for coloquia and final exam. Laboratory excersises within the following topics: Geometrical and wave optics. Electrooptical characteristics of LED's and lasers. Coupling efficiency, fiber missalignment and bending losses. Photodiodes and types of preamplifiers. Electrical/optical bandwidth and eye diagram. Analogue link with pulse modulations in wireless optical environment. Bit-error rate in a digital optical link.			
Textbooks/references				
1	G. Agrawal, Fiber Optic Communications Systems, John Willey & Sons, 2002			
2	J. M. Senior, Optical Fiber Communications, Principles and Practice, Prentice Hall, 1992			
3				
4				
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	1	1	0	0

Teaching methods	Theoretical lectures, auditory and laboratory excercises, homework, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	30
Exercises	15	**Oral exam**	20
Colloquia	30		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Laboratory Paracticum	
Lecturer (for lectures)			Milović M. Daniela, Milić N. Dejan, Đorđević T. Goran	
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)			Panajotović S. Aleksandra, Anastasov A. Jelena, Eferica M. Predrag	
Number of ECTS	4	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Acquiring knowledge and skills for work in the laboratory in the field of telecommunications. Training for team engineering work. Training for writing seminar work and oral presentation of measurement results.			
Course outcomes	Students will be able to independently perform measurements in laboratory conditions. They will learn to use measuring devices and will be familiar with modern measuring systems in the field of information and communication technologies. They will be able to prepare seminar work well and orally present the results of that work.			
Course outline				
Theoretical teaching	Application of measuring instruments and devices in the Laboratory for Telecommunication Systems. Oscilloscope, power source, signal generator, network analyzer and spectrum analyzer. Connecting devices and instruments. Device protection from static charge and external influences. Probes, attenuators, DC component removal, power supply blocks and networks. Counters and frequency meters. A/D and D/A converters. EVM measurement (Error Vector Magnitude). Pseudorandom bit string generators. Analysis of eye diagram, jitter and error probability. Acquisition, processing and visualization of laboratory results. Presentation of results. Writing Lab Reports. Basics of literature referencing. Characteristics of student works. Elements of student seminar report. Poster and oral presentation of student projects. Ethics in engineering and scientific work.			
Practical teaching (exercises, OFE, study and research work)	Practical classes include independent work of students (under the supervision of professors and assistants) in the Telecommunications Systems Laboratory on connecting, configuring and using measuring instruments and devices. Students carry out measurements of telecommunication signal and system parameters, analyze the obtained results, perform their acquisition, processing and visualization using appropriate software tools, as well as prepare laboratory reports, seminar papers, posters and oral presentations.			
Textbooks/references				
1	Z. Popovic, E. F. Kuester, Principles of RF and Microwave Measurements, University of colorado Boulder, Colorado, 2001.			
2	K. Feher, Telecommunications Measurements, Analysis, and Instrumentation, Noble Publishing Corporation, Atlanta, 1997.			
3				
4				
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
1	0	2	0	0

Teaching methods	Lectures, laboratory exercises, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	10	**Oral exam**	20
Colloquia			
Projects	40		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Computer Communications and Internet Technologies		
Lecturer (for lectures)		Stanković Ž. Zoran, Dončov S. Nebojša		
Lecturer/associate (for exercises)		Milijić R. Marija		
Lecturer/associate (for OFE)		Milijić R. Marija		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	The acquisition of theoretical and practical knowledge related to the use of computers in the realization of modern communication services as well as theoretical and practical knowledge of Internet access techniques.			
Course outcomes	Students acquire the ability to apply current methods and techniques for establishing reliable communication and data transfer at various levels of the OSI communication model, as well as the ability to use and analyze practical implementations of communication protocols, services, and network architectures used for Internet access.			
Course outline				
Theoretical teaching	The computer as a communication device. OSI and TCP/IP communication models. Physical layer of data transfer in computer communications. Modem communications and broadband Internet access. Data link layer. PPP Internet Protocol. Communications systems based on the IEEE 802.3 standard. Network layer and IP communications. IPv4 and IPv6. Static and dynamic routing protocols. IP communication infrastructure for Internet access. Transport layer. UDP and TCP protocols. Application layer in telecommunications for Internet access. Modern telecommunications services and Internet.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises: Solving practical problems related to data transfer between communication devices at different levels of the OSI communication model in the Internet environment. Laboratory exercises: Working with simulators of the network communication environment. Practical work with basic network devices for Internet access.			
Textbooks/references				
1	V. Stallins, Data & Computer Communications, 10th edition, Pearson Education Limited, 2013.			
2	D. Comer, Internetworking with TCP/IP, 6th Edition, Pearson, 2013.			
3	A. Tanenbaum, D. Wetherall, Computer Networks, 5th edition, Pearson, 2010.			
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	0	0

Teaching methods	Lectures, auditory exercises, practical laboratory work, homework, 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	40		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Cable and Fiber-optic Communication Systems		
Lecturer (for lectures)		Marinković D. Zlatica, Dončov S. Nebojša		
Lecturer/associate (for exercises)		Stošić P. Biljana, Mladenović M. Ksenija		
Lecturer/associate (for OFE)		Mladenović M. Ksenija		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	The aim of the course is to acquire fundamental knowledge about the structure, elements, and principles of operation of cable and optical communication systems, as well as about the operating principles of basic optoelectronic components and their application in modern communication systems.			
Course outcomes	pon successful completion of the course, the student has knowledge of the structure of cable and optical communication systems and basic optoelectronic components, understands their operating principles, analyzes and compares different types of communication systems, and evaluates their advantages and disadvantages depending on the application.			
Course outline				
Theoretical teaching	History of cable and fiber-optic communication systems' development. Telecommunication cables with metal conductors. Optical Cables. Break detection on optical fibers. Structure of fiber optical communication systems. Optical links. Optical networks. Hybrid fiber-coaxial systems. Structured cabling. Telecommunication and signaling installations. Basic principles of design of cable and fiber-optic systems.			
Practical teaching (exercises, OFE, study and research work)	Exercises:Examples of calculations related to propagation in optical fibers. Examples of calculations for passive and active optoelectronic components. Examples of calculations in cable and fiber-optic communication systems. Laboratory work: Typical measurements in cable and fiber-optic communication systems. Software packages for design and analysis of cable and fiber-optic communication systems			
Textbooks/references				
1	D. Large, J. Farmer, Broadband Cable Access Networks: The HFC Plant, Morgan Kaufmann, 2008.			
2	J. M. Senior, Optical Fiber Communications, Priciples and Practice, Prentice Hall, 2009			
3	A.B. Semenov, S.K. Strizhakov, I.R. Suncheley, Structured Cable Systems, Springer, 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	1	0	0

Teaching methods	Lectures; Exercises; Laboratory 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	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Creative Laboratory		
Lecturer (for lectures)	Maleš-Ilić P. Nataša, Milić N. Dejan		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)	Atanasković S. Aleksandar, Eferica M. Predrag		
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Training students for practical work on solving project tasks starting from specification of problem, development of ideas, planning of realization process, team work, work with laboratory equipment and specialized software.		
Course outcomes	Ability of students to design and / or access the project task and devise a methodology of work. Ability to organize and implement the project through planned procedures and phases. Training for working with laboratory equipment and specialized software. Getting communication skills for group and team work. Acquiring the skill of presenting the results achieved and the possibility of critical analysis.		
Course outline			
Theoretical teaching	Introduction to laboratory work and protective measures for laboratory work. Development of the project idea. Access to the problem - creating a project task and methodology. Project development through all its phases-from the idea to the realization. Organization of work on the project. Working in groups. Communication between groups and work in the team. Final presentation. Critical analysis of the results achieved.		
Practical teaching (exercises, OFE, study and research work)	Practical work on project tasks in the laboratory. Visit to ICT companies for realization of specific measurements in real environment.		
Textbooks/references			
1	Z. Popovic, E. F. Kuester, Principles of RF and Microwave Measurements, University of Colorado Boulder, Colorado, 2001		
2	K. Feher, Telecommunications Measurements, Analysis, and Instrumentation, Noble Publsihisng Corporation, Atlanta, 1997.		
3	User manuals for software packages. Introduction to work in Laboratory.		
4			
5			

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

Lectures	Exercises	OFE	Study and research work	Other classes
1	0	2	0	0

Teaching methods	Practical work in teams. Presentation of project results and discussion.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Academic Writing and Presentation of Results		
Lecturer (for lectures)	Đorđević T. Goran		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)	Đorđević T. Goran		
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Learning the basics of academic writing and mastering techniques of effective presentation.		
Course outcomes	Students will be trained to write a paper for a student conference, as well as to learn how to prepare an oral and poster presentation of their work. Additionally, students will learn how to prepare a CV and effectively present their knowledge and skills when applying for a job.		
Course outline			
Theoretical teaching	Preparation and delivery of a high-quality presentation. Methods of presenting academic work (presenting at seminars, conference papers, scientific articles). Gathering materials for research. Structure of a scientific paper for a student conference. Referencing sources. Quoting and paraphrasing. Formatting the bibliography. Submitting a paper for peer review and revising it based on reviewers' comments. Using artificial intelligence tools for preparing presentations, formulating text, searching for sources, translating into English, etc. Ethics in scientific research. Body language and interaction with the audience during oral presentations. Preparing a CV. Presenting one's knowledge and skills as a basis for a job interview.		
Practical teaching (exercises, OFE, study and research work)	During the seminar, students will apply the knowledge acquired in the lectures. They will prepare a paper for a student conference and deliver a presentation of that paper. Additionally, during the seminar, students will prepare their CV and present the knowledge and skills they have gained during their studies.		
Textbooks/references			
1	S. Bailey, Academic Writing, 5th Edition, Routledge, NY, USA, 2018.		
2	G. Reynolds, Presentation Zen: Simple Ideas on Presentation Design and Delivery, 3rd Edition, New Riders, 2019.		
3	C. Anderson, Ted Talks: The Official TED Guide to Public Speaking, Mariner Books, Boston, 2016.		
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	1	0	0

Teaching methods	Lectures. Individual consultations. Seminar (students will prepare a sample project and give a presentation of their work).

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	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Sensor Networks		
Lecturer (for lectures)	Milošević D. Nenad		
Lecturer/associate (for exercises)	Anastasov A. Jelena		
Lecturer/associate (for OFE)	Eferica M. Predrag		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	None
Course objectives	Enabling students to design, implement, and analyze the performance of wireless sensor networks. Developing engineering competencies necessary for selecting an adequate network architecture, optimizing energy consumption, and applying appropriate communication protocols in various practical scenarios, such as industrial automation, smart homes, and systems for general data acquisition.
Course outcomes	Upon successful completion of the course, the student is qualified to independently design a sensor node architecture and select the appropriate network topology depending on specific application requirements. The student possesses professional skills to practically configure and evaluate MAC and data link layer protocols, while actively resolving the tradeoffs between energy consumption, latency, and throughput. The student is capable of implementing techniques for dynamic network addressing and analyzing the efficiency of various mechanisms for error detection and data security. Additionally, the student is able to apply appropriate protocols for node time synchronization and implement quality of service (QoS) control mechanisms in continuous monitoring systems.
Course outline	
Theoretical teaching	Basic concepts of wireless sensor networks and their application in modern telecommunication systems. Hardware and software architecture of a sensor node. Network topologies and architecture: structure, organization, and key differences between distributed and centralized systems. Engineering principles of network design: methods for balancing energy consumption, transmission latency, and throughput. MAC protocols in sensor networks: medium access control mechanisms and comparative analysis of TDMA, CSMA, and FDMA techniques. Data link layer protocols: mechanisms for error detection and correction, as well as the fundamentals of wireless communication security. Naming and addressing in dynamic network environments. Time synchronization issues: the impact of latency in monitoring systems and analysis of the limitations and advantages of synchronization protocols (RBS, TPSN, FTSP). Transport layer: techniques for data flow management and ensuring quality of service (QoS).
Practical teaching (exercises, OFE, study and research work)	Computational exercises include mathematical modeling and calculation of the sensor node's energy budget, as well as estimating battery life depending on the network's operating mode. Solving engineering problems related to network latency calculation and throughput analysis of various MAC protocols. Laboratory exercises are carried out in a computer lab and on hardware platforms, including: working with software network simulators to create, test, and analyze sensor network topologies; practical configuration of microcontrollers on sensor nodes for data acquisition and wireless transmission; practical simulation of dynamic addressing mechanisms; experimental testing of transmission error detection algorithms; as well as software implementation and monitoring of node time synchronization protocols in real time.
Textbooks/references	
1	H. Karl, A. Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley, 2005.
2	S. Phoha, T. La Porta, C. Griffin, Sensor Network Operations, Wiley-IEEE Press, 2006.
3	I. Akyildiz,M. Can Vuran, Wireless sensor networks. John Wiley & Sons, 2010.
4	K. Yang, Wireless sensor networks: Principles, Design and Applications. Springer, 2014.
5	H.M.A. Fahmy, Wireless Sensor Networks: Concepts, Applications, Experimentation and Analysis, Springer, 2016.

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	1	1	0	0

Teaching methods	Teaching is carried out through interactive theoretical lectures during which sensor network concepts are explained through the analysis of real-world case studies from industry and practice. Classroom auditory exercises are based on the independent solving of numerical and design problems related to network performance and energy efficiency. Practical teaching takes place in the laboratory, where students acquire direct engineering skills through individual and team work on hardware sensor modules and in software simulators. Knowledge assessment is conducted continuously through colloquiums and the final exam, while additional professional support for students in completing laboratory assignments is provided through regular consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	10	**Oral exam**	20
Colloquia	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			VoIP	
Lecturer (for lectures)			Milić N. Dejan, Panajotović S. Aleksandra	
Lecturer/associate (for exercises)			Anastasov A. Jelena	
Lecturer/associate (for OFE)			Anastasov A. Jelena	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Acquiring fundamental knowledge about the technologies that enable VoIP, as well as knowledge about possible implementation of specific systems.			
Course outcomes	Students will be able to use the acquired knowledge to find and practically apply solutions to engineering problems in the field of voice signal transmission over the Internet			
Course outline				
Theoretical teaching	VoIP concept and its importance in modern networks. Techniques and algorithms for voice transmission. Waveform coders, vocoders and hybrid coders. Compression and coding standards for of voice signals: G.711, G.721, G.726, G.729 and G.723.1. Compression based on speech analysis and synthesis. RTP and other real-time transport protocols. The concept of quality of services. The components of VoIP system. Call processing and CPL. VoIP implementation using TCP/IP. Call center services.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises cover the following areas: standards for signal coding and compression, real-time transport protocols, QoS, and voice packet transmission over the network. Laboratory work will be orginized according to number of students and their affinities.			
Textbooks/references				
1	A. Raake, Speech Quality of VoIP: Assessment and Prediction, John Wiley & Sons, 2006.			
2	P. K. Verma, Voice over IP Networks: Quality of Service, Pricing and Security, Springer, 2011.			
3	R. Swale, D. Collind, Carrier-Grade VoIP, third edition, McGRaw-Hill Education, 2014.			
4	E. C. Coll, Fundamentals of Voice over IP, Teracom Training Institute, 2023			
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	0	0

Teaching methods	Lectures, auditory and laboratory exercises, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	30
Exercises	15	**Oral exam**	20
Colloquia	30		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Computer Systems for Data Acquisition		
Lecturer (for lectures)		Dinčić R. Milan, Denić B. Dragan		
Lecturer/associate (for exercises)		Miljković S. Goran		
Lecturer/associate (for OFE)		Jocić V. Aleksandar		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Introducing students to data acquisition techniques, including connecting sensors to acquisition modules and computers, as well as implementing computer-based acquisition systems.			
Course outcomes	Students will acquire comprehensive knowledge about different types and operating principles of sensors, techniques for measurement data acquisition and signal conditioning, methods for interfacing sensors with acquisition cards and computers, as well as software development for implementing computer-based measurement and data acquisition systems.			
Course outline				
Theoretical teaching	General structure of computer-based measurement and acquisition systems. Principles of operation, importance, and applications of sensors. Electronic circuits for sensor interfaces. Techniques for data acquisition. Acquisition cards. Connecting acquisition cards and measuring instruments to a computer. Programming computer software for data acquisition. The concept of virtual instrumentation. Hardware-software implementation of measurement and acquisition systems.			
Practical teaching (exercises, OFE, study and research work)	Tutorials, problem-solving exercises, laboratory exercises, seminar papers, and project assignments focused on the practical implementation of measurement and data acquisition systems. Developing software for computer-based measurement and acquisition systems, as well as programming hardware platforms for data acquisition.			
Textbooks/references				
1	Behzad Ehsani, "Data Acquisition using LabVIEW", Packt Publishing, 2017.			
2	Maurizio Di Paolo Emilio, "Data Acquisition Systems: From Fundamentals to Applied Design", Springer-Verlag, 2013.			
3	John Park, Steve Mackay, Edwin Wright, "Practical data acquisition for instrumentation and control systems", Newnes, 2007.			
4	National Instruments, "Data Acquisition and Signal Conditioning Course Manual", 2012.			
5	Robert Bishop, "Learning With LabVIEW", Pearson, 2015.			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures, problem-solving exercises, computer and laboratory exercises, preparation of seminar papers and project assignments, consultations.

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	25		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Optical networks		
Lecturer (for lectures)	Milović M. Daniela		
Lecturer/associate (for exercises)	Panajotović S. Aleksandra		
Lecturer/associate (for OFE)	Panajotović S. Aleksandra		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Acquiring knowledge of optical networks from the physical level to the network functions. Students will be able to analyze optical networks from the aspect of optical network components, the evolution of optical network, reliability, control, network management and optimization.		
Course outcomes	Identifying the advantages and limitations of optical transmission, discerning of protection and renewal procedures in the optical network. Distinguishing the possibility of realization of optical network in the core, metro and access network. Introduction to the basic principles of optical networks with wavelength multiplexing and optical components.		
Course outline			
Theoretical teaching	Introduction to optical networks - topology, protection capacity, routing and wavelength assignment. Optical fiber and transmission effects, optical network components, high-speed optical networks and constraints. Optical network with wavelength multiplexing (WDM). Fiber network node structure. Optical switching and optical ADM. Optical core and access network. Routing and wavelength allocation. Optical networks with channel, packet and beam switching. Optical Time Multiplexing (OTDM). Optical network management, protection and regeneration. Design and optimization of optical network.		
Practical teaching (exercises, OFE, study and research work)	Analysis and modeling of optical communication networks, computational analysis of optical system parameters, analysis of the impact of optical fiber effects on transmission quality; WDM networks and algorithms for routing and wavelength allocation; Design, optimization, protection and restoration of optical networks using software tools (Net2Plan and MATLAB).		
Textbooks/references			
1	G. P. Agrawal, Fiber-Optic Communication Systems, Wiley-Interscience, 2010.		
2	B. Chomycz, Planning Fiber Optic Networks, McGraw-Hill, 2009.		
3	F. Cavaliere, L. Poti, New Trends in Optical Networks, MDPI, 2023.		
4	B. Mukherjee, I. Tomkos, M. Tomatore, P. Winzer, Y. Zhao, Handbook of Optical Networks, Springer, 2020.		
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, homeworks, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Radar Technology and Radiolocation	
Lecturer (for lectures)			Milić N. Dejan	
Lecturer/associate (for exercises)			Anastasov A. Jelena	
Lecturer/associate (for OFE)			Anastasov A. Jelena	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Mastering the basic knowledge necessary to determine the performance of digital modulation techniques.			
Course outcomes	Students will be able to understand, classify and analyze radar systems, and come with signal processing solutions related to the specified applications			
Course outline				
Theoretical teaching	Radar range, signal-to-noise ratio, radar cross-section, ambiguities of range and velocity, background signals, detection and architecture of the receivers, transmitters, and antenna systems. Design of signals and pulse compression. Optimal filtering for radar signal in white and colored Gaussian noise. Likelihood ratio. Detection of radar signals based on multiple observations. Radar signal parameter estimation. Variable amplitude, phase, and frequency of radar signals. Influence of Doppler effect. Decision criteria. Radar signal random signal analysis. Applications of pulse, continuous, FM, Doppler radars, and synthetic aperture radars. Sonar and Lidar.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises that deal with the types of problems required for colloquia and final examination. Laboratory work will be organized according to the number of students and their affinities.			
Textbooks/references				
1	Merrill I. Skolnik, Introduction to Radar Systems, McGraw-Hill, 2003			
2	Mark A. Richards, Fundamentals of Radar Signal Processing, McGraw-Hill, New York, 2005			
3	François Le Chevalier, Principles of Radar and Sonar Signal Processing, Artech House, 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	0	0

Teaching methods	Theory classes, auditory and laboratory exercises, homework, consulatations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	Written exam	30
Exercises	15	Oral exam	20
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Audio and Video Systems		
Lecturer (for lectures)	Ćirić G. Dejan, Joković J. Jugoslav		
Lecturer/associate (for exercises)	Ćirić G. Dejan		
Lecturer/associate (for OFE)	Ćirić G. Dejan, Perić S. Nemanja		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Gaining theoretical and practical knowledge in the field of audio and video systems.This knowledge includes insights into audio and video signals/systems, aquisition, processing, storing, visualization and interpretation of audio and video information, as well as the application of audio and video in communication systems, multimedia, industry and medicine.		
Course outcomes	Knowledge of the operating principles of modern audio and video systems, analysis of their functional characteristics, and interpretation of their application possibilities in various fields. Skills in the use of audio and video devices and relevant software tools, application of configuration and integration procedures for audio-video systems, and implementation of basic functional interconnections. Competencies in selecting appropriate audio and video components for simple applications, evaluating the functionality of implemented systems, and proposing solutions in accordance with specified requirements.		
Course outline			
Theoretical teaching	Audio signals. Audio systems. Standards for sound recording and reproduction. Audio signal compression. Parallel and serial audio signal processing. Spatial dimensions of the sound image. Virtual spatial sound (recording, spatial processing, encoding and decoding, virtual reality systems). Applications of sound in industry and medicine. Video signals – basics of production, digital video, scalable video coding. Video compression standards (H.26X and MPEG). Error control in video communications. Synchronization concept. Digital interfaces, servers, storage systems. Sensors and displays of various resolutions. Virtual and augmented reality systems – VR, AR. Video monitoring. Examples of video systems.		
Practical teaching (exercises, OFE, study and research work)	Computational exercises: solving of problems in the fields of acquisition, digitalisation, processing, visulisation, storage and interpretation of audio and video signals. Practical teaching: usage of standard procedures and software tools for work with sound (Sound Forge, Adobe Audition, Audacity) and video (Adobe Premier, ATEM), usage of audio equipment for sound acquisition in diverse environments (e.g., industry), usage of audio and video information for virtual environment generation.		
Textbooks/references			
1	I. McLoughlin: Applied speech and audio processing with Matlab examples, Cambridge University Press, Cambridge, 2009.		
2	G. Ballou: Handbook for sound engineers, 4th edition, Elsevier, Focal Press, Burlington, 2008.		
3	M. Vorlander: Auralization - Fundamentals of acoustics, modelling, simulation, algorithms and acoustic virtual reality, Springer, Berlin, 2008.		
4	Y. Wang, J. Ostermann, Y-Q Zhang: Digital video processing and communications, Prentice Hall, 2002.		
5	K. Paulsen: Moving media storage technologies - Applications & workflows for video and media, Focal Press, 2011.		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	2	0	0

Teaching methods	Lectures; Computational exercises; Lab sessions; Studio exercises; Consultations.

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			
Projects	25		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Satellite Telecommunications		
Lecturer (for lectures)	Đorđević T. Goran		
Lecturer/associate (for exercises)	Panajotović S. Aleksandra		
Lecturer/associate (for OFE)	Panajotović S. Aleksandra		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Acquisition of knowledge in satellite telecommunications in the area of modulation formats and error-correcting codes. Gaining the necessary knowledge for interference calculation and becoming familiar with commercial applications of these systems.		
Course outcomes	Within this course, students will: 1) become familiar with the basic components of satellite telecommunication systems; 2) learn the modulation techniques and error-correcting codes used in these systems; 3) be able to perform calculations related to multiple access to the satellite; 4) be capable of assessing the impact of various types of interference in the satellite channel; 5) understand the applications of satellite telecommunication systems.		
Course outline			
Theoretical teaching	Historical development of satellite telecommunications. Applications of satellite systems. Frequency bands. Orbits. Satellite link budget. Propagation effects. Satellite and ground station equipment. Antenna characteristics for satellite systems. Link design for a given average signal-to-noise ratio. Modulation techniques in satellite systems. Error-correcting codes in satellite systems. Multiple access to the satellite: frequency, time, and code division multiplexing. Satellite mobile systems. VSAT (Very Small Aperture Terminal) systems. Transmission of radio and television signals via satellite. DVB-S2 and H.264 standards. Internet access via satellite. Navigation systems: basic principles of positioning using satellite signals; satellite navigation systems: GPS, GLONASS, BeiDou-COMPASS, Galileo; use of GPS for vehicle positioning; traffic density modeling and travel time estimation.		
Practical teaching (exercises, OFE, study and research work)	Tutorial classes and laboratory exercises will be organized for all topics covered in the lectures. During tutorial sessions, students solve problems and practical tasks that are closely aligned with the theoretical course content. Laboratory exercises are conducted both in the laboratory and in the computer classroom. In the laboratory, students become familiar with satellite transmitting and receiving antennas, their positioning, and the associated supporting equipment. In the computer classroom, students are trained to use MATLAB for link budget calculations, mobile satellite channel modeling, and the evaluation of signal transmission quality between a ground station and a satellite.		
Textbooks/references			
1	T. Pratt, J. E. Allnutt, Satellite Communications, 3rd Edition, Willey, NJ, USA, 2020.		
2	ITU Handbook on Satellite Communications, 3rd edition, ITU, Geneva, Switzerland, 2002.		
3	L. Castanet (Ed.), Influence of the Variability of the Propagation Channel on Mobile, Fixed Multimedia and Optical Satellite Communications, Shaker Verlag GmbH, Germany, 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	1	0	0

Teaching methods	Lectures. Problem-solving sessions. Laboratory work. Individual consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	Written exam	20
Exercises	5	Oral exam	30
Colloquia	30		
Projects	10		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Measurements in Telecommunications		
Lecturer (for lectures)	Dončov S. Nebojša		
Lecturer/associate (for exercises)	Atanasković S. Aleksandar		
Lecturer/associate (for OFE)	Atanasković S. Aleksandar, Eferica M. Predrag		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	The course aims to develop students' understanding of the operating principles, architecture and application of basic measuring instruments used in telecommunications. Development of the ability to select appropriate measurement methods, properly configure measuring equipment, perform measurements, process and interpret results, as well as to apply software tools for data acquisition and automation of measurement procedures.		
Course outcomes	Upon successful completion of the course, the student is able to select and properly use basic measuring instruments and measurement methods in telecommunications, perform measurements in the time, spectral, RF/microwave, optical and digital domains, as well as process, present and interpret the obtained results. The student is able to assess the performance of communication systems based on measurement results, identify the limitations of the applied measurement method and prepare a technical report on the performed measurement.		
Course outline			
Theoretical teaching	Specific aspects of measurements in communication systems and required measurement instrumentations for measurement (spectrum analyzers, frequency counters, power meters and appropriate power sensors, time domain reflectometers and optical reflectometers, network analyzers, BERTS measuring instruments, protocol analyzers, etc.) Measurement methods in time and spectral domain. Measuring frequency of RF and microwave signals. Time domain reflectometry. Optical reflectometry. Microwave scalar and vector measurements. Measurements in optical communication systems. Specific measurements on optical fibers. Measurements in digital communication systems. Automation of measurement. Software tools for data acquisition and automation of the measurement procedure. Virtual instrumentations. Algorithms and techniques for control of measurement equipment and receiving and processing of different types of communication signals.		
Practical teaching (exercises, OFE, study and research work)	Problem-solving auditory exercises related to measurement units, decibel calculations, signal levels, measurement errors and processing of results. Laboratory exercises including the setup and use of basic measuring equipment, measurement of signal frequency, power and spectrum, work with a spectrum analyser, measurement of RF/microwave circuit parameters using a network analyser, application of time-domain reflectometry, basic measurements on optical fibres, measurements in digital communication systems and processing of measurement results. Practical work with software tools for data acquisition, measurement automation and preparation of laboratory reports.		
Textbooks/references			
1	R. A.Witte, Spectrum and Network Measurements, 2nd edition, SciTech Publishing, 2014.		
2	C. Rauscher, Fundamentals of Spectrum Analysis, 5th edition, Rohde & Schwarz, 2007.		
3	R. Collier, D. Skinner, Microwave measurements, 3rd edition, IET, 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	0	0

Teaching methods	Lectures, problem-solving auditory exercises, laboratory exercises, demonstration of measuring equipment operation, independent practical work of students, processing of measurement results, preparation of laboratory reports and consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	Written exam	20
Exercises	40	Oral exam	20
Colloquia	15		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Smart Systems and IoT	
Lecturer (for lectures)			Maleš-Ilić P. Nataša, Pronić-Rančić R. Olivera	
Lecturer/associate (for exercises)			Dimitrijević Ž. Tijana	
Lecturer/associate (for OFE)			Atanasković S. Aleksandar, Perić S. Nemanja	
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	None			
Course objectives	Getting acuainted with concepts of smart systems and Internet of Things (IoT). Getting the necessary knowledge about function and design of smart systems.			
Course outcomes	The students will be able to: Define and explain the fundamental concepts and architecture of the "Internet of Things" (IoT) and smart systems, Select and integrate appropriate sensors and actuators according to the requirements of specific applications within smart systems, Analyze and apply relevant communication protocols and techniques for connecting devices in IoT networks, Implement a simpler practical smart system project.			
Course outline				
Theoretical teaching	Basic concept of smart systems. Internet of Things (IoT). Sensors and actuators in smart systems. Communication techniques for smart systems. Data processing for IoT. Security in IoT systems. Device power supply and renewable energy sources. Platforms for IoT systems. Examples of smart systems (smart home, smart cities, smart systems in traffic, IoT in medicine, etc.) Development perspectives and social aspects of IoT applications. Practical training: Communication with sensors and data acquisition. Connecting devices to the Internet. Data processing. Project (group work): Designing simpler examples of smart systems.			
Practical teaching (exercises, OFE, study and research work)	Solving selected problems in computational exercises. Practical work in the laboratory. Work on the project. Lecture by experts from companies and a study visit to one of the companies to learn about how to implement smart systems.			
Textbooks/references				
1	D. Serpanos, M. Wolf, Internet-of-Things (IoT) Systems: Architectures, Algorithms, Methodologies, Springer 2018			
2	Neera Batra, Sonali Goyal: IoT Fundamentals with a Practical Approach, Springer, 2025			
3	M. A. Iqbal, S. Hussain, H. Xing, M. A. Imran, Enabling the Internet of Things: Fundamentals, Design and Applications, Wiley, 2021			
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	0	0

Teaching methods	Lectures, classroom exercises, practical work in the laboratory, team project, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	
Exercises	30	**Oral exam**	50
Colloquia			
Projects	15		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Computer Networks and Internet Access		
Lecturer (for lectures)	Stanković Ž. Zoran, Dončov S. Nebojša		
Lecturer/associate (for exercises)	Milijić R. Marija		
Lecturer/associate (for OFE)	Milijić R. Marija		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Acquiring theoretical and practical knowledge related to the usage of computers and network equipment for the realization of advanced communication and network architectures for Internet access.
Course outcomes	Students acquire the ability to apply current methods and techniques for connecting and properly configuring network equipment in order to establish advanced TCP/IP network architectures for Internet access, to use modern switches and routers with dynamic routing protocols in the implementation of heterogeneous Internet access networks based on IEEE 802.3/802.11/802.15 standards, and to administer heterogeneous Internet access networks.
Course outline	
Theoretical teaching	Internet access based on the IEEE 802.11 standard. Wi-Fi and service sets. Virtual Local Area Network (VLAN) architecture. Organization of VLAN communication ports and STP protocol. Static NAT, Dynamic NAT and PAT. Advanced concepts in routing. OSPG and EIGRP protocols. External BGP protocol and its implementation. Wide Area Network (WAN). Hardware implementation of point-point WAN. CC (Cloud Computing) communication infrastructure. SNMP protocol for managing Internet access networks. Basics of designing Internet access heterogeneous networks based on IEEE standards 802.3 / 802.11 / 802.15.
Practical teaching (exercises, OFE, study and research work)	Auditory exercises: Solving problems related to configuration of the network equipment and Internet access network architectures realization using standard simulators. Laboratory exercises: Practical work related to configuration of routers and switches in a complex heterogeneous network environment based on 802.3/802.11/802.15 standards.
Textbooks/references	
1	V. Stallins, Data & Computer Communications, 10th edition, Pearson Education Limited, 2013.
2	D. Comer, Internetworking with TCP/IP, 6th Edition, Pearson, 2013.
3	A. Tanenbaum, D. Wetherall, Computer Networks, 5th edition, Pearson, 2010.
4	W. Odom, CCENT/CCNA ICND1 Official Exam Certification Guide, 2nd edition, Cisco Press, 2007.
5	W. Odom, S. Hogg, CCNA Routing and Switching ICND2 Official Cert Guide, Cisco Press, 2017.

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures, auditory exercises, practical laboratory work, homework, consultations

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	25	**Oral exam**	20
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Developing Applications for Communication Systems		
Lecturer (for lectures)	Stanković Ž. Zoran, Dončov S. Nebojša		
Lecturer/associate (for exercises)	Milijić R. Marija		
Lecturer/associate (for OFE)	Milijić R. Marija		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquiring theoretical and practical knowledge related to the usage of the Python programming language for the development of applications for communication systems.		
Course outcomes	Students acquire knowledge and skills related to the use of the Python programming language and the basics of functional programming, as well as the ability to apply Python in the development of applications for controlling communication and measurement devices, and for modeling and analyzing the operation of communication system components.		
Course outline			
Theoretical teaching	Data and object organization, use of operators and control structures in the Python development environment. Function definition and module organization. Standard module libraries. Lambda operator and functional programming in the Python environment. Object-oriented approach to developing Python applications. Development of applications for controlling measurement devices in communication systems. Application of the Python environment for programming communication devices based on the Raspberry Pi platform. Application of the Python environment for developing applications for antenna modeling, electromagnetic wave propagation modeling, and modeling and analysis of wireless communication system operation.		
Practical teaching (exercises, OFE, study and research work)	Auditory exercises: Solving practical problems that demonstrate methods of data and object organization, use of operators, control structures, and functions in the Python development environment. Laboratory exercises: Hands-on work on a computer in the Python development environment and development of applications intended for specific use in communication systems.		
Textbooks/references			
1	W. Chun, Python: Core Python Applications Programming (Core Series), 1st Edition, Pearson P T R, 2012.		
2	S. Lott, Functional Python Programming, Packt Publishing Ltd, 2015.		
3	Sai Yamanoor, Srihari Yamanoor, Python Programming with Raspberry Pi, Packt Publishing Ltd, 2017		
4	W. Donat, Learn Raspberry Pi Programming with Python, Apress, 2014.		
5	Bert van Dam, Raspberry Pi: Explore the RPi in 45 Electronics Projects, Elektor Publishing, 2014		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures, auditory exercises, practical laboratory work, homework, consultations

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	35	**Oral exam**	20
Colloquia	20		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital Signal Processing		
Lecturer (for lectures)	Nikolić R. Jelena		
Lecturer/associate (for exercises)	Nikolić R. Jelena, Vučić J. Nikola		
Lecturer/associate (for OFE)	Vučić J. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Provide fundamental knowledge about digital signals in the time and frequency domains, as well as about systems for their processing. Enable students to analyze and design algorithms for digital signal processing.		
Course outcomes	Acquiring knowledge of fundamental algorithms for discrete-time signal processing and gaining practical experience in software implementation of these algorithms.		
Course outline			
Theoretical teaching	Advantages of digital signal processing compared to analog signal processing. Application areas of digital signal processing. Main characteristics of discrete signals. Classes of discrete-time signals ((Finite-Length Signals, Infinite-Length Signals). Basic operations on discrete signals. Discretization of analog signals. Practical aspects of discretization and reconstruction of analog signals. Properties of discrete systems. Linear Time-Invariant (LTI) systems. Finite Impulse Response (FIR) systems. Infinite Impulse Response (IIR) systems. Properties of the Z-transform. Inverse Z-transform and methods for calculating it. Discrete Fourier Transform (DFT). Discrete Fourier Series (DFS). Discrete-Time Fourier Transform (DTFT) and its properties. Inverse DTFT. Fast Fourier Transform (FFT). Zero-padding technique. Radix-2 FFT algorithm with decimation in time. Radix-2 FFT algorithm with decimation in frequency. Practical applications of FFT. Time-frequency analysis. Spectral analysis of deterministic discrete-time signals.		
Practical teaching (exercises, OFE, study and research work)	Auditory exercises: During auditory exercises, theoretical knowledge is reinforced through solving tasks, enabling students to understand the importance of applying algorithms for digital signal processing. Laboratory exercises: In laboratory exercises, students gain practical experience in the software implementation of algorithms for digital signal processing.		
Textbooks/references			
1	S. M. Alessio, Digital Signal Processing and Spectral Analysis for Scientists, Springer International Publishing, Cham, Switzerland, 2016.		
2	V. K. Ingle, J. G. Proakis, Digital Signal Processing Using MATLAB, Third Edition, CL Engineering, Stamford, CT 06902 USA, 2012.		
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	0	0

Teaching methods	Lectures, PowerPoint presentations, auditory exercises, practical computer lab sessions, homework assignments, consultations.

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	25		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Error Control Coding		
Lecturer (for lectures)	Jovanović Ž. Aleksandra		
Lecturer/associate (for exercises)	Jovanović Ž. Aleksandra, Vučić J. Nikola		
Lecturer/associate (for OFE)	Jovanović Ž. Aleksandra, Vučić J. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	To provide students with fundamental knowledge of error control coding, and to present modern principles of coding and decoding algorithms that enable the practical implementation of efficient error-correcting codes.		
Course outcomes	The student will acquire the theoretical and practical knowledge necessary for the application and design of error control codes in modern communication systems.		
Course outline			
Theoretical teaching	Introduction to error control coding and Shannon's channel coding theorem. Archetype of error control codes. Galois field, vector spaces, and polynomials over Galois fields. Linear block codes: Generator and parity-check matrices. Decoding of linear block codes based on the standard array. Syndrome-based decoding. Classical linear block codes: Hamming codes, Reed–Muller codes, Hadamard codes. Repetition codes. Simple parity-check codes. Techniques for constructing codes with long codewords. Algebra and cyclic codes: Systematic cyclic codes. Shortened cyclic codes. Quasi-cyclic codes. Low-Density Parity-Check (LDPC) codes: Matrix representation and independence condition. Tanner graph representation of LDPC codes. Gallager's method for LDPC code construction. Message passing concept. Turbo principle and iterative decoding. Bit-flipping algorithm for LDPC decoding. Convolutional codes: Generator polynomials and matrices, state diagram. Trellis representation of convolutional codes. Viterbi decoding algorithm. Fundamentals of turbo codes.		
Practical teaching (exercises, OFE, study and research work)	Tutorial exercises: Determining the impact of codeword length on code rate and undetected error probability. Formulation of ML and MAP decision rules in error control coding and their geometric interpretation. Application of Hamming codes for single-error detection. Investigation of the relationship between Hamming distance and the number of errors that can be detected and/or corrected. Identification of the key steps involved in determining error probability in BSC and BI-AWGN channels using Monte Carlo simulation. Performing arithmetic operations in vector spaces over Galois fields, and determining bases and dual spaces. Construction of generator and parity-check matrices of linear block codes. Determination of distance spectra. For given parity-check matrices and received codewords, decoding of linear block codes using standard arrays and syndrome decoding. Construction of the generator matrix of Reed–Muller codes and determination of orthogonal sums in the decoding process. Construction of product codes and interleaved codes based on multiple short codes. Establishing the relationship between algebraic and vector-space approaches to coding theory. Construction and analysis of cyclic codes using generator polynomials. Formation of systematic and shortened cyclic codes. Construction of Tanner graphs from parity-check matrices of LDPC codes and vice versa. Construction of generator matrices for Gallager codes. Application of the bit-flipping decoding algorithm for Gallager codes. Representation of convolutional codes using state diagrams and trellises. Decoding using the Viterbi algorithm. Parallel concatenation of constituent encoders and iterative decoding in turbo coding. Laboratory exercises: Software implementation of block and convolutional codes in MATLAB/Python environments. Monte Carlo simulation of transmission over BSC and AWGN channels. Performance analysis of error control codes based on BER and FER characteristics.		
Textbooks/references			
1	S. Lin, D. J. Costello, Error Control Coding: Fundamentals and Applications, McGraw-Hill, 2004.		
2	W. E. Ryan, S. Lin, Channel Codes - Classical and Modern, Cambridge University Press, 2009.		
3	T. Richardson, R. Urbanke, Modern Coding Theory, Cambridge University Press, Cambridge, 2008.		
4	T. K. Moon, Error Correction Coding: Mathematical Methods and Algorithms, Wiley, 2005.		

5				
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	1	1	0	0
Teaching methods	Lectures, auditory exercises, practical computer-based lessons, homework assignments, 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		40		
Projects				

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Antennas and Propagation	
Lecturer (for lectures)			Stanković Ž. Zoran, Dončov S. Nebojša	
Lecturer/associate (for exercises)			Dimitrijević Ž. Tijana	
Lecturer/associate (for OFE)			Mladenović M. Ksenija	
Number of ECTS		6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None			
Course objectives	The acquisition of theoretical and practical knowledge of radiation and reception of EM waves using antennas and EM waves propagation radiated by antennas.			
Course outcomes	Students acquire the ability to understand the EM nature and operating principles of antennas in transmitting and receiving modes, to analyze different types of antennas used in telecommunications, to apply antenna design and measurement procedures, and to explain the nature of EM wave propagation over the Earth's surface.			
Course outline				
Theoretical teaching	Basic theory of transmitting and receiving antennas. Hertzian dipole. Wire antennas. Horn antennas. Reflector antennas. Lens antennas. Printed antennas. Wideband and frequency-independent antennas. Antenna arrays. Software tools for antenna design and optimization. Measurement of antenna characteristics. Influence of antenna parameters and the environment on the trajectory of EM waves. Ground wave. Space wave. Propagation of EM waves in the ionosphere. Propagation models in specific regions.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises: Practical problem solving in the field of antennas analysis, antennas synthesis and EM wave propagation analysis. Laboratory exercises: Antenna measurements, practical work with software tools for the antenna design and software tools for the EM wave propagation analysis.			
Textbooks/references				
1	C. Balanis, Antenna theory: Analysis and Design, 4rd edition, Wiley, 2016.			
2	W. Stutzman, G. Thiele, Antenna Theory and Design, 3rd Edition, Wiley, 2012.			
3	J. Kraus, Antennas, Mc Graw Hill, 1988.			
4	J. S. Seybold, Introduction to RF Propagation, Wiley, 2005.			
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	0	0

Teaching methods	Lectures, auditory exercises, practical work in a laboratory, homeworks, 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	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Modeling and Simulation of Telecommunication Systems		
Lecturer (for lectures)	Đorđević T. Goran		
Lecturer/associate (for exercises)	Đorđević T. Goran		
Lecturer/associate (for OFE)	Đorđević T. Goran		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Acquisition of theoretical and practical knowledge necessary for modeling and simulation of telecommunication channels, transmitters, and receivers. Deepening of the knowledge gained in Telecommunications Theory.		
Course outcomes	Students will learn to generate and perform spectral analysis of random signals, and to model telecommunication channels, transmitters, and receivers. They will be able to simulate the transmission of uncoded and coded signals (ASK, FSK, PSK, QAM) through telecommunication systems and evaluate the quality of signal transmission. They will learn to implement adaptive equalization, the Viterbi algorithm, and the BCJR algorithm in software.		
Course outline			
Theoretical teaching	Algorithms for generating random variables with given distributions. Convolution and correlation of random signals – estimation based on generated or measured samples. Power spectral density of random signals. Application of the autoregressive moving average (ARMA) model for generating signal samples with a given autocorrelation function. Simulations of digital modulation schemes. Modeling of telecommunication channels. Modeling of transmitters and receivers. Simulation of digital signal transmission in the baseband and passband. Systems for adaptive processing of random signals. Simulation of filtering and adaptive equalization. Software implementation of the Viterbi and BCJR (Bahl, Cocke, Jelinek, Raviv) algorithms. Software implementation of block and convolutional coding and decoding. Monte Carlo simulations for error probability estimation. Importance Sampling method for accelerated performance evaluation. Space-time codes – simulation of the Alamouti scheme.		
Practical teaching (exercises, OFE, study and research work)	Tutorial classes and laboratory exercises will be organized for all topics covered in the lectures. During tutorial sessions, students solve problems and practical tasks that are closely aligned with the theoretical course content. Laboratory exercises are conducted in the computer classroom. Students are trained to use MATLAB for the spectral analysis of random processes and acquire proficiency in methods for random process generation. They apply Monte Carlo simulations, modulation and demodulation techniques, as well as encoding and decoding algorithms for convolutional and block codes.		
Textbooks/references			
1	J. Proakis, M. Salehi, G. Bauch, Contemporary Communication Systems Using MATLAB, 3rd Edition, Cengage Leraning, USA, 2013.		
2	M. C. Jeruchim, P. Balaban, K. Sam Shanmugan, Simulation of Communication Systems – Modeling, Methodology, and Techniques, Kluwer Academic/Plenum Publishers, NY, 2000.		
3	W. C. Jakes, Microwave Mobile Communications, John Wiley – IEEE Press, 2nd edition, 2004.		
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	0	0

Teaching methods	Lectures. Problem-solving sessions. Laboratory work. Individual consultations. Preparation and presentation of seminar papers.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	5	**Oral exam**	30
Colloquia	30		
Projects	10		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Broadband Telecommunications		
Lecturer (for lectures)		Milović M. Daniela, Milić N. Dejan		
Lecturer/associate (for exercises)		Panajotović S. Aleksandra		
Lecturer/associate (for OFE)		Panajotović S. Aleksandra		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Students will gain the necessary knowledge about the principles of managing the fixed and mobile broadband networks.			
Course outcomes	The student is able to model and analyze broadband communication networks, apply Quality of Service (QoS) mechanisms and traffic management techniques, as well as independently solve engineering problems and realize projects in the field of broadband communication networks.			
Course outline				
Theoretical teaching	Broadband network architecture. Packet core network. Physical layer technologies, data layer, link layer and network layer. Mechanisms for achieving the quality of service in broadband networks. Models of integrated and differentiated services. Traffic management in broadband networks. Software-defined networks (SDN). OpenFlow as network communication protocol used between controllers and forwarders in an SDN architecture.			
Practical teaching (exercises, OFE, study and research work)	Solving various problems related to physical layer, data link layer and network layer. QoS (quality of Service) in broadband networks. Investigation of traffic management mechanisms in broadband networks based on QoS, required bandwidth and SLA (Service Level Agreement). Application, control and infrastructure layers of SDN (Software Defined Networking) architecture. Students research work on projects in order to apply the acquired knowledge.			
Textbooks/references				
1	S. Gorshe, A. R. Raghvan, T. Starr, S. Galli, Broadband Access: Wireline and Wireless - Alternatives for Internet Services, Wiley, 2014.			
2	A. Stavdas, Core and Metro Networks, Wiley, 2010.			
3	F. Hu, Network Innovation through OpenFlow and SDN: Principles and Design, CRC Press, 2014.			
4	P. Kuhn, R. Ulrich, Broadband Communications: The Future od Telecommunications, Springer, 2013.			
5	J. F. Kurose, K. Ross, Computer Networking: A Top-Down Approach, Pearson, 2025.			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, auditory and laboratory exercises, homeworks, consultations, student seminar works.

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	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Mathematical Foundations of Statistical Learning		
Lecturer (for lectures)	Perić H. Zoran, Milošević M. Dušan, Nikolić R. Jelena		
Lecturer/associate (for exercises)	Eferica M. Predrag		
Lecturer/associate (for OFE)	Eferica M. Predrag		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to the mathematical basics of statistics and statistical learning. Train students to apply the acquired knowledge to the concrete problems.		
Course outcomes	Acquired fundamentals of statistical learning and ability to practicaly implement the acquired knowledge in telecommunications and data processing.		
Course outline			
Theoretical teaching	Estimation of parameters of known probability density function (mean, variance). Estimation of probability. Estimation of coefficients of correlation, autocorrelation and prediction. Testing hypothesis in statistics. Point estimates, confidence intervals. Nonparametric methods for distribution hypothesis testing. Maximum likelihood method. Linear regression, dependence between two random variables, regression line, dependence between random and control variable. Nonlinear regression, piecewise linear regression, logistic regression. Time series analysis, linear and nonlinear prediction.		
Practical teaching (exercises, OFE, study and research work)	Study and solve selected problems from the areas that are covered by the content of the subject.		
Textbooks/references			
1	D. Milosevic, L. Rancic, M. Petkovic, Mathematics 4 (In Serbian), Faculty of Electronic Engineering, Nis, 2015.		
2	M. Merkle, Probabiity and statistics, four edition, Akademic mind, 2016.		
3	T. Hastie, R. Tibshirani, J. Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd Edition, Springer, 2009.		
4	G. James, D. Witten, T. Hastie, R. Tibshirani, An Introduction to Statistical Learning with Applications in R, Springer, 2014.		
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	0	0

Teaching methods	Lectures, PowerPoint presentations, practical exercises, homework assignments, consultations

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises		**Oral exam**	20
Colloquia	35		
Projects	20		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Random processes in telecommunication systems		
Lecturer (for lectures)		Milović M. Daniela		
Lecturer/associate (for exercises)		Eferica M. Predrag		
Lecturer/associate (for OFE)		Eferica M. Predrag		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	The course aims to provide students with a deep theoretical foundation in the theory of random processes and their applications in modern telecommunication systems, with emphasis on developing the ability to independently apply advanced statistical methods in engineering research and to critically evaluate existing analytical approaches.			
Course outcomes	Upon completion of this course, students will be able to: Critically analyze statistical properties of random processes (stationarity, ergodicity, spectral characteristics) and evaluate their applicability in telecommunication modeling; Independently apply and compare parameter estimation methods (MLE, Bayes, MMSE) and assess their performance in the context of original research; Design optimal receivers and filters (Wiener, matched) based on rigorous mathematical derivations and critically evaluate trade-offs in practical implementations; Apply hypothesis testing frameworks (NP, ML, MAP, Bayes) to signal detection problems and interpret results in terms of detection performance bounds; Critically review current scientific literature and identify open research problems in statistical signal processing for telecommunications.			
Course outline				
Theoretical teaching	The course covers the following topics with emphasis on rigorous mathematical analysis and critical evaluation of methods: Continuous and discrete random signals — statistical characterization, stationarity, independence, and ergodicity; analysis of model assumptions and their validity in real systems; Correlation functions and power spectral density — derivation, properties, and application to telecommunication channel modeling; Behavior of random processes in linear systems — analytical methods and their limitations; Parameter estimation: statistical models, MLE, Bayes, and MMSE methods — comparative analysis of estimation accuracy, bias-variance trade-offs, and applicability to research problems; Signal detection and noise modeling — optimal linear systems, Wiener and matched filters, signal extraction and correlation — critical review of classical and modern approaches; Hypothesis testing: NP, ML, MAP, Bayes, sufficient statistics — performance analysis and open problems in detection theory.			
Practical teaching (exercises, OFE, study and research work)	MATLAB/Python simulation of random processes: verification of stationarity, independence, correlation functions, and power spectral density; Linear system response modeling and parameter estimation exercises using MLE, Bayes, and MMSE methods; Implementation of optimal filters (Wiener, matched) for signal detection and noise suppression; Hypothesis testing exercises using NP, ML, MAP, and Bayes criteria — evaluation of detection performance (ROC curves, probability of error); Critical review and discussion of selected recent research papers in statistical signal processing.			
Textbooks/references				
1	Probability, Random Variables and Stochastic Processes, A. Papoulis, S. Unnikrishna Pillai., Mc Graw Hill,2002			
2	Statistical Signal Processing, Steven M. Kay, Vol. I: Estimation Theory and Vol. II: Detection Theory, Prentice Hall Signal Processing Series, 1993			
3	Statistical Signal Processing, Louis Scharf. Statistical Signal Processing, Prentice Hall, 1991			
4	Probability and Random Processes, Grimmett & Stirzaker, Oxford, 4th Ed., 2020			
5	Information Theory, Inference, and Learning Algorithms, David J. C. MacKay, Cambridge University Press, 2003			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, auditory exercises, homeworks, consultations.		
Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	25
Exercises	25	**Oral exam**	25
Colloquia			
Projects	20		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Machine Learning 2		
Lecturer (for lectures)	Perić H. Zoran, Jovanović Ž. Aleksandra, Nikolić R. Jelena		
Lecturer/associate (for exercises)	Vučić J. Nikola		
Lecturer/associate (for OFE)	Vučić J. Nikola		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	To build upon knowledge of supervised learning algorithms and to acquire understanding of unsupervised and semi-supervised learning algorithms. To apply the acquired theoretical knowledge to solve engineering problems in modern communication systems.		
Course outcomes	Students will be able to understand and implement Bayesian classifiers, decision tree algorithms and random forests, ensemble methods, clustering algorithms, and dimensionality reduction techniques. Additionally, they will be capable of developing solutions for specified practical tasks using supervised, semi-supervised, and unsupervised learning.		
Course outline			
Theoretical teaching	Bayes' rule and quadratic classifiers. Naive Bayes classifier. Decision trees. Random forest method. Ensemble models (bagging and boosting). k-Nearest Neighbors classifier. Unsupervised learning and introduction to clustering. K-means algorithm. Hierarchical clustering. Fuzzy C-Means algorithm. K-Medoids algorithm. Gaussian Mixture Model (GMM) algorithm. Dimensionality reduction methods (PCA and LDA). Semi-supervised learning. Application of supervised, semi-supervised, and unsupervised learning methods in solving practical engineering problems.		
Practical teaching (exercises, OFE, study and research work)	During the exercises, theoretical knowledge is reinforced and skills in supervised, unsupervised, and semi-supervised learning are acquired through the analysis of Python code.		
Textbooks/references			
1	A. Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 1st ed., O'Reilly Media, 2019.		
2	F. Chollet, Deep Learning with Python, 2nd Edition, MANNING PUBLICATIONS, 2021.		
3	S. Raschka, Y. Liu, V. Mirjalili, Machine Learning with PyTorch and Scikit-Learn: Practical guide for building real-world intelligent systems, Packt Publishing, 2022.		
4	D. Rothman, Artificial Intelligence By Example, 2nd Edition, Packt Publishing, 2020.		
5	C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2007.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	1	1	0	0

Teaching methods	Lectures, PowerPoint presentations, auditory exercises, practical computer-based lessons, homework assignments, consultations.

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	25		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Advanced RF IC for Communication Systems		
Lecturer (for lectures)	Milić N. Dejan		
Lecturer/associate (for exercises)	Anastasov A. Jelena		
Lecturer/associate (for OFE)	Anastasov A. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to design of advanced RF devices and circuits used in telecommunications. Wireless and mobile networks present an ongoing request for low power, high performance, and low cost RF designs. The course will reflect proven concepts and discuss recent advances for next generation radio platforms.		
Course outcomes	- Analyze and design basic RF circuits and systems for communication - Understand various RF circuit blocks, highlighting design architectures and circuit implementation tradeoffs - Design RF circuits using an advanced design tool - Measure appropriate device parameters using VNA and/or spectrum analyzer		
Course outline			
Theoretical teaching	Transceiver architectures and systems issues for current wireless communications standards. Passive discrete components in RF domain. Connectors and cables. Impedance matching. Envelope detector. Narrow/wide-band amplifiers. Mixers. Voltage Controlled Oscillators. Phase-locked loop IC's. Frequency synthesis. Low Noise Amplifiers and Limiting Amplifiers. Variable Gain Amplifiers and Automatic Gain Control. Logarithmic amplifiers. Frontends. Simulation of circuit models. IC examples, datasheet/application note mining.		
Practical teaching (exercises, OFE, study and research work)	Auditory exercises are available on all thematic units. Laboratory exercises and team projects are realized in the laboratory, using available devices and components.		
Textbooks/references			
1	Thomas H. Lee, The design of CMOS radio-frequency integrated circuits, New York, NY, USA : Cambridge University Press, 2003.		
2	B. Razavi, RF Microelectronics, Upper Saddle River, New Jersey: Prentice Hall PTR, 1998		
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	0	0

Teaching methods	Course will include hardware team projects that will provide hands-on laboratory experience for the students. Student teams will be assembled depending on the complexity of the projects and individual student's interests. Projects include discrete prototype manufacture of the designed circuits as RF-modules and evaluation of their performance.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	30
Exercises	30	**Oral exam**	20
Colloquia	15		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital Image Processing		
Lecturer (for lectures)	Perić H. Zoran, Jovanović Ž. Aleksandra, Nikolić R. Jelena		
Lecturer/associate (for exercises)	Vučić J. Nikola		
Lecturer/associate (for OFE)	Vučić J. Nikola		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Acquisition of theoretical and practical knowledge in the field of digital image processing, with an emphasis on fundamental techniques of analysis, transformation, filtering, image compression, and segmentation.		
Course outcomes	The student will be able to: apply basic statistical and structural measures for image analysis; perform fundamental operations on images in the spatial and frequency domains; apply techniques for image enhancement and restoration; understand and implement algorithms for lossy and lossless image compression; apply methods for edge detection and image segmentation in practical applications.		
Course outline			
Theoretical teaching	Image acquisition and digitization. Types of digital images (binary, grayscale, color). Basic image properties (resolution, pixel relationships, mean value, standard deviation, histogram). Histogram equalization. Objective and subjective image quality metrics. Operations on individual pixels. Geometric transformations and interpolation. Spatial operations – image filtering (blurring, sharpening, median filter, Wiener filter). Image transformations in the frequency domain (FFT, DCT, DHT, rectangular transforms). Image restoration. Image compression (lossy and lossless). Edge detection. Image segmentation.		
Practical teaching (exercises, OFE, study and research work)	Practical training includes the application of fundamental digital image processing techniques in programming environments such as MATLAB or Python. Through working with real images, students acquire skills in image processing and analysis, including histogram analysis, filtering, quality enhancement, edge detection, and segmentation.		
Textbooks/references			
1	R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson; 4th edition, 2018.		
2	R. C. Gonzalez, R. E. Woods, S. L. Eddins, Digital Image Processing Using MATLAB, Gatesmark Publishing; 2nd edition, 2011.		
3	C. Solomon, T. Breckon, Fundamentals of Digital Image Processing: A Practical Approach with Examples in MATLAB, John Wiley & Sons, 2011.		
4	M. Sonka, V. Hlavac, R. Boyle, Image Processing, Analysis, and Machine Vision, CL Engineering, 4th Edition, 2015.		
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	0	0

Teaching methods	Lectures, auditorium exercises, practical computer labs, homework assignments, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	25	**Oral exam**	20
Colloquia			
Projects	30		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Design of Telecommunication Systems		
Lecturer (for lectures)		Milić N. Dejan, Milović M. Daniela, Đorđević T. Goran		
Lecturer/associate (for exercises)		Anastasov A. Jelena		
Lecturer/associate (for OFE)		Anastasov A. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	The aim of the course is for students to gain practical knowledge of modern communication systems, with a special focus on optical, satellite and RF links. Through the analysis of link components, link budget and the impact of various factors on transmission quality, students will learn how to design, optimize and evaluate the performance of different types of communication links. Special emphasis is placed on understanding technical limitations, resource planning, and applications in real-world conditions.			
Course outcomes	Based on defined project tasks, students will learn to design a specific system and independently create appropriate project documentation. They will also know how to apply software tools for designing and optimizing communication links, as well as make technically sound decisions when planning and implementing communication systems.			
Course outline				
Theoretical teaching	Design of optical links and specifications of their components (optical transmitters, receivers, fibers, connectors, free space). Design of satellite and terrestrial radio links, with the aim of optimizing resources, estimating capacity and improving link quality. Estimation of propagation losses (free space, rain, gases, multipath effects) and the importance of planning. Determining the service area of radio broadcast systems using statistical methods. Designing links between drones and transceivers on the Earth's surface. Introduction to the design of IoT systems using the example of choosing a modulation technique. Content of project documentation. Legal regulations during design. Using available and creating your own software for design automation.			
Practical teaching (exercises, OFE, study and research work)	Computational and laboratory exercises are performed from all thematic units.			
Textbooks/references				
1	Roger L. Freeman, Telecommunication system engineering, John Wiley & Sons, 2015.			
2	Roger L. Freeman, Radio system design for telecommunications, John Wiley & Sons, 2007.			
3	Govind P. Agrawal, Fiber-optic Communication Systems, Fifth Edition, John Wiley & Sons, 2021.			
4	Correspodning ITU-R recommendations.			
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	0	0

Teaching methods	Theoretical classes, computational and laboratory exercises, homework, consultations. Within the framework of the seminar, the design of a telecommunications system based on the given project task and the preparation of project documentation for that case.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	10
Exercises	15	**Oral exam**	20
Colloquia			
Projects	50		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microcontrollers and Applications in Communications		
Lecturer (for lectures)	Stanković Ž. Zoran, Pronić-Rančić R. Olivera		
Lecturer/associate (for exercises)	Atanasković S. Aleksandar		
Lecturer/associate (for OFE)	Perić S. Nemanja		
Number of ECTS	4	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquiring theoretical and practical knowledge in the field of application of open-source microcontroller development systems in the digital data transmission.		
Course outcomes	Students acquire the ability to understand the architecture, operation, and programming of open-source microcontroller platforms, apply different types of communication protocols at the physical layer and implement them in a microcontroller environment, as well as integrate wireless communication modules and microcontrollers for the realization of wireless sensor nodes.		
Course outline			
Theoretical teaching	Open-source microcontroller platforms (Arduino, Raspberry Pi). Arduino IDE. Sensors, actuators. Communication protocols: RS232, UART, SPI, I2C, CAN Bus, ZigBee, Bluetooth, MQTT. Wireless communication modules: LoRa (Long Range) HC-12, HC-05, nRF24l01, ESP8266. GSM shield. Using the Arduino platform for creating a sensor node. Using the Raspberry Pi platform as a gateway and communication between sensor nodes.		
Practical teaching (exercises, OFE, study and research work)	Auditory exercises: Solving practical problems in the field of application of open-source microcontroller development systems in the digital data transmission. Laboratory exercises: Practical work with microcontroller open source platforms (program realization of communication protocols, realization of sensor nodes)		
Textbooks/references			
1	S. Monk, Arduino: introduction to programming, Mikro knjiga, 2017.		
2	J. Oxer, H. Blemings, Practical Arduino: Cool Projects for Open Source Hardware, Apress, 2011.		
3	D. Ibrahim, Raspberry Pi 3 - from basic to advanced projects, InfoElektronika, 2018.		
4	S. Rizvi, Microcontroller Programming: An Introduction, CRC Press, 2016.		
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	0	0

Teaching methods	Lectures, auditory exercises, practical laboratory work, homework, consultations

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	35	**Oral exam**	20
Colloquia	20		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Artificial Neural Networks in Radiocommunication Systems		
Lecturer (for lectures)	Marinković D. Zlatica, Stanković Ž. Zoran		
Lecturer/associate (for exercises)	Milijić R. Marija		
Lecturer/associate (for OFE)	Mladenović M. Ksenija		
Number of ECTS	4	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquiring knowledge about artificial neural networks (ANN) and their applications in radiocommunication systems. Training students to apply artificial neural networks for solving paricular problems.		
Course outcomes	Upon completing the course, students will be able to explain the structure of artificial neural networks and the procedures required for developing neural models. The students will be also able to independently develop and verify models, as well as implement them in standard software packages for the simulation and analysis of communication systems and circuits.		
Course outline			
Theoretical teaching	Artificial intelligence and machine learning - introduction. Types of learning. Neuron and neuron model. Types of artificial neural networks. Multilayer artificial neural networks. Recurrent neural networks. Convolutional neural networks. Training, test and validation of artificial neural networks. Principles of development of models based on artificial neural networks. Examples of application of artificial neural networks for modeling RF and microwave components and circuits. Examples of the application of artificial neural networks in the field of EM wave propagation. Other applications of artificial neural networks in communication systems. Implementation of neural models in software tools for simulation and analysis of communication systems.		
Practical teaching (exercises, OFE, study and research work)	Computer-based exercises: creating, training and testing of artificial neural networks. Examples of the development of neural models. Students' project: application of artificial neural networks for solving a specific problem in radiocommunication systems.		
Textbooks/references			
1	Q. J. Zhang, K. C. Gupta, Neural Networks for RF and Microwave Design, Artech House, 2000.		
2	C. Christodoulou, M. Gerogiopoulos, Applications of Neural Networks in Electromagnetics, Artech House, 2001.		
3	Z. Marinković, V. Marković, A. Caddemi, "Artificial Neural Networks in Small-Signal and Noise Modeling of Microwave Transistors", Chapter 6 in „Artificial Neural Networks“ edited by Seoyun J. Kwon, Nova Science Publishers Inc., 2011, pp. 219-236		
4	Sebastian Raschka, Machine Learning with PyTorch and Scikit-Learn, Packt, 2022.		
5	Selected scientific papers		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures. Exercises. Project. Consultations.

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	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Communication Hardware Programming		
Lecturer (for lectures)	Maleš-Ilić P. Nataša, Stanković Ž. Zoran		
Lecturer/associate (for exercises)	Atanasković S. Aleksandar		
Lecturer/associate (for OFE)	Stošić P. Biljana, Eferica M. Predrag		
Number of ECTS	4	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Acquiring basic knowledge about hardware platform architectures and procedures and tools for their programming.
Course outcomes	Students will be able to: •Classify and compare the characteristics of various hardware platforms (FPGA, DSP, SDR) in the context of implementing digital communication systems. •Model functional block diagrams and state-transition logic for data processing systems using tools such as Stateflow. •Design software-defined transmitter and receiver modules within the MATLAB/Simulink development environment. •Implement communication algorithms using hardware description languages (VHDL), while mastering the fundamentals of digital logic and syntax. •Execute the migration of developed models from high-level software environments to target hardware platforms using HDL Coder tools and automated code synthesis. •Evaluate system performance after deployment on a real hardware platform, analyzing discrepancies between simulation models and practical implementations.
Course outline	
Theoretical teaching	Programmable hardware platforms – FPGA, DSP, SDR. Software implementation of digital transmitter and receiver. Procedures for migrating a communication model developed in LabVIEW/MATLAB/Simulink environment to the desired DSP/FPGA/SDR platform. Using Stateflow tools for modeling and simulating functional block diagrams and state transitions in data processing on a hardware platform. VHDL basics. Using HDL coders for synthesizing VHDL/Verilog code from source code developed in MATLAB/Simulink environment and migrating it to the desired DSP/FPGA platform.
Practical teaching (exercises, OFE, study and research work)	Student research work related to solving specified tasks through individual and team projects.
Textbooks/references	
1	M. Zwolinski, D. System Design with VHDL, 2nd edition, Prentice Hall, 2004
2	S. T. Karris, Digital Circuit Analysis and Design With Simulink Modeling and Introduction to CPLDs and FPGAs, Orchard Publications, 2007
3	R. W Stewart, K. W Barlee, D. S W Atkinson, Software Defined Radio using MATLAB & Simulink and the RTL-SDR, Strathclyde Academic Media, 2015
4	J. M. Reyland, Software Defined Radio Theory and Practice, Artech House, 2024
5	R. K. Snider, Advanced Digital System Design using SoC FPGAs - An Integrated Hardware_Software Approach, Springer, 2023

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures, classroom exercises, practical work in the laboratory, team project, consultations

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Design of Information and Communication Systems and Instalations		
Lecturer (for lectures)		Marinković D. Zlatica, Joković J. Jugoslav, Dončov S. Nebojša		
Lecturer/associate (for exercises)		Atanasković S. Aleksandar		
Lecturer/associate (for OFE)		Perić S. Nemanja		
Number of ECTS	4	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	None			
Course objectives	Students will acquire theoretical and practical knowledge in the field of design of information-communication and signaling systems, which are applied in modern buildings (commercial, industrial, residential). Special attention is given to the structure and integration of telecommunication, security, and IoT systems, as well as the analysis of communication technologies in both technological and economic contexts.			
Course outcomes	Upon sucessful completion of the course stdent will have the following abilities. The ability to analyze user needs and propose system/installation types and select communication technologies; the ability to perform techno-economic analysis of the proposed solution; the ability to conduct comparative analysis of multiple proposed systems; and the ability to use software tools for design of information-communication systems and preparing technical documentation.			
Course outline				
Theoretical teaching	Role of information-communication (IC) systems in smart buildings, industry, and infrastructure. Overview of modern IC system solutions. Macro-structural and functional decomposition of IC systems. Structured cabling and infrastructure. Telecommunication and signaling installations in buildings. IoT systems. Design of IC systems – phases and documentation. Analysis of user needs and requirement definition. Selection of communication technology. Techno-economic system analysis. Development of a technical solution. Preparation of project documentation. Project presentation.			
Practical teaching (exercises, OFE, study and research work)	Practical exercises: characteristic calculations for different types of information-communication systems considered. Analysis of existing solutions (case studies). Work with software packages for design of information-communication systems and creating technical documentation. Project development.			
Textbooks/references				
1	C. Czarnecki, C. Dietze, Reference Architecture for the Telecommunications Industry: Transformation of strategy, Organization, Processes, Data, and Applications, Springer, 2017.			
2	A.B. Semenov, S.K. Strizhakov, I.R. Suncheley, Structured Cable Systems, Springer, 2008.			
3	M. McCarthy, B. Burd, I. Pollock, Concise Guide to the Internet of Things A Hands-On Introduction to Technologies, Procedures, and Architectures, Springer, 2025			
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	0	0

Teaching methods	Lectures. Exercicses. Project work. 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			
Projects	40		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Security and Protection of Telecommunications Transmission		
Lecturer (for lectures)	Milović M. Daniela, Milić N. Dejan		
Lecturer/associate (for exercises)	Panajotović S. Aleksandra		
Lecturer/associate (for OFE)	Panajotović S. Aleksandra		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	To make students familiar with the concept of security, implementation and maintenance of secure transmission in telecommunication networks.		
Course outcomes	Students will be able to assess the potential vulnerabilities and needs for protection in telecommunications networks, as well as to design appropriate protection systems.		
Course outline			
Theoretical teaching	Protection of different types of communication networks and information content from the physical to the application level. Techniques of attack. Design of the protection system and its maintenance. Authorized access and authorization systems for public and private telecommunications networks and media. Fundamentals of cryptography - public key infrastructure, protocols, techniques and algorithms. Basic security protocols in wireless networks. Availability and reliability of the optical network.		
Practical teaching (exercises, OFE, study and research work)	Research of different methods of protection and their possibilities through the application of traditional and modern cryptographic methods, hybrid cryptosystems, digital signatures and hash functions to solve various examples and problems. Work with the CrypTool2 software package. Work with X.509 protocol and authentication protocols. Students' works on projects in aim to apply the acquired knowledge.		
Textbooks/references			
1	L. Chen, G. Gong, Communication System Security, CRC Press, 2012.		
2	P. Stavroulakis, M. Stamp, Handbook of Information and Communication Security, Springer, 2010.		
3	J. Holden, The Mathematics of Secrets – Cryptography from Caeser to Digital Encryption, Princeton University Press, 2017.		
4	J. –P. Aumasson, Serious Cryptography – A Practical Introduction to Modern Encryption, No Starch Press, 2017.		
5			

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	1	1	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, homework, consultations, seminar projects.

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			Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Contemporary Laboratory	
Lecturer (for lectures)			Panajotović S. Aleksandra, Ćirić G. Dejan, Milošević D. Nenad	
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)			Panajotović S. Aleksandra, Anastasov A. Jelena, Eferica M. Predrag	
Number of ECTS	5	**Course status (obligatory/elective)**		Obligatory
Prerequisites	None			
Course objectives	To take knowledge of equipment that can be applied in communication technologies and information processing area. Special attention is paid to the practical knowledge and skills of using device and software packages for acquisition, analysis, measurements and simulations. Students should be familiar with practical work in laboratory for communication technologies.			
Course outcomes	Acquiring theoretical and practical knowledge (skills), and the students' ability to use equipment, devices and software tools in communication technologies.			
Course outline				
Theoretical teaching	Use of microcontroller platforms for data acquisition. Software radio, USRP, possibilities for use in laboratory conditions. Methods for estimating the error probability for wireless systems. Measurement of signal-to-noise ratio, interference power and characterization of fading effects in wireless communications. Implementation of modulators and demodulators on hardware platforms. Practical realizations of coders and decoders for error- control codes. Application of codes for error correcting in wireless communications. Empower students to work with the EMONA hardware platforms. Software signal processing. Measuring the sound level, as well as its spectral analysis using hand-held devices. Application of the spectrum analyzer to determine the transfer characteristics of the tasted devices (e.g. filter or acoustic transducer in a mobile phone). Simulation of room acoustics with simulation software (EASE or other appropriate software).			
Practical teaching (exercises, OFE, study and research work)	Practical classes consist of laboratory exercises and practical work in laboratories on equipment, devices and software packages. Laboratory equipment is used for channel measurement and estimation in wireless communications and free-space optical communications, as well as for sound measurement and analysis. Software packages are used for evaluating error probability in wireless systems, studying the characteristics of error-correcting codes, signal processing, and room acoustics simulation.			
Textbooks/references				
1	D. Milić, A. NikoŁajew, G. T. Đorđević, Laboratory Practicum in Telecommunications, ERASMUS+, 2023.			
2	A. Breznik, Emona-101 Telecommunications Trainer User Manual, Emona Instruments Pty Ltd, 2010			
3				
4				
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	0	2	0	0

Teaching methods	Lectures, laboratory exercises, studio exercises, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	35	**Oral exam**	35
Colloquia	20		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Seminar - System Engineering and Radiocommunications		
Lecturer (for lectures)	Marinković D. Zlatica, Joković J. Jugoslav, Pronić-Rančić R. Olivera		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)	Milijić R. Marija		
Number of ECTS	2	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to the objectives, structure, and presentation of the final (graduation/diploma) thesis.		
Course outcomes	Students will acquire the necessary knowledge to, depending on the type of final thesis, organize their research and the methods used to obtain results, properly present and discuss the obtained results, and format them according to the required structure of the final thesis. They will also gain the skills needed for the oral presentation of their thesis.		
Course outline			
Theoretical teaching	Concept and format of the final thesis. Types and structure of the final thesis. Original solutions to the defined problem. Review papers with comparative analysis and evaluation. Current topics in system engineering and radiocommunications. Selection and types of topics. Methods for describing/presenting research, measurements, simulations, and comparative analyses. Presentation and discussion of data and results. Drawing conclusions. Planning activities and time management during thesis development. Academic writing style. Writing a summary. Literature search and methods of referencing and citing sources. Concepts of plagiarism. Preparation for the oral presentation and defense of the thesis. Selected seminars for soft skills development.		
Practical teaching (exercises, OFE, study and research work)	Exercises are not included; instead, students independently work on their final thesis based on the knowledge they have acquired. ECTS credits for the course are awarded upon the successful defense of the final thesis.		
Textbooks/references			
1	Milutinovic, V., "A good method to prepare and use transparencies for research presentations," TCCA Newsletter, March 1997		
2	Seminar slides. Additional materials - good practice case studies.		
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	1	0	0

Teaching methods	Lectures. Preparation of the final thesis and presentation.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	30	**Oral exam**	40
Colloquia			
Projects	30		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Metrology of Electrical Quantities		
Lecturer (for lectures)	Denić B. Dragan, Simić M. Milan		
Lecturer/associate (for exercises)	Jovanović R. Jelena, Ranđelović S. Ivana		
Lecturer/associate (for OFE)	Miljković S. Goran, Jocić V. Aleksandar, Stojanović S. Milica, Pešić T. Miroljub		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Education and introduction of students to basic theoretical and practical knowledge in the field of metrology and measurement of electrical quantities.		
Course outcomes	Students' training and ability to solve practical problems in the field of measuring electrical quantities, based on a good knowledge of measurement methods and techniques, with the proper use of modern instruments and equipment for measuring electrical quantities. In addition, an important segment is the training of students for the later application of acquired knowledge in measurement techniques in engineering professions in the field of electrical engineering and computer science.		

Course outline

Theoretical teaching	Introduction to metrology. Definition and materialization of the measurement units of amperes, ohms and volts of the MKSA system. Functional diagrams of the process of measuring electrical quantities. Methods of measuring electrical quantities. Processing of measurement results and measurement uncertainty. Determination of measurement uncertainty in more complex modern measurement systems. Analog and digital measuring instruments and their basic measurement errors. Virtual instrumentation. Expansion of the measurement range of ammeters, voltmeters and ohmmeters. Working with modern measuring instruments. Oscilloscopes.
Practical teaching (exercises, OFE, study and research work)	Computational, laboratory and demonstration exercises: training students to solve computational problems in the field of measuring electrical quantities, as well as for the practical application of measurement methods and measuring instruments through engagement in laboratory and demonstration exercises. The basic areas covered in laboratory exercises are: calibration of measuring devices, analysis of measurement results and assessment of measurement uncertainty, expansion of the measurement range of ammeters and voltmeters, resistance measurement, work with modern digital measuring instruments, as well as the application of analog and digital oscilloscopes. According to the Practicum for working on laboratory exercises, students submit an appropriate report on each completed laboratory exercise. There is also the possibility of choosing additional laboratory exercises in accordance with the needs of individual study modules.

Textbooks/references

1	J. G. Webster, "Measurement, Instrumentation and Sensors Handbook", CRC Press, 2014.
2	S. Tumanski, “Principles of Electrical Measurements”, Taylor & Francis Group, 2006.
3	W. Nawrocki, Measurement Systems and Sensors. London, Artech House, 2005.
4	P. Sydenham, “Handbook of Measurement Science“, John Wiley & Sons, Ltd., 1982
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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	1	2	0	0

Teaching methods	Lectures (theoretical teaching) with graphical presentation of material in the form of slides. Computational exercises with solving problems in the field of electrical measurements. Practical teaching in the form of laboratory and demonstration exercises. Daily student consultations with teachers or associates. Individual work of students in the form of homework assignments.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	20
Exercises	10	**Oral exam**	20
Colloquia	40		
Projects	0		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electronic Materials		
Lecturer (for lectures)	Paunović V. Vesna		
Lecturer/associate (for exercises)	Marjanović B. Miloš, Paunović V. Vesna		
Lecturer/associate (for OFE)	Paunović V. Vesna, Veljković Z. Sandra		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to the microstructural and electrical properties of inorganic (conducting, semiconducting, dielectric, magnetic and superconducting) and organic electronics materials.		
Course outcomes	The learning outcome enables the student to: •Identify the basic material types used to fabricate electronic components and devices. •Describe the crystal structures of materials and explain how they affect electrical characteristics. •Distinguish and classify the physical and electrical properties of conductive, semiconducting, dielectric, and magnetic materials. •Recognize and select appropriate materials for fabricating basic electronic components based on required operating characteristics. •Experimentally determine key material parameters (e.g., electrical conductivity, dielectric permittivity, or magnetic properties) through laboratory measurement.		
Course outline			
Theoretical teaching	Introduction. Electronics materials and electronics devices. Crystal structure of materials. Miller indices. Crystal lattice energy and defects in materials. Conductors: definitions and general properties, metals, alloys, non-metallic conductors, application. Semiconductors: definitions and general properties, semiconductors, semiconductor compounds and alloys, application. Dielectrics: definitions, mechanisms of polarization, the static and dynamic properties, special dielectrics, application. Magnetic materials: definitions and general relations, types of magnetic materials, applications. Superconductors: phenomenology of superconductivity, applications. Organic materials and application.		
Practical teaching (exercises, OFE, study and research work)	Practical and laboratory exercises in the field of crystal structure of materials, Miller indices, energy and defects of materials, conductive (electrical conductivity, electrical resistivity, Hall effect), semiconducting (electrical characteristics of intrinsic and doped semiconductors, Hall effect, thermoelectric properties), dielectric and magnetic materials.		
Textbooks/references			
1	S. O. Kasap, Principles of Electronic Materials and Devices, McGraw-Hill, 2018		
2	W. D. Callister, D.G.Rethwisch, Materials Science and Engineering, John Wiley & Sons Inc, 2014		
3	M.X.Keshavarz, T.M.Klapötke The Properties of Energetic Materials, De Gruyter Graduate, 2018		
4	Wei Gao, Zhengwei Li, Nigel M Sammes, Introduction to electronic materials for engineers, (2nd edition) World Scientific Publishing Company, 2016		
5	S. L. Tripathi, P. A. Alvi, U. Subramaniam, Electrical and Electronic Devices, Circuits and Materials, Design and Applications, CRC Press, 2021		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, consultations, laboratory and practical exercises

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	20		
Projects	5		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Solid State Electronics		
Lecturer (for lectures)	Prijić P. Aneta		
Lecturer/associate (for exercises)	Prijić P. Aneta, Stojković S. Aleksandra		
Lecturer/associate (for OFE)			
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The objectives of the course are focused on: - Introduction to the crystalline structure of the semiconductor; - Representation of the concept of energy bands, Fermi level, distribution functions, and effective mass of charge carriers in semiconductors; - Understanding the properties of intrinsic and doped semiconductors; - Definition of the drift and diffusion transport of the charge carriers inside the semiconductors; - Getting acquainted with the recombination of charge carriers; - Definition of equations that describe charge carriers transport and equilibrium in a semiconductor; - Understanding of the carriers' behavior in high electric fields; - Study of the properties of the P-N junction (built-in voltage, depletion region, and capacitance); - Study of the properties of MOS structures (threshold voltage and C-V plots).		
Course outcomes	Learning outcomes allow a student to: - Visualize the concept of energy bands and the position of the Fermi and doping levels; - Explain the dependence of the charge carriers' distribution functions on the semiconductor type, temperature, and doping concentration; - Determine the concentration of free charge carriers in the semiconductor, depending on the concentration of the dopants; - Analyze the effects of drift, diffusion, and recombination of charge carriers in the semiconductor; - Formulates the transport and continuity equations within the semiconductor; - Determine the built-in voltage, depletion region width, and the capacitance of the defined P-N junction; - Determine the threshold voltage of the defined MOS structure; - Define the difference between the low-frequency and high-frequency C-V plots of the MOS structure.		
Course outline			
Theoretical teaching	Introduction. Structure of the atom and types of bonds in materials. Crystal structure of a semiconductor. Energy bands. Intrinsic semiconductor. Doped semiconductors. Fermi level. Charge carriers' distribution functions. Dual nature of the electron. E(k) dependencies. The effective mass of charge carriers. Concentrations of free charge carriers in the lightly, moderately, and heavily doped semiconductor. Ionization of the dopants. Drift velocity and mobility of charge carriers. Electric conductivity of a semiconductor. Drift and diffusion currents. Einstein's relation. Transport equations. Quasi-Fermi levels. Recombination of carriers in semiconductors. Equation of continuity. Conductivity in high electric fields. P-N junction: abrupt and linear. Built-in voltage, depletion region width, and capacitance of the P-N junction. Contact metal-semiconductor. MOS structure (capacitor). Threshold voltage and C-V plots of the MOS structure. Bandgap voltage reference.		
Practical teaching (exercises, OFE, study and research work)	Computer simulations of physical phenomena in semiconductor structures under different technological, thermal, and electrical conditions: Distribution functions of charge carriers and ionization of dopants; Fermi-Dirac distribution and Fermi level in semiconductors; drift velocity and dependence of charge carriers mobility on temperature and doping concentrations; drift currents presented through energy bands; Haines-Schokley experiment; drift, diffusion, and recombination of charge carriers; P-N junction: built-in voltage, depletion region width, energy bands and capacitance; MOS capacitor - the influence of gate material, the effect of bias on charge carriers in the substrate, the influence of oxide thickness and electric charge in the oxide; MOS capacitor - C-V plots.		
Textbooks/references			
1	S. Dimitrijev, "Principles of Semiconductor Devices", Oxford University Press, 2011.		

2	D. Neaman, "Semiconductor Physics and Devices", 4th ed., McGraw-Hill, 2011 - selected chapters.
3	B.-L. Anderson, R. Anderson, "Fundamentals of Semiconductor Devices", 2nd ed., McGraw-Hill Education, 2018 - selected chapters.
4	J. Flux, "Semiconductor Physics Modeling Made Easy", Independently published, 2024.
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	0	0

Teaching methods	Theoretical leactures - using slides; PC exercises

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	30	**Written exam**	40
Exercises		**Oral exam**	30
Colloquia			
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies Electrical Engineering and Computer Science / Electron Devices and Microsystems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Components for Telecommunications	
Lecturer (for lectures)			Manić Đ. Ivica, Danković M. Danijel	
Lecturer/associate (for exercises)			Danković M. Danijel, Veljković Z. Sandra	
Lecturer/associate (for OFE)			Danković M. Danijel, Veljković Z. Sandra	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	None			
Course objectives	To make introduction to most important passive and active devices for transmission, processing, amplification, receiving and emission of signals in telecommunications			
Course outcomes	Students gain understanding of standard and specific electronic devices and comprehension of their applications in telecommunications.			
Course outline				
Theoretical teaching	Peculiarities of devices for telecommunications. Transmission lines. Classification of transmission lines. Connectors and sockets. Passive electronic components. Ferrite and combined components. Semiconductor materials: Si and III-V compounds. Diodes. Bipolar transistor. MOS transistor. LDMOS transistor. FET. Integrated circuits. Digital circuit technologies. CMOS. BiCMOS. Dynamic RAM cells: capacitive cell, FLASH, FeRAM. Low noise receivers. Components in SMD technology.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises cover the areas of transmission lines, passive devices, bipolar and MOS transistors, CMOS circuits, memories and SMD devices. Laboratory exercises include realization of basic circuits with rectifying, Zener, Schottky diodes and LEDs, measurements of bipolar and MOS transistor and CMOS inverter characteristics, realization of basic amplifying and oscilatory circuits, frequency multipliers, filters, amplitude and frequency modulators and demodulators, basic arythmetic operation circuits, and photodiode and phototransistor based remote control units.			
Textbooks/references				
1	A. Belous, V. Saladukha, Basic Components of Telecommunication Systems. In: High-Speed Digital System Design. Springer, 2020, ISBN 978-3-030-25408-7			
2	T.S. Laverghetta, Microwaves and Wireless Simplified (2nd ed.), Artech House, Boston, 2005, ISBN 1-58053-943-2			
3	Allan W. Scott, Understanding Microwaves, Willey, 2005, ISBN 978-0-471-74533-4			
4	S. Dimitrijev, Understanding Semiconductor Devices, Oxford University Press, New York, 2000, ISBN 0-19-513186-X			
5	Printed matter – lecture texts and PowerPoint slides, problems with solutions and instructions for laboratory exercises			

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

Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

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**	20
Exercises	30	**Oral exam**	20
Colloquia	20		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electron Devices and Microsystems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Fundamentals of Quantum and Statistical Physics	
Lecturer (for lectures)			Ristić S. Goran	
Lecturer/associate (for exercises)			Aleksić M. Sanja	
Lecturer/associate (for OFE)				
Number of ECTS	6	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Introduction to the fundamentals of nonrelativistic quantum mechanics and the principle of quantum components. Introduction to classical and quantum statistics and their application to photons and electrons.			
Course outcomes	Mastering methods for solving the problem of tunneling electrons through potential barriers and finding the energy of electrons in potential well. The possibility of applying quantum statistics to solid states, with particular reference to semiconductors.			
Course outline				
Theoretical teaching	Limitations of classical physics. Introduction to quantum mechanics. Particle-wave dualism. De Brol's hypothesis and Heisenberg's uncertainty relations. Wave function. Stationary and non-stationary Schrödinger equation. Potential step, potential barriers and well. WKB approximation. Tunnel diode. Quantum microstructure. Quantum transistors. Maxwell-Boltzmann, Boze-Einstein and Fermi-Dirac distribution. Statistics of electrons and photons.			
Practical teaching (exercises, OFE, study and research work)	Practical classes take place through computational exercises. Concrete problems are solved during computer tutorials in order to make students more easily and successfully master certain areas that are covered in theoretical classes.			
Textbooks/references				
1	Micheal Lui, Fundamentals of quantum mechanics, statistical mechanics and solid state physics, Amiga Press Inc, 2019.			
2	Carlo Heissenberg, Augusto Sagnotti, Classical and Quantum Statistical Physics: Fundamentals and Advanced Topics, Cambridge University Press, 2022.			
3				
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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	0	0	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	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Materials Characterization		
Lecturer (for lectures)	Paunović V. Vesna		
Lecturer/associate (for exercises)	Mitrović I. Nikola		
Lecturer/associate (for OFE)	Mitrović I. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Acquiring basic knowledge of materials characterization methods. Connecting theoretical knowledge and its practical applications in materials characterization. Introduction to modern methods and devices for materials characterization.		
Course outcomes	The learning outcome enables the student to: •Explain the cause-and-effect relationship between a material's internal structure and its macroscopic properties. •Select appropriate experimental methods for the structural and electrical analysis of a specific material type. •Combine measurement methods and instruments to obtain detailed, precise characterization of samples. •Independently conduct structural and electrical measurements in accordance with technical instructions and standards. •Critically analyze and integrate results from various instruments into a cohesive whole.		
Course outline			
Theoretical teaching	Modern materials analysis methods. Structural properties of materials. Technology (synthesis) – structural properties – materials correlation. Symmetry and crystallography in the structural hierarchy of materials. Materials characterization methods: Optical microscopy, XRD spectroscopy, SEM and TEM microscopy, EDS analysis, laser spectroscopy, infrared and Raman spectroscopy, ultraviolet and visible spectroscopy. Thermal analysis. Ultrasonic testing of materials. Stereologiacal methods (quantitative metallography). Characterization of thin films. New methods of measuring the electrical characteristics of materials. Electrical characterization of materials depending on the conditions of their preparation. Automated measurement of electrical parameters of materials. New characterization methods for nanomaterials.		
Practical teaching (exercises, OFE, study and research work)	Practicals and laboratory exercises in SEM and EDS analysis. Preparation of samples for SEM and EDS analysis. Analysis of spectra obtained by UV, IR, and Raman spectroscopy. Electrical characterization of materials. Determination of electrical parameters as a function of frequency and temperature. Manual and automated measurement of electrical parameters. Writing and using appropriate software tools for data acquisition and analysis of measured results		
Textbooks/ref			
1	Yang Leng, Materials characterization- Introduction to Microscopic and Spectroscopic Methods, Wiley-VCH, 2013		
2	S.Zhang, L.Li, A.Kumar, Materials Characterization Techniques,CRC press 2008		
3	R.P.Campos, A.C.Cuevas, R.E.Munoz, Materials Characteriyation, Springer, 2015		
4	Surender Kumar Sharma, Handbook of Materials Characterization, Springer, 2018		
5	E.O.Ortega, H.Hosseinian, I.B.A.Meza, M.J.R. Lopez, A.R.Vera, S.Hosseini, Material Characterization Techniques and Applications, Springer, 2022		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, consultations, laboratory and practical exercises

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	20		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electron Devices and Microsystems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Numerical Mathematics	
Lecturer (for lectures)			Marinković D. Slađana, Marjanović M. Zvezdan, Rančić Z. Lidija	
Lecturer/associate (for exercises)			Stanković M. Hranislav	
Lecturer/associate (for OFE)				
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Mastering the basic principles of numerical mathematics, ways to choose the appropriate method depending on the nature of the problem, and applications in practice.			
Course outcomes	Understanding the concept of numerical mathematics. Students' ability to select and apply numerical methods for solving problems related to the approximate solution of equations, approximation of functions, numerical differentiation and integration in vocational courses and practice.			
Course outline				
Theoretical teaching	Elements of error theory: types of errors, computation with approximate numbers, significant and safe digits. Iterative processes. Solving nonlinear equations and systems of nonlinear equations: localization of solutions, iterative methods. Numerical solving of systems of linear equations: direct and iterative methods. Matrix inversion. The concept and types of approximation of functions. Interpolation: Lagrange, Newton, Hermite interpolation polynomial. Best approximations. Numerical differentiation. Numerical integration: Newton-Cotes and Gaussian quadrature formulas, error estimation.			
Practical teaching (exercises, OFE, study and research work)	Solving problems that follow the content presented in the theoretical classes. Implementation of numerical algorithms through program packages for symbolic calculation. Through the preparation of homework and analysis of their solutions, the application of mathematical and software tools in the context of numerical mathematics is gradually mastered.			
Textbooks/references				
1	Richard L. Burden, J. Douglas Faires, Numerical Analysis, MA : Brooks/Cole, Cengage Learning, Boston, 2011.			
2	L. Ridgway Scott, Numerical Analysis, Princeton University Press, 2011.			
3	J. Kiusalaas, Numerical methods in engineering with MATLAB, Cambridge University Press, 2016.			
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	0	0

Teaching methods	Lectures, computational exercises, computer exercises, homework, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	40
Exercises	10	**Oral exam**	10
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microsystem Technologies		
Lecturer (for lectures)	Paunović V. Vesna		
Lecturer/associate (for exercises)	Marjanović B. Miloš		
Lecturer/associate (for OFE)	Branković Lj. Neda		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Learning basic knowledge of materials for microsystems, and the most important technological processes in various technologies for microsystems realization, as well as the assembly and microsystems integration.		
Course outcomes	The learning outcome enables the student to: •Explain the physical principles and theoretical foundations of individual phases in the technological process of microsystem fabrication. •Apply mathematical models for the numerical solution of engineering problems and the calculation of key parameters within technological processes. •Independently use software tools for modeling and simulation of the complete manufacturing process of microelectronic components. •Configure, optimize, and analyze operating parameters and microsystem structures through the simulation of semiconductor substrate preparation, thermal oxidation, diffusion, ion implantation, as well as lithography, etching, and metallization processes.		
Course outline			
Theoretical teaching	Definitions and classification of microsystems. Materials for microsystems. Microelectronic technologies: obtaining substrates, films growth and deposition, doping, litography, etching, Ion implantation, oxidation, diffusion. Bulk micromachining technology: technological processes, structures, applications. Surface micromachining technology: technological processes, structures, applications, LIGA technologies: technological processes, applications. Assembly and microsystems integration,		
Practical teaching (exercises, OFE, study and research work)	Practical exercises showing numerical problem solving in the technological processes. Exercises are performed on a computer using the simulator of technological processes. Preparation of semiconductor substrates, epitaxial growth, oxidation, diffusion, ion implantation, lithography, etching, metallization, CMOS technological array.		
Textbooks/references			
1	James D. Plummer, Peter B. Griffin, "Integrated Circuit Fabrication - Science and Technology", Stanford University, California, 2023.		
2	Kumar Shubham, Ankaj Gupta, "Integrated Circuit Fabrication", CRC Press, 2021.		
3	V. Barzdenas, R. Navickas, Microtechnologies, a laboratory manual, Vilnius Technika, 2012		
4	L. A. Francis, K. Iniewski, Novel Advances in Microsystems Technologies and Their Applications, CRC Press, 2017		
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	0	0

Teaching methods	Lectures, practice work, consultations

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	20		
Projects	5		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Semiconductor Devices		
Lecturer (for lectures)	Prijić P. Aneta		
Lecturer/associate (for exercises)	Prijić P. Aneta		
Lecturer/associate (for OFE)	Stojković S. Aleksandra, Vračar Zlatković M. Jana		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The objectives of the course are focused on: - Study of the structure and functioning principles of the basic semiconductor devices; - Getting acquainted with the current-voltage characteristics and safe operating area of the devices; - Understanding of the parameters from the datasheets of the devices; - Introduction to the main applications of semiconductor devices in electronic circuits; - Analysis of the behavior of devices within electronic circuits under different operating conditions.		
Course outcomes	Learning outcomes allow a student to: - Describe the structure, operation principle, and basic parameters that characterize specific groups of semiconductor devices; - Specify the basic applications of semiconductor devices in electronic circuits; - Select the appropriate semiconductor devices for a variety of practical applications based on their datasheets; - Analyze the functioning of devices within electronic circuits from the aspect of parameter tolerances and temperature stability using the LTSpice software tool; - Examine the operation of a given electronic circuit using laboratory measurement instruments (power source, signal generator, oscilloscope, multimeter).		
Course outline			
Theoretical teaching	Introduction. Overview of the basic types of semiconductor devices. Basic properties of semiconductors. Structure, operation principle, and characteristics of basic types of diodes. Applications of diodes. Structure, operation principle, and characteristics of bipolar junction transistor (BJT). Bipolar junction transistor as a switch. Bipolar junction transistor as an amplifier. Basic amplifier circuits with BJTs. Structure, operation principle, and characteristics of junction field effect transistors (JFET). Constant current sources with JFET. Structure, operation principle, and characteristics of metal-oxide-semiconductor field effect transistor (MOSFET). NMOS and PMOS field effect transistors. NMOS inverter. CMOS inverter. Multi-junction and other types of semiconductor devices.		
Practical teaching (exercises, OFE, study and research work)	Classroom exercises (solving problems). PC and laboratory exercises on the topics: Current-voltage characteristics of diodes; Diode rectifiers; Clippers and clampers with diodes; Voltage multipliers; BJT as a switch; BJT as an amplifier; Constant current sources with a JFET; NMOS and CMOS inverter.		
Textbooks/references			
1	R. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", 11th ed., Pearson, 2012.		
2	A. Malvino, D. Bates, "Electronic Principles", 8th ed., McGraw-Hill Education, 2016.		
3	J. Fiore, "Semiconductor Devices: Theory and Applications", 2021, Online Available: https://www2.mvcc.edu/users/faculty/jfiore/Linear/SemiconductorDevices.pdf		
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	0	0

Teaching methods	Theoretical lectures - using slides; Classroom exercises; PC exercises; Laboratory exercises; Project tasks presentations.

Grade (maximum number of points 100)

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

Colloquia	30		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Basics of Optics		
Lecturer (for lectures)		Živanović N. Emilija		
Lecturer/associate (for exercises)		Živanović N. Emilija		
Lecturer/associate (for OFE)		Živanović N. Emilija, Vračar Zlatković M. Jana		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	To introduce students to the fundamental properties of light and the physical laws it obeys. The course aims to provide both theoretical and practical knowledge necessary to understand key concepts from geometric, wave, and quantum optics, as well as the operating principles of optoelectronic components.			
Course outcomes	Upon successful completion of the course, the student is able to analyze and explain fundamental optical phenomena and processes, apply the laws and models of optics to solve practical problems, interpret the results of experimental measurements, and evaluate the performance of optical and optoelectronic systems. The student uses the acquired knowledge to select and apply appropriate methods and instruments in fields involving optical and optoelectronic processes.			
Course outline				
Theoretical teaching	The course covers physical processes based on the laws of geometric optics, including: Reflection of light from mirrors; Refraction of light through lenses and plane-parallel plates; Dispersion of light through optical prisms; Operating principles of optical instruments. From wave optics, the course includes: Interference and diffraction of light through single and multiple slits; Optical gratings; Polarization of light and its applications; Concept of coherent light. It also covers the physical foundations of the photoelectric effect, Compton effect, and X-ray radiation, as well as the operating principles of optoelectronic components.			
Practical teaching (exercises, OFE, study and research work)	Practical instruction will be delivered through exercises—both classroom (problem-solving) and laboratory-based—as well as through independent work on seminar papers. These activities will help students master concepts and effects from geometric and wave optics, understand the functioning of various optoelectronic components, and gain experience in their characterization and application in electronic circuits. Practical instruction takes place in the Laboratory of Physics.			
Textbooks/references				
1	Raymond A. Srway and John W. Jewett, Physics for Scientist and Engineers with Modern Physics, 9th Edition, Brooks/Cole, Cengage Learning, USA, 2014.			
2	Thomas L. Floyd and David M. Buchla, Electronics Fundamentals: Circuits, Devices and Applications, 8th Edition, Prentice Hall, Pearson, USA, 2010.			
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	0	0

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	5	**Written exam**	15
Exercises	10	**Oral exam**	15
Colloquia	30		
Projects	25		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Renewable Energy		
Lecturer (for lectures)	Pantić S. Dragan, Aleksić M. Sanja		
Lecturer/associate (for exercises)	Aleksić M. Sanja		
Lecturer/associate (for OFE)	Branković Lj. Neda		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	The aim of the course is to provide students with fundamental and applicable knowledge about various types of renewable energy sources (RES), their operating principles, advantages, limitations, and methods of integration into the energy system. Students will be equipped to perform basic technical and energy analyses of RES-based systems.
Course outcomes	Upon completion of the course, the student will be able to: Identify the main types of renewable energy sources and their characteristics; Understand the physical and technical principles of converting renewable resources into energy; Assess the technical and economic aspects of using renewable energy sources under specific conditions; Perform basic calculations and simulations of simple renewable energy systems.
Course outline	
Theoretical teaching	Introduction to renewable energy sources – importance, classification, and potentials. Solar radiation – characteristics and measurement. Photovoltaic systems – operating principles, components, and types. Solar thermal systems (water heating, solar collectors). Wind energy – wind characteristics, types of turbines. Hydropower – small and large hydroelectric plants. Geothermal energy – principles and applications. Biomass and biogas – characteristics and technologies. Modern hybrid systems – PV + batteries + diesel, wind + PV. Integration of RES into the grid – challenges, balancing, flexibility. Technical, economic, and environmental criteria for system selection. Legal regulations and incentives in Serbia and the EU. Sustainability, life cycle, and carbon footprint of RES. Backup and battery technologies for RES systems. Student presentations/practical projects.
Practical teaching (exercises, OFE, study and research work)	Calculation of solar radiation for a given location (using PVGIS), design of a simple PV system in PVsyst, calculation of wind turbine power based on wind speed, LCOE calculation for PV or wind energy systems, basic LCA analysis for PV or biomass systems (using Excel or SimaPro, if available). Design and calculation of a PV system for a rural household, comparison of energy yields for PV and wind energy in a specific region, LCOE analysis for solar and hybrid systems, selection of the most cost-effective RES system for a given application (water pumping, street lighting, etc.).
Textbooks/references	
1	Kaltschmitt, M., Streicher, W., & Wiese, A. (Eds.). Renewable Energy: Technology, Economics and Environment. (2007) Springer. https://doi.org/10.1007/978-3-540-34339-6
2	Twidell, J., & Weir, T. Renewable Energy Resources (3rd ed.). (2015) Routledge. https://doi.org/10.4324/9781315766416
3	PVGIS, NREL, Global Wind Atlas – online tools; PVGIS (Photovoltaic Geographical Information System): A web-based tool for estimating solar radiation and photovoltaic system performance at any location worldwide. NREL (National Renewable Energy Laboratory) tools: A suite of online resources for renewable energy data, modeling, and analysis, including the System Advisor Model (SAM) for energy system simulation. Global Wind Atlas: An online platform providing high-resolution wind resource data to support wind energy planning and development.
4	Solar Components: Solved Problems and Exercises, S. Aleksić, A. Pantić, N. Stanojević, A. Petković, D. Pantić, Faculty of Electronic Engineering, 2023. ISBN: 978-86-6125-263-1
5	Internal scripts and lectures by the instructors are available on the course website.

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures aimed at the theoretical understanding of the subject matter, using presentations and practical examples. Exercises include computational (analytical) tasks and laboratory work in computer and technical labs. Practical training using simulators. Team projects. Continuous assessment through quizzes, homework assignments, and projects.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	10	**Oral exam**	30
Colloquia	10		
Projects	25		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Measurements in Microelectronics		
Lecturer (for lectures)	Simić M. Milan		
Lecturer/associate (for exercises)	Đorđević-Kozarov R. Jelena, Jovanović R. Jelena		
Lecturer/associate (for OFE)	Đorđević-Kozarov R. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Education and introduction of students with basic theoretical and practical knowledge related to measuring basic parameters of analog and digital microelectronic components and circuits.		
Course outcomes	Students' training and ability to solve practical measurement problems in the field of microelectronics, based on a good knowledge of measurement methods and techniques, with the proper use of modern devices and equipment for measuring and testing microelectronic components and circuits.		
Course outline			
Theoretical teaching	The role and importance of measuring the parameters of microelectronic components and circuits. Metrological assurance of the measurement process and the accuracy of measurement results, Test engineering, Hardware components of systems for measuring the parameters of microelectronic components and circuits. Testing DC and dynamic parameters of ADC and DAC circuits. Equipment for automatic testing of microelectronic components and circuits (ATE). Microsensors and MEMS technology. Application of virtual measurement instrumentation in the process of measuring the parameters of microelectronic components and circuits.		
Practical teaching (exercises, OFE, study and research work)	Computational and laboratory exercises: training students to solve computational problems and the practical application of measurement methods and devices for measuring and testing microelectronic components and circuits, through engagement in computational, laboratory and demonstration exercises. The basic areas covered in laboratory exercises are: methods for measuring basic parameters and characteristics of semiconductor components, the application of modern measurement instrumentation as part of equipment for automatic testing of microelectronic components and circuits, and the application of virtual measurement instrumentation in the process of measuring parameters of microelectronic components and circuits. According to the instructions for working on laboratory exercises, students submit an appropriate report on each completed laboratory exercise.		
Textbooks/references			
1	Gordon W. Roberts, Friedrich Taenzler, Mark Burns, “An introduction to mixed-signal IC test and measurement, Second Edition”, Oxford University Press, 2012.		
2	S. Tumanski, “Principles of Electrical Measurements, Chapter 6. Computer Measuring Systems, Virtual Measuring Systems”, Taylor & Francis Group, 2006.		
3	Amir Afshar, “Principles of Semiconductor Network Testing”, Elsevier Inc., 1995.		
4	J. G. Webster, "Measurement, Instrumentation and Sensors Handbook", CRC Press, 2014.		
5	W. Nawrocki, Measurement Systems and Sensors. London, Artech House, 2005.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures (theoretical teaching) with graphical presentation of material in the form of slides. Computational exercises and practical teaching in the form of laboratory and demonstration exercises. Daily student consultations with teachers or associates. Individual work of students in the form of homework assignments and preparation of seminar papers.

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	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Dosimetry and Dosimeters		
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	None		
Course objectives	Mastering the basic knowledge of ionizing and non-ionizing radiation, dosimetric size and units, and basic types of radiation dosimeters.		
Course outcomes	Students' ability to apply acquired knowledge in professional work in conditions where elevated levels of radiation occur, as well as to successfully address the problem of dosimetry.		
Course outline			
Theoretical teaching	Theoretical lectures will take place in the following areas: Sources and types of radiation, division of radiation. Ionizing radiation: particulate and electromagnetic, the law of radioactive decay, dosimetric variables and units, radiation interaction with matter, radiation effects on living matter, radiation detection. Principle of work and description of different types of dosimeters of ionizing radiation. Non-ionizing radiation (radio-frequency and optical): characteristics, variables and units, measuring and instruments for measuring the electric field, biological effects.		
Practical teaching (exercises, OFE, study and research work)	Practical classes will take place through computational exercises. Solving concrete problems will enable students to acquire some practical knowledge.		
Textbooks/references			
1	G. Ristić, Dosimetry and dosimeters, script, Faculty of Electronic Engineering, Niš (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	0	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**	35
Exercises		**Oral exam**	35
Colloquia			
Projects	30		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electron Devices and Microsystems	
Type and level of studies		Undergraduate Academic Studies	
The name of the course		Applied Electromagnetics	
Lecturer (for lectures)		Raičević B. Nebojša, Jovanović B. Dejan	
Lecturer/associate (for exercises)		Raičević B. Nebojša, Cvetković N. Nenad	
Lecturer/associate (for OFE)			
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The objective of the course is to deepen knowledge in the field of electromagnetics, with particular emphasis on electromagnetic wave propagation, transmission lines, radiation, and basic concepts of electromagnetic compatibility, as well as to enable students to apply analytical and numerical methods in the analysis of electromagnetic phenomena and electronic devices.		
Course outcomes	Upon successful completion of the course, the student is qualified to analyze and solve basic problems in electromagnetics using Maxwell's equations, wave propagation models, and fundamental methods for the analysis of transmission lines, plane waves, and radiation. The student is able to calculate propagation parameters along transmission lines, analyze standing waves and reflections, determine characteristics of plane waves in different media, analyze basic antenna structures, and apply fundamental concepts of electromagnetic compatibility in assessing the behavior of electronic systems.		
Course outline			
Theoretical teaching	Electric and magnetic fields. Static and time-varying fields. Transmission lines: Wave propagation. Lossless transmission lines. Reflection coefficient. Standing waves. Electrostatics: Maxwell's equations. Electric scalar potential. Poisson's equation. Boundary conditions. Method of images. Magnetostatics: Biot–Savart law. Magnetic field of surface and volume currents. Ampère's law. Magnetic vector potential. Boundary conditions. Plane wave propagation: Polarization of plane waves. Phase and group velocity. Snell's laws. Fresnel coefficients of reflection and diffraction. Metamaterials. Radiation and antennas: Short dipole. Far-field region. Radiated power. Radiation pattern. Antenna gain. Electromagnetic compatibility.		
Practical teaching (exercises, OFE, study and research work)	Application of Maxwell's equations in the analysis of electric and magnetic fields. Determination of electric and magnetic fields for basic source distributions. Solution of Poisson's equation and application of boundary conditions. Method of images in electrostatics. Analysis of wave propagation along transmission lines: reflection coefficient, standing waves, and impedance. Plane electromagnetic waves: phase and group velocity, Snell's laws, Fresnel coefficients. Basic antenna radiation parameters: radiated power, gain, and radiation resistance.		
Textbooks/references			
1	F. T. Ulaby, "Fundamentals Applied Electromagnetics", Pearson, Prentice Hall, New York, 2010.		
2	J. Vanderlinde, "Classical Electromagnetic Theory", Kluwer Academic Publishers, 2004.		
3	H. Neff, "Introductory Electromagnetics", John Willey & Sons, 1991.		
4	D. M. Veličković, F. H. Uhlmann, K. Brandisky, R. D. Stancheva, H. Brauer, "Fundamentals of Modern Electromagnetics for Engineering", TU Ilmenau, Germany, 2005.		
5	E. Rothwell, M. Cloud, "Electromagnetics", CRC Press, 2001.		

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

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

Teaching methods	Lectures, auditory exercises, homework, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Differential equations		
Lecturer (for lectures)	Rančić Z. Lidija		
Lecturer/associate (for exercises)	Stankov D. Stefan		
Lecturer/associate (for OFE)			
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Gaining basic mathematical knowledge of differential equations. Developing skills of recognizing appropriate methods depending on real problem and application in practice.		
Course outcomes	Students' competence to put the gained knowledge into practice and studying. Competence to identify and define the problems, develop mathematical models, choose the appropriate methods for their solving and the application of methods.		
Course outline			
Theoretical teaching	Ordinary differential equations (ODE): Cauchy and boundary value problems, typess of solutions, methods for exact solving. Systems of ODE. Numerical solving of Cauchy problem ODE: Euler method, multistep methods, Runge-Kutta methods. Numerical solving of boundary problem ODE: finite differences method, variational methods. Error analysis. Stability. Partial differential equations (PDE): classification of problems and equations. Analytic methods for solving PDE. Numerical methods for solving PDE: finite differences method, finite element method.		
Practical teaching (exercises, OFE, study and research work)	Exercises of knowledge gained from the lectures. Practicing selection of methods for solving ODE and PDE and their application.		
Textbooks/references			
1	C. Henry Edwards, David E. Penney, Elementary Differential Equations with Boundary Value Problems. Academic Press, 2010, ISBN-13 978-0123747198		
2	Kendal Atkinson, Weimin Han, David Stewart, Numerical solution of ordinary differential equations, John Wiley and Sons Inc Publication 2009		
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	0	0

Teaching methods	Lectures, exercises, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Analog Microelectronics		
Lecturer (for lectures)		Prijić D. Zoran, Danković M. Danijel		
Lecturer/associate (for exercises)		Prijić D. Zoran		
Lecturer/associate (for OFE)		Danković M. Danijel, Mitrović I. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Learning objectives are defined so that the student will: - Learn the basic configuration of linear and switching power sources; - Learn about the basic architecture of the operational amplifier and the technology in which it is implemented; - Understand the purpose and principle of applying negative and positive feedback in the operating amplifier circuit as well as basic configurations; - Understand the difference between an ideal and a real operational amplifier; - Understand the meaning of parameters from the technical specification (datasheet) of the operational amplifier; - Learn applications of the operational amplifier; - Understand the influence of other components in the circuit on the operation of the operational amplifier and the function of the circuit itself; - Understand the principle and method of realization of analog / digital signal conversion.			
Course outcomes	Learning outcomes are defined so that the student will: - Distinguish the types of power supplies and DC/DC converters, their advantages and disadvantages for various applications; - Distinguish the types of operating amplifiers, using data from their technical specification; - Explain the concepts of using operational amplifiers for different applications; - Formulate the electrical specification of the electronic circuit with the selected operating amplifiers, for the given type of application; - Design and simulate a circuit with models of real operational amplifiers and other microelectronic components, using SPICE simulators; - Practically realize the designed circuit on a breadboard; - Examine the operation of the circuit, using laboratory instruments (power supply, signal generator, oscilloscope); - Diagnose and repair faults within the circuit; - Design an improved version of the circuit.			
Course outline				
Theoretical teaching	DC power supplies: linear, switching. Operational amplifiers, ideal and real. Frequency response of operational amplifiers. Basic configurations: Inverting, non-verifying, voltage follower. Applications of operational amplifiers: summing, integrator, differentiator, logarithmic and antilogarithmic, differential and instrumentation amplifiers, precision rectifiers, comparators, oscillators, multivibrators, transconductance amplifiers (OTA), attenuators; optionally: A / D converters.			
Practical teaching (exercises, OFE, study and research work)	Computer simulation of circuits with analog microelectronic components. Selection of operational amplifiers and other microelectronic components based on the data from technical specifications. Practical realization of the circuit with discrete components and integrated circuits, using breadboards. Checking the operation of the circuit and remedying the defects in the realization.			
Textbooks/references				
1	S. Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 4th Ed., McGraw-Hill, 2015.			
2	"Op Amp Applications Handbook", Analog Devices, 2005. https://www.analog.com/en/education/education-library/op-amp-applications-handbook.html			
3	"Op Amps for Everyone", ed by. R. Mancini, Texas Instruments 2002. http://web.mit.edu/6.101/www/reference/op_amps_everyone.pdf			
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	0	0
Teaching methods	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**	
Exercises		40	**Oral exam**	50
Colloquia				
Projects				

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Characterization of Electronic Devices		
Lecturer (for lectures)	Manić Đ. Ivica, Davidović S. Vojkan		
Lecturer/associate (for exercises)	Davidović S. Vojkan, Manić Đ. Ivica		
Lecturer/associate (for OFE)	Manić Đ. Ivica, Veljković Z. Sandra		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Mastering theoretical knowledge on which the most important techniques for the characterization of electronic components and microsystems are based, mastering the handling of standard laboratory devices and the practical application of individual techniques on standard components, as well as mastering techniques for processing and analyzing results.		
Course outcomes	Students understand the concept and structure of test chips and are able to perform measurements by accessing components on wafers with the help of an optical microscope and probes. They are able to use standard laboratory equipment and are proficient in recording I-V characteristics and measuring static and dynamic parameters of various types of electronic components and microsystems. They understand GPIB and RS232 protocols. They are proficient in interface characterization techniques. They are able to process measurement results, draw characteristics, perform necessary calculations and extract parameters. They are able to analyze the content of technical documentation. They know safety measures for high voltage measurements.		
Course outline			
Theoretical teaching	On-wafer characterization: the role of probes and optical microscopes; test chips and test structures. Component layout. Electrical characterization: transfer and output I-V characteristics. Measurement results processing, parameter extraction. Application of curve tracers and electrical parameter analyzers. In-package characterization of components: application of test adapters. Characterization of power devices and sensors. Techniques for characterization of interfaces and electrophysical parameters: CV technique, Charge Pumping technique, I-V techniques. Analytical techniques for characterization. Detailed analysis of technical documentation (datasheets) of components: parameters and their meaning. Instrument connectivity: GPIB and RS232 protocol. Safety measures for measurements requiring the application of high voltages.		
Practical teaching (exercises, OFE, study and research work)	The lecture exercises covered the areas of electrical characterization of components, results processing and parameter extraction, characterization of electrophysical parameters, analytical techniques, and chip topography and surface analysis. Laboratory exercises include: measurements on open components on wafers using probes, manual and automated (using a computer and appropriate software) recording of electrical characteristics of components in the housing - measurement of breakdown voltages and determination of static and dynamic parameters (resistance, forward voltage, threshold voltage, gain, transconductance) of various types of diodes, bipolar transistors, MOS transistors, thyristors, JFETs, CMOS inverters and sensor components using curve tracers Tektronix, electrical parameter analyzers, equipment for combined measurement and power supply (Source Measure Unit), C-V meters, oscilloscopes, signal generators and other universal power supply and measurement devices.		
Textbooks/references			
1	Badih El-Kareh, Richard J. Bombard, INTRODUCTION TO VLSI SILICON DEVICES - Physics, Technology and Characterization, Kluwer Academic Publishers, 2001, ISBN 0-89838-210-6		
2	The Parametric Measurement Handbook, Third Ed., March 2012, Agilent Technologies.		
3	Sony Tektronix 370 Programmable Curve Tracer, Operations manual		
4	D.K. Schroder, Semiconductor material and device characterization (3rd ed.), John Willey & Sons, New York, 2006, ISBN-13: 978-0-471-73906-7		
5	Technical documentation of laboratory measuring devices.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, classroom exercises, laboratory exercises, consultations

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	25	**Oral exam**	20
Colloquia	20		
Projects	10		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Simulation of microelectronic components and circuits		
Lecturer (for lectures)	Pejović M. Milić, Marjanović B. Miloš		
Lecturer/associate (for exercises)	Pejović M. Milić		
Lecturer/associate (for OFE)	Vračar Zlatković M. Jana		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to development of projects using various software packages intended for the simulation of microelectronic circuits.		
Course outcomes	Training for independent development of projects in various software packages intended for simulation of microelectronic circuits. Training for modeling at the component level as well as predicting the behavior of the component under the influence of various physical effects. Electronic circuit simulation and analysis, DC analysis, AS analysis, transient analysis as well as noise analysis and statistical analysis. Optimization and problem solving.		
Course outline			
Theoretical teaching	Introduction to software packages intended for simulation and modeling of microelectronic circuits. The simulations would be focused on learning about the basic peripherals of microcontrollers developed by different manufacturers as well as their practical application. Basic examples would cover digital inputs and outputs of microcontrollers, analog-to-digital conversion, basic communication protocols (I2C, SPI, UART) as well as connecting certain modules and their communication with the microcontroller with the aim of learning about the possibilities of developing more complex circuits based on microcontrollers.		
Practical teaching (exercises, OFE, study and research work)	Practical teaching involve the simulation of microcontroller-based circuits in one of the Arduino development environment emulators and their practical implementation. Circuits will be implemented that demonstrate the use of general-purpose input-output pins, timers, interrupts, analog-to-digital converters, UART, I2C, SPI communication interfaces of microcontrollers. Students will be trained to create libraries in the Arduino environment, design digital microcontroller systems using finite state machines. Through practical exercises, students will use the development environment and appropriate components and modules.		
Textbooks/references			
1	"MikroC Pro for PIC User Manual", MikroElektronika, 2009.		
2	Alyssa Pasquale, "Microcontrollers", College of DuPage, 2025.		
3	"SPICE a guide to circuit simulation and analysis using PC spice", Paul W. Tuinenga, Prentice Hall, New Jersey, 1993.		
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	0	0

Teaching methods	Lecture-based teaching, practical exercises in laboratory involving problem solving through the practical tasks and project-based learning individually or in teams, where students will work on different projects over extended time period.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	20	**Oral exam**	60
Colloquia	10		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Reliability of Microelectronic Devices		
Lecturer (for lectures)	Davidović S. Vojkan		
Lecturer/associate (for exercises)	Davidović S. Vojkan		
Lecturer/associate (for OFE)	Veljković Z. Sandra		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The aim of the course is for the student to master the basic skills in the field of reliability and failure diagnostics of microelectronic components. This includes knowledge of the elements of reliability theory (failure, reliability function, distribution functions, time to failure), knowledge of the causes of failure related to the structure of the component (substrate, oxide, metallization, housing), modeling of failure mechanisms, as well as knowledge of failure diagnosis techniques. The course also aims to introduce students to laboratory methods for accelerated testing (HALT, HASS, BURN-IN, thermal cycling, centrifugation), to existing standards (MIL-STD, IEC), and to enable students to define the necessary set of tests for reliability testing.		
Course outcomes	The student acquires the necessary theoretical and practical knowledge about the importance of testing and predicting the reliability and diagnostics of failures of microelectronic components. He is able to define a sampling plan, understand reliability tests, is able to perform failure cause analysis in the case of standard failure mechanisms, and knows how to calculate the mean time to failure of a device. The student knows the models for testing with elevated temperature, humidity, vibrations, electric field, thermal cycling. The student knows what MIL-STD and IEC standards are and knows how to define a set of tests according to the application of the component.		
Course outline			
Theoretical teaching	Component degradation and failure. Concept of failure mode, mechanism and cause. Elements of reliability theory. Bath-tub curve. Selection of reliable components. Accelerated testing - elevated temperature, humidity, voltage and mechanical stress tests. Reliability prediction and failure modeling. Failure physics: defects in the substrate, failures at contacts and metallization, failures in the oxide (breakdown, hot carriers, electrical stress), failures due to external effects (effect of moisture, ionizing radiation, electrostatic discharge. Failure diagnostics, non-destructive testing (radiography, PIND testing), electrical testing, structural characterization (optical microscopy, SEM, TEM, X and Auger spectroscopy, thermal imaging). Implementation of reliable components - redundancy. MIL-STD and IEC and standards.		
Practical teaching (exercises, OFE, study and research work)	Within the classroom part of the exercise, students master the necessary mathematical concepts related to the failure density function, time-to-failure calculations, calculations when selecting a sample from a large batch, calculations of acceleration factors during testing, and calculations necessary for setting testing conditions through tasks and examples. Within the practical part of the course, students learn and master the techniques of electrical characterization and failure diagnostics of components on wafers (using tracer, probe and optical microscope), as well as simpler techniques for opening the case (mechanical grinding on a CNC milling machine and chemical etching) and failure analysis of components of a lower level of complexity, which also includes analysis using an electron microscope. Students also perform NBTI experiments with MOS transistors at elevated temperatures. Visit to an industry that has a reliability testing department.		
Textbooks/references			
1	E.A. Amerasekera and D.C. Campbell, Failure Mechanisms in Semiconductor Devices, John Wiley, 1987		
2	F. Jensen, Electronic Component Reliability, John Wiley, 1995		
3	J. W. MsPherson, Reliability Physics and Engineering (Time-To-Failure Modeling), Springer, 2010, ISBN 978-1-4419-6347-5		
4	M. Ohring, Reliability and Failure of Electronic Materials and Devices, Academic Press, 1998		
5	Microelectronics Reliability, Elsevier, selection of the latests suitable papers from the field		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures (classical method and PowerPoint presentations), consultations, computational exercises with examples from practice, laboratory exercises (experiment with discrete components and stressing components to failure, decapsulation, electrical analysis of the chip, microscopy), seminar teamwork, homework.

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	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microwave Technique and Electronics		
Lecturer (for lectures)	Maleš-Ilić P. Nataša, Pronić-Rančić R. Olivera, Joković J. Jugoslav		
Lecturer/associate (for exercises)	Joković J. Jugoslav, Mladenović M. Ksenija		
Lecturer/associate (for OFE)	Joković J. Jugoslav, Mladenović M. Ksenija		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Acquiring theoretical and practical knowledge in the field of microwave techniques and electronics .		
Course outcomes	Acquire knowledge of the theory of EM wave propagation by transmission lines. Ability to use Smith chart in analysis / design of microwave circuits. Acquire knowledge of the wave parameters and ability to use them in the analysis and design of microwave circuits. Understand microstrip lines and acquire the ability to analyse, synthesize, and implement microstrip lines in microwave devices. Understand semiconductor components and learn the basic principles of the design of active microwave devices. Ability to use specialized software tools for analysis and optimization of microwave circuits and devices		
Course outline			
Theoretical teaching	Microwave properties, specifics and areas of application. Propagation through transmission lines. Characteristic parameters of transmission lines. Smith chart and its applications in the analysis of microwave circuits. Techniques for solving impedance matching problems in microwave circuits. Microstrip lines. Wave matrices. Determination of S parameters of networks and circuits with two and more ports.		
Practical teaching (exercises, OFE, study and research work)	Computational exercises. Practical work in laboratory.		
Textbooks/references			
1	Giovanni Ghione, Marco Pirola, Microwave electronics, Cambridge University Press, 2017.		
2	Andrey D. Grigoriev , Vyacheslav A. Ivanov , Sergey I. Molokovsky, Microwave Electronics, Springer, 2018.		
3	Subhash Chandra Bera , Microwave Active Devices and Circuits for Communication, Springer, 2019.		
4	D. Pozar, "Microwave Engineering - third edition", John Wiley & Sons, Inc., 2005.		
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	0	0

Teaching methods	Lectures. Auditory exercises. Laboratory work. Homeworks. 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	40		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Optoelectronic Devices		
Lecturer (for lectures)		Živanović N. Emilija		
Lecturer/associate (for exercises)		Živanović N. Emilija		
Lecturer/associate (for OFE)		Mitrović I. Nikola		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	To acquire theoretical knowledge necessary for understanding the operating principles of optoelectronic components, as well as their characterization and application.			
Course outcomes	Upon successful completion of the course, the student is able to analyze and explain the physical processes underlying the operation of optoelectronic components, evaluate their characteristics and application potential in various technical systems, apply acquired knowledge in the selection and interconnection of optoelectronic elements, interpret the results of measurements and testing of their parameters, and use microcontroller platforms to implement simple optoelectronic systems and devices.			
Course outline				
Theoretical teaching	Students will be introduced to the following topics: Nature of light. Light as an electromagnetic wave. Photometry. Wave optics. Spectra. Introduction to quantum theory. Thermal radiation of a blackbody. Photoelectric effect. Compton effect. Wave-particle duality. Heisenberg's uncertainty principle. Operating principles of various optoelectronic components, such as LED diodes, RGB diodes, photoresistors, phototransistors, and optocouplers. Operating principles and applications of Arduino microcontrollers.			
Practical teaching (exercises, OFE, study and research work)	Practical instruction is conducted in the Laboratory for Practical Training in the Electronic Components and Microsystems module. It includes demonstrations and hands-on presentations of the operation of various optoelectronic components (LED diode, RGB diode, photoresistor, phototransistor, optocoupler, etc.), their characterization and application in electronic circuits, as well as spectrum acquisition and simulation using various software tools. The basics of using Arduino microcontrollers are also covered.			
Textbooks/references				
1	Xun Li, Optoelectronic Devices, design, modeling, and simulation, Cambridge University press, 2010.			
2	Raymond A. Serway, John W. Jewett, Jr., Physics for scientists & engineers with modern physics, tenth Edition, Cengage, 2018.			
3				
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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	1	1	0	0

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	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Component and Circuit Modeling		
Lecturer (for lectures)	Marjanović B. Miloš		
Lecturer/associate (for exercises)	Marjanović B. Miloš		
Lecturer/associate (for OFE)	Marjanović B. Miloš		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The course objectives are defined so that the student will: become familiar with SPICE and Verilog models of components and circuits; be capable of using software tools based on SPICE and the Vivado tool for modeling and simulating components and circuits; understand the importance of component and circuit models in accelerating the development of complex systems.		
Course outcomes	The learning outcomes specific to the course are defined so that the student will: distinguish between SPICE and Verilog models of components and circuits; create and modify SPICE netlists and perform circuit simulations in various domains using SPICE-based software tools; create circuit models using the Verilog language and perform simulations using the Vivado software tool; analyze the behavior of modeled circuits and debug any encountered errors.		
Course outline			
Theoretical teaching	Introduction to SPICE (Simulation Program with Integrated Circuit Emphasis), model accuracy and convergence. Types of analysis: DC, AC, and transient simulation. Sources and subcircuits in SPICE. SPICE models of passive and active electronic components. Modeling of temperature effects and component self-heating. Noise modeling. Using SPICE libraries. Extraction of model parameters from measured data. Introduction to Verilog (lexical conventions, modules, data types, operators). Gate-level modeling in Verilog. Behavioral modeling in Verilog (procedural block statements, conditional assignment statements, loops). Verilog models of digital components and circuits.		
Practical teaching (exercises, OFE, study and research work)	During practical classes, students will work in simulation environments on computers, using LTspice for simulations based on SPICE models, as well as Vivado for digital modeling in the Verilog language. Within the LTspice environment, topics such as types of analysis (DC, AC, and transient analysis), the use of signal generators and subcircuits, as well as modeling of passive and active electronic components, will be covered. In the Verilog section, through the Vivado tool, students will learn the basics of the language's lexical structure, module creation, working with data types and operators, as well as logic and behavioral modeling of digital components and circuits.		
Textbooks/references			
1	Paul Tuinenga, SPICE – a Guide to Circuit Simulation and Analysis Using Pspice, Prentice Hall, 1995.		
2	R. Jacob Baker - CMOS Circuit Design, Layout, and Simulation, IEEE Press Series on Microelectronic Systems, John Wiley & Sons, 2019.		
3	Stephen Brown, Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design, McGraw Hill, 2014.		
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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	1	1	0	0

Teaching methods	Theoretical lectures. Practical computer-based exercises. Independent student work through homework assignments. Consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Layout Design of Components and Circuits		
Lecturer (for lectures)		Marjanović B. Miloš		
Lecturer/associate (for exercises)		Marjanović B. Miloš		
Lecturer/associate (for OFE)		Marjanović B. Miloš		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	The course objectives are defined so that the student will: become familiar with the types of processes and software tools used for the layout design of components and circuits; become familiar with the layout design rules for microelectronic circuits, with a particular focus on the design and optimization of components such as resistors, capacitors, MOS transistors, diodes, and bipolar transistors; be capable of using the Glade software tool for layout design; understand the concepts of component matching and strategies for minimizing undesired effects in the layout design process.			
Course outcomes	The learning outcomes specific to the course are defined so that the student will: distinguish between different types of processes and be familiar with the basic layout design rules for components and circuits; design and optimize layouts of microelectronic circuits, including the design of basic electronic components; analyze strategies for minimizing undesired effects in the layout design process.			
Course outline				
Theoretical teaching	Design flow. Software tools in the layout design process. Wells: design rules. Metal layers: design rules. Role of silicide. Active and poly layers: design rules. Resistors: design rules. Guard ring. On-chip capacitors and inductors. MOS transistors: design rules. Diode layouts. Bipolar transistor layouts. Component matching. Noise issues. Antenna effect. Electrostatic discharge (ESD) protection. CMOS Inverter layout. Logic gate layouts. Current mirror layout. Amplifier layout.			
Practical teaching (exercises, OFE, study and research work)	Design of the layout of resistors, capacitors, MOS transistors, inverters, combinational logic circuits, current mirrors, voltage references, amplifiers, and differential amplifiers using the open-source software tool Glade (Peardrop Design Systems) or similar tools.			
Textbooks/references				
1	Alan Hastings, The Art of Analog Layout, Pearson, 2024.			
2	R. Jacob Baker - CMOS Circuit Design, Layout, and Simulation, IEEE Press Series on Microelectronic Systems, John Wiley & Sons, 2019.			
3	Mikael Sahrling, Layout Techniques for Integrated Circuit Designers, Artech House, 2022.			
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	0	0

Teaching methods	Theoretical lectures. Practical exercises. Independent student work through homework assignments and a final project. Consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Custom laboratory systems design		
Lecturer (for lectures)		Pejović M. Milić		
Lecturer/associate (for exercises)		Pejović M. Milić		
Lecturer/associate (for OFE)		Pejović M. Milić		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Mastering the knowledge necessary to understand the concept of custom designed laboratory systems and their application in modern laboratories.			
Course outcomes	Training for independent design, implementation and application of special purpose laboratory systems. The outcome of the course is focused on enabling students to design, implement and automate specialized measurement and research systems that are not commercially available on the market. Students would be trained to make a smart, automated system from a laboratory where manual measurements are performed, where a single click on a computer runs a complex experiment that collects thousands of data per second, performs their analysis and generates a ready-made report.			
Course outline				
Theoretical teaching	Introduction to the concept of custom designed laboratory systems. Design of software support for general-purpose commercial devices and their integration into complex measurement systems. Data acquisition, storage and visual display. Basic concepts of data acquisition with the implementation of practical examples using acquisition cards and the implementation of software support. Basic concepts and examples of the implementation of special-purpose laboratory systems not available on the market. Design of software support for both personal computers and mobile devices.			
Practical teaching (exercises, OFE, study and research work)	Practical teaching takes place in the laboratory and involves the practical realization of various types of complex laboratory systems. The focus would be on creating fast and automated experimental measurement systems as well as their testing.			
Textbooks/references				
1	John Park, Steve Mackay, Edwin Wright, "Data communications for instrumentation and control", 2003.			
2	"Data Acquisition and Control Handbook", 1. edition, Keithley Instruments			
3	Sandip Das, "Laboratory manual for enginerring electronics", 2019, open textbook, Kenshaw University.			
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	0	0

Teaching methods	Lecture-based teaching, practical exercises in laboratory involving problem solving through the practical tasks and project-based learning individually or in teams, where students will work on different projects over extended time period.

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	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital Microelectronics		
Lecturer (for lectures)	Danković M. Danijel, Prijić D. Zoran		
Lecturer/associate (for exercises)	Danković M. Danijel, Stojković S. Aleksandra		
Lecturer/associate (for OFE)	Danković M. Danijel, Stojković S. Aleksandra		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to basic digital microelectronic circuits and their practical implementation.		
Course outcomes	Learning outcomes are defined so that the student, in addition to theoretical knowledge, will have: Ability to use of digital circuit simulator. The ability to choose the types of digital microelectronic circuits, using data from their technical specification. The ability to use digital circuits in practice. Adopted technique of testing the operation of circuits, using laboratory instruments (power supply, signal generator, oscilloscope). The ability of diagnose and repair faults within the circuit.		
Course outline			
Theoretical teaching	Basic logic gates: gates technology - CMOS logic circuits, TTL logic. Combinational logic circuits: a universal logic elements, combining the functions of logic - adders, comparators, encoders and decoders, multiplexers and demultiplekseri. Bistable memory unit: latch, flip-flop, flip-flop types and implementation. Counters: asynchronous and synchronous counters, counter design, cascading counters. Shift registers: types of registers, shift registers as counters, other applications of shift registers. Memory: RAM, ROM, flash. D/A conversion.		
Practical teaching (exercises, OFE, study and research work)	Computer simulation of circuits with digital microelectronic components. Selection of digital components on the basis of the technical specifications (datasheets). Practical implementation of digital circuits, on a breadboard level.		
Textbooks/references			
1	Thomas L. Floyd, „Digital Fundamentals“, 11th Edition, Pearson Education, 2015, ISBN 978-1-292-07598-3.		
2	William Kleitz, „Digital Electronics a Practical Approach with VHDL“, 9th Edition, Pearson Education, 2012, ISBN 978-0138146467.		
3	Andrew Rushton, „VHDL for Logic Synthesis“, 3rd Edition, A John Wiley and Sons, 2011, ISBN 978-4709787972.		
4	A. Anand Kumar, „Fundamentals of Digital Circuits“, 4th Edition, PHI Learning Private Limited, 2016, ISBN 978-81-203-5268-1.		
5	Dhanasekharan Natarajan, „Fundamentals of Digital Electronics“, Springer, 2020, ISBN: 978-3-030-36195-2.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures; Computer simulations; Practical laboratory work; Consultation.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Electron Devices and Microsystems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Sensors and Actuators	
Lecturer (for lectures)			Vračar M. Ljubomir, Pejović M. Milić	
Lecturer/associate (for exercises)			Vračar M. Ljubomir	
Lecturer/associate (for OFE)			Vračar M. Ljubomir, Stojanović D. Milan	
Number of ECTS		6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None			
Course objectives	Acquiring the knowledge for understanding and practical application of modern sensor components and their application in Microsystems.			
Course outcomes	Upon successful completion of this course, the student will be able to explain the operating principles of various types of sensors and transducers, analyze their static and dynamic characteristics, design accompanying electronic circuits for signal processing, and apply appropriate measurement solutions in industrial and biomedical systems.			
Course outline				
Theoretical teaching	Information-processing systems. Measurement and control systems. Actuators. Sensor definitions and classification. General sensor characteristics and limitations. Parameters definition. Sensor calibration methods. Error corrections. Fabrication technology. Reliability issues. Sensors for radiation, mechanical, thermal ,magnetic , chemical and biological signals. Sensors design and operation. Applications. Smart integrated sensors and actuators. Functional blocks. Micro-electro-mechanical sensors (MEMS), technology, components and systems. Integrated sensors and MEMS components.			
Practical teaching (exercises, OFE, study and research work)	The laboratory exercises include courses on sensors operation and electrical characterisitcs found in practice. Especially, the introductory cource is aimed to educate students with programing micorcontrolers for data processing from different snensor devices.			
Textbooks/references				
1	J. Fraden, Handbook of modern sensors: physics, designs, and applications, 3rd ed. New York: Springer, 2004.			
2	J. G. Webster, Measurement, instrumentation, and sensors handbook: CRCnetBASE, 1999. Boca Raton, Fla.: Chapman & Hall/CRCnetBASE, 1999.			
3	S. W. Smith, Digital signal processing: a practical guide for engineers and scientists. in Demystifying technology series. Amsterdam: Newnes, 2003.			
4	Analog Devices, inc and D. H. Sheingold, Eds., Transducer interfacing handbook: a guide to analog signal conditioning, 1st. ed. in Analog Devices technical handbooks. Norwood, Mass: Analog Devices, 1980.			
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	0	0

Teaching methods	Lectures; Computer simulations; Practical laboratory work; Consultation.

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		Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Design of Microelectronics Devices		
Lecturer (for lectures)		Pantić S. Dragan		
Lecturer/associate (for exercises)		Branković Lj. Neda		
Lecturer/associate (for OFE)		Branković Lj. Neda		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Acquisition of knowledge and practical skills in the design, simulation, and analysis of microelectronic components (MOSFET, diodes, BJT, IGBT) using Silvaco tools. Through theoretical and laboratory work, students will learn how to simulate technological processes (diffusion, deposition, lithography), analyze electrical characteristics, and perform 2D/3D modeling of semiconductor structures.			
Course outcomes	Upon completion of the course, the student will be able to: Understand the technological processes involved in integrated circuit fabrication; Create 2D/3D models in Athena and simulate them in Atlas; Perform structural and electrical analysis using the DeckBuild interface; Analyze operating parameters of transistors and other components; Interpret simulation results such as I–V and C–V characteristics, doping profiles, electric fields, and temperature distributions.			
Course outline				
Theoretical teaching	Introduction to microelectronics design. Overview of CMOS technology and basic components. Technological processes: deposition, diffusion, lithography. Physical models of semiconductors. MOSFET design – structure and operation. Electrical analysis of MOSFETs. Introduction to 3D simulation. BJT transistor design. Capacitance, interface monitoring, and C–V characteristics. Optimization and parametric analyses. Simulation of advanced structures: SOI, LDMOS. Assessment of technology impact on device characteristics. Project preparation: task definition. Project development and analysis. Project presentations and discussions.			
Practical teaching (exercises, OFE, study and research work)	Basics of working with DeckBuild: commands, input, simulation, creating a p–n junction – structure, doping profiles, I–V analysis; technological process flow for NMOS transistor; electrical characteristics of MOSFETs (Vth, ID, SS); static analysis of BJT transistor; simulation of C–V characteristics and dielectric models; project – 2D structure of choice (MOSFET, diode, IGBT).			
Textbooks/references				
1	Sze, S. M., & Ng, K. K. Physics of Semiconductor Devices (3rd ed.). (2007). Wiley.			
2	Taur, Y., & Ning, T. H. (2009). Fundamentals of Modern VLSI Devices (2nd ed.). Cambridge University Press.			
3	Silvaco User Manuals: Athena, Atlas, DeckBuild			
4	Pantić, D., Pešić, T., & Jovanović, E. (2020). Modeling and Simulation in Microelectronics. University of Niš, Faculty of Electronic Engineering. ISBN: 9788680321346			
5	Internal scripts and lectures by the instructors are available on the course website.			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures focused on theoretical mastery of the material, using presentations and practical examples. Exercises include computational (analytical) tasks and laboratory work in computing and technical labs. Practical simulator-based training. Team projects. Continuous assessment through quizzes, homework assignments, and projects.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	10	**Oral exam**	30
Colloquia	10		
Projects	25		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Photovoltaic devices and systems		
Lecturer (for lectures)	Pantić S. Dragan, Aleksić M. Sanja		
Lecturer/associate (for exercises)	Aleksić M. Sanja		
Lecturer/associate (for OFE)	Aleksić M. Sanja, Branković Lj. Neda		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Acquisition of theoretical and practical knowledge about individual components and the overall architecture of photovoltaic (PV) systems. Students will become familiar with the operating principles, characteristics, design, and integration of PV systems into the electrical grid and standalone (off-grid) systems.
Course outcomes	Upon completion of the course, the student will be able to: Understand the physics and electrical operation of photovoltaic cells; Identify and select key components of PV systems; Design basic configurations of PV systems (on-grid and off-grid); Perform energy production simulations using software such as PVsyst or MATLAB/Simulink; Analyze the impact of environmental conditions on system performance.
Course outline	
Theoretical teaching	Introduction to photovoltaic systems and renewable energy sources. Principles of photovoltaic cell operation. Characteristics of PV modules (I–V and P–V curves). Types of PV modules: monocrystalline, polycrystalline, thin-film. Inverters and MPPT algorithms. Batteries and energy storage systems. Charge controllers, DC/DC converters. PV system configurations: on-grid, off-grid, hybrid. Impact of meteorological conditions (global irradiance, temperature, albedo). Mechanical and electrical characteristics of components. Sun tracking (solar trackers). Simulation of PV system performance using PVsyst. Economic analysis: LCOE, payback period, subsidies. Standards, certification, and safety of PV systems. Student presentations and project work.
Practical teaching (exercises, OFE, study and research work)	Simulation of I–V characteristics of a PV module in MATLAB. Calculation of solar radiation on an inclined surface. Simulation of MPPT algorithm in Simulink (Perturb & Observe method). Design and calculation of a battery storage system for an off-grid installation. Simulation of PV system performance in PVsyst for a selected location.
Textbooks/references	
1	Sera, D., Kerekes, T., & Teodorescu, R. PV System Modeling and Design. (2021) Wiley-IEEE Press. https://doi.org/10.1002/9781119871119
2	PVsyst SA. (n.d.). PVsyst Help & Tutorials. Retrieved June 2, 2025, from https://www.pvsyst.com/help
3	MathWorks. (n.d.). MATLAB/Simulink Examples for PV Modeling. Retrieved June 2, 2025, from https://www.mathworks.com/help/physmod/sps/examples.html
4	Solar Components: Solved Problems and Exercises, S. Aleksić, A. Pantić, N. Stanojević, A. Petković, D. Pantić, Faculty of Electronic Engineering, 2023. ISBN: 978-86-6125-263-1
5	Internal scripts and lectures by the instructors are available on the course website.

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	2	0	0

Teaching methods	Lectures are focused on the theoretical mastering of the material, supported by presentations and practical examples. Exercises include computational (analytical) tasks and laboratory work in computing and technical labs. Practical training with simulators. Team projects. Continuous assessment through quizzes, homework assignments, and projects.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	10	**Oral exam**	30
Colloquia	10		
Projects	25		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Data transfer protocols		
Lecturer (for lectures)	Pejović M. Milić		
Lecturer/associate (for exercises)	Stojanović D. Milan		
Lecturer/associate (for OFE)	Stojanović D. Milan		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to communication protocols for data transmission. Introduction to the design and architecture of hardware in which different communication protocols are used. Design of software support for different communication protocols.		
Course outcomes	Training for independent design and implementation of parts as well as complete systems with the implementation of communication protocols. The outcome of the course focuses on understanding the rules, algorithms, and architectures that enable different devices to successfully and securely exchange information.		
Course outline			
Theoretical teaching	Introduction to communication protocols for data transfer. Introducing students with the design and architecture of hardware in which different communication protocols are used. Designing software support for different communication protocols. Practical examples of the implementation and use of systems based on standard communication protocols available on the market. Communication protocols for communication between microcontrollers and different environments (I2C, SPI, UART). Standard protocols for connection and communication between personal computers and various instrumentation (RS232, RS485, GPIB, HID).		
Practical teaching (exercises, OFE, study and research work)	Practical teaching takes place in the laboratory and includes practical examples of different communication protocols and their testing on specific laboratory devices and systems.		
Textbooks/references			
1	Steve Heath, "Embeded system design", Elsevier, 2003.		
2	"Data acquisition handbook", Measurement Computing Corporation, USA, 2012.		
3	"Embedded Hardware Communication for Beginners: A Practical Guide to UART, SPI, I2C & Other Wired Communication Protocols", Zlatica Kos, Indipendently published, 2026.		
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	0	0

Teaching methods	Lecture-based teaching, practical exercises in laboratory involving problem solving through the practical tasks and project-based learning individually or in teams, where students will work on different projects over extended time period.

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		Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Design of Programmable Components		
Lecturer (for lectures)		Danković M. Danijel, Marjanović B. Miloš		
Lecturer/associate (for exercises)		Danković M. Danijel		
Lecturer/associate (for OFE)		Marjanović B. Miloš		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Extending the knowledge of basic digital microelectronic components and circuits and their practical implementation. Introduction to VHDL programming, software packages for programming of FPGA circuits and FPGA development boards.			
Course outcomes	Learning outcomes are defined so that the student, in addition to extensive theoretical knowledge of digital microelectronic components and circuits, will have: Mastering the basis of the VHDL programming language and the ability to implement hardware design on a FPGA chip by using software packages. Adopted technique of checking the functionality of programmed circuits using development kits.			
Course outline				
Theoretical teaching	Basic concepts of hardware description languages. An introduction to VHDL. Organization of VHDL code: declaration of libraries and packages; entity declaration; architecture description. Language constructions of VHDL code. Signal assignements in VHDL: When and Select. Process and Wait statements. If statements, Case statements and Loops. VHDL code examples of combinational and sequential circuits. Creating a project in one of the software packages, entering of VHDL code, simlation and functional verification. Use of development kits for implementing hardware design on FPGA chip. Checking the functionality of programmed circuits using development kits			
Practical teaching (exercises, OFE, study and research work)	Practival lectures take place in the laboratory. Description of digital devices and circuits using VHDL. Simulation of digital devices and circuits. Creating a project in one of the software packages, entering of VHDL code, simulation and functional verification of digital devices and circuits.			
Textbooks/references				
1	Andrew Rushton, „VHDL for Logic Synthesis“, 3rd Edition, A John Wiley and Sons, 2011, ISBN 978-4709787972.			
2	William Kleitz, „Digital Electronics a Practical Approach with VHDL“, 9th Edition, Pearson Education, 2012, ISBN 978-0138146467.			
3	Stephen Brown, Zvonko Vranesic, „Fundamentals of Digital Logic with VHDL Design“, 3rd Edition, McGraw-Hill, 2009, 978–0–07–352953–0.			
4	Majid Pakdel, „Fundamentals of VHDL for FPGA Programming Using Vivado“, Wiley Online Library, 2025, Online ISBN 9781394343126.			
5	Charles H. Roth, Jr., Lizy Kurian John, „Digital Systems Design Using VHDL“, Cengage Learning, 2018, ISBN: 978-1-305-63514-2.			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	2	0	0

Teaching methods	Lectures; Computer simulations; Practical laboratory work; Consultation.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	30
Exercises	20	**Oral exam**	30
Colloquia			
Projects	20		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital TV systems, services and components		
Lecturer (for lectures)	Joković J. Jugoslav		
Lecturer/associate (for exercises)	Joković J. Jugoslav, Atanasković S. Aleksandar		
Lecturer/associate (for OFE)	Joković J. Jugoslav, Perić S. Nemanja		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The course provides fundamental knowledge in the field of digital television, transmission and reproduction of television content to the users. Digital TV technologies are being processed within the DVB standard, focusing on the architecture and design of software for digital TVs.		
Course outcomes	Students will be able to analyze devices that receive and play digital TV content. Within the practical work, students analyze the real set-top box in accordance with the DVB-T2 standard. They will fully understand all the broadcasting phases, as well as content reproducing solutions and controls the processing of all components of digital TV content, including audio, video and graphics on the TV screen.		
Course outline			
Theoretical teaching	The main advantages and disadvantages of digital transmission; Digital broadcasting and receiving techniques; Standards in DTV - DVB; Architecture of digital TV receivers; Input level; Transceiver Processor; Decoder; Output interfaces; Communication between integrated circuits; Digital TV software; Architecture of TV applications; Access control systems for content; Conditional access to DVB; Scrambling; Security features in hardware and software; System integration and practical aspects; Components of DTV receivers; DTV middleware; Convergence in Television and Two-way communication; Hybrid television; Television over IP; Internet Television and Over-The-Top Services; Actual standards: HbbTV, MHEG.		
Practical teaching (exercises, OFE, study and research work)	Practical exercises involve solving problems in areas that are covered by the content of the subject. Laboratory exercises through practical work include the characterization of the receiver and measurement of the digital TV signal transmitter.		
Textbooks/references			
1	E. P. J. Tozer, Broadcast Engineer's Reference Book, Focal Press, Oxford, 2004.		
2	J.C. Whitaker, Standard Handbook of Broadcast Engineering, McGraw-Hill, NY 2005.		
3	U. Reimers, DVB - The Family of International Standards for Digital Video Broadcasting, Springer, 2005.		
4	H. Benoit, Digital Television - Satellite, Cable, Terrestrial, IPTV, Mobile TV in the DVB Framework, Focal Press 2008.		
5	W. Ficher, Digital Video and Audio Broadcasting Technology, Springer, 2010		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures, classroom exercises, practical work in the laboratory

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	3D printing Technologies		
Lecturer (for lectures)	Vračar M. Ljubomir, Pejović M. Milić		
Lecturer/associate (for exercises)	Vračar M. Ljubomir		
Lecturer/associate (for OFE)	Stojanović D. Milan		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Acquiring the knowledge for understanding 3D printing technologies		
Course outcomes	Upon successful completion of this course, the student will be able to classify and compare leading additive manufacturing technologies and associated materials, apply engineering design principles for 3D printing, independently prepare and optimize digital models in slicing software, as well as operate the equipment, troubleshoot printing defects, and perform adequate post-processing of finished parts.		
Course outline			
Theoretical teaching	This course introduces students to additive manufacturing technologies with a focus on 3D printing principles, processes, and applications. It explores the development of digital models, material selection, and the operation of various 3D printing systems. Emphasis is placed on understanding layer-by-layer fabrication, design for additive manufacturing, and post-processing techniques. The course also covers the role of additive technologies in prototyping, production, and innovation across industries. Students will gain practical experience in model preparation, printer calibration, and evaluating the mechanical and functional properties of printed parts, preparing them for advanced applications in engineering and product development.		
Practical teaching (exercises, OFE, study and research work)	Anatomy of 3D printer. Using softwares for 3D printing. Using 3D scanners. Post procesing of 3D printed objects.		
Textbooks/references			
1	L. Jyothish Kumar, Pulak M. Pandey, David Ian Wimpenny, "3D Printing and Additive Manufacturing Technologies", Springer, 2019.		
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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	1	1	0	0

Teaching methods	Lectures; Computer simulations; Practical laboratory work; Consultation.

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	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microsystems Design		
Lecturer (for lectures)	Prijić P. Aneta		
Lecturer/associate (for exercises)	Prijić P. Aneta, Stojković S. Aleksandra		
Lecturer/associate (for OFE)	Prijić P. Aneta, Stojković S. Aleksandra		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The objectives of the course are focused on: - Introduction to the basic steps of the microsystems design process; - Indicating the importance of the computer-aided design (CAD) of microsystems; - Understanding the operation principles of the basic components of the microsystems (sensors and actuators); - Presentation of materials and technologies involved in the fabrication of microsystems; - Getting acquainted with the laws of mechanics, fluid flow, and heat transfer involved in the microsystem design process; - Analysis of the scaling laws in microsystems; - Mastering the software tool ANSYS Workbench to design and analyze the functioning of the microsystems.		
Course outcomes	Learning outcomes allow a student to: - Specify the basic phases and activities related to the design of the microsystems; - Clarify the necessity of using a computer in designing microsystems; - Explain the structure, the principle of operation, and the limitations of the various components of the microsystems; - Describe the basic materials and technologies used for the fabrication of the microsystems; - Indicate the basic physical, fluid flow, and heat transfer laws necessary in microsystems design; - Summarize the significance of the scaling laws of microsystems for their application; - Create an adequate project that analyzes the functionality of the given microsystem in the ANSYS Workbench software package; - Design components of microsystems that meet specified characteristics with the help of the software tool ANSYS Workbench.		
Course outline			
Theoretical teaching	Introduction. Steps in the microsystems design procedure. Basic design settings. Design analysis. Verification of a design. Design and analysis of microsystems using a computer (CAD). Interdependence of microsystems components. Characteristics of sensors as microsystems components. Principles of operation of microactuators. Materials for microsystems fabrication. Technologies for microsystems manufacturing. Laws of mechanics, fluid flow, and heat transfer in the design of microsystems. Scaling laws of the microsystems. Analysis of microsystems based on the pressure sensors and thermoelectric generators.		
Practical teaching (exercises, OFE, study and research work)	Classroom exercises (solving problems). PC exercises in ANSYS Workbench software on topics related to the design and analysis of microsystems: bending of a monolithic cantilever beam under steady-state and transient applied forces; bilayer strip as a microactuator; accelerometer with inertial mass; micro thermoelectric generator; blade-type electro-thermo-mechanical microactuator.		
Textbooks/references			
1	Chang Liu,"Foundations of MEMS", 2nd ed., Pearson Education, 2012.		
2	Tai-Ran Hsu, "MEMS and Microsystems: design, manufacture, and nanoscale engineering", 2nd ed., John Wiley & Sons, Inc., 2008.		
3	Written and video tutorials for ANSYS Workbench, Online Available: https://www.ansys.com/academic/learning-resources.		
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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	0	0

Teaching methods	Theoretical teaching - using slides; Classrom exercises; Demonstration teaching - presenting realized microsystems; Exercises using PC. Project tasks presentation.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	20	**Written exam**	25
Exercises	30	**Oral exam**	25
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Printed Circuit Boards Design		
Lecturer (for lectures)	Prijić D. Zoran, Danković M. Danijel		
Lecturer/associate (for exercises)	Prijić D. Zoran, Danković M. Danijel		
Lecturer/associate (for OFE)	Stojković S. Aleksandra		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Learning objectives are defined so that the student will: - Know the process of designing printed boards and to apply it in practice; - Know the process of designing an electronic device as a whole; - Be able to use software packages for electrical (ECAD) and mechanical (MCAD) design; - Understand the principle of ECAD-MCAD Collaboration and basic concept of Product Data Management (PDM); - Have the knowledge and confidence to analyze and improve existing ones, as well as to create new projects; - Adopt a behavioral pattern necessary for productive teamwork.		
Course outcomes	Learning outcomes are defined so that the student will: - Distinguish between different types of printedcircuit boards, elements of their structure and technology of their production; - Explain the procedure and phases of designing electronic product collaboratively using ECAD and MCAD packages; - Formulate the functional, electrical and mechanical specifications of the product and break it at the block / logic level; - Design and examine electrical schematic, using ECAD package; - Construct electro-mechanical parts and sub-assemblies, using MCAD package; - Design a printed circuit board, using ECAD package; - Compile and check the whole device assembly, using ECAD and MCAD package; - Create project and production documentation, using ECAD and MCAD packages; - Propose product versions with enhanced / expanded specifications, as a member of the project team;		
Course outline			
Theoretical teaching	"Technology of printed circuit board production. SMD assembly technology components. Single and double sided boards. Electromechanical design. Software packages for electrical and mechanical design. 3D modeling of components, printed boards and enclosures. Design rules. Layout of the components on the board. Model exchange between ECAD and MCAD package. Design for production. Introduction to the product data management and collaborative design. More details in: D. Danković, Lj. Vračar, A. Prijić, Z. Prijić, „An Electromechanical Approach to a Printed Circuit Board Design Course“, IEEE Trans. Education, Vol. 56, No. 4, pp. 470-477, 2013."		
Practical teaching (exercises, OFE, study and research work)	Use of ECAD and MCAD packages. Electromechanical design and practical realization of device models (electrical schematic, printed circuit board, connectors, harnessing, housing, technical documentation).		
Textbooks/references			
1	C. Combs and H. Holden, "Printed Circuits Handbook", 7th ed., McGraw-Hill Education, 2016.		
2	C. Robertson, "Printed Circuit Board Designer's Reference: Basics", Prentice Hall, 2003.		
3	Built-in help systems of ECAD and MCAD pacakages		
4	Application notes of electronic devices' manufacturers		
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	0	0

Teaching methods	Project teaching - entire content is practically applied to the project of an electronic apparatus (device). The device is conceived as a generic, so it is a basis that can be modified, enhanced, and expanded, on which the content of student activities is based. 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	40	**Oral exam**	25
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Optoelectronics		
Lecturer (for lectures)	Paunović V. Vesna		
Lecturer/associate (for exercises)	Mitrović I. Nikola		
Lecturer/associate (for OFE)	Mitrović I. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to the light properties, light sources and detectors, and optoelectronic circuits and systems.		
Course outcomes	The learning outcome enables the student to: •Explain the operating principles, characteristics, and fabrication technology of modern optoelectronic components and systems. •Apply optoelectronic techniques for the design and implementation of functional electronic circuits. •Connect and configure different types of displays, including seven-segment displays, RGB LED components, LED matrices, as well as LCD, OLED, and TFT displays. •Design and implement control circuits using specialized LED drivers. [•Diagnose and troubleshoot problems in the operation of optoelectronic systems through practical work with measurement and diagnostic equipment. .		
Course outline			
Theoretical teaching	Optics, electronics, classical and quantum electrodynamics and statistical physics as the basis of optoelectronics. The dual nature of light. Emission, propagation and absorption of light. Quantum optoelectronics. Spontaneously and stimulated emission of light. Optical fibers and cables. Optoelectronic devices. Types of lasers. Solid-state lasers, gas lasers, semiconductor lasers, liquid lasers. Types of displays. CRT monitors, liquid crystal LCD displays, LED displays, OLED displays. Optoelectronic devices in the computer (readers and scanners, storage units) and telecommunication (switches, semiconductor, ceramic and other special displays; modulators and demodulators) devices and systems. Nanomaterials and optoelectronic technology.		
Practical teaching (exercises, OFE, study and research work)	Exercises on the computer and microcontroller development bord, independent use of commercial software tools for design and simulation of optoelectronic systems.Introduction to and work with seven-segment displays, work with components for RGB light emission, implementation and control of matrix displays using LED drivers, introduction to and work with alphanumeric LCD displays, introduction to and work with graphic OLED displays, introduction to and work with graphic TFT displays, introduction to touch screen technology.		
Textbooks/references			
1	John Dakin, Robert Brown, Handbook of optoelectronics- Applied Optical Electronics,CRC press, 2022		
2	S.C.Gupta, Optoelectronic devices and systems, Prentice Hall of India Private, 2015		
3	J.A. Hernández-Cordero, M. Hautefeuille, Field guide to optoelectronics and photonics , SPIE press 2021		
4	Santiago Silvestre ,Optoelectronics, photonics and sensors , TechPedia 2017		
5	Anil K. Maini, Lasers and Optoelectronics, John Wiley and Sons Ltd, 2013		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Classical lectures, consultations, exercises on the computer and microcontroller development environments.

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	20		

Projects	5		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Nanotechnology		
Lecturer (for lectures)	Paunović V. Vesna, Aleksić M. Sanja		
Lecturer/associate (for exercises)	Paunović V. Vesna, Aleksić M. Sanja		
Lecturer/associate (for OFE)			
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Nanotechnology is designed for students who wish to learn more about the foundations of nanotechnology, technological advances and the applications enabled by nanotechnology.		
Course outcomes	The learning outcome enables the student to: •Explain the basic physical and chemical principles of nanotechnologies and the specific effects that occur at the nanoscale (e.g., quantum effects, increase in specific surface area). •Distinguish and classify different types of nanomaterials based on their dimensionality, structure, and specific properties. •Analyze the application possibilities of nanomaterials in various fields of engineering, electronics, medicine, or power engineering. •Identify modern methods for the synthesis and characterization of nanostructured materials.		
Course outline			
Theoretical teaching	Types of nanotechnology and nanomachines. Surfaces and dimensional space – top down and bottom up. Electronic transport in quantum wires and carbon nano tubes. Magnetic behavior of single domain particles and nanostructures.Carbon nanotubes (CNTs). Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs), graphenes, fullerenes. Metal/oxide nanoparticles, nanorods, nanowires, nanotubes, and nanofibers. Discussion of sensors for various gases. Gas sensors based on semiconductor devices. Biosensors: Principles. DNA based biosensors. Semiconductror nanodevices: Single electron devices. Nano scale MOSFET – resonant tunneling transistor. Single electron transistors. Nanorobotics and nanomanipulation. Nanocomputers. Optical fibers for nanodevices. DNA based nanodevices. Micro and Nanomechanics. Nanotechnology for sustainable energy.		
Practical teaching (exercises, OFE, study and research work)	To demonstrate familiarity with the topic and ability to communicate concepts across discipline boundaries, each student in the course is expected to give a short oral presentation on a topic related to his /her own research interest in nanotechnology. Similarities and differences between micro and nanotechnologies and processes. Simulations of mechanical and optical characteristics of nanomaterials. NanoMOS transistor. NanoCMOS. Nanowires.		
Textbooks/references			
1	S. Kelley, T. Sargent, Introduction to Nanotechnology: The New Science of Small, The Great Courses, The Teaching Company, 2012.		
2	G.L. Hornyak, J.J. Moore, H.F. Tibbals, J.Dutta, Fundamentals of Nanotechnology, CRC Press, 2018		
3	S.Roy, C.K. Ghosh, C.K.Sarkar, , Nanotechnology: Synthesis to Applications,CRC Press, 2018.		
4	N.B.Sing, Md. A. B. H. Susan and R. G. Chaudhary, Applications of Emerging Nanomaterials and Nanotechnology, MRF, 2023		
5	C.Binns, Introduction to Nanoscience and Nanotechnology, Wiley, 2010		

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

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

Teaching methods	Lectures, consultations, exercises, computer exercises, seminar work.

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			
Projects	25		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Autonomous Microsystems		
Lecturer (for lectures)	Vračar M. Ljubomir, Prijić D. Zoran		
Lecturer/associate (for exercises)	Vračar M. Ljubomir		
Lecturer/associate (for OFE)	Vračar M. Ljubomir		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to the design of autonomous microsystems and their practical implementation.		
Course outcomes	Upon successful completion of this course, the student will be able to explain the architecture and operating principles of autonomous microsystems, design and integrate microsensor components with signal processing and wireless communication hardware, optimize energy harvesting and management systems, and apply these concepts in the development of smart, self-powered devices for the Internet of Things (IoT) or biomedicine.		
Course outline			
Theoretical teaching	Autonomous microsystems - definition and classification by application areas. Architecture of autonomous microsystems. Battery-powered systems. Types of batteries. Battery-charging circuits. Energy Harvesting systems: thermal, solar, chemical, mechanical. Optimization of the power consumption. Design principles of autonomous microsystems. Energy harvesting block. Energy storage block. Sensor block. Telemetry block. Embedded software for autonomous microsystems.		
Practical teaching (exercises, OFE, study and research work)	Computer simulation using the ECAD package. The choice of components (low-power, micro-power). Demonstration of the application realized using microsystem on a PCB level. Practical design of the autonomous telemetry microsystem using a development kit.		
Textbooks/references			
1	Energy Harvesting Technologies and Applications for the Internet of Things and Wireless Sensor Networks, MDPI Books, Basel, Switzerland, 2024. [Online]. Available: https://www.mdpi.com/books/reprint/10239-energy-harvesting-technologies-and-applications-for-the-internet-of-things-and-wireless-sensor		
2	Energy Harvesting and Energy Storage Systems, MDPI Books, Basel, Switzerland, 2022. [Online]. Available: https://mdpi-res.com/bookfiles/book/5235/Energy_Harvesting_and_Energy_Storage_Systems.pdf		
3	Advanced Energy Harvesting Technologies, MDPI Books, Basel, Switzerland, 2022. [Online]. Available: https://www.mdpi.com/books/reprint/5352-advanced-energy-harvesting-technologies		
4	Vibration Energy Harvesting for Wireless Sensors, MDPI Books, Basel, Switzerland, 2022. [Online]. Available: https://www.mdpi.com/books/reprint/5696-vibration-energy-harvesting-for-wireless-sensors		
5	Mobility and IoT for the Smart Cities, MDPI Books, Basel, Switzerland, 2020. [Online]. Available: https://www.mdpi.com/books/reprint/2900-mobility-and-iot-for-the-smart-cities		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	2	0	0

Teaching methods	Lectures; Computer simulations; Practical laboratory work; Consultation.

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	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electronics Materials Design		
Lecturer (for lectures)	Paunović V. Vesna		
Lecturer/associate (for exercises)	Stojković S. Aleksandra		
Lecturer/associate (for OFE)	Stojković S. Aleksandra		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to the principles prognosis of the material properties with special emphasises on the design and production of materials for electronics and nanomaterials with desired properties.		
Course outcomes	The learning outcome enables the student to: •Apply a systematic scheme for predicting material properties, relating crystal structure to electronics requirements •Select the appropriate technological fabrication method based on the required technical characteristics of the electronic component. •Calculate and design a material with specified physical, electrical, and structural properties for a concrete engineering application. •Critically analyze and optimize the "structure-property-technology" relationship to improve the efficiency of electronic systems. •Integrate theoretical knowledge and practical skills to solve complex tasks within the development process of new functional materials.		
Course outline			
Theoretical teaching	Prognosis of the materials properties (relationship between structure, properties and materials technology). Selection and design of electronics materials. Database of electronics materials (inorganic and organic). The basic and supporting electronics materials. Materials for microsystems. Prognosis and design of metallic, ceramic and polymeric materials. Design of noncrystalline and organic materials. Composite materials.Thin film materials. Superconducting, supermagnetic, semiconducting, optoelectronic and piezoelectric nanomaterials.		
Practical teaching (exercises, OFE, study and research work)	Practical exercises that are specific presentation of properties, structures and technologies for most widely used materials in modern electronics and microelectronics. Formation of databases of materials used in electronics and microelectronics.		
Textbooks/references			
1	S. O. Kasap, Principles of Electronic Materials and Devices, McGraw-Hill, 2018		
2	Eugene A. Irene, Electronic materials science, John Wiley & Sons, Inc.2005		
3	K.M. Gupta Nishu Gupta, Advanced Electrical and Electronics Materials: Processes and Applications, John Wiley & Sons, 2015		
4	W. D. Callister, D.G.Rethwisch, Materials Science and Engineering, John Wiley & Sons Inc, 2014		
5	S. L. Tripathi, P. A. Alvi, U. Subramaniam, Electrical and Electronic Devices, Circuits and Materials, Design and Applications, CRC Press, 2021		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, consultations, practice exercises and seminars

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Integrated Circuits Design		
Lecturer (for lectures)	Andrejević-Stošović V. Miona		
Lecturer/associate (for exercises)	Mirković D. Dejan		
Lecturer/associate (for OFE)	Radivojević S. Novak		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Systematization of knowledge related to the design of digital integrated circuits and fully custom-designed integrated circuits.		
Course outcomes	Acquiring competence in designing digital integrated circuits at the transistor and register-trasfer level (RTL). Students are expected to learn to dimension the transistors in digital circuits, use programs for describing and simulating digital integrated circuits, and learn how to write and present the results of their work.		
Course outline			
Theoretical teaching	Verilog as HDL. Bottom-up and Top-Down methodology. Module as a basic unit. Sequential Verilog block types. Operators. Registers. Memories. Flow control statements. Loops. Subroutines. Concurrent processes. Blocking and non-blocking allocation. Instantiation. Pins. Time representation. Parameters. Directives. Test benches. Description of digital integrated circuits using Verilog HDL language. Metrics for performance evaluation of designed digital integrated circuits. MOS transistor, PN junction and wiring (connections) of digital integrated circuits. Analysis and design of standard digital cells (gates) at the transistor level. Symbolic design (stick diagram). Physical design (layout).		
Practical teaching (exercises, OFE, study and research work)	Acquiring design skills using professional software packages for designing integrated circuits, such as Cadence and Mentor Graphics (Siemens EDA).		
Textbooks/references			
1	David Harris and Sarah Harris. Digital Design and Computer Architecture, Second Edition (2nd. ed.). Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2012.		
2	Jan M. Rabaey, Anantha P. Chandrakasan, and Borivoje Nikolic. Digital integrated circuits: a design perspective. Vol. 2. Englewood Cliffs: Prentice hall, 2002.		
3	Neil HE Weste and David Harris. CMOS VLSI design: a circuits and systems perspective. Pearson Education India, 2015.		
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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	1	2	0	0

Teaching methods	Lectures, auditory exercises, computer laboratory exercises, 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	0		
Projects	40		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Sensor Networks Protocols		
Lecturer (for lectures)	Milić N. Dejan, Milošević D. Nenad		
Lecturer/associate (for exercises)	Anastasov A. Jelena		
Lecturer/associate (for OFE)	Milić N. Dejan		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Enabling students to analyze, select, and apply communication protocols in wireless sensor networks. Developing engineering competencies necessary for designing energy-efficient network architectures, optimizing network parameters, and practically implementing protocols across different layers of the network model in real-world applications.		
Course outcomes	Upon successful completion of the course, the student is qualified to independently analyze the hardware architecture and calculate the energy budget of a sensor node. The student possesses professional skills to configure and apply appropriate MAC protocols, including the IEEE 802.15.4 standard, with the goal of optimizing energy consumption through the node wake-up concept. The student is capable of implementing error control mechanisms at the data link layer and designing geographic and dynamic addressing schemes in the network. The student is trained to practically apply and evaluate the performance of various routing protocols, including energy-efficient transmission, data-centric routing, and data aggregation techniques in wireless sensor networks.		
Course outline			
Theoretical teaching	Introduction. Node architecture. Hardware components. Sensor node energy consumption. Overview of operating systems. Network architecture. Sensor network scenarios. Optimization and quality measures. Sensor network design principles. Gateway concept. Physical layer. MAC protocols. Fundamentals of (wireless) MAS protocols. Protocols for ad hoc communication and the concept of node “wake-up”. Channel-based protocols. Time-sharing protocols. IEEE 802.15.4 protocol. Data link protocols. Error control. Frame usage. Link management. Naming and addressing. Naming and addressing management in sensor networks. MAC address assignment. Geographical and occupancy-based addressing. Routing protocols. Random forwarding. Energy-efficient sending to a specific node (unicast). Sending to all or specific nodes (broadcast and multicast). Geographic routing. Mobile nodes. Data-centric and Content-based networking. Data-centric routing. Data aggregation. Data-centric data storage.		
Practical teaching (exercises, OFE, study and research work)	Laboratory exercises are carried out in a computer lab and on specialized hardware platforms, directly following the theoretical lectures. They include: software simulation of sensor node energy consumption under different operating modes (sleep, wake-up, transmission); configuration and performance analysis of the IEEE 802.15.4 MAC protocol in network simulators; practical implementation of error detection and correction mechanisms at the data link layer level; software implementation and comparative testing of various routing algorithms (geographic, unicast, broadcast); practical work with data-centric network architectures and the implementation of data aggregation techniques from multiple sensor nodes before transmitting them to the gateway.		
Textbooks/references			
1	Holger Karl, Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley, 2005		
2	Shashi Phoha, Thomas F. La Porta, Christopher Griffin, Sensor Network Operations, Wiley-IEEE Press, 2006		
3	I. F. Akyildiz, M. C. Vuran, Wireless Sensor Networks, John Wiley & Sons, Chichester, 2010.		
4	W. Dargie, C. Poellabauer, Fundamentals of Wireless Sensor Networks: Theory and Practice, John Wiley & Sons, Chichester, 2010.		
5	C. S. Raghavendra, K. M. Sivalingam, T. Znati, Wireless Sensor Networks, Springer, New York, 2010.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Teaching is carried out through interactive lectures using multimedia tools, during which theoretical concepts of sensor network architecture and protocols are directly linked with modern engineering practice. Classroom auditory exercises are based on the independent solving of analytical problems related to calculating the energy budget of nodes and analyzing network traffic performance. Laboratory exercises are conducted in a specialized laboratory, where students acquire specific professional skills in configuring, testing, and optimizing communication protocols across all network layers through practical work in network simulators and on hardware platforms. Continuous monitoring of student progress, assistance with laboratory assignments, and additional professional support in mastering more complex concepts are provided through regular individual consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	25
Exercises	40	**Oral exam**	25
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Technical Documentation		
Lecturer (for lectures)	Davidović S. Vojkan		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)	Davidović S. Vojkan		
Number of ECTS 2	**Course status (obligatory/elective)**	Elective	
Prerequisites	None		
Course objectives	The aim of the course is to acquire the necessary level of knowledge for: - understanding technical documentation of the lowest level of complexity - electronic components (resistors, capacitors, coils, diodes, transistors, integrated circuits), the so-called datasheet, - understanding technical documentation of more complex devices (typically measuring instruments, which are most commonly encountered in engineering practice, power supplies, multimeters, signal generators, oscilloscopes), as well as quickly finding solutions to specific requirements or problems, navigating both user and service manuals, as well as understanding technical documentation from the industry, - independently creating specific technical documentation for potential users for a project implemented independently or in a team as an assignment from another subject.		
Course outcomes	The student has the necessary level of knowledge and experience to: - successfully search the technical documentation of electronic components (datasheet), find the necessary parameters, understand the graphics and contents of tables, - understand the technical documentation of measuring devices, quickly find the necessary data in the user manual to solve a problem or achieve a given goal, - understands the service manual for serviceable devices, finds the appropriate physical positions, understands the connections between blocks using a given example - finally, is able to create the necessary user or service manual for a device that he has implemented independently or in a team, clear enough for technically educated people to easily understand.		
Course outline			
Theoretical teaching	The concept of technical documentation; technical documentation in civil engineering and mechanical engineering. Technical documentation of electronic components (resistors, capacitors, coils, transistors, power components, optocomponents, integrated circuits, connectors, heat sinks, printed circuit boards, etc.), electrical, temperature and dynamic characteristics. User and service manual (analysis of document organization, displayed diagrams, tables) of measuring instruments (power supplies, multimeters, signal generators, oscilloscopes) of reputated world manufacturers (Tektronix, Agilent, Rigol, Keysight). Technical documentation in the industry, specifics of the company and production program (services), requirements and standardization. User manuals for development kits (UNI DS3, EasyPIC5, Arduino, Altium).		
Practical teaching (exercises, OFE, study and research work)	Datasheet analysis of discrete components of higher complexity (EPAD ALD1108E, AD633), characteristics and application notes. Using user manuals - laboratory work with measuring instruments and development kits. Visit to the industry and familiarization with the specifics of the company and the production program (services) and the need for technical documentation and standardization. Teamwork on creating documentation.		
Textbooks/references			
1	Technical documentation of components (datasheets), available in catalogs and online.		
2	Technical documentation of laboratory instruments (Tektronix, Agilent, Rigol, Keysight) - users and service manuals.		
3	Technical documentation of development kits (UNI DS3, EasyPIC5, Arduino, Altium)		
4	Katherine Haramundanis, The Art of Technical Documentation, Elsevier, 2014, ISBN 9781483184012		
5	Available technical documentation from the industry.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	0	1	0	0

Teaching methods	Lectures using PowerPoint presentations, practical classes, industry visits, seminars, consultations.		
Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	30	**Oral exam**	20
Colloquia			
Projects	20		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electron Devices and Microsystems	
Type and level of studies		Undergraduate Academic Studies	
The name of the course		Project Management	
Lecturer (for lectures)		Danković M. Danijel	
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)		Danković M. Danijel	
Number of ECTS	2	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to concepts: project, project management concept and project lifecycle. Introduction to important functional areas of project management and project management software and tools.		
Course outcomes	Learning outcomes are defined so that the student, in addition to theoretical knowledge, will have: Mastering the concept of project management and the acquired ability to initiate, plan, implement, monitor and control the project. Ability to use different available project management software and tools.		
Course outline			
Theoretical teaching	Concept and types of projects. Introduction to the concept of project management. Project management methodology. Project lifecycle: initiation, planning, implementation, monitoring and control, project close-out. Project management plan. Functional areas of project management. Managing the scope and time of the project (defining activities, ordering activities and timetable). Cost Management (Cost estimating and budgeting). Quality management of the project. Resource management (project team, equipment and material). Project risk management (identification, analysis and risk response planning). Plan for communication. Introduction to basic functions of one of the most common software project management tools - Microsoft Project. Report on the completed project, preparation of technical documentation and presentation of the completed project.		
Practical teaching (exercises, OFE, study and research work)	Students work on a project that is assigned to them or who they devise themselves. Practical laboratory work.		
Textbooks/references			
1	CarlChatfield, Timothy Johnson, „Microsoft Project 2016 Step by Step“, Microsoft Press, 2016, ISBN: 978-0-7356-9874-1.		
2	Harold Kerzner, „Project Management, A System Approach to Planning, Scheduling, and Controlling“, 12th Edition, John Wiley & Sons, 2017, ISBN: 978-1-119-16535-4.		
3	„A Guide to the Project Management Body of Knowledge (PMBOK® Guide)“, Eighth Edition, Project Management Institute, 2025, ISBN 9781628258295.		
4	Nehal Patel, „Practical Project Management for Engineers“, Artech House Publishers, 2019, ISBN: 978-1-630-81585-1.		
5	John M. Nicholas, Herman Steyn, „Project Management for Engineering, Business and Technology“, Routledge, 2021, ISBN: 978-0-367-27734-5.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	0	1	0	0

Teaching methods	The subject is processed through project teaching so that its entire content is practically applied to the realized project.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Product Data Management		
Lecturer (for lectures)		Prijić D. Zoran		
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)		Prijić D. Zoran		
Number of ECTS	2	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Learning objectives are defined so that the student will: - Learn about the process of product lifecycle management (PLM); - Know the data management process during the design, production and exploitation of the electronic product (PDM); - Learn advanced data management features in a collaborative environment; - Be able to use embedded data management functions in electrical (ECAD) and mechanical (MCAD) design.			
Course outcomes	Learning outcomes are defined so that the student will: - Distinguish the types of data needed for an appropriate management process; - Select the data management model and include the appropriate functions in the ECAD and MCAD packages for the given project; - Monitor changes over the selected data set during the design of the electronic device, using feedback from the previously included functions; - Form revisions of the existing project; - Implement new versions of the project, using some of the existing audits;			
Course outline				
Theoretical teaching	The concept of data management. Definition and elements of design of electronic product lifecycle management (PLM). Definition of the product data management process (PDM). Managed datasets. Managed functions. Tools that allow the execution of functions. Examples of application during the design, production and exploitation of an electronic product. Centralized and distributed version control systems. Introduction to Subversion and Git.			
Practical teaching (exercises, OFE, study and research work)	Selection of data managed in the electromechanical design process. Turn on data management functions and their usage in appropriate software packages. Practical realization in a predefined case or in a case suggested by the students.			
Textbooks/references				
1	B. Collins-Sussman, B. W. Fitzpatrick, and C. Michael Pilato, "Version control with Subversion", https://www.visualsvn.com/support/svnbook/			
2	S. Schacon and B. Straub, "Pro Git", 2nd ed., Apress, 2014, https://git-scm.com/book/en/v2			
3	Whitepaper, E-Books, and Technical notes from ECAD and MCAD software manufacturers			
4	J. Stark, "Product Lifecycle Management (Volume 1): 21st Century Paradigm for Product Realisation", 5th Ed., Springer, 2022 (Selected chapters).			
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	0	1	0	0

Teaching methods	Active teaching.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	40	**Oral exam**	50
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Software design for supporting electronic systems		
Lecturer (for lectures)	Pejović M. Milić		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)	Pejović M. Milić		
Number of ECTS	2	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Obtaining the knowledge necessary to understand the concept of designing and implementing software support for electronic devices and systems.		
Course outcomes	Introduction to the basics of designing software to support electronic devices. Introduction to the connection of laboratory instrumentation into complex systems and the development of adequate software support. Independent design and implementation of electronic system control software. Introduction to various development environments in which software support for laboratory devices and electronic systems of different purposes would be realized and tested.		
Course outline			
Theoretical teaching	Introduction to the basics of designing software to support electronic devices. Introduction to connecting laboratory instrumentation into complex systems and developing adequate software support. Independent design and implementation of software for controlling electronic systems. Introduction to various development environments for the development of software support for laboratory devices and electronic systems for various purposes.		
Practical teaching (exercises, OFE, study and research work)	Practical teaching takes place in the laboratory and involves the practical realization of various types of software support to various devices, both commercially available on the market and independently developed laboratory prototypes.		
Textbooks/references			
1	Selected chapters and tutorials on different types of development environments		
2	Visual studio tutorial		
3	"Embedded Software Design: A Practical Approach to Architecture, Processes, and Coding Techniques", Beningo Jackog, 2022, Apress		
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	1	0	0

Teaching methods	Lecture-based teaching, practical exercises in laboratory involving problem solving through the practical tasks and project-based learning individually or in teams, where students will work on different projects over extended time period.

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	Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Power Devices and Circuits		
Lecturer (for lectures)	Manić Đ. Ivica, Marjanović B. Miloš		
Lecturer/associate (for exercises)	Manić Đ. Ivica		
Lecturer/associate (for OFE)	Manić Đ. Ivica, Stojanović D. Milan		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The goal of the course is to familiarize students with the basic types, structure, operating principles, and characteristics of semiconductor power devices (diodes, transistors, thyristors, IGBTs, MOSFETs, etc.), as well as their application in power electronic circuits. Students will be enabled to understand the physical phenomena and reliability of power devices, as well as to apply modeling, simulation, and design techniques for power electronic circuits using modern tools.		
Course outcomes	Upon completion of the course, the student will be able to: identify and explain the types of semiconductor power devices and their applications in electronic systems; apply the basics of modeling and simulation of power circuits using SPICE; analyze and design power electronic circuits with the use of microcontrollers.		
Course outline			
Theoretical teaching	Introduction to Power Devices – definition, types, and application areas. Carrier transport and lifetime. Breakdown voltages: avalanche, punch-through, thermal breakdown. Techniques for reducing edge effects. Power diodes: PiN and Schottky. Power bipolar transistors – structure, operation, gain, breakdown, and safe operating area. Darlington pair. Thyristors – modes of operation, turn-off, types: triac, photothyristor. Static induction devices. Power MOS devices – LDMOS, VDMOS, parasitic elements. IGBT transistors – structure, operating principle, characteristics. Power electronic circuits: integration, power modules, high-voltage and intelligent circuits. Reliability of power devices. Power device packaging, heat dissipation.		
Practical teaching (exercises, OFE, study and research work)	In the exercises, circuits with power diodes, power transistors, thyristors, triacs, IGBTs, switching power supply circuits, inverter circuits, and phase control circuits for AC signals are analyzed using simulations. In the laboratory, circuits with power devices are implemented using a microcontroller development environment.		
Textbooks/references			
1	Muhammad H. Rashid, Power Electronics Handbook, Butterworth-Heinemann, 2024.		
2	Hubert Henry Ward, Mastering Analog Electronics : Unlocking the Power of Circuits and Semiconductors, Apress, 2024.		
3	Muhammad H. Rashid, SPICE and LTspice for Power Electronics and Electric Power, CRC Press, 2024.		
4	Daniel W. Hart, Power Electronics, McGraw-Hill, 2011.		
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	0	0

Teaching methods	Theoretical lectures. Practical exercises on computers and in the laboratory. Independent student work through homework assignments. 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	20		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Basics of Electronics	
Lecturer (for lectures)			Đorđević D. Srđan, Mirković D. Dejan	
Lecturer/associate (for exercises)			Đorđević D. Srđan, Mirković D. Dejan	
Lecturer/associate (for OFE)			Đorđević D. Srđan, Mirković D. Dejan	
Number of ECTS		6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None			
Course objectives	Acquiring basic knowledge of electronics, amplifying techniques, oscillators, rectifiers and voltage regulators.			
Course outcomes	Students will be able to recognize schematics, understand the principle of operation, and to understand the application of basic electronic circuits: amplifiers, oscillators of sinewave signals, rectifiers and voltage regulators.			
Course outline				
Theoretical teaching	Diodes and diode circuits. Bipolar transistors, operating point and load line. Model of bipolar transistors. MOSFET transistor, operating point and load line. Model of MOSFET transistors. Basic amplifier stages with bipolar and MOSFET transistor. Multistage amplifiers. Amplifiers with direct coupling. Differential and operational amplifier. Application of operational amplifiers. Frequency analaysis. Negative feedback. Oscillators. Large-signal amplifiers. Rectifiers and voltage regulators.			
Practical teaching (exercises, OFE, study and research work)	Analysis of discrete-component amplifiers, including DC bias and small-signal AC parameter calculations. Operational amplifier circuit analysis. Analysis of: rectifiers, oscillators, active filters, power amplifiers, and voltage regulators.			
Textbooks/references				
1	B. Razavi, Fundamentals of Microelectronics, 3rd edition, Wiley, 2021, ISBN: 978-1-119-69514-1			
2	A. Sedra, K. Smith, Microelectronic Circuits, 8th edition, Oxford University Press, 2020, ISBN-13: 978-0190853464			
3				
4				
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	2	1	0	0

Teaching methods	Lectures, laboratory exercises, consultations, project a

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	10	**Oral exam**	20
Colloquia	40		
Projects	0		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electric Circuits in Power Engineering		
Lecturer (for lectures)	Javor L. Vesna		
Lecturer/associate (for exercises)	Javor L. Vesna		
Lecturer/associate (for OFE)			
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Mastering methods for analyzing electrical circuits with lumped and distributed parameters for different types of excitation, in steady-state and transient regimes. Acquiring basic knowledge for analyzing three-phase electrical circuits. Introduction to matrix methods for analyzing electrical circuits and computer programs for circuit analysis.		
Course outcomes	Theoretical and practical knowledge of students in the field of electrical circuit analysis. Ability of students to analyze electrical circuits with lumped and distributed parameters, in steady-state and transient regimes, as well as for different types of excitation. Knowledge of matrix methods for the analysis of electrical circuits. Ability to use computer programs for the analysis of electrical circuits.		
Course outline			
Theoretical teaching	Properties of electrical circuits and their elements. Signals in electrical circuits. Primary and secondary parameters of two-ports networks (quadrupoles). Connection of two-ports networks and special configurations. Analysis of electrical circuits in the stationary regime. Natural frequencies of circuits, resonances and antiresonances. Analysis of circuits in the transient regime in the time domain, using differential equations and the classical method of solving. Application of the Laplace transform. Analysis of networks with distributed parameters. Transmission lines. Analysis of three-phase circuits using the symmetrical components method. Matrix methods and analysis of electrical circuits using computers.		
Practical teaching (exercises, OFE, study and research work)	Practical teaching is implemented through computational exercises and problem solving using the theory of electrical circuits with the aim of acquiring functional knowledge.		
Textbooks/references			
1	Nilsson J. W., Riedel S. A., "Electric circuits," Prentice Hall, 2018.		
2	Shenkman A. L., Zarudi M., "Circuit Analysis for Power Engineering Handbook," Springer, 1998.		
3	Bird J., "Electrical Circuit Theory and Technology," Newnes, 2017.		
4	Das J. C., "Understanding Symmetrical Components For Power System Modeling," IEEE Press, Wiley, 2017.		
5	Chattopaddhyay D., Rakshit P. C., "Fundamentals of Electric Circuit Theory," S. Chand Publishing, 2020.		

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

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

Teaching methods	Lectures, exercises and consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Measurements in Electrical Power Engineering		
Lecturer (for lectures)	Živanović B. Dragan, Simić M. Milan		
Lecturer/associate (for exercises)	Stojanović S. Milica, Jovanović R. Jelena		
Lecturer/associate (for OFE)	Ranđelović S. Ivana, Stojanović S. Milica		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Education and introduction of students with basic theoretical and practical knowledge of measurement methods and measurement instrumentation in the field of electrical power engineering.		
Course outcomes	Students' training and ability to apply measuring devices and systems in the electrical power engineering. The student will be able to independently select and use measuring instruments and equipment, depending on the required measurement accuracy and limitations when working with appropriate measuring instrumentation in the area of electrical power engineering.		
Course outline			
Theoretical teaching	Introduction to metrology and measurement systems. Methods of measuring electrical quantities. Processing of measurement results. Measurement of voltage, current and resistance. Fundamentals of digital measuring instruments, measurement of period, frequency and phase. Analog-to-digital converters. Observation of signal waveforms. Insulation and grounding in measuring systems. Safety in handling measuring equipment. Measurement of high voltages and currents. Voltage and current measuring transformers. Measurement of electrical power and energy. Measurement in three-phase systems. Electricity consumption meters. Measurement of non-electrical quantities.		
Practical teaching (exercises, OFE, study and research work)	Computational and laboratory exercises. Training students to solve computational problems in the field of measurements in the electrical power industry, as well as for the practical application of measurement methods and measuring instruments through engagement in laboratory exercises. The basic areas covered in the laboratory exercises are: basic methods for measuring voltage and current, application of various types of current sensors, measurement of electrical power, measurement of electrical energy consumption, and application of modern measuring devices for measuring electrical power quality parameters. According to the Practicum for work on laboratory exercises, students carry out practical measurements and submit an appropriate report on each completed laboratory exercise.		
Textbooks/references			
1	J. G. Webster, "Measurement, Instrumentation and Sensors Handbook", CRC Press, 2014.		
2	Ewald F. Fuchs, Mohammad A.S. Masoum, “Power quality in power systems and electrical machines”, Elsevier Inc., 2008.		
3	Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H. Wayne Beaty, “Electrical power systems quality, Second Edition”, McGraw-Hill, 2003.		
4	S. Tumanski, “Principles of Electrical Measurements”, Taylor & Francis Group, 2006.		
5	W. Nawrocki, Measurement Systems and Sensors. London, Artech House, 2005.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	2	0	0

Teaching methods	Lectures (theoretical teaching) with the use of modern means for presenting material in the form of slides, computational exercises with solving tasks in the field of measurements in electrical power engineering, laboratory exercises, daily consultations of students with teachers or associates, individual work of students.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	15
Exercises	20	**Oral exam**	15
Colloquia	40		
Projects	0		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electromechanical Energy Conversion	
Lecturer (for lectures)			Mitrović N. Nebojša, Stajić P. Zoran	
Lecturer/associate (for exercises)			Banković G. Bojan	
Lecturer/associate (for OFE)			Banković G. Bojan, Radić M. Milan	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Acquiring fundamental knowledge in the field of electromechanical energy conversion, electrical machines, and electrical drives.			
Course outcomes	Understanding the basic principles of electromechanical energy conversion. Understanding the fundamental characteristics and operation of rotating machines and transformers.			
Course outline				
Theoretical teaching	Basic laws and principles of electromechanical energy conversion. Magnetic and electric circuits of electrical machines. Power balance of general machines. Equations of motion. Electromagnetic torque. Examples of single-excitation and multiple-excitation systems. Operating principles of basic types of machines. Magnetic fields of DC and AC machines. Magnetic forces. Windings of electrical machines. Electromotive forces. Mechanical characteristics. DC machines. Synchronous machines. Induction machines. Power transformers.			
Practical teaching (exercises, OFE, study and research work)	Practical work is conducted in the laboratory. Recognition of certain types of machinery. Basic components and structures. Commissioning of specific types of machines. Mechanical characteristics of electric machines.			
Textbooks/references				
1	S.A. Nasar, "Electric machines: steady-state operation",New York : Hemisphere Pub. Corp.1990.			
2	G. R. Slemon, A. Straughen, “Electric Machines”, Adison-Wesley publishing Company, 1980.			
3	Stephen D. Ulmans, “Electric machinery”, McGraw-Hill, 2014			
4	Paul Krause, Oleg Wasynczuk, Scott Sudhoff, Steven Pekarek, "Analysis of Electric Machinery and Drive Systems", Institute of Electrical and Electronics Engineers, 2013.			
5	Slobodan N. Vukosavic, "Electrical machines", Springer Science & Business Media, 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	0	0
Teaching methods	Classes are conducted through lectures and exercises. Lectures employ modern teaching methods. Auditory exercises, featuring numerous examples, encourage students to independently solve problems from engineering practice. Part of the exercises is carried out in the laboratory to obtain the steady-state characteristics of electric machines.			
Grade (maximum number of points 100)				
Pre-exam duties	**Points**	**Final exam**	**Points**	
Activity during lectures	5	**Written exam**	30	
Exercises	15	**Oral exam**	20	
Colloquia	30			
Projects				

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electrotechnical Materials		
Lecturer (for lectures)	Paunović V. Vesna		
Lecturer/associate (for exercises)	Veljković Z. Sandra		
Lecturer/associate (for OFE)	Veljković Z. Sandra		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Acquiring basic knowledge of the structure of materials and technological processes. Practical application of theoretical knowledge in technological processes, especially in the fabrication of electronic materials for energy applications. Introduction to the latest developments in the field of advanced materials, especially for the field of modern energy, alternative, and new energy sources.		
Course outcomes	The learning outcome enables the student to: •Relate the microstructure of materials with their macroscopic properties and engineering applications. •Identify and classify the specific properties of conductive, semiconducting, dielectric, magnetic, and superconducting materials. •Select appropriate functional materials for application in various power systems and facilities. •Design material structures with predefined physical and electrical properties for specific needs in the field of power engineering.		
Course outline			
Theoretical teaching	Introduction. Materials for energy. Crystal structure and crystal lattice energy. Conducting materials in energy: definitions and general properties, metals, alloys, non-metallic conductors. Semiconductor materials. Dielectrics: polarization mechanisms, static and dynamic properties, breakdown voltage and dielectric strength, special dielectrics, applications. Magnetic materials: definitions and general relations, types of magnetic materials, applications. Superconductors: phenomenology of superconductivity, applications. Materials for new, renewable, and alternative energy sources. Traditional and new materials for hydroelectric power plants. Nanomaterials for solar systems. Applications and importance of graphene for renewable energy sources.		
Practical teaching (exercises, OFE, study and research work)	Practical and laboratory exercises in the crystal structure of materials, energy of materials, conductive (electrical conductivity, electrical resistivity, Hall effect), semiconducting (electrical characteristics of semiconductors, Hall effect, thermoelectric properties), dielectric (dielectric losses, dielectric breakdown), and magnetic materials.		
Textbooks/references			
1	M.X.Keshavarz, T.M.Klapötke The Properties of Energetic Materials, De Gruyter Graduate, 2018		
2	S. O. Kasap, Principles of Electronic Materials and Devices, McGraw-Hill, 2018		
3	W. D. Callister, D.G.Rethwisch, Materials Science and Engineering, John Wiley & Sons Inc, 2014		
4	Wei Gao, Zhengwei Li, Nigel M Sammes, Introduction to electronic materials for engineers, (2nd edition) World Scientific Publishing Company, 2016		
5	S. L. Tripathi, P. A. Alvi, U. Subramaniam, Electrical and Electronic Devices, Circuits and Materials, Design and Applications, CRC Press, 2021		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, consultations, laboratory and practical exercises

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	20		
Projects	5		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Metrology of Electrical Quantities		
Lecturer (for lectures)	Denić B. Dragan, Simić M. Milan		
Lecturer/associate (for exercises)	Ranđelović S. Ivana		
Lecturer/associate (for OFE)	Stojanović S. Milica		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Education and introduction of students to basic theoretical and practical knowledge in the field of metrology and measurement of electrical quantities.		
Course outcomes	Students' training and ability to solve practical problems in the field of measuring electrical quantities, based on a good knowledge of measurement methods and techniques, with the proper use of modern instruments and equipment for measuring electrical quantities. In addition, an important segment is the training of students for the later application of acquired knowledge in measurement techniques in engineering professions in the field of electrical engineering and computer science.		
Course outline			
Theoretical teaching	Fundamentals of metrology. Definition and materialization of the measurement units of amperes, ohms and volts of the MKSA system. Functional diagrams of the process of measuring electrical quantities. Analysis of measurement results and measurement uncertainty. Determination of measurement uncertainty in more complex modern measurement systems. Analog and digital measuring instruments and their basic measurement errors. Virtual instrumentation. Expansion of the measurement range of ammeters, voltmeters and ohmmeters. Working with modern measuring instruments. Oscilloscopes.		
Practical teaching (exercises, OFE, study and research work)	Computational, laboratory and demonstration exercises: training students to solve computational problems in the field of measuring electrical quantities, as well as for the practical application of measurement methods and measuring instruments through engagement in laboratory and demonstration exercises. The basic areas covered in laboratory exercises are: calibration of measuring devices, analysis of measurement results and assessment of measurement uncertainty, expansion of the measurement range of ammeters and voltmeters, resistance measurement, work with modern digital measuring instruments, as well as the application of analog and digital oscilloscopes. According to the Practicum for working on laboratory exercises, students submit an appropriate report on each completed laboratory exercise.		
Textbooks/references			
1	J. G. Webster, "Measurement, Instrumentation and Sensors Handbook", CRC Press, 2014.		
2	S. Tumanski, “Principles of Electrical Measurements”, Taylor & Francis Group, 2006.		
3	W. Nawrocki, Measurement Systems and Sensors. London, Artech House, 2005.		
4	P. Sydenham, “Handbook of Measurement Science“, John Wiley & Sons, Ltd., 1982		
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	0	0

Teaching methods	Lectures (theoretical teaching) with graphical presentation of material in the form of slides. Computational exercises with solving problems in the field of electrical measurements. Practical teaching in the form of laboratory and demonstration exercises. Daily student consultations with teachers or associates. Individual work of students in the form of homework assignments.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	20
Exercises	10	**Oral exam**	20
Colloquia	40		
Projects	0		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Software Tools in Electrical Power Engineering		
Lecturer (for lectures)		Petronijević P. Milutin, Kostić Z. Vojkan		
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)		Filipović R. Filip, Vučković D. Dragan		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Introducing students to software tools within the MATLAB program package, which are used to solve problems in the electrical power engineering. Introducing students to how to implement virtual experiments in the field of electrical power engineering using the Simulink program package.			
Course outcomes	Students' ability to independently use modern software tools (MATLAB, Simulink and additional software packages and libraries) for simulation and analysis of various engineering problems. Students' ability to interpret and visualize available data obtained either from external devices or from the Simulink software package.			
Course outline				
Theoretical teaching	Fundamentals of the MATLAB programming environment. MATLAB scripts. MATLAB functions. Debugging code. Basic inspection of loaded data. Drawing two-dimensional graphics, drawing three-dimensional graphics, drawing specialized graphics. Using built-in MATLAB applications. Symbolic and numerical solution of equations. Solving differential equations. Simulink software plug-in for graphical programming. Modeling of basic elements of electrical circuits. Analysis of steady-state and transient regimes. Modeling of electromechanical systems of electric motors. Modeling of basic electrical power elements using specialized libraries. Basic electrical power calculations.			
Practical teaching (exercises, OFE, study and research work)	Practical, interactive exercises on the computer: 1. Fundamentals of the MATLAB programming environment. Variable initialization and reserved words. Basic data types. 2. MATLAB scripts. MATLAB functions. Data arrays. Matrix calculations. Basic inspection of loaded data. 3. Symbolic solving of equations and systems of equations. 4. Drawing two-dimensional graphs – plot, area, semilog, stairs. Drawing specialized graphs – scatter, histogram, piechart, bar, polarplot, contour. Drawing three-dimensional graphs – surf, pcolor, mesh, heatmap. 5. Using built-in MATLAB applications. Signal analysis using the Signal Analyzer application. 6. Simulink software plug-in for graphical programming. Fundamentals of the graphical environment. The relationship between MATLAB and Simulink. Implementation of basic mathematical functions. 7. Mathematical modeling of basic electrical circuits using differential equations. Mathematical modeling of basic mechanical systems using differential equations. 8. Modeling basic electrical circuits using the specialized Simulink library Simscape. Inspection of voltage and current waveforms in single-phase and three-phase circuits. Measurement of power, effective signal values, and harmonic distortion. 9. Modeling of a simple power grid and calculations of power flows, voltages and currents in operating modes, short circuit calculation. 10. Analysis of transient processes in electrical circuits with passive power components.			
Textbooks/references				
1	D. C. Attaway and S. Attaway, MATLAB: A Practical Introduction to Programming and Problem Solving. Elsevier, 2022.			
2	Y. Chen and L. Huang, MATLAB roadmap to applications. 2025. doi: 10.1007/978-981-97-8788-3.			
3	Edward Magrab, Shapour Azarm, Balakumar Balachandran, Keith Herold, Gregory Walsh, "An Engineers Guide to MATLAB", Prentice Hall, 2011			
4	Z. Stojkovic, Computer- aided design in power engineering: Application of Software Tools. Springer, 2012.			
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	0	3	0	0

Teaching methods	Lectures are delivered using slides, animations and simulations. Interactive computer exercises are performed in the laboratory using MATLAB.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	0
Exercises	45	**Oral exam**	30
Colloquia	0		
Projects	20		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Power Transformers		
Lecturer (for lectures)		Kostić Z. Vojkan, Petronijević P. Milutin		
Lecturer/associate (for exercises)		Kostić Z. Vojkan, Radić M. Milan		
Lecturer/associate (for OFE)		Radić M. Milan		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Acquiring basic knowledge of power transformers and their applications in power networks and industry.			
Course outcomes	Mastering techniques for selecting power transformers based on plant characteristics; the ability to design and analyze transformers in various operational modes; and developing skills in monitoring, testing, and maintenance.			
Course outline				
Theoretical teaching	Power transformer construction and principle of operation. Three-phase transformer winding connections and vector groups. Magnetization. Power losses and efficiency of power transformers. Equivalent circuit. No-load and short-circuit tests. Phasor diagram. Voltage drop in transformers. Parallel operation. Special transformers. Transformer heating. Transient phenomena in transformers. Unsymmetrical operation of three-phase transformers. Basics of power transformer design. Maintenance and testing of transformers.			
Practical teaching (exercises, OFE, study and research work)	Numerical exercises cover calculations of transformer operating modes relevant to practical applications. Laboratory experiments include: General characteristics of power transformers, Vector groups of three-phase transformers, No-load and short-circuit tests of three-phase transformers, Parallel operation of transformers, Computer simulation of transient regimes, Measurement of power transformer efficiency.			
Textbooks/references				
1	J. Harlow; "Electric power transformer engineering"; 3rd Edition; CRC Press; 2012.			
2	John Winders; "Power Transformers: Principles and Applications", CRC Press, 2002.			
3	K.R.M. Nair; "Power and Distribution Transformers: Practical Design Guide"; CRC Press, 2021.			
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	0	0

Teaching methods	Lectures with application of demonstrative aids – slides, simulations and details of transformers. Numerical exercises with example problems guide students in independently solving engineering practice problems. Laboratory exercises are conducted with the aid of Laboratory Exercise manuals and lecturer advice. Students independently analyze the results and prepare a report for each laboratory exercise.

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	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electrical Installations and Lighting	
Lecturer (for lectures)			Kostić Z. Vojkan, Petronijević P. Milutin	
Lecturer/associate (for exercises)			Vučković D. Dragan	
Lecturer/associate (for OFE)			Vučković D. Dragan, Filipović R. Filip	
Number of ECTS		6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None			
Course objectives	Acquisition of basic knowledge necessary for preparing and interpreting technical documentation related to low-voltage electrical installations and lightning protection installations, the application of various devices and equipment used in low-voltage electrical installations, and the design of indoor lighting.			
Course outcomes	At the end of the course, students will be able to independently prepare and interpret technical documentation related to low-voltage electrical installations and lightning protection installations. Additionally, students will be capable in the execution, supervision, verification, and maintenance of electrical and lightning protection installations, and in the design of indoor lighting.			
Course outline				
Theoretical teaching	Technical regulations. Technical documentation. Devices and equipment used in low-voltage electrical installations. Basic calculations. Conditions and requirements for the execution and use of electrical installations. Technical protection measures against electric shock; overcurrent; overvoltage; voltage drop and voltage interruption; by disconnection, switching off and functional switching on and off of the electrical circuit; fire protection. Procedures and methods for inspecting and verifying the features, characteristics, and quality of electrical installations. Design and execution of lightning protection installations. Maintenance and verification of lightning protection installations. Photometric quantities and units. Electric light sources. Correlated color temperature. Color rendering index. Criteria for the design of indoor lighting.			
Practical teaching (exercises, OFE, study and research work)	Numerical exercises cover examples of wiring diagrams for various devices and equipment used in electrical installations, as well as calculation examples that are an integral part of the technical documentation (calculation of the maximum instantaneous current, selection and verification of power cables, voltage drop calculation, short-circuit current calculations, selection and verification of protective devices for short-circuit current and overcurrent protection, calculation of protection against electric shock in case of indirect contact, calculation of lightning protection installations, earthing system calculation, lighting level calculation). Laboratory experiments include: Insulation resistance measurement, Fault loop impedance measurement, Continuity testing of the protective conductor, Soil resistivity measurement, Measurement of earth electrode resistance, Lighting level measurement. An additional form of exercise is the project design of electrical installations for a single-family home (category A building).			
Textbooks/references				
1	Günter G. Seip; "Electrical Installations Handbook"; Third Edition; John Wiley & Sons; 2000.			
2	Geoffrey Stokes; "Handbook of Electrical Installation Practice"; Fourth Edition; Blackwell Science; 2003.			
3	Wout van Bommel; "Interior Lighting - Fundamentals, Technology and Application"; Springer; 2019.			
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	0	0

Teaching methods	Lectures with application of demonstrative aids – slides, simulations and details of devices and equipment used in electrical and lightning protection installations, as well as appropriate examples of technical documentation from engineering practice. Numerical exercises with example problems guide students in independently solving engineering practice problems. Laboratory exercises are conducted with the aid of Laboratory Exercise manuals and lecturer advice. Students independently analyze the results and prepare a report for each laboratory exercise. An additional form of exercise, the project design of electrical installations for a single-family home (category A building), students independently complete, with consultations from the lecturer.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	25
Exercises	5	**Oral exam**	25
Colloquia	25		
Projects	15		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electromagnetics	
Lecturer (for lectures)			Cvetković N. Nenad, Perić T. Mirjana, Jovanović B. Dejan	
Lecturer/associate (for exercises)			Vukić B. Dragana, Jovanović B. Dejan	
Lecturer/associate (for OFE)				
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Enabling students to understand, analyze, and apply electromagnetic field theory in solving engineering problems, as well as to model and calculate electromagnetic phenomena in power systems, substations, and devices.			
Course outcomes	Upon successful completion of the course, the student is qualified to recognize and analyze problems in the field of electromagnetic field theory, formulate appropriate mathematical models, and apply suitable methods for solving simpler engineering problems encountered in the design, analysis, and operation of components of power systems, substations, and devices.			
Course outline				
Theoretical teaching	Electromagnetic field. Maxwell's equations. Electromagnetic properties of materials. Boundary conditions. Electromagnetic field potentials. Electromagnetic problems classification. Poynting's theorem. Superposition principle. Quasi-stationary image theory in conducting and dielectric mirror. Electrodes systems and their parameters. Average potential method. Estimation method. Stationary current field. Image theory in finitely conducting mirror. Static electromagnetic field. Quasi-stationary image theory for a boundary surface between two media of different magnetic permeabilities, i.e. specific conductivities. Electrostatic and quasi-stationary magnetic field energy. Neumann's formula.			
Practical teaching (exercises, OFE, study and research work)	Application of Maxwell's equations. Determination of electromagnetic field potentials and parameters. Calculation of electrostatic and steady-state current fields. Application of boundary conditions and the method of images. Calculation of electromagnetic field energy. Analysis of electrode and grounding systems. Determination of parameters of quasi-static magnetic fields and inductances.			
Textbooks/references				
1	F. T. Ulaby, "Fundamentals Applied Electromagnetics", Pearson, Prentice Hall, New York, 2010.			
2	J. Vanderlinde, "Classical Electromagnetic Theory", Kluwer Academic Publishers, 2004.			
3	H. Neff, "Introductory Electromagnetics", John Willey & Sons, 1991.			
4	D. M. Veličković, F. H. Uhlmann, K. Brandisky, R. D. Stancheva, H. Brauer, "Fundamentals of Modern Electromagnetics for Engineering", TU Ilmenau, Germany, 2005.			
5	E. Rothwell, M. Cloud, "Electromagnetics", CRC Press, 2001.			

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	2	0	0	0

Teaching methods	Lectures, classroom (practical) exercises, homeworks, and consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Power Distribution and Industrial Networks		
Lecturer (for lectures)	Korunović M. Lidija		
Lecturer/associate (for exercises)	Vučković D. Dragan, Krstić N. Nikola		
Lecturer/associate (for OFE)	Krstić N. Nikola, Vučković D. Dragan		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The goal of the subject is to introduce the principles and the issues regarding operation and planning of distribution and industrial networks, to the students. Besides, the students should be learned the economical aspects of network operation and permissible thermical regimes.		
Course outcomes	Students will be habilitated to perform individually tasks relating to design, planning and analysis of distribution and industrial networks, with the emphasis on computer application for these purposes.		
Course outline			
Theoretical teaching	Characteristics of electricity consumption. Distribution network configurations. Industrial network configurations. Electrical energy and power forecasting. Load flow and voltage profile calculation in distribution networks. Reconfiguration of distribution networks. Electrical energy losses. Reliability and security of distribution networks. Techno-economical aspects of distribution networks. Thermal limits of distribution network element loading. Reactive energy compensation. Voltage regulation.		
Practical teaching (exercises, OFE, study and research work)	The exercised are from various areas: characteristics of electricity consumption, configurations of distribution networks, load forecasting, basic distribution network calculations - voltage drops and load flows, estimation of energy losses, distribution network reliability, technical and economical aspects of the networks, reactive power compensation, and voltage regulation in distribution and industrial networks. Laboratory exercises are performed on computers and include calculations from numerous areas covered in theoretical lectures and exercises: characteristics of electricity consumption; load forecasting; load flow, voltage profile and calculation of losses in distribution networks; distribution network reliability calculation.		
Textbooks/references			
1	T.Gonen: "Electric Power Distribution Enginering", fourth edition, CRC Press, Taylor & Francis Group, Boca Raton, 2024.		
2	T. A. Short: "Electric Power Distribution Handbook", second edition, CRC Press, Taylor & Francis Group, Boca Raton, 2018.		
3	F. Shahnia, A. Arefi, G. Ledwich: "Electric Distribution Network Planning", Springer, Singapore, 2018.		
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	0	0

Teaching methods	Theoretical lectures are performed on a board, using also up to date methods for teaching. Exercises include the solution of computational examples that relate to the theoretical lectures. The students are encouraged to independently solve problems from engineering practice. Laboratory exercises habilitate students to use commercial software for the solution of problems in the areas treated during theoretical lectures and computational exercises, under the assistant supervision.

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	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electric Power Components	
Lecturer (for lectures)			Tasić S. Dragan, Klimenta O. Dardan	
Lecturer/associate (for exercises)			Stojanović S. Miodrag, Krstić N. Nikola	
Lecturer/associate (for OFE)				
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	The objective of the course is to introduce students with current (electrodynamic and thermal) and voltage stress of electric poweer components, and also with physical processes that occur in switchgear when changing network topology. Besides, students will meet with different kinds of switchgear and their basic construction elements.			
Course outcomes	Students will be able to work in production, testing and exploitation of high voltage switchgear. Because of knowledge about switchgear characteristics it can be usefull to designers of poweer substations.			
Course outline				
Theoretical teaching	Classification of electric power components. Short-circuit current. Electrodynamic stress. Electrodynamic forces in single phase and three phase systems. Thermal load. Steady state heating. Heating during short-circuit. Basics of electric arc. AC electric arc characteristics. Ways of electric arc suppression. Commutation overvoltages. Interruption of short-circuit currents. Contacts. Classification and construction characteristics of high voltage switchgear: power switches, disconnectors, fuses, resistors, chokes, capacitors, surge arresters.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises in the field of: electrodynamic forces, thermal heating, electric arc models and interaction between power switch, network and electrical contacts.			
Textbooks/references				
1	V. Ya. Ushakov, A. V. Mytnikov, I. U. Rakhmonov, High-Voltage Equipment of Power Systems, Springer, 2023.			
2	K. Niayesh, M. Runde , Power Switching Components, Springer, 2017.			
3	V. Ya. Ushakov, Insulation of High-Voltage Equipmenth, Springer, 2024.			
4	M. Braunovic, V. V. Konchits, N. K. Myshkin, Electical Contacts: Fundamentals,Applications and Technology, CRC Press, 2007.			
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	0	0

Teaching methods	Lectures, auditory exercises, discusions, demonstrations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	25
Exercises		**Oral exam**	20
Colloquia	50		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Renewable Energy Sources and Energy Storage		
Lecturer (for lectures)	Petronijević P. Milutin, Jovanović D. Igor		
Lecturer/associate (for exercises)	Filipović R. Filip, Panić D. Aleksandar		
Lecturer/associate (for OFE)	Panić D. Aleksandar, Filipović R. Filip		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquiring basic knowledge about renewable energy sources, energy conversion and storage techniques. Understanding operating modes and the impact of environmental parameters, applied technologies and consumers on efficiency and functionality.		
Course outcomes	Upon completion of the course, the student will be able to analyze, model, and perform basic sizing of solar and wind energy conversion systems, as well as battery energy storage systems.		
Course outline			
Theoretical teaching	Basic concepts and theoretical models of electromagnetic radiation from the Sun. Calculation of the position of the Sun. Calculation of the potential of solar radiation. Principle of photovoltaic (PV) conversion. Basic types of PV cells and materials. Equivalent replacement scheme of PV cells. Connection of PV cells into modules and arrays. The influence of irradiance, temperature and shading on the characteristics of the PV module. Wind energy. Wind turbines - construction and basic characteristics. Ideal power characteristic of a wind turbine. Electromechanical energy conversion in wind turbines. Operational characteristics of wind turbines. Battery storage of electricity: technologies, basic parameters and characteristics. Ecological aspects of energy production and storage.		
Practical teaching (exercises, OFE, study and research work)	Calculation exercises: Calculations of the position of the Sun and the optimal orientation of the PV panel. Calculation of the direct, diffuse and reflected components of irradiance. Calculation of the basic characteristics and parameters of the PV cell. Equivalent characteristics of PV modules and arrays. Calculation of the required power of the wind turbine based on data on wind energy potential. Calculation and selection of electrical power equipment for integrating wind turbines into the grid. Calculation of the required battery capacity based on a typical daily production and consumption diagram. Laboratory exercises: Introduction to solar irradiance measurement devices. Determination of the average daily/monthly solar insolation on the surface of a solar collector based on measured values of horizontal insolation. Influence of temperature and irradiation on the current-voltage characteristic of a PV cell. Testing of PV modules in laboratory conditions. Current and power characteristics of wind turbines. Testing of wind turbines in laboratory conditions.		
Textbooks/references			
1	K. Mertens, Photovoltaics: Fundamentals, Technology, and Practice. John Wiley & Sons, 2018.		
2	A. V. Da Rosa, Fundamentals of renewable energy processes. Academic Press, 2013.		
3	R. Gasch and J. Twele, Wind power plants: Fundamentals, Design, Construction and Operation. Springer Science & Business Media, 2011.		
4	J. Twidell and T. Weir, Renewable energy resources. Routledge, 2021.		
5	N. Kularatna and K. Gunawardane, Energy storage devices for renewable Energy-Based systems: Rechargeable Batteries and Supercapacitors. Academic Press, 2021.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures are delivered using slides, animations and simulations. Numerical exercises include solving examples to illustrate lectures and solving specific engineering problems. Exercises are performed in the laboratory using MATLAB and on laboratory models.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points

Activity during lectures	5	**Written exam**	30
Exercises	15	**Oral exam**	20
Colloquia	30		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electronic Measurements	
Lecturer (for lectures)			Živanović B. Dragan	
Lecturer/associate (for exercises)			Pešić T. Miroljub	
Lecturer/associate (for OFE)			Đorđević-Kozarov R. Jelena, Stojanović S. Milica	
Number of ECTS		6	**Course status (obligatory/elective)**	Elective
Prerequisites	None			
Course objectives	Expanding knowledge of modern electronic measuring instruments and systems, as well as their application in laboratory work and industrial environments.			
Course outcomes	The student will be able to independently select appropriate measurement methods in engineering practice, choose and use electronic measuring instruments with the required specifications, and assess the achieved accuracy and limitations when working with instrumentation.			
Course outline				
Theoretical teaching	Characteristics of Measurement Systems. Static and Dynamic Characteristics. Waveform and Reference Signal Generators. Signal Generators. Pulse Generators. Process Calibrators. Electrical Signal Analyzers. Analog and Digital Oscilloscopes. Measurements with Oscilloscopes. Spectrum Analyzers. Testing of Components and Electronic Circuits. Ground Resistance Measurement. Power Quality Measurement. Device Protection against Transient Voltages.			
Practical teaching (exercises, OFE, study and research work)	Computational exercises covering the topics presented in lectures. Laboratory exercises with training boards and measuring instruments: testing generator characteristics, measuring signal parameters, working with digital oscilloscopes.			
Textbooks/references				
1	S. Tumanski „ Principles of Electrical Measurement“, Taylor&Francis, 2006.			
2	N. Kularatna, "Digital and Analogue Instrumentation testing and measurement", The Institution of Engineering and Technology, 2008.			
3	Clyde F. Coombs, "Electronic Instrument Handbook", Mc Graw-Hill. 1999.			
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	0	0

Teaching methods	Lectures using modern presentation tools, computational exercises, laboratory exercises, discussion of students’ solutions to assigned tasks, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	20	**Oral exam**	20
Colloquia	35		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Power Quality		
Lecturer (for lectures)		Korunović M. Lidija		
Lecturer/associate (for exercises)		Krstić N. Nikola		
Lecturer/associate (for OFE)		Krstić N. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Introducing the importance of power quality and basic terms in this area to the students. Introducing the causes and effects of disrupted power quality to students. Consideration of the actions for maintenance of desired power quality and existent standards in this area.			
Course outcomes	Students are habilitated to calculate and analyse power quality indices in accordance with existing standards, and suggest the procedures for power quality improvement and the elimination of the consequences that inadequate power quality causes in electric power network. Students know how to measure and analyse power quality indices by themselves.			
Course outline				
Theoretical teaching	Power quality in up to date electric power systems. Power quality indices: voltage variations, frequency variations, unbalance, transients, voltage sags, voltage swells, short interruptions, overvoltages, undervoltages, interruptions, harmonics, interharmonics, notches, flicker and noise. Sources of particular power quality indices. Damages due to disrupted power quality and actions for the maintenance of desired power quality. Standards regarding power quality.			
Practical teaching (exercises, OFE, study and research work)	During computing exercises students solve computational tasks related to individual voltage quality factors, such as: voltage variations, frequency variations, unbalance,voltage sags, harmonics. They calculate power quality indices and compare them to the actual standard. In the case of impaired voltage quality, they propose specific measures to improve it. During laboratory exercises they measure power quality indices, explain measurement results using computer and compare them with existing standards.			
Textbooks/references				
1	R. Dugan, M. McGranaghan, S. Santoso, H. W. Beaty: "Electrical Power System Quality", second edition, McGraw-Hill Companies, 2004.			
2	A. Baggini: "Handbook of Power Quality", John Wiley & Sons, 2008.			
3	M. K. Mishra: "Power Quality in Power Distribution Systems: Concepts and Applications", CRC Press, 2023.			
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	0	0

Teaching methods	Theoretical teaching includes classic lectures and lectures in electronic form. Practical teaching includes solution of computational tasks, measurements in laboratory and the analysis of measurements using computer.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	20
Exercises	20	**Oral exam**	10
Colloquia	50		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	English Language I		
Lecturer (for lectures)	Stojković M. Nadežda		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Students learn about major differences between General English and English for Electronics. This course objective is to develop communication skills necessary for clear and appropriate layout of written and spoken communications in scientific and technical contexts. Students learn how to present themselves, their academic education and study program, to adopt terminology and rhetorical structures related to key areas of electronics. This course is the basis for self asured and adequate use of English language in academic and scientific environments related to electronics.		
Course outcomes	Upon completion of English language 1 course students will be able to differentiate between General and Specific English - English for Electronics, recognize and appropriately use basic terminology and rhetorical structures, to organize written and spoken text, clearly and effectively present themselves, their study program and fields of professional and scientific interests, understand and successfully communicate in English language at relevant topics that are part of their domain studies, develop basic academic and professional vocabulary and syntax range.		
Course outline			
Theoretical teaching	1. Presenting oneself, institution - university, faculty, chosen module, courses; 2. Basic mathematical terminology; 3. Description of Electrotechnology field; 4. Structure of short answer or paragraph; 5. Description of a complex structure; 6. Typical workday of an electrotechnology engineer; 7. Basic areas of electrotechnology; 8. Operative System; 9. Grammar revision; 10. Robotics. Theoretical lectures are designed as introduction to academic and professional communication. The focus is at understanding and use of basic notions of electrotechnology, as well as developing language skills through work on characteristics of scientific discourse, genres of academic writing, basic rhetorical structures and relevant grammatical forms. .		
Practical teaching (exercises, OFE, study and research work)			
Textbooks/references			
1	S. R. Esteras, E. M. Fabre (2007). Professional English in Use - ICT. Cambridge University Press.		
2	M. Ibbotson (2009). Professional English in Use - Engineering. Cambridge University Press.		
3	Darko Kovačević (2021). English Language for Electrical Engineers 1 - General Concepts. Akademska misao. Elektrotehnički fakultet Univerziteta u Istočnom Sarajevu.		

4	Darko Kovačević (2021). English Language for Electrical Engineers 2 - ICT. Akademska misao. Elektrotehnički fakultet Univerziteta u Istočnom Sarajevu.			
5				
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	0	0	0	0
Teaching methods	Socratic method of deduction, demonstration, practial work, written work, reading and comprehension, conversation, oral presentation.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures		20	**Written exam**	30
Exercises		20	**Oral exam**	30
Colloquia				
Projects				

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Alternating Current Machines		
Lecturer (for lectures)	Kostić Z. Vojkan, Stajić P. Zoran		
Lecturer/associate (for exercises)	Radić M. Milan		
Lecturer/associate (for OFE)	Radić M. Milan, Banković G. Bojan		
Number of ECTS	7	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Acquiring basic knowledge of alternating current machines, specifically asynchronous and synchronous machines, and their applications in electricity generation and industry.		
Course outcomes	Mastering techniques for analyzing the operation and control of asynchronous and synchronous machines in steady-state operating conditions; and developing skills in monitoring, testing, and maintenance.		
Course outline			
Theoretical teaching	Construction and classification of asynchronous machines. Principle of operation. Power losses and efficiency. Equivalent circuit. No-load and short-circuit tests. Expression for the electromagnetic torque of an asynchronous motor and mechanical characteristic. Operating modes. Operating stability. Reversing the direction of rotation. Starting and speed control. Reactive power in asynchronous motors. Construction and classification of synchronous machines. Principle of operation. Operating modes. Equivalent circuit and phasor diagram of a synchronous generator. Expressions for active and reactive power. Operating stability. Control of active and reactive power. Operating characteristics.		
Practical teaching (exercises, OFE, study and research work)	Numerical exercises cover calculations of asynchronous and synchronous machines in steady-state operating modes relevant to practical applications. Laboratory experiments include: Basic construction elements of asynchronous machines, Starting of asynchronous motors, No-load and short-circuit tests of three-phase asynchronous motor, Basic construction elements of synchronous machines, Recording the no-load characteristic of a synchronous generator, Operation of a synchronous machine in the synchronous compensator mode.		
Textbooks/references			
1	A.E. Fitzgerald, Charles Kingsley Jr., Stephen D. Umans; "Electric Machinery"; McGraw-Hill; 2003.		
2	Bahram Amin; "Induction Motors - Analysis and Torque Control"; Springer; 2001.		
3	T.A. Lipo; "Analysis of Synchronous Machines"; 2nd Edition; CRC Press; 2012.		
4			
5			

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	2	1	0	0

Teaching methods	Lectures with application of demonstrative aids – slides, simulations and details of asynchronous and synchronous machines. Numerical exercises with example problems guide students in independently solving engineering practice problems. Laboratory exercises are conducted with the aid of Laboratory Exercise manuals and lecturer advice. Students independently analyze the results and prepare a report for each laboratory exercise.

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	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electric Power Transmission	
Lecturer (for lectures)			Tasić S. Dragan, Klimenta O. Dardan	
Lecturer/associate (for exercises)			Krstić N. Nikola	
Lecturer/associate (for OFE)				
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Introducing with the basics of transmission networks, basic calculations, planning and exploitation of electric power systems. Analysis of normal and disturbed operating regimes in power systems.			
Course outcomes	Acquired knowledge about electric power transmission and power system operation as a whole. Students will be trained to work on the design and exploitation of transmission lines.			
Course outline				
Theoretical teaching	Electric power system. Power line as an element of power system. Mechanical calculations of overhead power lines. Electric parameters of power lines. Telegrapher's equations. Equivalent circuit models of power lines. Steady state regime calculations of power lines. Active and reactive power balance. Power transformer as an element of power system. Synchronous generator as an element of power system. Short-circuits in electric power networks. Symmetrical components. Positive-sequence, negative-sequence and zero-sequence parameters of the power system elements. Currents and voltages during the fault. Grounding of power system neutrals.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises in power system elements calculation, equivalent circuits parameters, steady state regimes, short-circuits.			
Textbooks/references				
1	T. Gönen, Electric Power Transmission System Engineering Analysis and Design, CRC Press, 2024.			
2	L. M. Slavin, Overhead Distribution Lines: Design and Applications, Wiley, 2020.			
3	C. Bayliss, B. Hardy, Transmission and Distribution Electrical Engineering, Elsevier, 2011.			
4				
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	2	0	0	0

Teaching methods	Lectures, auditory exercises, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises		**Oral exam**	20
Colloquia	50		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Automatic Control		
Lecturer (for lectures)	Mitić B. Darko, Perić Lj. Staniša		
Lecturer/associate (for exercises)	Perić Lj. Staniša, Đorđević D. Anđela, Dimitrijević G. Jelena		
Lecturer/associate (for OFE)	Đorđević D. Anđela, Dimitrijević G. Jelena		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Students acquire fundamental knowledge of the basic concepts, structures and components of automatic control systems. The focus is on the modeling, analysis and synthesis of linear continuous-time systems, as well as their application in industry using modern software tools and controller design techniques.		
Course outcomes	Upon completion of the course, students will be able to understand and apply the basic principles of automatic control, to model and analyze linear systems in time, frequency and complex domains, to assess their stability, and to design PID controllers. They will also be able to work with software tools and apply the acquired knowledge in industrial practice.		
Course outline			
Theoretical teaching	Overview of the development of automatic control systems (ACS). Classification of ACS. Modeling of components of linear ACS. Structure of ACS. Structural block diagrams of control systems. Analysis of linear systems in time, frequency and complex domains. System stability. Methods for stability analysis in the frequency and complex domains. Evaluation of the quality of system behavior and criteria for synthesis. Synthesis of continuous ACS. Industrial controllers. Design and tuning of industrial PID controllers. Examples of architecture and application of modern ACS.		
Practical teaching (exercises, OFE, study and research work)	Basic relations and application of Laplace transform. Application of signal graphs and Mason's rule in solving structural block diagrams. Electromechanical analogies and determination of transfer functions of electrical circuits. State-space system model. Determination of matrix models of linear electrical networks. Transformation of mathematical models from state space to complex domain. Direct programming. Serial programming. Parallel programming. Responses of components and systems (impulse, step, ramp and frequency response). Analysis of system stability using Hurwitz and Routh criteria. Application of Bode criterion. Application of Nyquist criterion. Root locus method (RLM). Application of RLM in the synthesis of compensators. Design of compensators and controllers using Bode plot method.		
Textbooks/references			
1	Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", Pearson, 2020.		
2	Norman S. Nise, Control Systems Engineering, John Wiley & Sons, 2015.		
3	M. Gopal, "Control Systems: Principles and Design", McGraw-Hill, 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	1	0	0

Teaching methods	Lectures; Auditory exercises; Laboratory exercises

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises		**Oral exam**	30
Colloquia	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Power Cable Engineering	
Lecturer (for lectures)			Tasić S. Dragan, Klimenta O. Dardan	
Lecturer/associate (for exercises)			Stojanović S. Miodrag, Krstić N. Nikola	
Lecturer/associate (for OFE)				
Number of ECTS	6	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	The aim of the course is to familiarize students with the structural elements of power cables, calculation of electrical and magnetic fields in the cable, the impact of the environment on the ampacity of cables, cable accessories, cable laying, testing and failure detection in the cable.			
Course outcomes	Students will be trained to work in the manufacturing, testing and exploatation of electric power cables. The acquired knowledge enables engineering work in teams for the design of cable lines and networks			
Course outline				
Theoretical teaching	Structural elements and types of power cables. Single-core cable electrical field. Three-core cable electrical field. Electrical parameters of the cable: resistance, inductance, capacitance, zero impedance, reduction factor. Power losses in the cables. Cable ampacity. The influence of the environment on the cable ampacity. Short circuit ampacity. Cable terminations and joints. Cable laying. Cable testing. Failure detection in the cable.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises in the fields of electrical field in the cable, electrical parameters of the cable, power loss in the cable, cable ampacity.			
Textbooks/references				
1	W. A. Thue, Electrical Power Cable Engineering, CRC Press, 2017.			
2	S. K. Ganguli, V. Kohli, Power Cable Technology, CRC Press, 2018			
3	IEC 60287-Ed.2024, IEC 60853-Ed.2013, IEC 62095-Ed.2020.			
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	0	0

Teaching methods	Lectures, exercises, discussions and practical demonstrations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	25
Exercises		**Oral exam**	20
Colloquia	50		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Practicum in Industrial Power Engineering		
Lecturer (for lectures)		Kostić Z. Vojkan, Stajić P. Zoran		
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)		Kostić Z. Vojkan		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Acquisition of basic knowledge necessary for practical work with equipment in industrial power engineering, as well as for preparing and interpreting technical documentation related to industrial power engineering.			
Course outcomes	At the end of the course, students will be able to independently select and verify the functionality of specific power engineering equipment, as well as prepare and interpret the corresponding technical documentation.			
Course outline				
Theoretical teaching	Technical documentation. Specification and selection of equipment in industrial power engineering. Conductors and cables. Control equipment. Switching equipment. Signaling equipment. Equipment for the protection of power installations. Equipment for the detection of electrical and non-electrical quantities. Position and level detection. Proximity sensors. Equipment for the measurement of electrical and non-electrical quantities. Measurements in electrical drives. Wiring of sensors. Programmable logic controllers – structure and wiring. Programmable logic controllers – programming. Communication equipment and protocols. Human-machine interface.			
Practical teaching (exercises, OFE, study and research work)	Practical exercises are conducted under laboratory conditions and include the following: Interpretation of technical documentation using a real-life example; Pushbutton and switch: functionality testing, wiring, and circuit testing; Relay: functionality testing, wiring, and circuit testing; Contactor: functionality testing, wiring, and circuit testing; Signal light and buzzer: functionality testing, wiring, and circuit testing; Thermal overload relay and phase monitoring relay: functionality testing, wiring, and circuit testing; Proximity sensors: functionality testing, wiring, and circuit testing; Temperature and pressure sensors: functionality testing, wiring, and circuit testing; Position and speed sensors: functionality testing, wiring, and circuit testing; Programmable logic controllers (PLCs): principle of operation, structure, and wiring; Project creation, hardware definition, and writing the first program for reading digital inputs and activating digital outputs; Defining a program block and reading analog inputs; Defining functions and scaling values read from the analog input; Connecting an HMI panel to a programmable logic controller (PLC).			
Textbooks/references				
1	John G. Webster, Halit Eren; "Measurement, Instrumentation, and Sensors Handbook"; CRC Press; 2014.			
2	Neha Kardam; "Industrial Automation Sensors and Motors"; OpenWA; 2024.			
3	Frank D. Petruzella; "Programmable Logic Controllers"; Fifth Edition; McGraw-Hill; 2017.			
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	3	0	0

Teaching methods	Lectures with application of demonstrative aids – slides and details of equipment used in industrial power engineering, as well as appropriate examples of technical documentation from engineering practice. Practical exercises are conducted with the aid of Laboratory Exercise manuals and lecturer advice. Students independently wire the laboratory exercises and then test them under voltage with the permission and in the presence of the lecturer's assistant.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	Written exam	
Exercises	50	Oral exam	40
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Numerical Analysis		
Lecturer (for lectures)	Džunić S. Jovana		
Lecturer/associate (for exercises)	Stankov D. Stefan		
Lecturer/associate (for OFE)			
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The aim of the course is to provide students with fundamental knowledge and skills in numerical mathematics, essential for solving a wide range of engineering and scientific problems. Special emphasis is placed on understanding the nature and propagation of errors in numerical procedures, as well as on the practical application of methods for solving systems of equations, function approximation, integration, and solving differential equations.		
Course outcomes	Upon completion of the course, the student will be able to understand and analyze the sources and impact of errors in numerical computations; apply basic direct and iterative methods for solving systems of linear and nonlinear equations; use techniques for function approximation and interpolation; solve ordinary differential equations using numerical methods; and utilize programming tools to implement and verify numerical procedures, with the ability to critically evaluate the accuracy and stability of the obtained results.		
Course outline			
Theoretical teaching	The course covers fundamental concepts of error propagation, numerical stability, and computational accuracy. It includes iterative methods, convergence criteria, and error estimation. Students will study the algorithms to solution of systems of linear equations using both direct and iterative methods (Gaussian elimination, matrix factorization, Gauss-Seidel method). In the area of function approximation, topics include interpolation polynomials, cubic splines, trigonometric interpolation, and the Fast Fourier Transform (FFT). The course also covers methods for solving nonlinear equations, numerical integration, and the numerical solution of ordinary differential equations using Euler and Runge-Kutta methods.		
Practical teaching (exercises, OFE, study and research work)	Exercises. Computer-based exercises. Use of software packages. Weekly assignments. The practical and computational sessions are designed to provide students with a deeper understanding of numerical methods through their application to real-world engineering problems, using the MATLAB software package. Through hands-on experience, students learn to formulate problems, select appropriate numerical methods, evaluate the accuracy of the results obtained, and analyze the stability of the procedures. Working in MATLAB allows students to test theoretical knowledge in practice, visualize solutions, and develop basic programming skills in the context of numerical analysis—an essential foundation for future applications.		
Textbooks/references			
1	J. Dzunic, e-book with exercises: Numerical analysis (Subject MS Teams), 2022		
2	J. Kiusalaas, Numerical methods in engineering with MATLAB, Cambridge University Press, 2016		
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	0	0

Teaching methods	Lectures. Computational exercises. Computer-based exercises. Project-based learning.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises		**Oral exam**	40
Colloquia			
Projects	60		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			English Language 2	
Lecturer (for lectures)			Stojković M. Nadežda	
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)				
Number of ECTS	3		**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None			
Course objectives	Perfecting use of professional and scientific discourse of electronics, rhetorical structures of various relevant formats of both written and spoken domain language. Mastering representative topics in the area of electronics, argumentative opinion layout and taking part in professional discussion. Critical reading of representative topics in this field and presenting supported opinion, adequate response towards opposing views. Considering use of AI tools for professional terminology translation.			
Course outcomes	Mastering electronics scientific and professional discourse, adoping relevant terminology and its proper translation into Serbian language, advanced conversation on topics of domain courses, capability of creating representative written documents in this field with application of inherent rhetorical structures.			
Course outline				
Theoretical teaching	1. Arguments formulation; 2. writing of argumentative presentation; 3. reading graphs; 4. process description and flow chart design; 5. Unit on Machine Learning; 6. Unit on Artificial Intelligence; 7. Unit IoT; 8. Unit Embedded Systems; 9. OverEngineering; 10. writing CV and other documentation. Theoretical lectures are devoted to developing skills of argumentation in scientific discourse, critical reading and interpretation of scientific texts and visual ilustrations, all through work on contemporary most relevant topics in the field of electronics. Special attention is paid to writing representative documentation that future engineers meet in their daily work.			
Practical teaching (exercises, OFE, study and research work)				
Textbooks/references				
1	Darko Kovačević (2021). English Language for Electrical Engineers 2: ICT. Akademska misao. Elektrotehnički fakultet Univerziteta u Istočnom Sarajevu.			
2	Darko Kovačević (2025). English Language for Electrical Engineers 4: Brave New World. Akademska misao. Elektrotehnički fakultet Univerziteta u Istočnom Sarajevu.			
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	0	0	0

Teaching methods	Socratic method of deduction, demonstration, practical work, written work, reading and comprehension, conversation, oral presentation.		
Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	20	**Written exam**	30
Exercises	20	**Oral exam**	30
Colloquia			
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			High Voltage Substations	
Lecturer (for lectures)			Korunović M. Lidija	
Lecturer/associate (for exercises)			Stojanović S. Miodrag	
Lecturer/associate (for OFE)			Stojanović S. Miodrag, Krstić N. Nikola	
Number of ECTS		6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None			
Course objectives	Introducing the elements of high voltage substations and the role of these substations in electric power systems, to the students. Calculation of short-circuit currents and their characteristic values necessary for the selection and testing of equipment and apparatus. Introducing the standards and recommendations for design of high voltage substations, and their application to particular substations.			
Course outcomes	Students will have the knowledge and skills necessary for the dimensioning of equipment and the design of substations of various voltage levels. They will also be trained to maintain equipment and solve practical problems in the operation of high voltage substations.			
Course outline				
Theoretical teaching	Transformer - the element of high voltage substations. Economic aspects of transformer operation. Heating of transformer. Selection of transformer. Time-dependent change of short-circuit current, ac and dc component. Calculation of short-circuit current in radial networks. Influence of loading, resistance and induction motors on short-circuit current. Characteristic values of short-circuit currents. Thermal and mechanical calculations of elements in high voltage substations. Selection and testing of elements and equipment in high voltage substations. Main and auxiliary schema of high voltage substations. Distribution TS HV/MV and MV/LV. Disposition of high voltage substations. Grounding of high voltage substations.			
Practical teaching (exercises, OFE, study and research work)	Practical teaching includes solving computational problems related to various aspects of transformer operation, short-circuit calculations, selection of elements and equipment, and substation grounding.The seminar paper presents a comprehensive calculation related to elements and equipment of a high voltage substation, which includes relevant principle diagrams and substation layout. Practical classes are complemented by visits to high voltage substations.			
Textbooks/references				
1	J. D. McDonald: "Electric Power Substations Engineering", third edition, CRC Press, Taylor & Francis Group, Boca Raton, 2012.			
2	N. Sclater: "Handbook of Electrical Design Details", second edition, McGraw-Hill Companies, 2003.			
3	CIGRE Study Committee B3: "Substations", CIGRE, Springer, 2019.			
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	0	0

Teaching methods	Theoretical teaching includes classic lectures and lectures in electronic form. Practical teaching includes solution of computational tasks, the work on seminar paper, and visiting high voltage substations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	25
Exercises	5	**Oral exam**	25
Colloquia	40		
Projects	5		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Testing of Electrical Machines		
Lecturer (for lectures)	Stajić P. Zoran		
Lecturer/associate (for exercises)	Radić M. Milan, Filipović R. Filip		
Lecturer/associate (for OFE)	Radić M. Milan, Filipović R. Filip		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Gaining knowledge about the program and the procedures for testing of electrical machines.		
Course outcomes	Students get theoretical and practical ability to perform the most important experiments on the electrical machinery and to process the experimental results.		
Course outline			
Theoretical teaching	Classification of tests performed on electrical machines. The test program for transformers, DC machines, induction machines and synchronous machines. Measurement of winding resistance and insulation resistance. Insulation testing by applied and induced voltage. Regenerative and direct methods for loading of electric machines. Measurement of speed and torque. Temperature rise test. Measurement of winding temperature. No-load and short-circuit test on induction machine. Determination of starting characteristics and variables in equivalent circuit. Segregation of power losses. No-load and short-circuit test on synchronous machine. Determination of synchronous machine reactances. Acceleration, retardation and overspeed tests.		
Practical teaching (exercises, OFE, study and research work)	Problems following lectures are solved on auditory exercises, including processing and interpretation of the results obtained by practice. Laboratory exercises are performed on real machines, involving insulation tests, vector group and winding terminals check on a three-phase transformer, transformer temperature rise test, regenerative tests on DC machines, recording performance characteristics of induction machines using direct loading method, short-circuit test of induction macnine at a lowered and at the rated frequency, segregation of no-load loses, winding terminals check on induction machine, determining the rotor moment of inertia from retardation test, no-load and short-circuit test on synchronous generator and synchronous machine parameters identification.		
Textbooks/references			
1	P. Gill, "Electrical Power equipment Maintenance and Testing", CRC Press, 2008.		
2	P. Vas, "Parameter Estimation, Condition Monitoring, and Diagnosis of Electrical Machines", Clarendon Press, 2023.		
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	2	0	0

Teaching methods	Lectures and auditory exercises are performed on blackboard; Laboratory exercises are performed on real machines where students work independently, with supervision. 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	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electric Vehicles		
Lecturer (for lectures)	Petronijević P. Milutin		
Lecturer/associate (for exercises)	Filipović R. Filip		
Lecturer/associate (for OFE)	Filipović R. Filip		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to the basic drive requirements, kinematics and dynamics of electric vehicles. Gaining knowledge about electric traction converters and drive motors. Understanding operating modes and control methods.		
Course outcomes	Mastering basic knowledge regarding electric traction requirements: traction resistance, traction requirements, adhesion, power and EE consumption. Basic knowledge regarding the selection of converters and electric motors for electric vehicles. Necessary engineering knowledge regarding the dimensioning of elements of the complete electric drive of the vehicle.		
Course outline			
Theoretical teaching	Basic concepts and principles. Traction and braking requirements. Adhesion. Power supply and consumption of electric energy. Hybrid vehicles: series and parallel hybrids, performance. Fully electric vehicles. Topology of electric vehicles. Basic elements of electric vehicles: sources of electric energy, electric drive, converters, control system. Traction motors: asynchronous, permanent magnet motors, reluctance motors. Operating modes of electric vehicle drives. Dynamic and regenerative braking. Control of electric vehicle drives. Optimization of electric vehicle consumption.		
Practical teaching (exercises, OFE, study and research work)	Calculation exercises: calculation of traction resistance - temporary and permanent resistance. Adhesion. Basic equation of vehicle motion. Vehicle drives with alternating current motors. Converters in electric traction - calculation based on the required traction requirements, dimensioning of components. Braking - dynamic and regenerative braking modes. Selection of drive motors for electric vehicles. Selection of drive system elements. Laboratory exercises: Simulation of vehicle movement. Regulation of traction force and engine torque. Optimization of vehicle consumption.		
Textbooks/references			
1	S. Zoepf, P. Enge, and N. Enge, Electric Vehicle Engineering. McGraw-Hill Education, 2020.		
2	Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC Press, 2018		
3	Ali Emadi, "Advanced Electric Drive Vehicles", McMaster University, Hamilton, Ontario, Canada, 2015		
4	J. G. Hayes, G. A. Goodarzi, Electric powertrain : energy systems, power electronics and drives for hybrid, electric and fuel cell vehicles, Wiley, 2018.		
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	0	0

Teaching methods	Lectures are conducted using slides, animations and simulations. Numerical exercises include solving examples to illustrate lectures and solve specific engineering problems. Exercises are performed in the laboratory - simulations in MATLAB and on laboratory facilities with various types of machines. Student seminar paper.

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	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Control and Automation of Energy Distribution Networks		
Lecturer (for lectures)	Stajić P. Zoran		
Lecturer/associate (for exercises)	Radić M. Milan		
Lecturer/associate (for OFE)	Stajić P. Zoran		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	To familiarize students with the principles of control and automation of energy distribution network and various types of control systems. Introduction to equipment used for network control and automation. Introduction to the concept of Smart Grids and methodology for designing remote control systems for medium voltage distribution networks (MVDN).		
Course outcomes	Students are prepared to identify effective MVDN strategies and hierarchical levels for control and automation of energy distribution network. Depending on the desired functionality, students are qualified to select the necessary power and communication equipment. They are also familiar with the significance, structure, and design methods of various decision support systems that can be used in control and automation of energy distribution networks.		
Course outline			
Theoretical teaching	Electric distribution activity throughout history and today, from the point of view of control and automation. Types and categories of control systems. SCADA (Supervisory Control and Data Acquisition) systems. Concept and components of smart grids. Basic system architecture. Database structure and interfaces. Primary and secondary equipment for network management, control, and protection equipment. Communication systems for distribution network management. Communication methods and protocols. Standards for interoperability in advanced distribution networks. Importance of decision support systems in distribution network management. Modern trends in the development of this field. Self-Healing and Self-Optimizing Grid projects. Examples of practical implementation of these systems.		
Practical teaching (exercises, OFE, study and research work)	Practical work with automatic control systems in distribution networks. Setting SCADA system parameters. Practical work with data from event lists recorded by real SCADA systems. Student research work consists of designing and/or analyzing data from real SCADA systems, specific events that occurred in certain parts of the distribution network, possibilities of readjusting trigger values to reduce the number of warnings and alarms, recommendations for maintenance teams of electrical power organizations, so that the SCADA system is relieved of redundant data and its smooth operation is enabled.		
Textbooks/references			
1	J. Northcote-Green, R. Wilson, „Control and Automation of Electrical Power Distribution System“, CRC Press, Taylor & Fransis Group, 2006.		
2	J. A. Momoh, “Smart grid: Fundamentals of Design and Analysis”, IEEE Press, John Willey& Sons Inc. 2012.		
3	J. A. Momoh, “Electric Power Distribution, Automation, Protection, and Control”, CRC Press, Taylor & Fransis Group, 2017.		
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	0	0

Teaching methods	Lectures and computational exercises are conducted on the blackboard. Modern teaching methods are used in lectures. In auditorium exercises, problems that accompany lectures are solved, directing students to independently solve problems from engineering practice. Part of the exercises is also conducted in the computer classroom using computer network models.

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	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Automatic Control Systems	
Lecturer (for lectures)			Spasić D. Miodrag, Danković B. Nikola	
Lecturer/associate (for exercises)			Spasić D. Miodrag, Danković B. Nikola	
Lecturer/associate (for OFE)			Danković B. Nikola	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Acquiring knowledge about nonlinear, discrete and optimal automatic control systems and implementation in other professional subjects and in practice.			
Course outcomes	Gain knowledge of the methods of analysis, modeling, simulations and synthesis of automatic control systems.			
Course outline				
Theoretical teaching	Reviewing the development of automatic control systems (ACSs). Nonlinear systems. Discrete systems. Digital system structure and sampling process. Discrete transfer function. Stability of discrete ACSs. Synthesis of discrete ACSs. Examples of nonlinear systems. Common nonlinearities and their characteristics. Linearization of nonlinear systems. Phase plane analysis. Stability of nonlinear ACSs. Optimal systems. Criterion functions. Kalman regulator design. Kalman regulator with a pre-appointment degree of exponential stability. Pole placement for multivariable feedback systems. Opserver design. Simulation of ACSs. Application of simulation in analysis and synthesis of ACSs. Software for simulation of ACSs.			
Practical teaching (exercises, OFE, study and research work)	Discrete transfer function. Stability of discrete ACSs. Z-transformation, inverse z-transformation. Jury stability criterion. Nyquist stability criterion for discrete systems. Root locus method. Design of digital compensators and regulators. Methods for analysis of nonlinear ACSs. Stability of nonlinear ACSs. Definition of stability, Lyapunov's direct and indirect methods. Examples of nonlinear systems. Parametric optimization. Kalman regulator. Opersver design.			
Textbooks/references				
1	Tore Hägglund, "Automatic control", 2021			
2	Sigurd Skogestad, Ian Postlethwaite, "MULTIVARIABLE FEEDBACK CONTROL Analysis and Design", 2006			
3	Hassan Khalil, "Nonlinear systems", 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	0	0

Teaching methods	Lectures; Auditory 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	20	**Oral exam**	20
Colloquia	30		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Engineering Education and Sustainable Development	
Lecturer (for lectures)			Bojkov S. Vanče	
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)				
Number of ECTS	3	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	The aim of the course is to present the dynamic development of environmental issues and sustainable development in the modern world, as well as their impact on the theory and practice of the engineering profession; to enable students to acquire new knowledge in the fields of engineering education, engineering, engineering ethics, and sustainable development; to encourage an understanding of their interdependence and help students master the principles of sustainable development and recognize the importance of ethics and education for engineers in both technology and society.			
Course outcomes	The expected outcomes include acquiring knowledge about the principles underlying the concept of sustainable development, the implementation of moral norms in forming critical assessments of strategies for environmental protection and sustainable development within the specific spatial, social, and cultural contexts in which engineering activities take place.			
Course outline				
Theoretical teaching	The origin of the term and the historical development of the idea of education. Education of engineers in Serbia. The concept of contemporary society. Technological changes, knowledge and new materials. Engineering, engineering ethics and the relevance of ethics in technics and society. Sustainable development. Philosophy, principles and practice of the sustainable development. Visions and approaches to sustainable development. The role of the interantional community in the formation of 'planetar' politics of sustainable development policy. World forums and strategic documents on establishing priorities, aims and the policy of sustainable development on both global and local levels. Sustainable development as an alternative to traditional political and economical paradigm. The role of technology in the sustainable development. Sustainable development and the technology changes. Dependence on technological changes, the failure of techonological improvements and the failure of adopting alternative technologies. Preventive engineering and sustainable development. Instruments for ecological politics. European programs, funds and projects. Ecological consequences and scientific technological revolutions.			
Practical teaching (exercises, OFE, study and research work)				
Textbooks/references				
1	Desha, C. J., & Hargroves, K. (2014). *Higher education and sustainable development: A model for curriculum renewal*. Routledge.			
2	UNESCO. (2021). *Engineering for sustainable development: Delivering on the Sustainable Development Goals*. Paris: UNESCO Publishing.			
3	Clift, R., & Morrison, J. (2011). *Engineering and sustainability: A technical and practical guide*. IET.			
4	Allenby, B. R., & Richards, D. J. (2011). *The theory and practice of sustainable engineering*. Pearson Education.			
5				
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**

2	0	0	0	0
Teaching methods	Lectures, consultations.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures		10	**Written exam**	20
Exercises			**Oral exam**	20
Colloquia		40		
Projects		10		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies			
Type and level of studies	Undergraduate Academic Studies			
The name of the course	Business Communications			
Lecturer (for lectures)	Bojkov S. Vanče			
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)				
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	None			
Course objectives	The aim of the subject is to introduce future engineers of electro technology with the role of business communications in business strategy, communications aspects in business relations, communication skills, as well as with didactics principles in practical business and electronic communications.			
Course outcomes	The readiness of engineers of electro technology to organize and indipendently make decisions in contemporary corporate business with gained communicational skills with the practical application of modern technique of planning.			
Course outline				
Theoretical teaching	Basic elements of communications.Structure of communicative process. Types of communications.Communicative aspects of business relations. Basic rules and principles of business negotiations. Technique of business negotiations. Basic characteristics of business communications. Public relations. Press conference. Leadership. CV. Business etiquette. Internet and electronic business. Forms of e-commerce. Risks and safety of e-commerce. Influence of the Internet on the shaping and development of contemporary society. European law regulations for e-communication. Legal and ethical problems of commerce on the Internet. Privacy protection.			
Practical teaching (exercises, OFE, study and research work)				
Textbooks/references				
1	Guffey, M. E., & Loewy, D. (2022). *Essentials of business communication* (12th ed.). Cengage Learning.			
2	Argenti, P. A. (2021). *Corporate communication* (7th ed.). McGraw-Hill Education.			
3	Markel, M., & Selber, S. A. (2021). *Technical communication* (13th ed.). Bedford/St. Martin's.			
4	Bojkov, V. Interaction in business communication, Knowledge International Journal, Skopje, 2018., 26(36), ISSN 2545-4439, Global Impact Factor (2018) 1.822, pp. 1597-1604.			
5	Vanče Bojkov, Darjan Bojkov; E-mail as a form of business communication, Journal of Process Management – New Technologies INTERNATIONAL, Ohrid, 2014, ISSN: 2334-7449 (Online) ISSN: 2334-735X (Print), page 457-459.			
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	0	0	0	0
Teaching methods	Lectures, consultations.			

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises		**Oral exam**	20
Colloquia	40		
Projects	10		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Engineering Entrepreneurship		
Lecturer (for lectures)	Stanković Z. Zorana, Milojković T. Marko, Stajić P. Zoran		
Lecturer/associate (for exercises)	Bogdanović D. Miloš		
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Development of academic and professional knowledge and skills that will facilitate future graduate engineers establishing and managing their own entrepreneurial ventures. Development of the ability to analyze and understand business situations in which entrepreneurs operate, including the identification and evaluation of risks, recognition of market opportunities, and potential innovations. Fostering an entrepreneurial mindset, mastering the fundamentals of entrepreneurial planning (including business plan development), as well as understanding the specific features of project management.		
Course outcomes	Students will be able to assess their readiness, capabilities, and inclinations toward entrepreneurship. Students will demonstrate the ability to collect primary and secondary data in order to generate ideas for entrepreneurial ventures. They will be equipped to independently and collaboratively develop entrepreneurial ideas, analyze the business aspects of innovations, define business models and commercialization strategies. Students will demonstrate key traits of entrepreneurial leadership and the ability to present a business idea effectively. They will also be trained to identify sources of funding and to prepare a project proposal or campaign aimed at providing financial resources.		
Course outline			
Theoretical teaching	Principles of engineering entrepreneurship. The entrepreneurial process. Market research. The paradox of choice. Innovation as the foundation of an entrepreneurial venture. Open innovation. Prototype with core functions. Patents and intellectual property. Elements of a business plan. Development of the Business Model Canvas. Preparation of a pitch presentation. Lean Start-up. Selection of legal business form. Sources of funding for new ventures (venture capital and crowdfunding). Applying for funding from government and EU funds. Preparation of tender documentation. Project proposal development. Support for entrepreneurship development in the early and growth stages.		
Practical teaching (exercises, OFE, study and research work)	Development of a business model. Pitch presentation. Crowdfunding campaign. Completion of a registration application. Preparation of documentation for tender submission. Drafting the framework of a project proposal.		
Textbooks/references			
1	Laverty, M., & Littel, C. (2024). Entrepreneurship. OpenStax. Houston, Texas, USA.		
2	Tidd J., Bessant J. R. (2024). Managing Innovation: Integrating Technological, Market and Organizational Change, 8th Edition, John Wiley & Sons.		
3	Soltanifar, M., Hughes, M., & Göcke, L. (2021). Digital entrepreneurship: Impact on business and society (p. 327). Springer Nature.		
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	0	0	0
Teaching methods	Oral presentation of course content related to theoretical concepts in entrepreneurship, accompanied by video presentations. Case study analysis. Organization of workshops and student team work. Data analysis for the development of a business model using Excel. Preparation of documentation for a tender application based on a concrete example. Drafting the framework of a project proposal in response to a specific, current call.			
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	20			
Projects				

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Power Plants	
Lecturer (for lectures)			Korunović M. Lidija	
Lecturer/associate (for exercises)			Vučković D. Dragan	
Lecturer/associate (for OFE)				
Number of ECTS	5	**Course status (obligatory/elective)**		Obligatory
Prerequisites	None			
Course objectives	Introducing the ways of electric power energy generation, to the students. Introducing different types of electric power plants, their elements and grid connection requirements.			
Course outcomes	Students gained knowledge about how different types of power plants work, their role in the power system, economic indicators of power plants, and procedures for fulfilling requirements for connection to the grid.			
Course outline				
Theoretical teaching	Sources of energy and energy division. Energy resources in the World and in Serbia. Hydro power plants. Hydraulic energy and power of the water. Hydraulic turbines. Types of hydro power plants. Elements of hydro power plants. Thermal power plants. Basic terms of thermodynamics. Elements of thermal power plants. Steam turbines. Nuclear power plants. Thermal power plants with gas turbines. Economic indicators of electric power plants. Photovoltaic systems. Wind farms. Connecting power plants to the grid. Power plant compliance tests with grid connection requirements.			
Practical teaching (exercises, OFE, study and research work)	The exercises cover calculations for different types of power plants - hydro power plants, thermal power plants, nuclear power plants. Calculations related to the economic indicators of power plants are also performed.			
Textbooks/references				
1	P. K. Nag: "Power Plant Engineering", third edition, Tata Mc Graw-Hill Publishing Co.Ltd., New Delhi, 2008.			
2	D. M. Tagare: "Electricity Power Generation: The Changing Dimensions", Wiley-IEEE Press, 2011.			
3	F. Zabihian: "Power Plant Engineering", CRC Press, 2021.			
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	0	0

Teaching methods	Theoretical teaching includes classic lectures and lectures in electronic form. Practice teaching includes solution of computational tasks.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electrical Drives		
Lecturer (for lectures)	Mitrović N. Nebojša, Petronijević P. Milutin		
Lecturer/associate (for exercises)	Mitrović N. Nebojša, Banković G. Bojan		
Lecturer/associate (for OFE)	Kostić Z. Vojkan, Banković G. Bojan		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introducing students to the role and significance of electric drives, their types, structures, and methods for analyzing static characteristics with a focus on practical applications.		
Course outcomes	Understanding of the fundamental principles of operation and structure of electric drives. Ability to analyze a complex electromechanical system through the functional integration of power converters, electrical machines, and load. Knowledge of steady-state characteristics.		
Course outline			
Theoretical teaching	The importance of electric drives. Selection of an electric motor. Drive characteristics with DC motors. Mathematical models, steady-state characteristics, equivalent circuit. Electric braking methods. Control techniques. Combined voltage and flux control. Application of converters in DC drives. Drives with induction and synchronous motors. Fundamental equations. Equivalent circuit. Influence of voltage, parameter, and frequency variations. Electric braking methods. Voltage and current converters for AC motor drives. Steady-state characteristics. Application of inverters. Control methods.		
Practical teaching (exercises, OFE, study and research work)	Practical training is conducted through laboratory experiments on real machines, which include: - Drives with DC motors (analysis of operating modes, control methods, braking modes). - Drives with induction and synchronous machines (analysis of operating modes, control methods, braking modes). - Application of converters in DC and AC drives.		
Textbooks/references			
1	Paul Krause, Oleg Wasynczuk, Scott Sudhoff, Steven Pekarek, "Analysis of Electric Machinery and Drive Systems", Institute of Electrical and Electronics Engineers, 2013.		
2	Andre Veltman , Duco W.J. Pulle , Rik W. De Doncker, "Fundamentals of Electrical Drives", Springer, 2016.		
3	Ion Boldea, Syed A. Nasar "Electrical Drives", CRC Press, 3rd edition 2022.		
4	R. Krishnan, "Electric Motor Drives" Virginia Tech, Prantice Hall 2001.		
5	Piotr Watch, "Dynamics and Control of Electrical Drives", Springer, 2011.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Classes consist of lectures and exercises. The lectures employ modern teaching methods. Auditory exercises, featuring numerous examples, encourage students to independently solve problems from engineering practice. Part of the exercises takes place in the laboratory to record the static characteristics of drives.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	30
Exercises	15	**Oral exam**	20
Colloquia	30		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Power System Analysis	
Lecturer (for lectures)			Tasić S. Dragan, Klimenta O. Dardan	
Lecturer/associate (for exercises)			Stojanović S. Miodrag	
Lecturer/associate (for OFE)			Stojanović S. Miodrag, Krstić N. Nikola	
Number of ECTS		6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None			
Course objectives	The objective of the course is to introduce the students with basic calculations in power systems: power flow calculations, short-circuit currents calculations and stability calculations.			
Course outcomes	After finishing this course, students will be able for physical understanding and independent solving and problems in power flow calculations, short-circuits and stability with an emphasis on computer applications.			
Course outline				
Theoretical teaching	Overview of fundamental theorems in electric power networks. The bus admittance and impedance matrices. Calculations of network symmetrical operating states. Gaus-Seidell solution method and Newton-Raphson solution method for power flow calculation. Short-circuit current calculation. Symmetrical components. Matrix methods for calculating short-circuit currents. Power systems stability criteria. Stability at small disturbances. Transient stability. Fundamentals of voltage stability.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises in the field of: power flow, short-circuits and power system stability. Laboratory exercises on computers in the field of: power flow, short-circuits and power system stability.			
Textbooks/references				
1	L.Powell, Power System Load Flow Analysis, McGraw-Hill, 2004.			
2	F. Saccomanno, Electric Power Systems: Analysis and Control, Wiley-IEEE Press, 2003.			
3	N. Tleis, Power Systems Modelling and Fault Analysis – Theory and Practice, Elsevier Ltd., (2nd edition), 2019.			
4	P.S. Kundur , Power System Stability and Control, McGraw Hill (2nd edition), 2022.			
5				

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	2	1	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electrical Drives Project Design	
Lecturer (for lectures)			Petronijević P. Milutin	
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)			Filipović R. Filip	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Introducing students to basic design solutions for modern electric motor drives at the energy and control levels. Introducing students to project planning and the process of creating project documentation.			
Course outcomes	At the end of the course, students should demonstrate: basic knowledge of design principles and the content of project documentation; ability to understand complex problems of protection, functionality and automation of drives. Ability to independently develop medium-complex projects of electric motor drives.			
Course outline				
Theoretical teaching	Project planning. Introduction to national and international legal and technical regulations. Device marking. Types and contents of documentation in accordance with legal norms. Application of engineering software in the design of electric motor drives (EMD). Design of the power part of the EMD: calculations, protection, equipment selection. Basic protection equipment: fuses, circuit breakers, relays, functional safety. Selection and design of the control part of the EMD: local and remote control. Selection of basic components and topology of industrial networks. Selection of PLC system components. Design of complex multi-motor drives.			
Practical teaching (exercises, OFE, study and research work)	Practical teaching takes place through all phases of developing a medium-complexity electric motor drive project: planning, calculations, conceptual design phase, development of the main project, equipment specifications, and development of assembly diagrams and situations. In the preparation of documentation, students use modern engineering software tools (EPLAN, AutoCad, Simaris) to solve the assigned project task. In the laboratory, students are introduced to the basic elements of modern electric motor drives and the practical implementation of design solutions.			
Textbooks/references				
1	M. Barnes, Practical Variable Speed Drives and Power Electronics, Elsevier, 2003			
2	Z. Stojkovic, Computer- aided design in power engineering: Application of Software Tools. Springer, 2012.			
3	Schneider Electric, "Electrical Installation Guide, IEC Standards", 2018			
4	Weidauer, Jens, and Richard Messer. Electrical Drives: Principles, Planning, Applications, Solutions. John Wiley & Sons, 2014.			
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	0	0

Teaching methods	Lectures are conducted using slides, animations and simulations. Exercises are conducted in the laboratory - using the specified, specialized software. Student seminar paper.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	40
Colloquia			
Projects	40		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Power Supplies		
Lecturer (for lectures)	Mančić D. Dragan, Jovanović D. Igor		
Lecturer/associate (for exercises)	Panić D. Aleksandar		
Lecturer/associate (for OFE)	Panić D. Aleksandar		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Acquiring the fundamental knowledge about power supplies, methods of their realisation and practical application.		
Course outcomes	Theoretical knowledge on power supplies. Mastering the techniques of development, realisation and application of power supplies.		
Course outline			
Theoretical teaching	Types of power supplies. Linear power supplies. Switching power supplies. Direct converters (buck, boost, inverting converter, Ćuk converter, SEPIC converter, reverse converters). Isolated converters (forward and flyback converters, Ćuk converter). Two-pulse converters. Control methods for switching sources. Power supply systems. Centralized and decentralized power supplies. Grounding of a system. Voltage balance. Uninterruptible power supplies (UPS). Elements of a system. Batteries and accumulators. Methods of implementation. Methods of regulation and control.		
Practical teaching (exercises, OFE, study and research work)	Linear voltage regulator. Switching voltage regulator. The switching flyback converter. Switching half-bridge converter. An uninterruptible power supply system.		
Textbooks/references			
1	A. Pressman, K.Billings, T.Morey, "Switching Power Supply Design", McGraw-Hill, 2009.		
2	R.W.Erickson, D. Maksimovic, "Fundamentals of Power Electronics, Third Edition", Springer, 2020.		
3	S.Maniktala, "Switching Power Supply Design and Optimization", McGraw-Hill, 2014.		
4	S.M.Sandler, "Switched-Mode Power Supply Simulation with SPICE", Faraday Press, 2018.		
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	1	1	0	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			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Groundings	
Lecturer (for lectures)			Tasić S. Dragan, Cvetković N. Nenad	
Lecturer/associate (for exercises)			Cvetković N. Nenad	
Lecturer/associate (for OFE)				
Number of ECTS	5		**Course status (obligatory/elective)**	Elective
Prerequisites	None			
Course objectives	The aim of the course is to familiarize students with the characteristics and types of groundings, as well as methods for the calculation and measurement of grounding systems characteristics.			
Course outcomes	Students will be trained to work on calculation of groundings EM characteristics, measurement and verification of characteristics of grounding systems realized in practice.			
Course outline				
Theoretical teaching	Definition of basic terms, classification and basic characteristics of earthings and groundings. Grounding electrodes types classification by shape and purpose. The electrical parameters of the ground and non-homogeneous soil modeling. Calculation of earthing parameters in homogeneous and inhomogeneous earth. Overhead lines and cable lines as parts of the grounding systems. Distribution of earth fault current in the earthing system. Groundings dimensioning. Mutual influences of earthing devices. Methods for measurement and verification of the grounding systems characteristics.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises from groundings and earting systems calculations			
Textbooks/references				
1	M. A. Salam, Q. M. Rahman, Power Systems Grounding, Springer, 2016.			
2	G. P. Bierals, Grounding Electrical Distribution Systems, River Publishers, 2024.			
3	J. He, R. Zeng, B. Zhang, Methodology and Technology for Power System Grounding, John Wiley & Sons, Singapore 2013.			
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	0	0

Teaching methods	Lectures, exercises, homework, consultations

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	25
Exercises		**Oral exam**	20
Colloquia	50		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Special Electrical Machines	
Lecturer (for lectures)			Petronijević P. Milutin	
Lecturer/associate (for exercises)			Filipović R. Filip	
Lecturer/associate (for OFE)			Radić M. Milan	
Number of ECTS	5		**Course status (obligatory/elective)**	Elective
Prerequisites	None			
Course objectives	Study of the basic properties of special electrical machines. Students are introduced to the principles of operation, construction, analysis of static and dynamic performances and their application in electric motor drives.			
Course outcomes	Understanding the basic principles of operation of permanent magnet electric machines and other machines of special construction. Students are trained to apply and implement the control of these electric machines in modern, highly efficient electric drives, in the automotive industry, servo applications, and the like.			
Course outline				
Theoretical teaching	Stepper motors. Construction and basic types. Basic expressions. Dynamic characteristics. Stability. Control of stepper motors. Permanent magnet synchronous motors: Construction and types. Basic equations and equivalent circuits. Transient phenomena. Applications with synchronous motors. Permanent magnet motor control. Brushless DC motors. Power supply and construction. Principles of operation. Basic expressions and equivalent circuit. Mechanical characteristics. Control. DC servo motors. Block diagrams and transfer functions. Reluctance motors. Construction and principle of operation. Expressions for torque and power. Static characteristics. Control.			
Practical teaching (exercises, OFE, study and research work)	Calculation exercises: operating modes of stepper motors, calculations of basic characteristics of synchronous machines with permanent magnets. Calculations in drives with brushless DC motors. Laboratory exercises: simulation of the operation of special electrical machines using Matlab and HIL technologies. Experiments with stepper and permanent magnet motors. Application of digital signal processors (DSP) for control. Seminar paper on the analysis of the operation of special machines and their applications			
Textbooks/references				
1	Jacek F. Gieras, Permanent Magnet Motor Technology: Design and Applications, Third Edition, CRC Press, 2009			
2	Miller, T.J.E. “Brushless permanent magnet and reluctance motor drives”,Clarendon Press, Oxford,1989			
3	P. P. Acarnley, Stepping Motors: A Guide to Theory and Practice, 4th edition, IET, 2007			
4	R.Krishnan, “Switched Reluctance Motors Drives: Modelling, Simulation, Analysis Design and Applications”, CRC Press, New York, 2001.			
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	0	0

Teaching methods	Lectures are supported by slide presentations, animations and simulations. Computational exercises deal with numerical examples related to the lecture and solving specific problems. Independent seminar work. In laboratory exercises, students use Matlab for off-line simulation, HIL for real-time simulations, and the practical part of the exercise is performed on stepper motors and permanent magnet motors using laboratory models and commercial drives.

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			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			High Voltage Engineering	
Lecturer (for lectures)			Javor L. Vesna	
Lecturer/associate (for exercises)			Javor L. Vesna	
Lecturer/associate (for OFE)				
Number of ECTS		5	**Course status (obligatory/elective)**	Elective
Prerequisites	None			
Course objectives	Basic knowledge in the field of high voltage engineering and surge protection of electrical power system elements.			
Course outcomes	Theoretical knowledge and ability to assess the need and apply surge protection techniques for electrical power system elements.			
Course outline				
Theoretical teaching	Applications of high voltage. Causes and classification of overvoltages: very fast, lightning, switching and temporary overvoltages in electrical power systems. Discharges in gaseous dielectrics. Townsend's theory. Paschen's law. Streamer theory. Electrical breakdown in SF6. Corona and losses on transmission lines. Electric arc. Gas-insulated high-voltage switchgear (GIS) plants. Discharges in liquid and solid dielectrics. Lightning discharge current according to the Standard IEC 62305. Standard waveform of overvoltage. Surge arresters. High voltage generators and applications. Preventive and corrective maintenance of electrical equipment. Partial discharges and measurement methods. Statistical coordination of insulation.			
Practical teaching (exercises, OFE, study and research work)	Solving problems in the field of lightning and switching overvoltages. Simulation of overvoltages using computer programs.			
Textbooks/references				
1	Kuffel E., Zaengl W. S., Kuffel J., "High-voltage engineering: fundamentals," Newnes, 2000.			
2	Abdel-Salam M., "High-voltage engineering: theory and practice," Taylor&Francis, CRC Press, 2018.			
3	Ryan H. M.,"High-voltage engineering and testing," IET, 2013.			
4	Arora R., Mosch W., "High-voltage and electrical insulation engineering," Wiley, 2011.			
5	Hauschild W., Lemke E., "High-voltage test and measuring techniques," Springer, 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	0	0
Teaching methods	Lectures, exercises and consultations.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures		10	**Written exam**	20
Exercises		10	**Oral exam**	20
Colloquia		40		
Projects				

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Sensors and Measurement of Non-Electrical Quantities in Industry	
Lecturer (for lectures)			Dinčić R. Milan	
Lecturer/associate (for exercises)			Pešić T. Miroljub, Đorđević-Kozarov R. Jelena	
Lecturer/associate (for OFE)			Pešić T. Miroljub, Đorđević-Kozarov R. Jelena	
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Acquiring fundamental knowledge essential for using sensors to measure non-electrical quantities via electrical methods.			
Course outcomes	Comprehensive theoretical and practical knowledge essential for developing measurement systems. Proficiency in utilizing appropriate sensors and electronic circuits.			
Course outline				
Theoretical teaching	Definition of sensors. Classification of sensors. Trends in sensor development. Static and dynamic characteristics of sensors. Resistive, capacitive, magnetic, inductive, and optical sensors. Sensors for strain, force, displacement, position, velocity, acceleration, pressure, flow, level, humidity, and temperature. Integrated Hall sensors. MEMS sensors. Connecting sensors with measurement bridges and amplifiers. Wireless sensors. Application of Hall sensors for current measurement. Application of sensors in predictive maintenance in industry.			
Practical teaching (exercises, OFE, study and research work)	Tutorials, problem-solving exercises and laboratory exercises, as well as project assignments, aimed at mastering the use of sensors and actuators and the development of measurement systems.			
Textbooks/references				
1	Ambarish Paul, Mitradip Bhattacharjee, Ravinder Dahiya, “Solid-State Sensors”, IEEE Press, Wiley Blackwell, 2024.			
2	Ekbert Hering, Gert Schönfelder, “Sensors in Science and Technology: Functionality and Application Areas”, Springer, 2022.			
3	Walter Lang, “Sensors and Measurement Systems”, River Publishers, 2021.			
4	Patrick F. Dunn, “Fundamentals of Sensors for Engineering and Science”, CRC Press, 2019.			
5	John Webster, „The Measurement, Instrumentation and Sensors Handbook“, CRC Press, 2014.			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	1	0	0

Teaching methods	Lectures, Tutorials, Problem-solving exercises, Laboratory exercises, Project assignments, Consultations

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	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electrical Drives - Selected Chapters		
Lecturer (for lectures)	Mitrović N. Nebojša, Petronijević P. Milutin		
Lecturer/associate (for exercises)	Mitrović N. Nebojša, Banković G. Bojan		
Lecturer/associate (for OFE)	Banković G. Bojan, Filipović R. Filip		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduce students to the dynamic characteristics of electric drives, as well as methods of analysis, synthesis, and modern control techniques.		
Course outcomes	Students become familiar with methods for analyzing complex electromechanical systems consisting of electrical machines, inverters, and loads.		
Course outline			
Theoretical teaching	Analysis of electrical drives: transfer functions and state-space models. Stability criteria. DC drives with separate and series excitation. Dynamic models. Influence of various parameters on system pole placement. Dynamic behavior depending on the control method. Dynamics in braking modes. Linearized models. Drives with AC motors. Transformation of coordinate systems. Transformations and their applications in drives with induction and synchronous machines. Dynamic equivalent circuits. Identification and estimation of drive parameters. Dynamics of AC motors in braking modes. Impact of actuators on the dynamics of AC drives. Voltage and current supply of AC motors. Scalar and vector control methods. Implementation.		
Practical teaching (exercises, OFE, study and research work)	Analysis of DC and AC drives based on mathematical models. Computational methods for analysis and simulation. Experimental verification of various control algorithms in the laboratory. Experimental evaluation of the dynamic characteristics of the drives. Multi-quadrant operation.		
Textbooks/references			
1	Paul Krause, Oleg Wasynczuk, Scott Sudhoff, Steven Pekarek, "Analysis of Electric Machinery and Drive Systems", Institute of Electrical and Electronics Engineers, 2013.		
2	Werner Leonhard, "Control of Electrical Drives", Springer, 2001.		
3	Mohammed Fazlur Rahman, Sanjeet K. Dwivedi, "Modeling, Simulation and Control of Electrical Drives", IET, 2019.		
4	R. Krishnan, "Electric Motor Drives", Virginia Tech, Prantice Hall 2001.		
5	Piotr Watch, "Dynamics and Control of Electrical Drives", Springer, 2011.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	2	1	0	0

Teaching methods	Classes consist of lectures and exercises. The lectures employ modern teaching methods. Auditory exercises, featuring numerous examples, encourage students to independently solve problems from engineering practice. Part of the exercises takes place in the laboratory to record the static and dynamic characteristics of drives.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	15	**Oral exam**	30
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Power System Protection		
Lecturer (for lectures)	Stojanović N. Zoran		
Lecturer/associate (for exercises)	Stojanović S. Miodrag		
Lecturer/associate (for OFE)	Stojanović S. Miodrag		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Explanation of the basic concepts of power system elements protection. Introduction of the basic concept of protection relays and protection of lines, generators, transformers buses, motors and capacitors. Explanation of the basics of electromechanical, solid-state and digital relays.		
Course outcomes	Students gain the ability to utilize and maintain protection systems of power system elements.		
Course outline			
Theoretical teaching	Basic functions of relay protection. Protective relaying fundamentals. First, second and third generation protective relays. Protection elements: current, voltage, frequency, thermal, time, directional, distance and differential relays. Protection of overhead and cable lines. Protection of synchronous generators. Protection of power transformers. Busbar protection. Protection of asynchronous and synchronous motors. Protection of capacitor banks and reactors. Backup protection. Standard labeling of power system protection functions.		
Practical teaching (exercises, OFE, study and research work)	Determining the input values of amplitude and phase comparators. Estimation of analog signal parameters using digital methods with a small number of samples and the Fourier method. Calculation of parameters for setting line protection (instantaneous overcurrent protection, definite-time overcurrent protection, inverse-time overcurrent protection, directional protection, eart-fault protection, differential protection and distance protection), generators, transformers and asynchronous motors. Laboratory exercises: Testing of protective relays: instantaneous overcurrent protection, definite-time overcurrent protection, inverse-time overcurrent protection, sensitive earth-fault protection, differential protection of transformers.		
Textbooks/references			
1	J. Lewis Bleckburn, Thomas J. Domin, "Protective Relaying: Principles and Application", Fourth Edition", CRC Press, 2014		
2	Paithankar, Yeshwant G., S. R. Bhide, "Fundamentals of power system protection", PHI Learning Pvt. Ltd., 2022.		
3	S. H. Horowitz, A. G. Phadke, "Power System Relaying", John wiley and Sons, 2008.		
4	W. Rebizant, J. Szafran, A. Wiszniewski, "Digital Signal Processing in Power System Protection and Control" Springer, 2011		
5	J. M. Gers, E. Holmes, "Protection of Electricity Distribution Networks", IET, 2021		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures are conducted using presentations, animations and simulations. Numerical exercises include solving examples to illustrate lectures and solve specific engineering problems. Exercises are performed in the laboratory with models of real protection relays and with the use of relay protection testing equipment.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	50
Exercises	10	**Oral exam**	
Colloquia	35		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Electrical Power Engineering		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Seminar Topics in Electrical Power Engineering		
Lecturer (for lectures)	Stajić P. Zoran		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	To familiarize students with examples of practical application of engineering knowledge and skills acquired during their studies in power engineering, through examples of good practice, as well as with current trends in this area, to prepare them for writing their final thesis in power engineering.		
Course outcomes	Students gain additional insights into the practical application of knowledge and skills acquired during their studies and become capable of innovative thinking in practical solutions to various technical problems. Students also receive information about current trends in the field of power engineering and areas where great demand for quality engineering personnel can be expected. Students are qualified to choose a topic and prepare their final thesis in power engineering.		
Course outline			
Theoretical teaching	The importance of an innovative approach to applying acquired engineering knowledge and skills. Market segmentation and recognition of user needs. Savings as the safest path to first jobs in the field of power engineering. Energy efficiency and ESCO business model through examples of good practice. RESCO (Resources and Energy Saving Companies) business model through examples of best practices. The importance of applying an interdisciplinary approach. Examples of good practice in the use of renewable energy sources. Examples of good practice in the field of asset maintenance. The importance of designing and applying specialized software in data processing. Modern trends in power engineering and areas where great demand for quality engineering personnel can be expected.		
Practical teaching (exercises, OFE, study and research work)			
Textbooks/references			
1	X. Zu, Q. Bai, X. Zhang, Good Practice and Success Stories on Energy Efficiency in China, China Energy Efficiency Series, 2017.		
2	D Kaya, F. C. Kilic, H. H. Ozturk, Energy Management and Energy Efficiency in Industry – Practical Examples, Springer Nature Switzerland AG, 2021.		
3			
4			
5			

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	0	0	0	0

Teaching methods	Lectures are given ex-cathedra using modern teaching methods, with the aim of presenting students with solutions to various technical problems that introduce them to problem-solving techniques from engineering practice. If necessary, part of the lecture is also given in the computer lab through demonstrations of the operation of certain software.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	**Written exam**	
Exercises		**Oral exam**	40
Colloquia			
Projects	50		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Logic Design		
Lecturer (for lectures)	Radmanović M. Miloš, Rajković J. Petar		
Lecturer/associate (for exercises)	Radmanović M. Miloš, Đorđević I. Anđelija		
Lecturer/associate (for OFE)	Petrović N. Nenad, Đorđević I. Anđelija		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Mastering the knowledge and principles for designing and testing logic networks and the possibilities of their application in solving practical problems.		
Course outcomes	Students are introduced to the methodology for designing and testing logic networks and are trained to use appropriate software packages for problem solving.		
Course outline			
Theoretical teaching	1. Switching functions, logic circuits, 2. Introduction to logic design, 3. Fundamentals of VHDL language (Part I), 4. Description of combinational networks in VHDL, 5. Description of MSI combinational networks in VHDL, 6. Sequential networks, 7. Fundamentals of VHDL language (Part II), 8. Description of sequential networks in VHDL, 9. Memory, 10. Programmable logic networks, 11. Arithmetic logic circuits, 12. Introduction to computer system design (Part I), 13. Introduction to computer system design (Part II)		
Practical teaching (exercises, OFE, study and research work)	Display of a series of solved tasks. Examples of descriptions of logic networks in VHDL. Design, simulation, testing of logic networks in the Intel ModelSim software package. Demonstration exercises: 1. Switching functions, 2. Logic circuits, 3. Description of combinational networks in VHDL, 4. Description of MSI combinational networks in VHDL, 5. Sequential networks, 6. Fundamentals of the VHDL language (Part II), 7. Description of sequential networks in VHDL, 8. Memories, 9. Programmable logic networks, 10. Arithmetic logic circuits, 11. Introduction to the design of computer systems, 12. Preparation for the written part of the exam.		
Textbooks/references			
1	B. LaMeres, Introduction to Logic Circuits & Logic Design with VHDL, Springer 2017.		
2	S. Brown, Z. Vranesic, Fundamentals of Digital Logic with VHDL Design, McGraw-Hill, 2009.		
3	J. Astola, R. S. Stanković, Fundamentals of Switching Theory and Logic Design, Springer, 2006.		
4	Materials on the website: http://cs.elfak.ni.ac.rs/nastava/		
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	0	0

Teaching methods	Lectures and demonstration exercises using slides, independent practical exercises using computers.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	40
Colloquia	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Discrete Mathematics	
Lecturer (for lectures)			Matejić M. Marjan, Džunić S. Jovana	
Lecturer/associate (for exercises)			Stankov D. Stefan	
Lecturer/associate (for OFE)				
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	The course aims to teach students to think logically and mathematically and how to apply these techniques to solving problems in other scientific and technical disciplines.			
Course outcomes	The student is ready to independently apply the acquired knowledge in computer and other technical subjects.			
Course outline				
Theoretical teaching	Mathematical logics. Propositional calculus. Propositional formulas. Coexistence and logical consequences. Normal forms. Sets. Sum principle. Inclusion-exclusion principle. Partitive set. Set decomposition. Permutations. Cartesian product. Relations. Matrix representation. Closure of relations. Lexicographic ordering. Functions. Dirichlet's principle. Sequences. Generating functions. Recurrent sequences. Solving linear recurrent relations. Fibonacci, Catalan and Stirling numbers. Permanent. Systems of different representatives. Integers. Divisibility. Modular arithmetics. The least common multiple and the greatest common divisor. Euclid's algorithm. Diophantine equations. Modular equations. Euler's function. Chinese remainder theorem. Combinatorics: permutations, variations and combinations. Number series. Convergence criteria. Power series.			
Practical teaching (exercises, OFE, study and research work)	Propositional calculus. Propositional formulas. Coexistence and logical consequences. Normal forms. Sum principle. Inclusion-exclusion principle. Partitive set. Set decomposition. Permutations. Cartesian product. Relations. Matrix representation. Closure of relations. Lexicographic ordering. Functions. Dirichlet's principle. Generating functions. Recurrent sequences. Solving linear recurrent relations. Fibonacci, Catalan and Stirling numbers. Permanent. Systems of different representatives. Integers. Divisibility. Modular arithmetics. The least common multiple and the greatest common divisor. Euclid's algorithm. Diophantine equations. Modular equations. Euler's function. Chinese remainder theorem. Combinatorics: permutations, variations and combinations. Number series. Power series.			
Textbooks/references				
1	James A. Anderson, Discrete Mathematics with Combinatorics, Second Edition, Prentice Hall, 2003.			
2	Susanna S. Epp, Discrete Mathematics with Applications, Fourth Edition, Brooks/Cole Cengage Learning, 2011.			
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**
3	2	0	0	0

Teaching methods	Lectures and exercises.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises		**Oral exam**	40
Colloquia	30		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies		Undergraduate Academic Studies	
The name of the course		Databases	
Lecturer (for lectures)		Stoimenov V. Leonid, Stanimirović S. Aleksandar	
Lecturer/associate (for exercises)		Bogdanović D. Miloš, Frtunić-Gligorijević B. Milena, Nikolić S. Mina	
Lecturer/associate (for OFE)		Frtunić-Gligorijević B. Milena, Nikolić S. Mina	
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to basic terminology, data models, the process of designing and using databases. Gaining theoretical knowledge about the relational model and relational algebra, which are the basis for implementing relational database management systems. Gaining practical knowledge related to designing using entity and relationship models, implementing relational databases, and using data via the SQL query language.		
Course outcomes	Theoretical and practical knowledge of database design and data models (ER, EER, UML). Theoretical and practical knowledge of the relational data model and database implementation. Theoretical and practical knowledge of relational algebra and relational algebra queries. Practical knowledge of the SQL language, as well as implementation, storage and retrieval of data in relational databases.		
Course outline			
Theoretical teaching	1. Introduction to databases: basic concepts (data, information, database, database management system, database system, database applications), conventional and database-based processing, database user categorization, advantages and disadvantages, development history. 2. Data models: levels of abstraction in DBMS, 3 schema architecture, the concept of a data model and its components. Database design process. 3. Conceptual database design, entity and relationship model - (E)ER data model, concepts of (E)ER model, graphical notation ((E)ER diagram). 4. Database design using (E)ER data model, examples of database design based on requirements. 5. Relational model: concepts of the relational model, structural and integrity component, relation schema, relation occurrence, relation key, constraint specification, SQL DDL commands for defining constraints. Translating the conceptual model into a relational model. 6. Relational algebra: relational algebra, relational algebra operations – selection, projection, join and types of joins, union, intersection, difference, Cartesian product. 7. Relational algebra queries, query examples, analogy with SQL queries. 8. Functional dependencies: definition of functional dependencies, rules for deriving functional dependencies, closure of a set of functional dependencies, closure of an attribute set, determining a single key of the relational schema, finding all keys. 9. Relational schema analysis: the process of finding and the quality of the designed database schema, anomalies in poorly designed databases, relational decomposition in normalization and properties. 9. Normalization: the purpose of normalization and normal forms, definitions and tests of normal forms (first, second, third normal form and Boyce-Codd normal form), the normalization process and practical examples. 10. Introduction to transactional processing: the concept of transactions, ACID properties of transactions, transactions at the DBMS level and potential problems with updates, transactions and database recovery. 11. Database system architecture, overview: monolithic systems, multi-user, client-server systems, two-tier and three-tier architectures, parallel/distributed database servers, data fragmentation.		

Practical teaching (exercises, OFE, study and research work)	1. ER diagrams (entities, relationships, attributes), tutorials for the database design process, requirements-based design - examples. 2. Translating an ER model into a relational model, examples 3. SQL DDL commands (CREATE TABLE command, data types), creating tables for a previously designed database 4. Queries and SQL SELECT command (basic form of the command, joining tables, advanced form of the command) 5. SQL commands for updating data (INSERT, UPDATE, DELETE) 6. SQL commands for working with views and indexes 7. ADO.NET (library architecture, Connection, Command, DataReader, DataAdapter, DataSet, parameterized queries, transactions) Homework: designing a database based on given requirements using the (E)ER model Project: implementing an application over a database using the ADO.NET library
Textbooks/references	
1	R. Emasri, S. Navathe, Fundamentals of Database Systems, Pearson; 7 edition (2016), ISBN-13: 9780133970777
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	1	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, independent work of students on homework and projects

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises		**Oral exam**	30
Colloquia	70		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Electronics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Object Oriented Programming		
Lecturer (for lectures)	Janković S. Dragan		
Lecturer/associate (for exercises)	Milenković M. Aleksandar, Veljanovski D. Aleksandar, Đorđević I. Anđelija		
Lecturer/associate (for OFE)	Milenković M. Aleksandar, Veljanovski D. Aleksandar		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Understanding the principles of object oriented paradigm in programming. Learning C++ as a representative object oriented language. You are seeing real-time changes in View Mode.		
Course outcomes	Students should fully understand concepts of object oriented programming and be able to develop object oriented programs using programming language C++.		
Course outline			
Theoretical teaching	Programming techniques overview. Problem definition process. Classes. Objects. Using classes in problem solving. Class definition. Class member access. Scope. The separation of interface and implementation. Inline functions. Constructors. Destructors. The call order of constructors and destructors. Copy constructors. Friend classes. Friend functions. Operator overloading. Side effects and connections between operators. Choosing return values for operators. Implementation, inheritance, specialization, generalization. Definition of inherited class. Access modifiers. Types of the inheritance. Constructors and destructors of inherited classes. Pointers and references. Polymorphism. Virtual functions. Pure virtual functions. Abstract classes. Virtual destructors. Arrays and derived classes. Multiple inheritance. Constructors and destructors in multiple inheritance. Multiple derived objects. Virtual base classes. generic mechanism - templates. Template functions. Template classes. Exception handling. Exception throwing. Exception catching. Uncaught exceptions. Input and output streams. Standard streams. Input stream classes. Input stream objects construction. Input stream operations. Extraction operator overloading. Output streams. Stream insertion operator. Output formatting. Output stream operations. Stream insertion operator overloading. Standard library. Namespaces. Container classes (vectors, lists, stack, queues, maps, sets). Iterators, Algorithms, class String		
Practical teaching (exercises, OFE, study and research work)	OO Programming using C++ programming language. Class definition in C++, attributes and methods. Lab: inline and constant functions. Lab: Static members. Constructors and destructors. Lab: Implementing constructors and destructors. Lab: Friend functions and classes. Design lab: Classes, constructors, destructors. Operators. Lab: Operators as class members. Friend operators. Design lab: Operators. Inheritance. Lab: Methods overloading. Lab: Virtual methods. Design lab: Inheritance. Pure virtual methods and abstract classes. Lab: Multiple inheritance. Lab: Virtual base classes. Template classes and template methods. Lab: tempalte class development. Design lab: Template classes. Input and output in C++. Lab: Using standard streams and textual files. Lab: Using binary streams Exception handling. Lab: Exception throwing. Lab: Exception catching. Design lab: using streams and exception handling		
Textbooks/references			
1	P.Deitel, H. Deitel, "C++ how to program", 9th edition, 2011, Amazon.		
2	Bjarne Stroustrup, C++ Programming Language, Addison-Wesley, 2013.		
3	Scott Meyers, Effective C++ Digital Collection: 140 Wayss to improve Your Programming, Addison-Wesley Professional, 2012.		
4	David Vandevoorde, C++ Templates: The Complete Guide, Addison-Wesley Professional, 2017.		
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	0	0

Teaching methods	Lectures, Exercises, Laboratory Exercises

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points

Activity during lectures		**Written exam**	20
Exercises	20	**Oral exam**	40
Colloquia	20		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Computer Architecture and Organization I		
Lecturer (for lectures)	Milentijević Z. Ivan		
Lecturer/associate (for exercises)	Vojinović M. Oliver, Milošević S. Marija, Drašković S. Vukadin		
Lecturer/associate (for OFE)	Vojinović M. Oliver, Milošević S. Marija, Drašković S. Vukadin		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The aim is to provide students with a basic knowledge of the computer architecture and organisation.		
Course outcomes	Students should be trained to design computer systems based on simple architectures and mid-level complexity assembly programs, and to master the efficient use of assembly techniques.		
Course outline			
Theoretical teaching	Basic components of a computer system. Instruction set. Addressing modes. Synthesis of a hypothetical processor. Processor structure and its functions. Register set. Control unit. ALU. Fetching and executing. Examples of simple computer architecture design. CPU programming model. Macro commands. Principles of assembly programming. Procedures and parameter passing. Bus. Interconnection of computer system elements. Memory subsystem. Interrupt system. Interrupt programs. Interrupt hierarchy. Input/output organization. Parallel and serial I/O. I/O devices, classification. Programmable I/O. Interrupt-driven I/O. Memory-mapped I/O. Dedicated I/O. Direct Memory Access - DMA technique.		
Practical teaching (exercises, OFE, study and research work)	Basic structure of microcomputers; instruction execution cycle. Intel family of processors; register set. Classification of assembler instructions; MOV, addition instructions; signed arithmetic; subtraction instructions. Multiplication and division; bit manipulation instructions; complex arithmetic expressions. Flow control; algorithmic structures. Elements of assembly language; memory allocation directives; assembly program; immediate and direct addressing. Indirect addressing; arrays; string instructions. Stack; procedures; parameter passing via registers and the stack. Nested loops; matrices. Combining assembly language with a higher-level programming language. FP unit; floating-point arithmetic. Laboratory exercises: a cycle of seven exercises.		
Textbooks/references			
1	W. Stallings, Computer Organization and Architecture: Designing for Performance, 11th Ed. Pearson Education, 2022.		
2	Noam Nisan, Shimon Schocken, "The Elements of Computing Systems: Building a Modern Computer from First Principles", The MIT Press, 2005.		
3	Kip Irvine, Assembly Language for x86 Processors, 8th edition, Prentice-Hall, 2019.		
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	0	0

Teaching methods	Lectures, practical and laboratory sessions

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	40
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Matrix Computing		
Lecturer (for lectures)	Džunić S. Jovana		
Lecturer/associate (for exercises)	Damnjanović G. Ivan		
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	Mathematics 1		
Course objectives	The objective of this course is for students to acquire advanced knowledge of linear algebra, with a focus on the structure, properties, and applications of various classes of matrices in engineering and computer science. A range of algorithms tailored to specific matrix types is covered. Students will explore the application of these tools through concrete problems. Through practical sessions and interactive programming, students will gain hands-on experience with the theoretical concepts and algorithms introduced in the course.		
Course outcomes	Upon completion of the course, students will be able to identify and apply various types of matrices—such as orthogonal, unitary, symmetric, positive definite, and stochastic—in the modeling and analysis of engineering problems. They will be capable of performing operations on block matrices, including computing determinants, inverses, and Schur complements, as well as applying matrix decompositions in scalar or block form. Students will master the practical application of these concepts in a Python Jupyter programming environment, using appropriate libraries for numerical linear algebra and data visualization.		
Course outline			
Theoretical teaching	Working with block matrices: operations on block matrices, determinant and inverse of a block matrix, Schur complement. Special types of matrices and their applications: orthogonal, unitary, positive definite, symmetric, nonnegative, Gram matrices, stochastic matrices. Matrix rank, matrix decompositions and applications: matrix diagonalization, Jordan canonical form, Frobenius form, LR factorization, QR factorization, SVD. Applications in interpolation, Fast Fourier Transform (FFT), affine transformations. Perron–Frobenius theory of nonnegative matrices. Markov chains.		
Practical teaching (exercises, OFE, study and research work)	Practical teaching is conducted through computer exercises, aimed at deepening students' understanding of theoretical concepts by applying them to specific tasks. Emphasis is placed on explorations and implementation of matrix methods and numerical algorithms in the Python Jupyter programming environment, utilizing libraries such as NumPy and SciPy. Through weekly assignments, students independently analyze and solve problems. The goal of the practical teaching is to enable students to efficiently apply built-in functions of specialized software and to independently solve engineering problems in practice.		
Textbooks/references			
1	J. Dzunic , e-book: Matrix methods, 2026, https://elfakrs.sharepoint.com/:b:/s/msteams_222330/EaNxMG6RyShEsG2erK5aQaUBr_uLcATQ9iZmkjkwkmrp0Q?e=AXhSYu		
2	J. Dzunic , Jupyter note books with exercises, 2026, https://elfakrs.sharepoint.com/:f:/s/msteams_222330/EkEDHqug6gBAmHPPIrNC04EBu37TCHwuJFPbOp6vtuJ8VQ?e=sXPbcS		
3	L. N. Trefethen and III D. Bau. Numerical linear algebra. SIAM, 3600 University City Science Center, Philadelphia, 1997.		
4	T. Shores. Applied Linear Algebra and Matrix Analysis. Springer, 233 Spring Street, New York, NY 10013, USA, 2000.		
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0	0	0

Teaching methods	Lectures. Calculation exercises. Computer-based exercises. Project-based learning.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises		**Oral exam**	40

Colloquia			
Projects	60		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Graph Theory	
Lecturer (for lectures)			Matejić M. Marjan, Džunić S. Jovana	
Lecturer/associate (for exercises)			Stankov D. Stefan, Damnjanović G. Ivan	
Lecturer/associate (for OFE)				
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	None			
Course objectives	This course offers an introduction to graph theory, with an emphasis on applications and modelling.			
Course outcomes	Students should be qualified to apply knowledge from graph theory in various areas of engeneering.			
Course outline				
Theoretical teaching	Definitions. Node degrees. Graph representation. Diameter, eccentricity, radius, center. Graph sequences. Paths in a graph. Connectivity. Connectivity components. Shortest paths. Line graph. Bipartite graphs. Graph isomorphism. Spectra of graph. Euler's graphs. Fleury's algorithm. Chinese postman problem. Hamilton's graphs. The salesman problem. Nearest neighbor algorithm. Graph operations. Planar graphs. Dual graph. Euler's theorem. Trees. Cyclomatic number. Spanning trees. Minimal spanning trees. Transformations of spanning trees. Tree coding.			
Practical teaching (exercises, OFE, study and research work)	Node degrees. Graph representation. Diameter, eccentricity, radius, center. Graph sequences. Paths in a graph. Connectivity. Connectivity components. Shortest paths. Line graph. Bipartite graphs. Graph isomorphism. Spectra of graph. Euler's graphs. Fleury's algorithm. Chinese postman problem. Hamilton's graphs. The salesman problem. Nearest neighbor algorithm. Planar graphs. Trees. Cyclomatic number. Spanning trees. Tree coding.			
Textbooks/references				
1	Graph Theory and its Applications, J.L. Gross & J. Yellen, Chapman & Hall/CRC, 2nd Edition, ISBN 1-58488-505-X.			
2	J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, NORTH-HOLLAND, New York • Amsterdam • Oxford, 1982.			
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	1	0	0	0

Teaching methods	Lectures and exercises.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises		**Oral exam**	40
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Numerical Algorithms		
Lecturer (for lectures)	Marjanović M. Zvezdan, Marinković D. Slađana, Rančić Z. Lidija		
Lecturer/associate (for exercises)	Stanković M. Hranislav		
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	Mastering the concepts of numerical mathematics.
Course outcomes	Understanding the principles of numerical mathematics, its possibilities and limitations. Students' ability to recognize practical problems, select an appropriate method for solving them, apply the methods and interpret the results.
Course outline	
Theoretical teaching	Arithmetic of finite length and numerical processes. Nonlinear equations and systems of nonlinear equations: Newton's method, secant method, bisection method, error estimation. Solving algebraic equations. Newton-Kantorovich method for systems of nonlinear equations. The concept and types of approximations of functions. Interpolation: Lagrange and Hermite interpolation polynomial. Least squares problem. Numerical differentiation and integration: quadrature formulas and error estimation. Symbolic calculations and algorithms.
Practical teaching (exercises, OFE, study and research work)	Practical teaching is implemented through solving tasks that cover the content of theoretical teaching, with the aim of enabling the student to transform previously presented theoretical considerations into their own functional knowledge. Through the preparation of homework assignments and the analysis of their solutions, the student gradually masters the application of mathematical tools in the context of numerical mathematics.
Textbooks/references	
1	Richard L. Burden, J. Douglas Faires, Numerical Analysis, Boston, MA : Brooks/Cole, Cengage Learning, 2011.
2	L. Ridgway Scott, Numerical Analysis, Princeton University Press, 2011.
3	K. Atkinson, An Introduction to Numerical Analysis, John Wiley & Sons, 1989.
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	0	0	0

Teaching methods	Lectures. Computational exercises. Consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Probability and Statistics		
Lecturer (for lectures)	Milošević M. Dušan, Džunić S. Jovana		
Lecturer/associate (for exercises)	Rajković P. Jovan, Stanković M. Hranislav, Denić Z. Anđa		
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Mastering basic knowledge of probability and statistics.		
Course outcomes	Students' capability to draw conclusions under conditions of uncertainty and to analyze real-world data.		
Course outline			
Theoretical teaching	Random events. Definition of probability. Conditional probability. Total probability and Bayes' formula. Random variables. Distribution function. Numerical characteristics of random variables. Mathematical expectation, moments, dispersion, standard deviation. Chebyshev's inequality. Characteristic function. Distributions of discrete and continuous random variables. Limit theorems. Basic concepts of statistics. Central theorem of mathematical statistics. Some distributions important in statistics. Point estimates of parameters and efficiency of estimation. Confidence intervals. Linear regression and correlation.		
Practical teaching (exercises, OFE, study and research work)	Random events. Definition of probability. Conditional probability. Total probability and Bayes' formula. Random variables. Distribution function. Numerical characteristics of random variables. Mathematical expectation, moments, dispersion, standard deviation. Chebyshev's inequality. Characteristic function. Distributions of discrete and continuous random variables. Limit theorems. Basic concepts of statistics. Central theorem of mathematical statistics. Some distributions important in statistics. Point estimates of parameters and efficiency of estimation. Confidence intervals. Linear regression and correlation.		
Textbooks/references			
1	Arak M. Mathai, Hans J. Haubold, Probability and Statistics, De Gruyter, Berlin/Boston, 2017.		
2	Murray R. Spiegel, John J. Schiller, R. Alu Srinivasan, Probability and Statistics, McGraw-Hill, 2009.		
3	Joseph K. Blitzstein, Jessica Hwang, Introduction to Probability, Chapman & Hall, 2019.		
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	0	0	0

Teaching methods	Lectures, computer exercises, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Geometric methods with applications		
Lecturer (for lectures)	Džunić S. Jovana		
Lecturer/associate (for exercises)	Damnjanović G. Ivan		
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	Mathematics 2		
Course objectives	The aim of this course is for students to acquire fundamental and applicable knowledge in the areas of vector functions, multivariable functions, differential calculus, and numerical analysis, which form the foundation for understanding and applying approximate methods in engineering and technical sciences. Special emphasis is placed on developing geometric intuition and understanding the structure of algorithms used in fields such as computer graphics, artificial intelligence, and optimization. Through work in the Python Jupyter programming environment, students will master modern numerical analysis techniques and develop the ability to apply theoretical concepts in practical contexts by analyzing and solving real engineering problems.		
Course outcomes	Students will be equipped to apply concepts of differential calculus and numerical analysis to functions of one and multiple variables, as well as to vector-valued functions. They will be able to interpret and analyze geometric properties of curves and surfaces, identify extrema, and apply interpolation and approximation techniques in solving practical problems. Students will master methods for finding function zeros, numerical differentiation, and integration. Through work in the Python Jupyter environment, they will develop the ability to implement algorithms, analyze errors and stability, and apply these skills in areas such as simulations, optimization, and data analysis.		
Course outline			
Theoretical teaching	Classification of errors, accuracy, precision, conditioning, and stability. Introduction to iteration theory. Differential calculus and approximation of functions of one variable. Interpolation and approximation using algebraic polynomials and piecewise-defined functions. Vector functions of one real variable. Conic sections and their canonical forms. Parametrization of curves, properties of differential calculus, and applications. Differential calculus of functions of several variables. Linear and affine functions. Convex functions. Gradient. Level curves and surfaces. Surfaces and tangent planes. Extreme values. Higher-order derivatives. Interpolation and approximation of functions of multiple variables. Applications of approximations: finding zeros of functions of one and several variables, numerical differentiation, and integration of functions of one and multiple variables.		
Practical teaching (exercises, OFE, study and research work)	Practical teaching includes computational exercises and computer work, aiming to enable students to master the application of theoretical concepts in solving specific problems. Exercises are conducted in the Python Jupyter programming environment, using modern libraries for numerical calculations, symbolic processing, and graphical data representation. Through regular weekly homework assignments (DON), students develop independence in formulating algorithms, their implementation, and interpretation of results, as well as connecting mathematical models with real engineering tasks. The goal of practical teaching is to prepare students to apply the acquired knowledge in areas such as data analysis, optimization, and practical use of approximate numerical methods in engineering.		
Textbooks/references			
1	J. Dzunic , e-book: Geometric methods and applications, 2026, https://elfakrs.sharepoint.com/:f:/s/msteams_222330/EkEDHquq6gBAmHPPIrNC04EBu37TCHwuJFPbOp6vtuJ8VQ?e=sXPbcS		
2	J. Dzunic , Jupyter note books with exercises, 2026, https://elfakrs.sharepoint.com/:f:/s/34A05/Etwi_Dc5gR1JoBf7GY1t66sB9E6SMxslbAtBobmW-zYYdA?e=fMWvQh		
3	Z. Nitecki, Calculus in 3D: Geometry, Vectors, and Multivariate Calculus, Numerical Mathematical Society, 2018		
4	J. Solomon, Numerical Algorithms: Methods for Computer Vision, Machine Learning and Graphics, CRC Press, 2015		
5	W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery. NUMERICAL RECIPES: The Art of Scientific Computing. Cambridge University Press, The Edinburgh Building, Cambridge CB2 8RU, UK, 2007.		
Number of classes of active education per week during semester/trimester/year			

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	0	0	0
Teaching methods	Lectures. Calculation exercises. Computer-based exercises. Project-based learning.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures			**Written exam**	
Exercises			**Oral exam**	40
Colloquia				
Projects		60		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Object Oriented Design	
Lecturer (for lectures)			Janković S. Dragan, Rančić D. Dejan	
Lecturer/associate (for exercises)			Rajković J. Petar, Milenković M. Aleksandar, Đorđević I. Anđelija	
Lecturer/associate (for OFE)			Milenković M. Aleksandar, Đorđević I. Anđelija	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Introducing students to the area of object-oriented (OO) software design and introduction to the basic techniques and principles of object-oriented software design.			
Course outcomes	Knowledge of object oriented software design basic principles as well as basic methodologies for the OO software design. Knowledge of design patterns and UML unified language. Practical knowledge for the OO applications design and realisation using Visual C#.			
Course outline				
Theoretical teaching	Review of methods and techniques for OO design. Object-oriented design using UML unified modeling language. Identification of the elements of the project. Identification of project mechanisms. Description of run-time architecture. Designing Use-Case diagrams. Subsystems design. Designing class: class structure, modeling the states, relations between classes. Design Patterns. The implementation model. Designing components. Distributing applications through Web services. The advantage of components with simpler classes. Decomposition of the system across processors, tasks and threads. Mapping project in a concurent system. OO project example of the real system.			
Practical teaching (exercises, OFE, study and research work)	Exercises. Practical work on the design and OO programming of Windows applications using UML and Visual C #. Consulting.			
Textbooks/references				
1	Gamma, Richard Helm, Ralph Johnson, John Vlissides,Design Patterns: Elements of Reusable Object-Oriented Software, Addison-Wesley, 2000.			
2	Larman, C., Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and the Unified Process (2nd Edition) , Prentice Hall Publishing Company, 2001.			
3	Mauricio Aniche, Simple Object-Oriented Design: Create clean, maintainable applications, Manning, 2024.			
4	JIm Arlow, Ila Neustadt, UML2 and The Unified Process: Practical Object-Oriented Analysis and Design, Pearson, 2016.			
5	Stephen Mellor, Marc Balcer, Ivar Jacobson, Executable UML: A Foundation for Model-Driven Architecture, Indipendently published, 2022.			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

Teaching methods	Lectures, Exercises, Laboratory Exercises

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	30
Exercises	20	**Oral exam**	30
Colloquia	20		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies		Undergraduate Academic Studies	
The name of the course		Data Structures	
Lecturer (for lectures)		Stoimenov V. Leonid, Bogdanović D. Miloš	
Lecturer/associate (for exercises)		Dimitrijević M. Aleksandar, Mihajlović T. Vladan, Davidović P. Nikola	
Lecturer/associate (for OFE)		Frtunić-Gligorijević B. Milena, Mihajlović T. Vladan, Davidović P. Nikola	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Mastering knowledge of basic data structures and how to use them. The goal is to introduce students to abstract data structures, memory representations of data structures, and basic operations for work. In the implementation of practical classes, the goal is for students to master the knowledge necessary for the design, implementation, and use of basic data structures to solve specific problems in the chosen programming language.		
Course outcomes	The student acquires theoretical knowledge about abstract data structures, various memory representations independent of the programming language and operations, as well as practical knowledge about the concepts, internal design and implementation of basic data structures in the programming languages C/C++ or Java.		
Course outline			
Theoretical teaching	1. Introduction: Definition and overview of data structures, data structures in software engineering, categorization of data structures, pseudocode, complexity and complexity assessment of algorithms. 2. Arrays: definition of arrays, 1D, 2D and multidimensional arrays, memory representation, use of arrays, sequential and binary search, sorting. 3. Arrays: definition of arrays, array operations, basic and composite operations, text search algorithms, string data types 4. Linked lists: definition of structure, types of linked lists - singly linked, doubly linked, cyclic, basic operations (traversal, addition, deletion), advanced operations, static and dynamic implementation of linked lists. 5. Stack, Queue, Deck: definition of structures, static and dynamic implementation of stack, queue and deck, basic operations (traversal, addition, deletion) in static and dynamic implementation. 6. Hash tables: definition of structure, definition of terms (hash function, collision and synonyms), collision resolution (open addressing, synonym chaining), implementation of hash table, basic operations (search, read/delete). 7. Trees: basic terms, binary trees, operations for binary trees (traversal, addition and deletion of nodes), static and dynamic implementation of trees. 8. Heap (heap), operations and application (sorting). 9. Ordered binary trees, operations and application (binary search). 10. General trees, method of formation, translation of general into binary tree, multipath search trees, B, B*, B++ trees 11. Graphs: definitions of terms, static (adjacency matrices, incidence matrices) and dynamic representation of graphs (chain structures), operations for static and dynamic implementation, breadth-first and depth-first traversal of graphs, algorithms for shortest path in a graph for static and dynamic representation 12. Files: sequential, direct, index-sequential, index-non-sequential, multi-key files. Bulk addressing.		
Practical teaching (exercises, OFE, study and research work)	1. Introduction: Introduction to the development environment for development and preparation for the implementation of exercises 2. Arrays and fields: implementation of arrays in a programming language, Sorting and sorting algorithms 3. Linked lists: Implementation of linked lists, static and dynamic, implementation of operations. 4. Queue, Stack, Deck: Implementation of stack, queue and deck in a programming language, static and dynamic 5. Hash tables: Implementation of Hash tables in a programming language 6. Trees: Implementation of trees in a programming language, implementation of special types of trees 7. Graphs: Implementation of graphs in a programming language, static and dynamic, operations for working with trees, shortest path in a graph.		
Textbooks/references			

1	M.T.Goodrich, R.Tamassia, D. Mount, Data Structures and Algorithms in C++, second edition, John Wiley, 2011, ISBN 978-1118136645
2	M.T.Goodrich, R.Tamassia, M. Goldwasser, Data Structures and Algorithms in Java, 6th edition, John Wiley, 2014, ISBN-13: 978-1118803165
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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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, independent work of students on homework and projects

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	40
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Programming Languages		
Lecturer (for lectures)	Stojković R. Suzana		
Lecturer/associate (for exercises)	Jovanović D. Martin, Marković M. Ivica, Đorđević D. Nikola		
Lecturer/associate (for OFE)	Jovanović D. Martin, Marković M. Ivica, Đorđević D. Nikola		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduce students with basic concepts of modern programming languages and programming paradigms. Enable to program in imperative, object-oriented, functional and logical programming languages. Increase the ability to learn new programming languages. Improve background for choosing appropriate programming languages for certain classes of programming problems.		
Course outcomes	After completion of the course, students should be able to: describe, compare, and contrast various language features, understud the fundamental concepts of object-oriented, functional, logical, concurrent and web programming, develop applications in Java and C# programming languages.		
Course outline			
Theoretical teaching	Evolution of programming languages and programming paradigms. Formal description of programming languages. Data types. Static and dynamic typing. Strongly and weakly typed languages. Imperative programming languages and control structures. Subprograms, parameter passing methods. Object-oriented programming languages. Exception handling. Concurent programming. Functional programming languages. Logical programming languages. Languages for web programming: markup languages and script languages.		
Practical teaching (exercises, OFE, study and research work)	Lexical elements of the programming language Java. Data types in Java: value and reference types. Expressions and control structures in Java. Class definition: attributes, methods and constructors. Inheritance in Java. Abstract classes and interfaces. Packages. Exception handling in Java. Generic types in Java. Data streams. Threads in Java. Lexical elements of the programming language C#. Data types in C#: value and reference types. Expressions and control structures in C#. Class definition: attributes, methods, properties and parameter passing. Inheritance in C#. Abstract classes and interfaces. Exception handling in C#. Data streams in C#. Delegates and events. Windows applications development in C#. Threads and sinchronization in C#.		
Textbooks/references			
1	R. W. Sebeste: Concepts of programming languages, 12th edition, Pirson, 2023.		
2	M. Scott, J. Aldrich: Programming Language Pragmatics, 5th Edition, Elsevier, Morgan Kaufmann, 2025.		
3	Y. D. Liang: Introduction to Java Programming and Data Structures. 12th ed., Global ed. Hoboken, NJ: Pearson, 2020.		
4	J. Sharp: Microsoft Visual C# Step by Step. 10th ed. Redmond, WA: Microsoft Press, 2022.		
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	0	0

Teaching methods	Lectures, auditive excercises, lab practicing

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	60
Exercises	40	**Oral exam**	
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Computer Architecture and Organization II		
Lecturer (for lectures)	Milovanović I. Emina, Milentijević Z. Ivan		
Lecturer/associate (for exercises)	Milenković M. Aleksandar, Stojnev Ilić I. Aleksandra, Vojinović M. Oliver, Ćojbašić Ž. Emilija		
Lecturer/associate (for OFE)	Milenković M. Aleksandar, Stojnev Ilić I. Aleksandra, Vojinović M. Oliver, Ćojbašić Ž. Emilija		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Detailed study of memory hierarchy organization, including cache and virtual memory operation principles, fundamentals of computer arithmetic, and the organization of arithmetic-logic units. Exploration of pipeline processor design principles for both RISC and CISC architectures.		
Course outcomes	Students should master the principles of cache and virtual memory operation, be capable of understanding different arithmetic-logic unit architectures, and know the working principles of pipeline processors based on RISC and CISC architectures.		
Course outline			
Theoretical teaching	Hardware description: paradigms and abstraction levels. VHDL principles and basic elements. Memory hierarchy organization. Main memory, cache memory, virtual memory. Virtualization principles. Computer arithmetic: addition, multiplication and division techniques in integer and floating-point arithmetic. Control unit design: hardwired control unit, microprogrammed control unit. RISC and CISC processor design approaches. Performance considerations. Pipeline processor organization: pipelined instruction execution, pipeline hazards (structural hazards, data hazards including data forwarding/bypassing, control hazards with delayed branching and dynamic branch prediction). FP instruction pipelining. Dynamic instruction reordering. Scoreboard method, Tomasulo's algorithm. Reorder buffer (ROB).		
Practical teaching (exercises, OFE, study and research work)	VHDL clauses; concurrent assignment clauses, aggregation. Structural and behavioral description; processes and delay models. Testbench; sequential clauses. RTL design approach. Complex data types; arrays. Finite state machines; digital design principles. Memory subsystem: access contention, cache memory organization. Virtual memory implementation. Computer system performance metrics. Pipelining concepts and hazards. Branch prediction techniques. Dynamic instruction reordering. The curriculum includes 5 laboratory exercises covering these concepts.		
Textbooks/references			
1	W. Stallings, Computer Organization and Architecture: Designing for Performance, 11th Ed. Pearson Education, 2022		
2	D. Patterson and J. Hennessy, Computer organization and design: The Hardware/Software Interface, 6th Edition, MK, 2020		
3	P. Ashenden, The Designer's Guide to VHDL, 3rd Edition, Morgan Kaufmann, 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	1	0	0

Teaching methods	Lectures, practical and laboratory sessions

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Introduction to the Theory of Games		
Lecturer (for lectures)		Vučković V. Vladan		
Lecturer/associate (for exercises)		Vučković V. Vladan, Veljanovski D. Aleksandar		
Lecturer/associate (for OFE)		Veljanovski D. Aleksandar		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Mastering the basic principles and models of game theory as well as the techniques of their application in modeling and analyzing various strategic and tactical interactions in a complex environment.			
Course outcomes	Students' ability to think strategically and analyze, as well as to apply game theory methods in solving real-world problems.			
Course outline				
Theoretical teaching	Subject and goal of studying game theory. Basic concepts and definitions. Terminology. Classification of games. Rules of the game. General classes of games and strategies: Cooperative and non-cooperative games. Application in computer logic games. Definition of chess as a game. Decision tree structure. Concept of complexity and combinatorial explosion. Forward/Backward pruning. Historical development of computer chess machines. IBM Deep Blue. The term GUI-engine. Universal Chess Interface. Storage standards (FEN and PGN). Move generator. Data structures. Game tree. Board representation methods in logic games. Matrix representations and bitboards. Move encoding. Transposition and history tables. Overview of basic logic game algorithms. Minimax. Alpha-Beta. PVS. Null-move. Terminal nodes. Structure of evaluation function. Ending bases.			
Practical teaching (exercises, OFE, study and research work)	Topic 1: Introduction to game theory (concept of two-player table games, explanation of basic terms, MinMax). Topic 2: MinMax explained in detail, Alpha+Beta with focus on cut-off and why it works. Topic 3: PVS, NegaScout. Topic 4: Null-Move, ProbCut and MultiProbeCut. Topic 5: Quiescence, MVV/LVA and SEE. Topic 6: Search algorithms (BFS, DFS, Dikstra, A*). Topic 7: Heuristics. Topic 8: Iterative Deeping, Minimal Window Search, Aspiration Window Search. Topic 9: Transposition table, Enhanced Transposition CutOff, History heuristics, Killer Heuristics. Topic 10: Alternative algorithms – Berlingov B*, MTDF. Topic 11: Transposition bases, machine learning enabled transposition bases and ENAX bases. Topic 12: Principle of positional repetition detection using variant sequences, Adaptive Depth Control (A.D.C.) algorithm. Topic 13: The principle of the zero evaluation function in mate solver applications, The principle of individualization of pieces and integration of move generators and evaluators, A method for distributed parallelization of chess algorithms using a local area network.			
Textbooks/references				
1	Dixit A., and Skeath S., Games of Strategy, 2nd edition, Norton, New York, 2004.			
2	Vladan Vučković, “Contribution to the Theory and Practice of Advanced Chess Algorithms”, PhD dissertation, Faculty of Electronics in Niš, October 2006.			
3	Chess Skill in Man and Machine edited by Peter W. Frey, Springer, New York 1977, 1978 ISBN: 0-387-07957-2, ISBN: 0-387-90815-3 2nd Edition 1983, ISBN: 0-387-90790-4 / 3-540-90790-4.			
4	Robert Gibbons, A Primer in Game Theory, ISBN-13: 978-0745011592, Pearson, 1992.			
5	R. Duncan Luce and Howard Raiffa, Games and Decisions: Introduction and Critical Survey, Dover Books on Mathematics, Courier Corporation, 1989.			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

Teaching methods	Lectures, computational exercises, laboratory exercises, independent work of students on projects.
Grade (maximum number of points 100)	

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Fundamentals of Signals and System Analyzes		
Lecturer (for lectures)		Radmanović M. Miloš		
Lecturer/associate (for exercises)		Radmanović M. Miloš		
Lecturer/associate (for OFE)		Radmanović M. Miloš		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Mastering the knowledge and principles for the analysis and design of continuous and discrete signals and the possibilities of their application in solving practical problems.			
Course outcomes	Students are introduced to the methodology for analyzing and designing continuous and discrete signals and are trained to use appropriate software packages for problem solving.			
Course outline				
Theoretical teaching	1. Continuous-time signals, 2. Discrete-time signals, 3. Continuous-time systems, 4. Discrete-time systems, 5. Fourier analysis (part - I), 6. Fourier analysis (part - II), 7. Laplace transform, 8. Z transform, 9. Frequency characteristics of signals, 10. Analog filter design (part - I), 11. Analog filter design (part - II), 12. Digital filter design (part - I), 13. Digital filter design (part - II).			
Practical teaching (exercises, OFE, study and research work)	Display of a series of solved tasks. Examples of signal and system descriptions in MATLAB. Design and analysis of signals and systems using MATLAB toolboxes: SymbolicMath, ControlSystem, SignalProcessing. Demonstration exercises: 1. Continuous-time signals (part I), 2. Continuous-time signals (part II), 3. Discrete-time signals, 4. Continuous-time systems, 5. Discrete-time systems, 6. Fourier analysis (part I), 7. Fourier analysis (part II), 8. Laplace transform, 9. Z transform, 10. Frequency characteristics, 11. Design of analog filters, 12. Design of digital filters.			
Textbooks/references				
1	S. Karris, Signals and Systems with MATLAB Applications, Orchard Publications, 2003.			
2	W. Yang, Signals and Systems with MATLAB, Springer 2009.			
3	Material on the website: http://cs.elfak.ni.ac.rs/nastava/			
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	0	0

Teaching methods	Lectures and demonstration exercises using slides, independent practical exercises using computers.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	40
Colloquia	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Algorithm Design and Analysis	
Lecturer (for lectures)			Janković S. Dragan, Rajković J. Petar	
Lecturer/associate (for exercises)			Rajković J. Petar	
Lecturer/associate (for OFE)			Rajković J. Petar, Đorđević I. Anđelija	
Number of ECTS	6	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Introduction to basic algorithmic paradigms. Introduction to classes of algorithms, areas of application, and methods of efficient implementation. Introduction to the concept of algorithm complexity, measures for evaluating algorithm complexity, and methods for determining complexity measures.			
Course outcomes	Knowledge of fundamental paradigms in designing algorithms for solving various problems. Understanding of algorithm classes, their complexity, implementation methods, and areas of application. Thorough knowledge of measures for evaluating algorithm complexity and methods for determining them. Developed critical perspective on the validity of algorithms.			
Course outline				
Theoretical teaching	The role and the importance of algorithms. Algorithm efficiency and complexity. Algorithm generation paradigms (brute force, iterative algorithms, recursive algorithms, recursion elimination, divide-conquer, backtracking, dynamic programming, linear programming). Algorithm classification (sorting algorithms, searching, string, graph, geometry algorithms, cryptographic algorithms, data compression, arithmetic algorithms, etc). Algorithms complexity calculation techniques. Algorithm complexity measures and criteria. Basic algorithm analysis: best, average and worst case; empirical. Proofing techniques overview. The role of probability. Data structures and operation complexity. Choosing data structure for algorithm implementation. String algorithms. Approximate matching. Suffix trees and suffix arrays. Dynamic programming. Greedy algorithms. FFT. NP problems. SAT.			
Practical teaching (exercises, OFE, study and research work)	The topics presented on the auditive and laboratory exercises follow material presented during lectures. The exercises are envisioned as a basis for the individual student projects development.			
Textbooks/references				
1	T.Cormen, C. Leiserson, R. Rives, Introduction to algorithms, MIT Press, Cambridge, 2001.			
2	R.Sedgevick, Algorithms in C, Addison Wesley, 1998.			
3	Jon Kleinberg, Eva Tardos, Algorithm Design, Pearson International Edition, USA, 2006.			
4	Steven Skiena, The Algorithm Design Manual, Springer, 2020			
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	0	0

Teaching methods	Lectures, Exercises, Laboratory Exercises

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	40		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Operating Systems		
Lecturer (for lectures)		Stojanović H. Dragan, Predić B. Bratislav		
Lecturer/associate (for exercises)		Stojanović H. Dragan, Stojnev Ilić I. Aleksandra, Davidović P. Nikola		
Lecturer/associate (for OFE)		Davidović P. Nikola, Stojnev Ilić I. Aleksandra, Drašković S. Vukadin		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	Algorithms and Programming, Computer Architecture and Organization 1			
Course objectives	Mastering the knowledge of basic concepts and principles of modern operating systems			
Course outcomes	Upon successful completion of the course, students will understand the fundamental concepts, architecture, and functions of operating systems, as well as their role in managing computer system resources. Students will be familiar with the principles of process and thread management, synchronization mechanisms, inter-process communication, and methods for addressing concurrency-related issues. They will be able to analyze and apply process scheduling algorithms and memory management techniques, including virtual memory. Students will understand the organization of input/output subsystems, file systems, and mechanisms for efficient resource utilization in operating systems. Through practical work on the Linux platform using the C programming language, students will be capable of developing multiprocess and multithreaded applications while applying principles of reliability, performance, and security.			
Course outline				
Theoretical teaching	Introduction to operating systems. Overview of fundamental principles, concepts, and architecture of operating systems. Process management, creation and termination. Threads, thread management, and implementation of multithreaded programs. Concurrency and mutual exclusion of processes and threads. Synchronization and communication between processes and threads. Deadlock and starvation of processes/threads. Execution planning and scheduling of processes and threads. Main memory management, paging, segmentation. Virtual memory, demand paging. Input/Output management and disk access scheduling. File management and file systems. Security and protection in operating systems. Architecture and implementations of modern operating systems: UNIX, Linux, MS Windows, macOS, etc.			
Practical teaching (exercises, OFE, study and research work)	Basics of Unix, Linux, and Windows operating systems. Advanced concepts and administration of Unix/Linux – Shell scripts. Program development in the Unix/Linux environment – the /proc file system. Implementation of process management and practical examples – applications. Thread creation and management. Methods and implementation of mutual exclusion and synchronization of processes and threads (lock, mutex, semaphore, monitor, etc.). Implementation of interprocess communication (pipes, signals, message queues). Implementation of memory management using virtual memory and demand paging. Implementation and use of shared memory between processes. Methods and algorithms for data management and file system implementation. Methods and implementation of I/O device management.			
Textbooks/references				
1	William Stallings, Оперативни системи: Принципи унутрашње организације и дизајна, превод 9-ог издања (Operating Systems: Internals and Design Principles, 9th edition, Pearson, 2017), CET, Београд, 2019.			
2	A. S. Tanenbaum, H. Bos, Modern Operating Systems, 5th edition, Pearson Education/Prentice-Hall, 2022			
3	A. Silberschatz, P. B. Galvin, G. Gagne, Operating System Concepts, 10th edition, John Wiley & Sons, 2021			
4	S. Đorđević-Kajan, D. Stojanović, A. Stanimirović, B. Predić, Lab Manual for System Software Exercises, Faculty of Electronic Engineering, Niš, 2004			
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	0	0

Teaching methods	Teaching methods:Lectures, auditory exercises, laboratory exercises, independent student work on assignments and projects.
Grade (maximum number of points 100)	

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Computer Networks		
Lecturer (for lectures)	Milovanović I. Emina		
Lecturer/associate (for exercises)	Dimitrijević M. Aleksandar, Milošević S. Marija, Drašković S. Vukadin		
Lecturer/associate (for OFE)	Milošević S. Marija, Drašković S. Vukadin		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The course provides an introduction to fundamental concepts in the design and implementation of computer networks, their protocols, and applications.		
Course outcomes	As a result of successfully completing this course, students will become familiar with layered communication architectures (OSI and TCP/IP); Understand the client/server model and key application layer protocols; Learn sockets programming and how to implement client/server programs; Understand the concepts of reliable data transfer and how TCP implements these concepts. The student acquires the skills required to configure and use basic local computer networks, as well as selected Internet services		
Course outline			
Theoretical teaching	Introduction. Uses of computer networks (CN). Taxonomy of CN. The OSI reference model. Protocols and services. TCP/IP reference model. Network hardware and software. Data link layer. Design issues. Services providede to network layer. Framing. Error and flow control. Elementary data link protocols. Examples od data link protocols. Local area networks. Media access sublayer. Channel alocation problem. Multiple access protocols (ALOHA, sloted ALOHA, CSMA/CD). Ethernet. Ethernet cabling. Repeaters, hubs, bridges, switches, routers, gateways. The network layer. Virtual circuits and datagrams. Routing algorithms. Network layer in the Internet. IP protocol. IP addresses. Subnets. CIDR routing. Internet control protocols (ICMP, ARP, DHCP). Routing protocols (OSPF, RIP). IPv6. The transport layer. Transport services. Addressing. Connection establishment. Internet transport protocols. UDP. TCP. Socket programming. The application layer. DNS. e-mail. www.HTTP. Network security and kriptography.		
Practical teaching (exercises, OFE, study and research work)	The exercises fully follow the lecture program: physical layer, line codes; Ethernet - Topology, MAC address, switching, STP; Routing and IP addresses; Router configuration - introduction to CISCO IOS and CLI, modes, address assignment, interpretation of routing tables, static routing, dynamic routing using the example of RIP and OSPF protocols, traffic management (standard and extended ACL), NAT, DHCP; Sockets - Programming datagram and stream sockets in Windows applications using C/C++; CGI - GET and POST methods, input encoding, HTML forms; IPv6 - addresses, subnetting, static routing, RIPng configuration. A cycle of 6 laboratory exercises is also planned. The exercises are held in a specialized computer laboratory using simulation packages for computer networks and the necessary communication devices.		
Textbooks/references			
1	Andrew S. Tanenbaum, David J. Wetheral, Computer Networks, 6th edition, Pearson, 2021.		
2	J. F. Kurose, K. W. Ross, Computer networking: A top-dpwn approach featuring the Internet, 8th edition, Pearson, 2019.		
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	0	0

Teaching methods	Lectures, oral and laboratory exercises

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Information Systems		
Lecturer (for lectures)	Tošić B. Milorad		
Lecturer/associate (for exercises)	Nejković M. Valentina		
Lecturer/associate (for OFE)	Nejković M. Valentina		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory

Prerequisites	Passed exams in Software Engineering and Databases for the domestic study program. If the exam is from a different program, then the passed exam is Algorithms and Programming.
Course objectives	Acquisition of engineering skills and theoretical knowledge, as well as adoption of a systematic approach to improving business and other systems through the implementation of information technologies.
Course outcomes	A systematic approach to the application of information technologies aimed at increasing the efficiency of complex systems, such as business systems, has been developed and adopted. Practical skills necessary for the design, implementation, and deployment of information systems in modern business environments.
Course outline	
Theoretical teaching	Introduction. A brief overview of the application of information systems, Informatics, Information Technologies, and Computing. Basic concepts of information systems. Information and communication technologies as the technological foundation of information systems. System modeling and analysis. Methods for analysis and design of information systems. Organizational aspects of information systems. Technological aspects of information systems. Information systems planning. System design. System implementation. Information systems at the strategic level. New value created through the use of information technologies. Information systems in supply chains. SWOT analysis and decision-making under uncertainty. Information systems based on artificial intelligence, multi-agent information systems, information systems supporting work with a large number of users, collaborative information systems. Cloud-based information systems. Information system architectures based on service buses and microservices. Application of new technologies in information systems.
Practical teaching (exercises, OFE, study and research work)	Familiarization with the workflow (Introductory notes; Introduction to the course and its methodology; Introduction to Eclipse; Introduction to working with svn). Modeling information systems by combining User Requirements Notation (URN) and UML (About the URN standard; UCM notation; GRL language; Example of URN application (UCM and GRL examples), UML examples). Translating UCM models into UML diagrams (Example of translating UCM models into UML diagrams). UML for business applications (Types of UML diagrams used for business applications with examples). Tools for modeling information systems (UCM and GRL plugins for Eclipse, Ericsson Penker extensions). Patterns and business patterns. Patterns. Resource and rule patterns. Goal patterns. Process patterns. Implementation of business patterns in Java. Example of a business model. Information system implementation. Introduction to Java Enterprise Edition (JEE). Using Wildfly server for deploying JEE applications. Maven. Persistence in information systems. Object-relational mappers – Java JPA, Hibernate, and MySQL. Implementation of the business logic layer. Business logic services in the JEE ecosystem. Service development with SessionBeans. Introduction to testing. Test case structure. Unit testing of JEE services using JUnit. Development of Java EE web applications using Java Server Faces (JSF). Examples of employee and store records. Implementation of microservices in business information systems. Containerization and Docker. Implementation of PHP and Node.js microservices. Application of Business Process Modeling Notation (BPMN) in documenting information system processes. Machine learning in information systems. Supervised machine learning. Weka machine learning framework in Java. Examples of classification and regression using Weka. Large language models in information systems. Development of LLM services using the Llama3 model and HuggingFace API for Python. Use of LLM services in JEE applications. Implementation of business patterns in Java. Example of a business model.
Textbooks/references	
1	Fujii, R.-U., i Ali, R. (2017). Object-Oriented Analysis and Design for Information Systems: Modeling with UML, OCL and IFML. Springer. ISBN 978-3-319-62613-5.
2	Brachman, R. J., & Levesque, H. J. (2004). Knowledge Representation and Reasoning. Morgan Kaufmann. ISBN 978-1558609327.

3	Rubinger, A. L., & Knutsen, A. (2013). Continuous enterprise development in Java. Addison-Wesley Professional.
4	Fowler, M. (2003). Patterns of Enterprise Application Architecture. Addison-Wesley Professional. ISBN 978-0321127426.
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, independent work of students on homework and projects

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	50	**Oral exam**	40
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Web Programming		
Lecturer (for lectures)	Petković M. Ivan		
Lecturer/associate (for exercises)	Petković M. Ivan, Veljanovski T. Marija, Puflović M. Darko		
Lecturer/associate (for OFE)	Veljanovski T. Marija, Puflović M. Darko		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	The aim of the course is to provide students with theoretical and practical knowledge required for the development of both client-side and server-side components of modern web applications, as well as to enable them to master the fundamental concepts of the Web, including protocols, technologies, and programming languages.		
Course outcomes	Upon successful completion of the course, students will be able to design and implement multi-tier web applications that integrate data from database systems, develop server-side functionality, and generate data-driven views and interactive user interfaces adapted to different device types and screen sizes.		
Course outline			
Theoretical teaching	Introduction to web programming, web applications, web application architecture, client-side and server-side challenges, protocols. HTML5, overview of client-side technologies, progressive enhancement, responsive design, CSS, JavaScript. JavaScript fundamentals: types, variables, functions, function expressions, lambda, arrays. Function execution context, closures, IIFE, object literals, module pattern. Prototypes, prototype chain, classes via prototypes, ECMAScript 6 classes, inheritance, properties (getters and setters), operators, data structures. Asynchronous programming, event loop, Promises, async/await. TypeScript, type system, type comparisons, unions, aliases, interfaces, type assertion (as operator), TS classes, inheritance, templates. Advanced types, type guards, TypeScript type narrowing, discriminated unions, function signatures. Web server, Node.js, ORM tools, server load balancing, cloud computing, serverless architecture, web services, REST, GraphQL, single-page web applications, progressive web applications, microservices, gRPC, virtualization, containerization, orchestration, WebAssembly, Blazor, blockchain.		
Practical teaching (exercises, OFE, study and research work)	Introduction to ASP.NET Core (Web API, Web Application, Real-time App), Entity Framework, model-first approach, model implementation and database creation, LocalDB, data validation, database connectivity, mapping and migrations. Controllers, synchronous and asynchronous controller methods, controller return types and methods, lambda expressions, LINQ queries, query optimization (lazy loading, explicit loading, eager loading). Data transfer with services, CORS (Cross-Origin Resource Sharing), RESTful services. Overview of client-side web technologies, introduction to HTML5 and CSS, responsive design. JavaScript fundamentals: DOM elements, functions (hoisting, closures, callbacks, anonymous functions), IIFE, event listeners, arrays and array methods. Object-oriented concepts (ECMAScript 2024), JavaScript server communication (sending/receiving data and commands). Building a simple ASP.NET web application: data model design, mapping and migrations, LocalDB, controllers, LINQ queries, method invocation via Swagger. HTML/CSS implementation of a simple application. JavaScript web page creation with server connectivity and method calls.		
Textbooks/references			
1	Jon Duckett, Beginning Web Programming with HTML, XHTML, and CSS, John Wiley & Sons, Aug 6, 2004		
2	Nicholas C. Zakas: Understanding ECMAScript 6: The Definitive Guide for JavaScript Developers, No Starch Press 2016		
3	Mark J. Price, C# 7.1 and .NET Core 2.0 – Modern Cross-Platform Development - Third Edition, Packt Publishing 2017		
4	B. Cherny: Programming TypeScript: Making Your JavaScript Applications Scale, O'Reilly Media, 2019		

5	K. Hoffman: Beyond the Twelve-Factor App, O'Reilly Media, 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	0	0
Teaching methods	Lectures, Exercises, Laboratory Exercises			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures			**Written exam**	
Exercises		20	**Oral exam**	40
Colloquia		40		
Projects				

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Internet of Things		
Lecturer (for lectures)	Dimitrijević M. Aleksandar		
Lecturer/associate (for exercises)	Petrović N. Nenad		
Lecturer/associate (for OFE)	Petrović N. Nenad		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Introduce IoT technologies and develop the knowledge required to design and implement microcontroller-based IoT devices and integrate them into IoT systems.		
Course outcomes	The student is able to design, build, program, and test microcontroller-based IoT devices that interact with the external environment. The student is able to connect sensors, actuators, and communication modules, apply appropriate IoT protocols and cloud services, and plan and design simpler IoT systems while taking into account connectivity, security, and data processing requirements.		
Course outline			
Theoretical teaching	Introduction to IoT, its forms and architecture. Development of IoT systems and prototyping platforms. The Arduino platform, fundamentals of microcontroller programming, interrupts, counters, and timers. Sensors, actuators, and energy harvesting. The networking ecosystem. IoT standards, frameworks, and protocols. Service and resource discovery. Cloud, Fog, and Edge data processing paradigms. Security and privacy. Data analytics. Cloud platforms for IoT. The ecosystem of smart technologies.		
Practical teaching (exercises, OFE, study and research work)	Introduction to Arduino programming. Implementation of interrupts, counters, and timers. Acquiring data from digital and analog sensors. Connecting output devices – LCD display. Actuators – servo motor control. Wired communication – Arduino as an HTTP client/server, use of the Ethernet shield. Wireless communication using WiFi and Bluetooth technologies. The MQTT protocol and communication examples over Ethernet and WiFi. Cloud services – ChatGPT integration. Development of complex applications, graphical visualization, and control via a web dashboard. Security implementation. Azure IoT Hub and AWS IoT Core platforms.		
Textbooks/references			
1	Raj, P., Raman, A. C. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, Auerbach Publications, 2017, ISBN: 978-1498761284		
2	Kumar, S. Fundamentals of Internet of Things, Chapman and Hall/CRC, 2022, ISBN: 978-1032126449		
3	Batra, N., Goyal, S. IoT Fundamentals with a Practical Approach, CRC Press, 2025, ISBN: 978-1032309699		
4	Ziegler, S. et al. Springer Handbook of Internet of Things, Springer, 2024, 978-3031396496		
5	Blum, J. Exploring Arduino: Tools and Techniques for Engineering Wizardry, 2nd edition, Wiley, 2019, ISBN: 978-1119405375		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, practical classes, and laboratory exercises.

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	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Human-Computer Interaction	
Lecturer (for lectures)			Rančić D. Dejan, Milosavljević Lj. Aleksandar, Dimitrijević M. Aleksandar	
Lecturer/associate (for exercises)			Dimitrijević M. Aleksandar, Đorđević D. Nikola	
Lecturer/associate (for OFE)			Đorđević D. Nikola	
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Introducing students to the subject area and introducing them to basic techniques and devices for human-computer interaction.			
Course outcomes	The student is able to analyze user requirements and mental models, as well as independently design, implement, and evaluate the usability of high-quality user interfaces by applying modern interaction paradigms and software tools.			
Course outline				
Theoretical teaching	Basic concepts and historical overview of the field. Goals of human-computer interaction and the relationship with interactive computer system applications. Psychological aspects. Mental models and interface design. Devices for human-computer interaction. Interaction paradigms. User interface development methodologies. Usability of interactive systems. Analysis and design of user interfaces. Standards and guides for user interface implementation. Software tools for user interface development. Evaluation of user interface usability. New paradigms for interaction.			
Practical teaching (exercises, OFE, study and research work)	Designing user interfaces using interface patterns. Understanding user needs. Organizing content through information architecture and application structure. Navigating through content. Organizing interface elements. Actions and commands. Displaying complex data. Forms and controls. Editors. Visual styles and aesthetics. Implementing multimodal web interfaces. Declarative techniques for developing advanced user interfaces. Implementing 3D interfaces.			
Textbooks/references				
1	B. Shneiderman, C. Plaisant, M. Cohen, S. Jacobs, N. Elmqvist, N. Diakopoulos, Designing the User Interface: Strategies for Effective Human-Computer Interaction, 6th ed., Pearson, 2016.			
2	A. Dix, J. Finlay, G. Abowd, R Beale, Human-Computer Interaction, 3rd ed., Pearson Education, 2004.			
3	J. Tidwell, C. Brewer, A. Valencia, Designing Interfaces, 3rd Edition, O'Reilly, 2020.			
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	0	0

Teaching methods	Lectures, auditory exercises, and laboratory exercises.

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	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Database Systems		
Lecturer (for lectures)	Stoimenov V. Leonid, Stanimirović S. Aleksandar		
Lecturer/associate (for exercises)	Stanimirović S. Aleksandar, Bogdanović D. Miloš		
Lecturer/associate (for OFE)	Puflović M. Darko		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The goal of the course is for students to gain a deeper understanding of database systems, including their architecture, data management, and application in modern software systems. The course covers advanced design techniques, data model translation, query optimization, security and protection mechanisms, as well as transaction management. Special emphasis is placed on the practical use of SQL and database management systems, with a focus on integration with applications through object-relational mappers. Students will develop the skills necessary for efficient work with relational databases and their application in real-world scenarios.		
Course outcomes	Upon successful completion of the course, the student is able to design relational databases, formulate and optimize SQL queries, apply transaction management and security mechanisms, and integrate database systems into modern software applications using ORM technologies.		
Course outline			
Theoretical teaching	Fundamentals of database systems. Architectures of database systems and their applications. Modern challenges and data management. Contemporary challenges in database design and usage. Principles of database management systems (DBMS). Advanced techniques in SQL. Transaction processing and ACID properties. Query optimization and efficient data access. Security of database systems. Database-driven application architectures. Separation of data access logic – typical design patterns. Object-relational mappers (ORM) and integration with applications. Advantages and disadvantages of using ORM in software development. Practical application of ORM and modern trends. Modern trends in database system technology.		
Practical teaching (exercises, OFE, study and research work)	Advanced SQL usage techniques. Practical application of advanced SQL concepts. Query optimization and performance analysis. Methods for improving query performance. Use of index structures and table partitioning. Using database management system (DBMS) tools for analysis and optimization. Optimization and efficiency of SQL queries through practical exercises. Advanced database design concepts. Extended Entity-Relationship model (EER model) – concepts and application. Practical examples of creating complex databases. Database design supporting advanced system requirements. Data model transformation. Translating the EER model into the relational model. Methods for mapping object-oriented models to relational models. Practical examples and tools for automated mapping. Object-relational mappers (ORM). The concept of ORM in modern applications. The role of ORM in database abstraction and productivity improvement. Advantages and challenges of using object-relational mappers. ORM technologies and practical application. Examples of ORM technologies: Hibernate, NHibernate – architecture and basic concepts. Examples of ORM technologies: Hibernate, NHibernate – basic mappings. Examples of ORM technologies: Hibernate, NHibernate – advanced mappings. Examples of ORM technologies: Hibernate, NHibernate – sessions, CRUD operations, queries, and transactions. Examples of ORM technologies: Hibernate, NHibernate – usage in application development – advantages, limitations, and examples. NoSQL databases: alternative approaches to data management.		
Textbooks/references			
1	R. Elmasri, S. Navathe, Fundamentals of Database Systems, Pearson; 7 edition (2016), ISBN-13: 9780133970777		
2	T. Connolly, C.Begg, Database Systems, A Practical Approach to Design, Implementation, and Management, 4th edition, Pearson Education Ltd, Addison Wesley, 2005		
3	G. Harrison, Next Generation Databases: NoSQL and Big Data, 1st edition, Apress, 2015, ISBN-13: 978-1484213308		
4	M. Fowler, Patterns of Enterprise Application Architecture, 1st edition, Addison-Wesley Professional, 2002, ISBN 978-0321127426		
5	M. Kleppmann, Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, O'Reilly Media, 2017, ISBN: 978-1449373320		
Number of classes of active education per week during semester/trimester/year			

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0
Teaching methods	Lectures, whiteboard exercises, lab exercises, independent student work on homework assignments and projects.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures		10	**Written exam**	
Exercises		30	**Oral exam**	30
Colloquia				
Projects		30		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Development of Web and Multiplatform Applications		
Lecturer (for lectures)		Petković M. Ivan		
Lecturer/associate (for exercises)		Petković M. Ivan		
Lecturer/associate (for OFE)		Petković M. Ivan		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites				
Course objectives	Acquainting with all aspects of designing and developing Web and cross-platform applications that integrate data from various Web services, working with client and server environments, containerization.			
Course outcomes	Upon successful completion of the course, students will be able to design and develop complex cross-platform applications using contemporary software frameworks and development environments, apply industry standards and best practices for developing production-ready applications, understand and employ architectural patterns commonly used in software development, and apply concepts and techniques for managing asynchronous data flows in modern software systems.			
Course outline				
Theoretical teaching	Asynchronous programming in ECMAScript. Basic concepts of functional programming. Introduction to reactive programming concepts. Environments for developing both client-side and server-side web applications. Server-side rendering. Techniques for storing and using application state. Design patterns in enterprise web applications. Principles of cross-platform web applications. WebAssembly. Application containerization. The impact and application of artificial intelligence in web application development.			
Practical teaching (exercises, OFE, study and research work)	Package managers. Module bundling and package generation. Basic concepts of functional programming. Code transpilation. Asynchronous programming in ECMAScript. Programming interfaces for asynchronous server communication. Reactive programming and RxJS. Observable data streams and operations on them. Environments for implementing single-page applications (SPAs). Flux architecture and its application state implementation. Support for mobile device functionalities. Frameworks for developing mobile applications using web technologies. Frameworks for building Web APIs using Node.js technology. API implementation and containerization. Working with databases using ORM (Object-Relational Mapping).			
Textbooks/references				
1	P. Ackermann: Full Stack Web Development: A Comprehensive, Hands-On Guide to Building Modern Websites and Applications, Rheinwerk Computing, 2023			
2	E. Scott: SPA Design and Architecture: Understanding Single Page Web Applications, Manning Publications, 2015			
3	A. Bampacos: Learning Angular: A practical guide to building web applications with modern Angular, Packt Publishing, 2025			
4	D. Correa, G. Lim: Practical Nest.js, 2025			
5	S. Blackheath, A. Jones: Functional Reactive Programming, Manning Publications, 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	0	0

Teaching methods	Lectures and demonstration exercises using computers. Independent practical exercises.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	Written exam	
Exercises	25	Oral exam	30
Colloquia			
Projects	40		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Mobile Application and Service Development		
Lecturer (for lectures)	Stojanović H. Dragan, Predić B. Bratislav		
Lecturer/associate (for exercises)	Davidović P. Nikola		
Lecturer/associate (for OFE)	Davidović P. Nikola		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites			
Course objectives	Mastery of the knowledge necessary for developing applications and services intended for mobile computing/communication devices using modern software, hardware, and communication technologies.		
Course outcomes	Upon successful completion of the course, the student understands the fundamental concepts, architectures, and principles of mobile systems, applications, and services, as well as the characteristics of mobile platforms and development technologies. The student is capable of designing and implementing mobile application architectures, developing user interfaces, and managing local and remote data using databases and cloud services. The student understands and applies concepts of network communication, background processing, concurrent execution, and data exchange between devices. The student is able to develop location-aware and context-aware mobile applications using sensors and GPS technologies, while applying appropriate security and privacy protection mechanisms. Through practical work, the student uses Android Studio and related tools for development, testing, debugging, and optimization of Android applications that integrate all key functionalities of mobile systems.		
Course outline			
Theoretical teaching	Introduction to Mobile Systems, Applications, and Services. Mobile platforms and development environments. Mobile and wireless networks and protocols. Architecture and components of mobile applications and services. Design of mobile applications and user experience. Mobile user interfaces and interaction with mobile applications. Data management in mobile applications and mobile databases. Concurrency, services, and background tasks. Mobile services in the cloud. Mobile messaging and ad-hoc communication. Mobile positioning and location-based services. Sensor data processing and context-aware mobile applications. Mobile web, hybrid, and cross-platform applications. Privacy and security of mobile applications and services. The mobile application development process, publishing on online stores, and monetization.		
Practical teaching (exercises, OFE, study and research work)	Introduction to the Development of Mobile Applications and Services for the Android Mobile Platform. Design and architecture of mobile applications. User interaction and user interface based on Jetpack Compose. MVVM architecture of mobile applications. Implementation of local data storage and mobile databases – RoomDB, Retrofit. Communication and message exchange between mobile application components – Intents, Broadcasts. Services in the Android architecture – Work Manager. Access to web services and cloud services – Firebase. Determining the location of mobile users and developing location-based functionalities. Accessing sensors on the mobile device and adapting functionalities and services to the user's context. Communication between mobile applications via BLE, NFC, etc. Animation in mobile applications – Jetpack Compose. Testing of mobile applications. Development of mobile web, hybrid, and cross-platform applications.		
Textbooks/references			
1	Bill Phillips, Chris Stewart, Brian Hardy, Kristin Marsicano, Android Programming: The Big Nerd Ranch Guide, 5th Edition, Big Nerd Ranch Guides, 2022.		
2	M. Murphy, Exploring Android, CommonsWare, https://commonsware.com/AndExplore/, 2021		
3	M. Murphy, Elements of Android Jetpack, CommonsWare, https://commonsware.com/Jetpack/, 2021		
4	Mobile Developer's Guide To The Galaxy, 18th Edition, Open-Xchange, 2019		

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	0	0
Teaching methods	Teaching methods: Lectures, auditory exercises, laboratory exercises, independent student work on assignments and projects, student seminars.			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures			**Written exam**	40
Exercises		20	**Oral exam**	
Colloquia		40		
Projects				

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies		Undergraduate Academic Studies	
The name of the course		System Programming	
Lecturer (for lectures)		Stanimirović S. Aleksandar	
Lecturer/associate (for exercises)		Nikolić S. Mina	
Lecturer/associate (for OFE)		Nikolić S. Mina	
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The aim of the course is for students to gain a deeper understanding of systems programming through the study of fundamental concepts, techniques, and tools for developing software that directly interacts with the operating system. Through this course, students will develop the skills necessary for memory management, working with executable files, debugging, profiling, and using system libraries. Special emphasis is placed on concurrent programming, process and thread management, as well as synchronization mechanisms. Additionally, students will become familiar with modern tools and techniques for version control and program performance optimization.		
Course outcomes	Upon successful completion of the course, the student is able to analyze and implement system software, apply concurrent programming mechanisms, utilize debugging and profiling tools, and optimize the performance of software systems.		
Course outline			
Theoretical teaching	Introduction to systems programming. Executable file formats, program linking and loading. Debugging methods, tools for debugging, performance analysis, and program profiling for optimization. Memory management. Working with software libraries. Version control systems. Concurrent programming: processes, threads, and lightweight threads (fibers). Issues in concurrent programming. Synchronization primitives in modern programming languages. Semaphores, monitors, and communication models. Typical synchronization problems and their solutions. Lock-free concurrent programming. Event-driven programming. Asynchronous input/output operations and parallel data processing.		

Practical teaching (exercises, OFE, study and research work)	The concept of multithreading, analysis of the advantages and disadvantages of using threads. Comparison between threads and processes. Overview of basic thread operations: thread creation, passing data to threads, setting thread priorities, foreground and background threads. Thread states, thread synchronization, and specifics of implementing synchronization in the .NET Framework. Basic blocking methods, locking primitives (synchronization and mutual exclusion), signaling primitives (signal sending), and non-blocking primitives (lock-free synchronization). The concept of thread-safe code, atomic operations, locking and atomicity, nested locks, performance analysis of locking with an overview of synchronization primitives available in the .NET Framework. Analysis of issues related to locking: reduced concurrency, deadlocks, and race conditions. The concept of a synchronization context and non-blocking synchronization. Working with the Interlocked class, Barrier class, and volatile operations. Using synchronization primitives such as Wait, Pulse, and ReaderWriterLock. The concept and usage of the Thread Pool, analysis of different approaches to accessing the Thread Pool (Task Parallel Library, QueueUserWorkItem, asynchronous delegates, BackgroundWorker class), use of asynchronous methods and events. Use of various types of timers, with a special focus on .NET Framework timer implementations. The concept and significance of thread-local storage. Overview of different approaches for implementing thread-local storage. The concept of a Task, launching Tasks, analyzing long-running tasks, returning values from Tasks, exception handling in Tasks, and the use of continuations. Principles of asynchronous programming, writing asynchronous functions in C#, analysis of the asynchronous execution call graph. Introduction to the Parallel Framework, PFX components, analysis of data-level and task-level parallelism, writing LINQ and PLINQ queries, overview of the PLINQ execution model. Overview of different methods of the Parallel class (Invoke, For, ForEach), concurrent collections and their use within the .NET Framework (ConcurrentStack, ConcurrentQueue, ConcurrentBag, BlockingCollection, ConcurrentDictionary). Principles of functional programming, functional data types, the concept of side effects, working with immutable collections, immutability in C#, CAS operations, and ABA problems. The concept of event-driven programming, introduction to reactive programming principles, .NET tools for reactive programming, processing large data streams in real time. Overview of working with Reactive Extensions (.NET Rx), using Rx for real-time streaming, the Rx publisher-subscriber model and concurrency, and the Rx Scheduler.
Textbooks/references	
1	William Stallings, Operating Systems: Internals and Design Principles, 7th edition, Pearson Education, 2011, ISBN-13 978-0132309981
2	M. Ben-Ari: Principles of Concurrent and Distributed Programming, 2nd Edition, Addison-Wesley, 2005, ISBN-13 978-0321312839
3	R. Bryant, D. O'Hallaron, Computer Systems: A Programmer's Perspective, 3rd edition, Pearson, 2016, ISBN-13: 978-9332573901
4	M. Herlihy, N. Shavit, The Art of Multiprocessor Programming, 2nd edition, Morgan Kaufmann, 2020, ISBN 978-0124159501
5	Official documentation and contemporary resources related to systems programming (.NET, Python, Go, Linux systems programming, and concurrent programming).

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, whiteboard exercises, laboratory exercises, independent work (homework assignments, projects).

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Cybersecurity		
Lecturer (for lectures)	Ćirić M. Vladimir		
Lecturer/associate (for exercises)	Milošević S. Marija		
Lecturer/associate (for OFE)	Drašković S. Vukadin		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The aim of the course is for students to acquire theoretical and practical knowledge in the field of cybersecurity, including threat identification and the implementation of security mechanisms. Through laboratory exercises, students will learn how to implement protective measures, analyze network traffic, and detect security vulnerabilities in systems.		
Course outcomes	Upon completion of the course, students will be able to implement security techniques and standards on computer systems to protect systems and data.		
Course outline			
Theoretical teaching	Fundamentals of Security. Security Policies and Strategies. Modern Local Area Networks. Protocols and Services. Network Security. Firewalls. Intrusion Detection Systems. Virtual Private Networks. Wireless Network Security. Operating System Security. Key Management. Access Control. Activity Monitoring. Security Network Topologies, Systems, and Devices. Ethical Hacking. Basics of Penetration Testing. Social Engineering. Malware Analysis. Web Application Security. OWASP Vulnerabilities. Security Data Collection, Analysis, and Visualization. Honeypot Systems. Security Operation Centers. Incident Response and Forensics. Network Traffic Analysis. General and International Information Security Standards. Guidelines for Implementing Security Measures. Privacy Management.		
Practical teaching (exercises, OFE, study and research work)	Threat Analysis and Modeling (OWASP Threat Dragon, Microsoft Threat Modeling Tool). Data Encryption and Security (OpenSSL). Traffic Analysis (Wireshark, tcpdump). Anomaly Detection (Zeek, Suricata). IDS/IPS (Snort, pfSense). VPN (OpenVPN, WireGuard). Authentication and Key Management (OpenSSL, HashiCorp Vault). Event Analysis (Wazuh, Osquery, ELK Stack, Auditd). Penetration Testing (Nmap, Nessus, Metasploit, etc.). Web Application Testing (sqlmap, Burp Suite). Reverse Engineering and Malware Analysis (Ghidra, Radare2). Honeypot Network Deployment (Dionaea, Cowrie). Anomaly Detection in Network Logs (Zeek, ELK). ML Models for Attack Prediction. Implementation of Security Policies. Access Control. GDPR and Privacy Protection. Data Anonymization (VeraCrypt, BitLocker).		
Textbooks/references			
1	Stallings, William, Cryptography and Network Security, Pearson, 2016, ISBN: 978-0134444284		
2	Erickson, Jon, Hacking: The Art of Exploitation, No Starch Press, 2008, ISBN: 978-1593271442		
3	Calder, Alan, ISO/IEC 27001:2013 - A Pocket Guide, IT Governance Publishing, 2014, ISBN: 978-1849284982		
4	Sikorski, Michael; Honig, Andrew, Practical Malware Analysis, No Starch Press, 2012, ISBN: 978-1593272906		
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, independent work of students on homework and projects

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Advanced Data Structures		
Lecturer (for lectures)	Stoimenov V. Leonid, Dimitrijević M. Aleksandar		
Lecturer/associate (for exercises)	Mihajlović T. Vladan, Davidović P. Nikola		
Lecturer/associate (for OFE)	Mihajlović T. Vladan, Davidović P. Nikola		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	Data Structures		
Course objectives	Acquisition of knowledge about advanced data structures and their applications, and introduction to problem-solving paradigms through concrete and representative examples of complex problems.		
Course outcomes	The student is able to select, apply, and implement appropriate advanced data structures for solving more complex algorithmic problems. The student is able to analyze the efficiency of data structures and algorithms, identify classes of problems in which particular structures can be applied, and design and implement original solutions in the field of data structure and algorithm development. Improvement of the ability to analyze structural and algorithmic problems and synthesize original solutions in the field of data structure and algorithm development.		
Course outline			
Theoretical teaching	Introduction to advanced data structures, their purpose, characteristics, efficiency, and applications. Data structures in C++ libraries. Priority queues. Advanced hashing structures. Balanced binary trees. Applications of general trees. Data structures for set and interval processing. Data structures for handling textual data. Data structures for indexing large datasets. Data structures for spatial data processing. Graphs. Memory hierarchy, models, and cache-oblivious data structures.		
Practical teaching (exercises, OFE, study and research work)	Introduction to advanced data structures. Application of structures implemented in the STL and Boost libraries. Implementation of priority queues. Implementation of advanced hashing structures. Implementation of balanced binary trees. Application of general trees. Examples of set and interval processing and implementation of corresponding data structures. Examples of text data search and implementation of corresponding data structures. Implementation of indexing for large datasets. Implementation of data structures for spatial data processing. Advanced graph implementation. Implementation of complex graph operations.		
Textbooks/references			
1	Mehta,D. P.; Sahni S. Handbook of Data Structures and Applications, Chapman & Hall/CRC Computer and Information Science Series, 2004, ISBN: 978-1584884354		
2	La Rocca, M. Advanced Algorithms and Data Structures, Manning Publications, 2021, ISBN: 978-1617295485		
3	Brass, P. Advanced Data Structures, Cambridge University Press, 2008, ISBN: 978-0521880374		
4	Abirami, A.; Priya, R. L. Advanced Data Structures and Algorithms: Learn how to enhance data processing with more complex and advanced data structures, BPB Online WeWork, 2023, ISBN: 978-93-5551-7937		
5	Cormen, T.; Leiserson, C.; Rivest, R.; Stein,C. Introduction to Algorithms 3rd Edition, MIT Press, 2009, ISBN: 978-0262033848		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, practical classes, and laboratory exercises.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Computer Science and Informatics Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Software Engineering		
Lecturer (for lectures)	Rančić D. Dejan, Milosavljević Lj. Aleksandar		
Lecturer/associate (for exercises)	Rančić D. Dejan, Čikić D. Đorđe		
Lecturer/associate (for OFE)	Rančić D. Dejan, Mihajlović T. Vladan, Čikić D. Đorđe		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites			
Course objectives	Mastering the basic knowledge necessary for the development and evolution of software systems.		
Course outcomes	The student is able to independently apply software development models, perform requirements engineering, design software architecture, and work in a team on the implementation, testing, and evolution of software systems.		
Course outline			
Theoretical teaching	The concept and need for software engineering. System engineering. Software development models. Software processes. Agile software development. Basic activities in software project management. Requirements specification. Requirements engineering methods. Software design. Software architectural models. Software project management. Software validation and verification. Systematic software testing. Software maintenance and evolution.		
Practical teaching (exercises, OFE, study and research work)	Project topic selection and submission. Project management. Project implementation plan. Project documentation. System vision. Requirements analysis and domain modeling. Requirements specification. Architectural design. Test plan. Test case specification. Test report. User documentation development.		
Textbooks/references			
1	I. Sommerville, Software Engineering, 10th ed., Pearson Education Limited, 2016.		
2	R. Pressman, Software Engineering A Practitioner's Approach, 9th ed., McGraw-Hill, 2019.		
3	Eric J. Braude, Software Engineering - An Object-oriented Perspective, Johns Wiley & Sons, 2001.		
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	0	0

Teaching methods	Lectures, auditory exercises, independent work of students on projects.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Parallel Computing systems		
Lecturer (for lectures)	Milovanović I. Emina		
Lecturer/associate (for exercises)	Stojanović M. Natalija, Stojnev Ilić I. Aleksandra, Milošević S. Marija		
Lecturer/associate (for OFE)	Stojnev Ilić I. Aleksandra, Puflović M. Darko, Milošević S. Marija		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites			
Course objectives	The goal of this course is to provide a deep understanding of the fundamental principles and engineering trade-offs involved in designing modern parallel computing systems as well as to teach parallel programming techniques necessary to effectively utilize these machines. Because writing good parallel programs requires an understanding of key machine performance characteristics, this course will cover both parallel hardware and software design		
Course outcomes	The student is able to describe the differences, advantages, and limitations of various parallel computer hardware architectures. Identify common communication patterns that arise in parallel programming and how several programming platforms make them possible. Implement a parallel programs using distributed memory, shared memory, and GPU/Co-processor paradigms. Evaluate the theoretical and actual efficiency of parallel programs using standard metrics		
Course outline			
Theoretical teaching	Technology trends. Classification of parallel computing systems. Performance. Speedup. Amdahl's law. Gustavson's law. Effective parallel algorithms. Designing parallel algorithms. Decomposition. Communication. Agglomeration. Mapping. Data-level parallelism in vector, SIMD, and GPU architectures. Architectures. Interconnection networks. Routing. Vectorization and loop parallelization. Program dependencies. Tests. Dependency elimination. Loop transformations. SIMD extensions for multimedia. Programming general-purpose applications on graphics processors. Multiprocessors. Cache coherence. Cache coherence protocols. Multiprocessor programming. Thread-level and task-level parallelism. OpenMP. Multicomputers. Multicomputer programming with MPI. Hybrid computing		
Practical teaching (exercises, OFE, study and research work)	The exercises follow the lecture program in full. MPI: data types; point-to-point communications; point-to-point and group operations; derived data types; groups, communicators and virtual topologies. CUDA: programming model; SIMD/SPMD/SIMT execution model; memory allocation and data transfer between the graphics and central processors; CUDA functions; host functions; device functions. OpenMP: fork-join execution model; directives for creating a thread team and for dividing work; clauses; directives for thread synchronization; task parallelism. A cycle of 6 laboratory exercises is also planned		
Textbooks/references			
1	John L. Hennessy, David A. Patterson, Computer Architecture: A quantitative approach, 6th edition, Morgan Kaufman, 2019.		
2	G. Barlas, Multicore and GPU Programming An Integrated Approach, Second Edition, 2023		
3	Timothy G. Mattson, Yun (Helen) He, Alice E. Koniges, The OpenMP Common Core: Making OpenMP Simple Again, MIT Press, 2019.		
4	Introduction to Parallel Computing, 2nd Edition by Grama, Gupta, Karypis, and Kumar. Addison-Wesley 2003.		
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	0	0

Teaching methods	Lectures, oral and laoboratory exercises.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Computer Networks Design		
Lecturer (for lectures)		Milovanović I. Emina, Ćirić M. Vladimir		
Lecturer/associate (for exercises)		Ćirić M. Vladimir, Milošević S. Marija		
Lecturer/associate (for OFE)		Milošević S. Marija		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	Computer Networks			
Course objectives	The aim of the course is for students to build upon their basic knowledge of computer networks and acquire the necessary applied knowledge and skills for designing and implementing small and medium-sized computer networks.			
Course outcomes	It is expected that the student will be able to design, implement, and maintain small and medium-sized networks, applying modern concepts, services, and protocols.			
Course outline				
Theoretical teaching	Basic Networking Concepts. Layer 2 and Layer 3 Switching. Characteristics of Passive and Active Network Equipment. Network Models, Hierarchical Network Design Model. Planning of Core Services, Distributed Services, Local Services, Network Reliability. Requirements, Identification, and Validation. Network Design. Logical and Physical Design, Testing, Optimization, and Documentation. Network Design and Implementation Process. Typical Models for Small and Medium-Sized Network Implementations. Virtual Networks. Trunks. ISL and IEEE 802.1 Protocols and Encapsulation. VTP. Redundant Topologies. Reliability and Availability Calculation for Network Topologies. Protocols for Implementing Redundant Topologies at Layer 2 of the OSI Model. STP and Rapid STP Protocols. Inter-VLAN Routing. Virtual Interfaces. Wireless Networks – Standards, Design Principles, Roaming Service for Mobile Devices. Network Security. Quality of Service (QoS).			
Practical teaching (exercises, OFE, study and research work)	Hands-on work through a set of computational and laboratory exercises. TCP protocol flow control. Switch access and basic configuration. Port-level security. VLAN creation and inter-VLAN routing configuration. Dot1q trunk links. VTP protocol configuration. Layer 3 switches. Addressing scheme design. Redundant topologies: STP, PVST+, HSRP. Design and configuration of wireless networks. Use of a RADIUS server in the network. VoIP, phone registration, and call routing.			
Textbooks/references				
1	D. McCabe, "Network Analysis, Architecture and Design", Morgan Kaufmann, 2003.			
2	Larry L. Peterson, Bruce S. Davie, Computer networks: A system approach, 5th edition, Morgan Kaufman, 2012.			
3	Wayne Lewis, “LAN Switching and Wireless”, Cisco Press, Indianapolis, USA, 2009, ISBN 978-1-58713-207-0			
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	0	0

Teaching methods	Lectures, oral and laboratory exercises.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	40
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Information Security		
Lecturer (for lectures)	Vučković V. Vladan		
Lecturer/associate (for exercises)	Rajković J. Petar, Đorđević I. Anđelija		
Lecturer/associate (for OFE)	Đorđević I. Anđelija		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Mastering the basic knowledge necessary for the use of basic and advanced procedures in information security.		
Course outcomes	In the area of theoretical knowledge, mastering mathematical techniques for encoding and decoding data. In the practical area, programming methods for encrypting information on a computer.		

Course outline

Theoretical teaching	Introduction. Elements of cryptology, cryptography and cryptanalysis. Basic cryptographic algorithms. Caesar cipher. Simple Substitution Cipher. Cryptanalysis of simple substitution systems. Statistical method. Double Transposition Cipher. Use of XOR functions in cryptography. One-Time Pad. Codebook encoding. Venon Project. Modern cryptosystems. Enigma encryption machine. Basic stream encoders. A5*. RC4. Basic block encoders. Feistel. DES. Public key method and infrastructure. RSA. Use of elliptic curves. Hash functions. Tiger hash system. Birthday problem. Authorized access. Identification methods. Authorized access systems. ATM machines. Passwords. Passphrase system. Captcha system. ACL and C matrices. Biometric methods. Fingerprint and palm print. IRIS. Types and types of malware.
Practical teaching (exercises, OFE, study and research work)	Topic 1: Concepts related to information protection. Encryption and decryption. Types of cryptographic algorithms. Classification and use of cryptographic systems. Topic 2: Basic encryption algorithms. Substitution and mixing principles. Single substitution, double transposition, Codebook and systems based on a combination of substitution and mixing principles. Topic 3: Symmetric cryptographic algorithms based on XOR arithmetic. One-Time-Pad and A5* series of algorithms. Topic 4: Stream encoders based on shuffle and substitution. RC4 and RC6 algorithms. Topic 5: Block encoders, Feistel encoder, DES, TEA. Topic 6: Complex block encoders: TDES, AES. Topic 7: Block encoder improvements. Encoder modes. CRT, CFB, OFB, PCMC. Topic 8: Preparation for the colloquium. Tasks related to topics 1 to 7. Topic 9: Differential cryptanalysis. TinyDES and its application. Topic 10: Public and private key; Knapsack. Topic 11: Encryption based on modular arithmetic. RSA algorithm. Topic 12: Data Hashing in Cryptography. CRC and Tiger-Hash. Topic 13: Hashing in Cryptography. MD5 and SHA Series Algorithms. Topic 14: Extension to Hash Algorithms. HMAC, UMAC. Topic 15: Preparation for the Second Colloquium. Tasks related to topics 9 to 14.

Textbooks/references

1	Mark Stamp, “Information Security Principles and Practice“, John Wiley and Sons, Inc, New Jersey, U.S.A., 2006.
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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	0	0

Teaching methods	Lectures, blackboard exercises, laboratory exercises, independent student work on homework and projects, consultations.

Grade (maximum number of points 100)

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

Colloquia	30		
Projects	10		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Advanced Databases		
Lecturer (for lectures)		Stanimirović S. Aleksandar		
Lecturer/associate (for exercises)		Nikolić S. Mina		
Lecturer/associate (for OFE)		Nikolić S. Mina		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	The goal is for students to gain insight into modern technologies and trends in the field of databases, with a particular focus on distributed databases and multi-tier architectures—their advantages, challenges, and applications. Students will also become familiar with current issues in information integration and potential solutions. Special attention will be given to the characteristics, purpose, and usage of NoSQL databases through concrete examples. In addition, modern database concepts will be covered, enabling students to develop a deeper understanding of contemporary approaches to data management and processing.			
Course outcomes	Upon successful completion of the course, the student is able to analyze modern database concepts and architectures, evaluate the advantages and limitations of different database models, apply contemporary technologies for data storage and processing, and analyze current trends and research directions in the field of advanced databases.			
Course outline				
Theoretical teaching	Introductory topics: traditional relational databases and their potential issues. Distributed databases: modern trends and challenges. NoSQL databases: definition and core concepts. Taxonomy of NoSQL databases. Key-value databases – fundamental concepts and typical representatives. Column store databases – fundamental concepts and typical representatives. Document databases – fundamental concepts and typical representatives. Graph databases – fundamental concepts and typical representatives. Text data search – core concepts and examples of different solutions. Time-series databases – core concepts and typical representatives. Vector databases – core concepts and typical representatives. Interoperability and information integration. NewSQL databases – core concepts and typical representatives.			
Practical teaching (exercises, OFE, study and research work)	Examples of modern database trends. NoSQL databases: classification and system examples. Key-value databases – example system: Redis. Key-value databases – examples of typical use cases. Column store databases – example system: Cassandra. Column store databases – examples of typical use cases. Document-oriented databases – example system: MongoDB. Document-oriented databases – examples of typical use cases. Graph databases – example system: Neo4j. Graph databases – examples of typical use cases. Time-series databases – example system: InfluxDB. Time-series databases – examples of typical use cases. Vector databases – example system: Milvus. Vector databases – examples of typical use cases.			
Textbooks/references				
1	R. Elmasri, S. Navathe, Fundamentals of Database Systems, Addison-Wesley; 6 edition (2010), ISBN-10: 0136086209, ISBN-13: 978-0136086208			
2	T. Connolly, C.Begg, Database Systems: A Practical Approach to Design, Implementation, and Management, 5th edition, Pearson, 2009, ISBN-13: 978-0321523068			
3	G. Harrison, Next Generation Databases: NoSQL and Big Data, 1st edition, Apress, 2015, ISBN-13: 978-1484213308			
4	L. Perkins, E. Redmond, J. Wilson, Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement, 2nd edition, Pragmatic Bookshelf, 2018, ISBN 978-1680502534			
5	M. Kleppmann, Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, O'Reilly Media, 2017. ISBN: 978-1449373320.			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, whiteboard exercises, laboratory exercises, independent work (homework assignments, projects).

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	Written exam	

Exercises	30	**Oral exam**	30
Colloquia			
Projects	30		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Software Architecture and Design		
Lecturer (for lectures)	Stojanović H. Dragan, Predić B. Bratislav		
Lecturer/associate (for exercises)	Predić B. Bratislav, Mihajlović T. Vladan		
Lecturer/associate (for OFE)	Mihajlović T. Vladan		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	Object-Oriented Programming, Object-Oriented Design		
Course objectives	Mastering the knowledge necessary for the development of architecture and the design of complex software systems, using architectural styles and patterns, design patterns, software components, application frameworks, and services.		
Course outcomes	Upon successful completion of the course, the student understands the fundamental principles of software architecture and design and their role in developing complex information systems. The student is capable of analyzing and selecting appropriate architectural styles, patterns, and technologies in accordance with functional and non-functional requirements. The student is able to design and document software system architectures using standard models, notations, and techniques. The student understands and applies object-oriented design principles, design patterns, and enterprise architecture principles across different layers of software systems. Through practical work software development, the student is able to implement, evaluate, and refactor software solutions in line with modern principles of quality and maintainability.		
Course outline			
Theoretical teaching	Introduction to Software Architecture and Design. Software architecture – fundamental principles and methods. Modularity of software systems, coupling and cohesion of modules. Quality attributes and software architecture. Architectural styles and patterns. Design, documentation, and evaluation of software architecture. Software components, application frameworks, and middleware platforms. Service-oriented architecture, web services, and microservices. Basic principles and methods of software design. Software design using design patterns. Object-oriented design patterns. Anti-patterns in software design. Refactoring design into design patterns. Design and architectural patterns for enterprise applications. Integration of enterprise applications (EAI).		
Practical teaching (exercises, OFE, study and research work)	Documentation of Software Architecture and Design Using UML. Defining non-functional requirements and quality attributes. Examination of examples of various architectural styles and patterns in the architecture of complex software systems. Layered architectural pattern. Pipes-and-Filters architectural pattern. Model-View-Controller (MVC) architectural pattern. Broker architectural pattern. ORM architectural pattern in the data source layer of information systems. Message broker architectural pattern in microservice architectures. Practical work on software design using design patterns. Design patterns in software architecture – Observer, Prototype, Strategy, Decorator, etc. Designing software architecture that satisfies quality attributes. Development and documentation of architecture. Refactoring existing designs into design patterns. Designing a real software system using appropriate styles and design patterns.		
Textbooks/references			
1	Bratislav Predić, Dragan Stojanović, Software Architecture and Design, Faculty of Electronic Engineering, University of Niš, 2023.		
2	Len Bass, Paul Clements Rick Kazman. Software Architecture in Practice, 4th edition, Addison-Wesley Professional, 2021		
3	Ian Gorton, Essential Software Architecture, 2nd Edition, Springer, 2011.		
4	Martin Fowler, Patterns of Enterprise Application Architecture, Addison-Wesley, 2003		
5	Dive Into Design Patterns, Refactoring.Guru, 2024, https://refactoring.guru/design-patterns/book		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, independent student work on homework and projects, student seminars.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	40

Exercises	20	**Oral exam**	
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Software Testing and Quality		
Lecturer (for lectures)	Janković S. Dragan, Bogdanović D. Miloš		
Lecturer/associate (for exercises)	Bogdanović D. Miloš, Puflović M. Darko		
Lecturer/associate (for OFE)	Puflović M. Darko		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to the concept of software quality and testing, basic techniques for software testing.		
Course outcomes	Theoretical and practical knowledge about software quality and testing techniques. Built critical approach to software quality and awareness of the importance of software testing.		
Course outline			
Theoretical teaching	Basic concepts of testing and software quality assurance. The process of testing and software quality assurance. Standards, strategies, techniques and methods of testing and software quality assurance. Test case design. Component, integration, acceptance and systems testing. Testing the quality attributes. User interface testing. Web applications testing. Regression testing. Standards and tools for testing and software quality assurance. Planning, monitoring and documenting the testing process. Measurement and managing of testing process.		
Practical teaching (exercises, OFE, study and research work)	Introduction to the process and types of software testing. Source code storage, management and versioning systems. Basics of software component testing. JUnit framework for component software testing. NUnit framework for component software testing. Basics of debugging the client side of web-based applications. Support for debugging within web browsers - Firebug and Chrome Developer Tools. Bug lifecycle management - Bugzilla tool. End-to-end application testing. API testing. Playwright framework - API testing. Playwright framework - end-to-end testing.		
Textbooks/references			
1	Boris Beizer, Software Testing Techniques, The Coriolis Group, 1990.		
2	Mauro Pezze, Michal Young, Software testing and Analysis: process, principles and techniques, John Wiley & Sons, 2007.		
3	Rick Craig, Stefan Jaskiel, Systematic Software Testing, Artech House Publisher, London, 2002.		
4	Arnon Axelord, "Complete Guide to Test Automation", Apress, 2018.		
5	Kristin Jackvony, "The Complete Software Tester: Concepts, Skills, and Strategies for High-Quality Testing", 2021.		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

Teaching methods	Lectures, Auditive exercises, Laboratory exercises. Student project realization.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	30
Exercises	20	**Oral exam**	20
Colloquia			
Projects	30		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Technology Enhanced Learning		
Lecturer (for lectures)	Milentijević Z. Ivan		
Lecturer/associate (for exercises)	Vojinović M. Oliver		
Lecturer/associate (for OFE)	Vojinović M. Oliver		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	To enable students to acquire knowledge about modern learning support platforms. To introduce students to contemporary approaches to learning and the possibilities for supporting such learning. To provide students with experiences in planning, evaluating, developing, and implementing components and systems that support modern types of learning.		
Course outcomes	At the end of the course, the student will be able to understand the possibilities of applying information technologies in education, to select suitable technologies for a specific educational environment and objectives, and to configure, administer, and adapt components and systems to support the educational process.		
Course outline			
Theoretical teaching	Modern platforms for learning support; the history of learning support technologies and the concept of technology-enabled learning. E-learning, m-learning, e-assessment, and personalized learning and assessment. Learning paradigms and types of technological support for learning. Organizational aspects of technology-supported learning. Pedagogical, psychological, and sociological aspects of e-learning. Open education. Technological support for instructional design. Learning management systems (LMS); virtual learning environments (VLE); multimedia and multimodal components for learning; intelligent tutoring systems. Computer games and gamification in learning. Support for students with disabilities; support for students with learning difficulties. The application of artificial intelligence in learning. Learning analytics. Learning evaluation support.		
Practical teaching (exercises, OFE, study and research work)	Hardware and software infrastructure of learning support platforms, strategies for technology selection, and design of the technological environment for learning. Systems for learning organization: architecture, components, customization and maintenance. Virtual learning environments. Technological support for instructional design. Application of gamification and computer games. Student projects: topics discussion, topic selection. Initial meetings with teams. Consultative work on projects. First seminar. Feedback after the first seminar. Consultative work on projects. Second seminar.		
Textbooks/references			
1	Sanju Saha, Santoshi Halder, The Routledge Handbook of Education Technology, Taylor&Francis, 2023.		
2	Yang Shen, Xin Yin, Yu Jiang, Lingkai Kong, Sheng Li, Haijun Zeng, Case Studies of Information Technology Application in Education: Utilising the Internet, Big Data, Artificial Intelligence, and Cloud in Challenging Times, Springer, 2023.		
3	Jim Goodell, Learning Engineering Toolkit: Evidence-Based Practices from the Learning Sciences, Instructional Design, and Beyond, Routledge, 2022.		
4	Joy L. Egbert, Supporting Learning with Technology, Pearson/Merrill/Prentice Hall, 2009.		
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	0	0

Teaching methods	Lectures, consultations, students' work on assignments and projects, seminars (presentations of student projects, with discussion).

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	10	Written exam	
Exercises		Oral exam	40
Colloquia			
Projects	50		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Fundamentals of Control Systems		
Lecturer (for lectures)	Perić Lj. Staniša, Nikolić S. Saša		
Lecturer/associate (for exercises)	Đorđević D. Anđela		
Lecturer/associate (for OFE)	Jovanović M. Anđela		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	To introduce students to the fundamentals of modeling, simulation, and design of control systems, including the application of modern technologies such as PLC and SCADA systems. The focus is on an algorithmic approach and digital implementation of controllers in the context of automation and computer engineering.		
Course outcomes	After completing the course, students will be able to understand the basic concepts of control systems, including modeling, feedback, stability, and system response, as well as the application of PID controllers. They will be capable of simulating simple systems in MATLAB, understanding the role of PLC and SCADA systems in industrial automation, and connecting knowledge in the domain of control systems with modern concepts such as IoT and Industry 4.0.		
Course outline			
Theoretical teaching	Introduction to control systems– open and closed loop. Basic components of control systems – sensors, actuators, controller, signal flows. Mathematical modeling. Concept of feedback – stability, robustness, and error correction. System response in the time domain – steady state, transient response, basic response parameters. System stability – pole location. PID controller – role of P, I, and D components, tuning, and applications. Introduction to simulation of dynamical systems – MATLAB/Simulink: modeling, response, stability. Introduction to PLC – hardware, programming, examples. SCADA systems – architecture, communication with PLC, remote monitoring and control. Examples of PLC + SCADA integration. Distributed control in the context of IoT and Industry 4.0 – digital twins, cloud SCADA, smart factories.		
Practical teaching (exercises, OFE, study and research work)	Open and closed-loop control. Structural block diagrams of automatic control systems. Mathematical modeling – first-order systems. System response in the time domain. System stability – pole location. PID controller – intuitive understanding. Simulation of closed-loop control in Simulink. Introduction to PLC programming. Implementation of PID logic in PLC. Introduction to SCADA – monitoring and visualization. Integration of PLC and SCADA. Distributed control – IoT concept. Mini-projects – practical application of knowledge. Project presentations and result analysis.		
Textbooks/references			
1	Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, "Feedback Control of Dynamic Systems", Pearson, 2020.		
2	M. T. White, "PLCs for Beginners: An Introductory Guide to Building Robust PLC Programs with Structured Text", Packt Publishing, 2024.		
3	D. Bailey, E. Wright, “Practical SCADA for Industry“, Newnes, 2003.		
4	J. Romagnoli, A. Palazoglu, “Introduction to Process Control”, CRC Press, 2006.		
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	0	0

Teaching methods	Multimedia lectures; Auditory exercises; Laboratory exercises

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			Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Computer Vision	
Lecturer (for lectures)			Milosavljević Lj. Aleksandar	
Lecturer/associate (for exercises)			Čikić D. Đorđe	
Lecturer/associate (for OFE)			Čikić D. Đorđe	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Introducing students to the field of computer vision and familiarizing them with basic algorithms and techniques for this field.			
Course outcomes	The student is able to analyze digital images and video sequences, apply algorithms for feature detection and object recognition, and implement solutions based on convolutional neural networks using modern software libraries.			
Course outline				
Theoretical teaching	Introduction and history of the field of computer vision. The human visual system. Image representation. Color spaces. Image filtering. Frequency domain. Binary images. Morphological operations. Edge detection. Line and circle detection. Feature point detection. Angle detection. Feature point matching and transformation finding (SIFT descriptor, RANSAC algorithm). Recognition - generative approach (Eigenfaces method for face recognition). Recognition - discriminative approach (Viola-Jones method for face recognition, HOG method). Bag of visual words method. Convolutional neural networks and deep learning. Camera model. Camera calibration. Epipolar geometry. Video processing (optical flow, background extraction). Body pose determination.			
Practical teaching (exercises, OFE, study and research work)	Introduction to the Python programming language and the Numpy and OpenCV libraries. Image filtering using OpenCV. Image translation and manipulation in the frequency domain. Image binarization and morphological operations in OpenCV. Detection of lines, circles and feature points using OpenCV. Matching feature points using SIFT descriptors. Finding transformations using the RANSAC algorithm. Implementation of Eigenfaces and Bag-of-Words algorithms using OpenCV. Implementation of Viola-Jones and HOG algorithms using OpenCV. Image classification using convolutional neural networks. Object detection in an image using the sliding window method. Camera calibration using OpenCV. Implementation of optical flow using OpenCV.			
Textbooks/references				
1	Richard Szelinski, Computer Vision: Algorithms and Applications, Second Edition, Springer, 2022.			
2	Joseph Howse, Joe Minichino, Learning OpenCV 4 Computer Vision with Python 3, Third Edition, Pack, 2020.			
3	Francois Chollet, Deep Learning with Python, Third Edition, Manning, 2025.			
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, independent work of students on projects.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	40	**Oral exam**	50
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	IT Project Management		
Lecturer (for lectures)	Milentijević Z. Ivan		
Lecturer/associate (for exercises)	Vojinović M. Oliver		
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduce students to the fundamental principles of project-based work organization. Provide them with hands-on experience in project planning, monitoring, and control.		
Course outcomes	Students will gain experience working in a project team during the planning phase; they understand project team organization challenges, user interactions, scheduling and budgeting, as well as risk management.		
Course outline			
Theoretical teaching	Management – characteristics and functions of IT projects. Project life cycle and product life cycle. Project management within an organizational context. The project management process: standards, process interactions. Engineering design management and project cost estimation. Scope management. Time management: defining and scheduling activities, duration and resources estimation, schedule monitoring and adjustments. Human resource management, project team structure. Communication management, collaboration and teamwork. Risk management: risk planning, identification, qualitative and quantitative analysis, response strategies, and monitoring/control. Technical support and maintenance. Current trends in IT project management.		
Practical teaching (exercises, OFE, study and research work)	Organization of team projects through planning phases. Implementation and project closure monitoring. Project definition, project types. Project objectives, alignment with portfolio. Project requirements, requirements engineering and requirements management. Feasibility studies, project initiation. Stakeholder and environmental analysis and management, KPI. Organizational structure. Project models. Project plan, structure plan, sequences. Resources, time and cost planning. Network planning. Risk management. Project implementation monitoring, quantitative progress indicators. Project closure.		
Textbooks/references			
1	Harold Kerzner: Project Management: A Systems Approach to Planning, Scheduling, and Controlling (13th Edition), Wiley (2022).		
2	Project Management Institute. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) – Fourth Edition. Project Management Institute, Inc., Pennsylvania, USA (2008).		
3	Kathy Schwalbe, Information Technology Project Management, Cengage Learning (2014).		
4	James Taylor: Managing Information Technology Projects: Applying Project Management Strategies to Software, Hardware, and Integration Initiatives, AMA (2004).		
5			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	0	0	0

Teaching methods	Lectures, practical sessions, students' work on assignments and projects.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Social, Legal and Ethical Aspects of Computer Science		
Lecturer (for lectures)	Bojkov S. Vanče, Nejković M. Valentina		
Lecturer/associate (for exercises)	Bojkov S. Vanče		
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	To familiarize students with the social and legal aspects of computer science and to develop social responsibility in relation to professional work in the field of computing and informatics.		
Course outcomes	To ensure that students understand their rights and obligations within the computing and informatics profession, and are familiar with concepts of privacy and rights protection.		
Course outline			
Theoretical teaching	Engineering ethics (IEEE Code of Ethics); Ethical codes and standards; Ethical dilemmas in software development; Patents in the IT industry; Copyright protection models in the digital age (issues with piracy and software copying). Product protection and licensing: Intellectual property rights in the IT industry (how technologies, software, and data are protected); Licensing procedures (licensing and use of software in various models — open-source, freeware, commercial software); Software industry rights: Licensing challenges and legal aspects in software development. Protection techniques and warranties; Privacy protection; Domestic and international legal regulations; Cybercrime; Types of cyberattacks; Digital forensics; Tools for digital forensics. Privacy rights and data protection, GDPR, Convention on Individual Rights on the Internet, Future legal aspects of informatics, Possible legal changes in the context of digitalization, Future legal regulations regarding emerging technologies; Ethics in artificial intelligence development.		
Practical teaching (exercises, OFE, study and research work)	Ethics in Information Technology and Data Protection. Analysis of case studies on ethical dilemmas in IT. Practical application of data protection laws (e.g., GDPR). Copyright and intellectual property. Examples of copyright infringement in digital environments. Practical exercise: Software licensing and creation of an End-User License Agreement (EULA). Cybersecurity and internet regulation. Simulation of cyberattacks and analysis of legal consequences. Exercises on legal regulations related to cybersecurity and the internet. Artificial intelligence and ethical dilemmas. Analysis of ethical issues in the application of artificial intelligence. E-business and cybercrime through examples. Practical examples of e-contracts and digital signatures. Case studies on cybercrime and legal implications. Impact of technology on the work environment and the future of legislation. Analysis of the impact of automation and artificial intelligence on the labor market. Discussion of future challenges for legislation in the IT sector. Ethics in Information Technology and Data Protection. Analysis of case studies on ethical dilemmas in artificial intelligence.		
Textbooks/references			
1	Online materials: "Software Engineering Code of Ethics and Professional Practice, http://www.acm.org/about/se-code"		
2	Denis I., Crime and the Net: An overwiev of criminal activity on the internet and legal community's reasponse, http:// www.law.ttn.edu/cyberspc/jour10.htm		
3	The Law on Copyright and Related Rights (Official Gazette of the FRY, No. 24/98), Criminal Code of Serbia (Official Gazette of the RS, No. 85/2005)		
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	0	0	0

Teaching methods	Lectures; Consultations

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Business Communications		
Lecturer (for lectures)	Bojkov S. Vanče		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The aim of the subject is to introduce future engineers of electro technology with the role of business communications in business strategy, communications aspects in business relations, communication skills, as well as with didactics principles in practical business and electronic communications.		
Course outcomes	The readiness of engineers of electro technology to organize and indipendently make decisions in contemporary corporate business with gained communicational skills with the practical application of modern technique of planning.		
Course outline			
Theoretical teaching	Basic elements of communications.Structure of communicative process. Types of communications.Communicative aspects of business relations. Basic rules and principles of business negotiations. Technique of business negotiations. Basic characteristics of business communications. Public relations. Press conference. Leadership. CV. Business etiquette. Internet and electronic business. Forms of e-commerce. Risks and safety of e-commerce. Influence of the Internet on the shaping and development of contemporary society. European law regulations for e-communication. Legal and ethical problems of commerce on the Internet. Privacy protection.		
Practical teaching (exercises, OFE, study and research work)			
Textbooks/references			
1	Guffey, M. E., & Loewy, D. (2022). *Essentials of business communication* (12th ed.). Cengage Learning.		
2	Argenti, P. A. (2021). *Corporate communication* (7th ed.). McGraw-Hill Education.		
3	Markel, M., & Selber, S. A. (2021). *Technical communication* (13th ed.). Bedford/St. Martin's.		
4	Bojkov, V. Interaction in business communication, Knowledge International Journal, Skopje, 2018., 26(36), ISSN 2545-4439, Global Impact Factor (2018) 1.822, pp. 1597-1604.		
5	Vanče Bojkov, Darjan Bojkov; E-mail as a form of businesscommunication, Journal of Process Management – New Technologies INTERNATIONAL, Ohrid, 2014, ISSN: 2334-7449 (Online) ISSN: 2334-735X (Print), page 457-459.		

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

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

Teaching methods	Lectures, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Artificial Intelligence		
Lecturer (for lectures)	Stoimenov V. Leonid, Frtunić-Gligorijević B. Milena		
Lecturer/associate (for exercises)	Frtunić-Gligorijević B. Milena, Mihajlović T. Vladan, Puflović M. Darko		
Lecturer/associate (for OFE)	Mihajlović T. Vladan, Puflović M. Darko		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory

Prerequisites	None
Course objectives	To provide students with insight into the field of artificial intelligence and basic research directions. To acquire knowledge about basic algorithms from various fields of artificial intelligence, as well as the possibility of their application in solving specific problems. To show students the possibilities of artificial intelligence programming languages and specifically, the possibilities of the selected programming language (Python or another functional language) for implementing the presented algorithms.
Course outcomes	The student will be able to understand the basic problems, possible solutions and research directions in artificial intelligence. The student will have theoretical knowledge and be able to answer the questions: what is artificial intelligence, what expert systems consist of, what is knowledge engineering and what formalisms are used to represent knowledge. The student will be able to recognize artificial intelligence problems and ways to solve them through algorithms from different areas of artificial intelligence that he has mastered. The student will be able to develop programs based on artificial intelligence techniques in Python and other programming languages.
Course outline	
Theoretical teaching	The concept of knowledge and artificial intelligence; areas of application of artificial intelligence (on examples of real systems). Artificial intelligence programming languages and their role in application development. Intelligent agents. Formal representation of problems. Problem solving and search (uninformed, blind and informed, heuristic algorithms: depth-first and breadth-first, uniform-cost search, first-best, A*, min-max, alpha-beta cutoff, etc.). Local search algorithms (Hill climbing, Simulate Annealing). Genetic algorithms - description and implementation. Constraint satisfaction problem and application examples. Definition and characteristics of knowledge; Knowledge representation: Logical models (first-order predicate logic, inference rules, logical axioms, resolution). Semantic networks. Production rules and production systems. Frameworks. Production rules and expert systems (architecture and implementation). Working in an uncertain environment. Planning. Machine learning: introductory notes. Decision trees. Neural networks and their applications. A brief overview of other areas through examples: Robotics, Speech and image recognition, Natural language processing, Games.
Practical teaching (exercises, OFE, study and research work)	Python programming language: basic language features, basic primitives, List functions. Other system and library functions. Development of user-defined functions for specific purposes. Implementation of breadth-first search, depth-first search and A* algorithms. Implementation of logic games and game algorithms (min-max, alpha-beta cutoff). Algorithms for unification and pattern matching. Implementation of a simple system with production rules. Implementation of the constraint satisfaction problem. Implementation of the ID3 decision tree. Example of using neural networks, implementation examples and use of existing environments and libraries. Implementation of the genetic algorithm. Green's and STRIPS planning methods.
Textbooks/references	
1	S. Russell, P. Norvig: Artificial Intelligence: A Modern Approach, 4th edition, Pearson, 2020. ISBN 978-0134610993.
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	1	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, independent work of students on homework and projects
Grade (maximum number of points 100)	

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

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Computer Graphics	
Lecturer (for lectures)			Rančić D. Dejan, Dimitrijević M. Aleksandar	
Lecturer/associate (for exercises)			Dimitrijević M. Aleksandar, Mihajlović T. Vladan, Ćojbašić Ž. Emilija	
Lecturer/associate (for OFE)			Mihajlović T. Vladan, Ćojbašić Ž. Emilija	
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Introduce students to the field of computer graphics and provide an overview of fundamental techniques and algorithms.			
Course outcomes	The student is able to explain and apply the basic principles, techniques, and algorithms of computer graphics, as well as to independently design and program simpler graphics applications. The student is able to implement two-dimensional rendering using the GDI API and three-dimensional rendering using the OpenGL API, using the C/C++ programming language and the Microsoft Visual Studio development environment.			
Course outline				
Theoretical teaching	Introduction to interactive computer graphics and computer graphics systems. Graphics application programming interfaces (Graphics APIs). Computer graphics hardware. Basic raster algorithms for rendering two-dimensional primitives. Filling of two-dimensional primitives. Clipping of two-dimensional primitives. Geometric transformations. Projections. 2D and 3D viewing. Hidden line and surface removal. Color models in computer graphics. Lighting and shading. The 3D graphics rendering pipeline. Modern 3D graphics application programming interfaces.			
Practical teaching (exercises, OFE, study and research work)	Introduction to two-dimensional computer graphics and the device context. Graphic objects (pens and brushes). Drawing two-dimensional primitives. Geometric transformations. Text rendering. Metafiles and bitmaps. Recap of the first part of the material and preparation for the first midterm exam. Introduction to three-dimensional graphics and OpenGL. Three-dimensional viewing. Lighting. Texturing. Recap of the second part of the material and preparation for the second midterm exam.			
Textbooks/references				
1	Foley, J., van Dam, A., Feiner, S., Hughes, J., Computer Graphics - Principles and Practice, second edition in C, Addison-Wesley Publishing Company, 1996. ISBN-13: 978-0201848403			
2	Foley, J., van Dam, A., Feiner, S., Hughes, J., Computer Graphics - Principles and Practice, third edition, Addison-Wesley Publishing Company, 2013. ISBN: 978-0321399526			
3	Marschner, S., Shirley, P. Fundamentals of Computer Graphics, 5th Edition, A K Peters/CRC Press, 2021. ISBN: 978-0367505035			
4	Yuan, F. Windows Graphics Programming: Win 32 Gdi and Directdraw, Hewlett-Packard Professional Books, Prentice Hall, 2000, ISBN: 978-0130869852			
5	Shreiner, D. OpenGL Programming Guide: The Official Guide to Learning OpenGL, Versions 3.0 and 3.1, 7th Edition, Addison-Wesley Professional, 2009, ISBN: 978-0321552624			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

Teaching methods	Lectures, practical classes, and laboratory exercises

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	30
Exercises	20	**Oral exam**	30
Colloquia	20		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Compilers		
Lecturer (for lectures)	Stojković R. Suzana		
Lecturer/associate (for exercises)	Marković M. Ivica, Đorđević D. Nikola		
Lecturer/associate (for OFE)	Marković M. Ivica, Đorđević D. Nikola		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The objectives of this course are to educate the students in th different phases of a compiler: lexical analysis, syntax and semantic analysis, interidiate code generation, optimization techniques and output code generation. Enable them to utilize compiler construction tools in the process of building a compiler.		
Course outcomes	By the end of the course, students will: gain an understanding of how compilers translate source code to machine executable, utilize tools to automate compiler construction, have the knowledge to design, implement, and test a compiler for a simple language.		
Course outline			
Theoretical teaching	Formal languages and formal grammars. Automata for language recognizing: Turing machine, pushdown automata and finite automata. Lexical analysis. Top-down and bottom-up parsing algorithms. LL(k) grammars. Operator precedence grammars and precedence grammars. LR grammars. Semanic analysis and atribute grammars. Intermediate codes: abstract syntax tree and three-address code. Machine dependent and machine independent code optimization. Code generation. Runtime memory management.		
Practical teaching (exercises, OFE, study and research work)	Formal grammars. Finite automata and regular expressions. Lexical analysis. jflex - scanner genrator. Top-down parsing algorithms. LL(1) grammars. Bottom-up parsig algorithms. LR grammars. CUP - parser generator. Symbol tables. Attributes of the symbols in cup specification. Intermidiate code generation. Code generation. Code generation for procedure calling when stack memory allocation strategy is used.		
Textbooks/references			
1	A. V. Aho, M. S. Lam, R. Sethi, J. D. Ullman: Compilers, Principles, Techniques, and Tool, Addison-Wesley, 2-nd edition 2006.		
2	D. Grune, K. van Reeuwijk, H. Bal, C. J. H. Jacobs, K. Langendoen: Modern Compiler design, 2nd edition, Elsevier, 2012.		
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	0	0

Teaching methods	Lectures, auditive excercises, lab practicing

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Multimedia Systems		
Lecturer (for lectures)		Janković S. Dragan, Rajković J. Petar		
Lecturer/associate (for exercises)		Rajković J. Petar, Jovanović D. Martin		
Lecturer/associate (for OFE)		Jovanović D. Martin		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Introduction to the concept of multimedia systems, basic features and elements of the media, classifications, and multimedia systems design.			
Course outcomes	After completion of course students should fully understand all elements that make multimedia systems with special emphasis on the types of media, removable media, media file formats, compression techniques, standards, types of multimedia systems and applications.			
Course outline				
Theoretical teaching	Introduction and overview of the media. The requirements of multimedia processing. Network protocols for multimedia and streaming information. Formats for audio, text, and smooth moving picture. Methods for image, audio and video compression. The complete MPEG-4 standard for multimedia. Other MPEG standards. Protection of multimedia content and methods for wathermarking. Types of multimedia systems and applications (e.g. video conferencing, learning on demand). Multimedia systems architecture. Performance of multimedia systems. Mobile multimedia systems. Perspectives on the development of multimedia systems..			
Practical teaching (exercises, OFE, study and research work)	Auditory, demonstrations and laboratory exercises: work with a variety of media formats, compression algorithms, design of multimedia system, demonstration and evaluation of the quality of videoconferencing by changing the connection parameters.			
Textbooks/references				
1	Ze-Nian Li, Mark Drew, Fundamentals of Multimedia, Prentice-Hall, 2004.			
2	Jennifer Coleman Dowling, Multimedia demystified, McGraw Hill, 2012.			
3	Tay Vaughan, Multimedia making it work, 8th ed, McGraw Hill, 2011.			
4	Li, ZN., Drew, M.S., Liu, J., Introduction to Multimedia. In: Fundamentals of Multimedia. Texts in Computer Science. Springer, Cham., 2021. https://doi.org/10.1007/978-3-030-62124-7_1			
5	Rajeev Tiwari, Neelam Duhan, Mamta Mittal, Abhineet Anand, Muhammad Attique Khan, Multimedia Computing Systems and Virtual Reality, CRC Press, 2022.			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

Teaching methods	Lectures, Exercises, Laboratory Exercises

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	30
Exercises	20	**Oral exam**	20
Colloquia	30		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Information Technologies and Systems		
Lecturer (for lectures)		Tošić B. Milorad		
Lecturer/associate (for exercises)		Nejković M. Valentina		
Lecturer/associate (for OFE)		Nejković M. Valentina		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Acquisition of practical knowledge and skills in the application of information technology for the improvement of business and other systems.			
Course outcomes	A systematic approach to the application of information technologies necessary for the successful development and programming of complex information systems has been developed and adopted. Practical skills required for programming components and technologies in modern information systems have been acquired.			
Course outline				
Theoretical teaching	Introduction. A brief overview of the application of information systems. Informatics, Information Technologies. Information system platforms. Platform-based development. Service bus. Service orientation. Distributed platforms, Mobile platforms, Web platforms, Cloud computing. IT infrastructure programming. Network services. Services for data processing and storage. Messaging services. Agile methodologies. Scrum, Agile management. Information and data management. Business intelligence. Working with big data. Semantic systems. Development of collaborative and mobile robotic applications. Collective intelligence. Programming systems with intelligent agents. Information systems applying artificial intelligence. Automated reasoning and symbolic inference. Large language models.			
Practical teaching (exercises, OFE, study and research work)	Reactive programming in Java. Containerization and Docker. Microservices development. Container orchestration. Docker Swarm and Kubernetes. Infrastructure as Code. DevOps tools and continuous integration. Blockchain. Smart contracts. Examples of Solidity smart contracts on the Ethereum platform. Development of educational web platforms. Frontend and backend development for web applications. Computer vision in information systems. PyTorch library for implementing computer vision services. Traditional machine learning in information systems. Libraries in Java and Python programming languages. Ontology development. RDF standard and SPARQL queries. Application of ontologies in bioinformatics. Bioinformatics ontologies, tools, and services. Application of generative artificial intelligence. Large language models. Multimodal summarization. Basics of ROS (Robot Operating System). Integration of robots in information systems.			
Textbooks/references				
1	Serles, Umutcan, and Dieter Fensel. An Introduction to Knowledge Graphs. Springer, 2024.			
2	Arp, Robert, Barry Smith, and Andrew D. Spear. Building ontologies with basic formal ontology. Mit Press, 2015.			
3	Albrecht, Stefano V., Filippos Christianos, and Lukas Schäfer. Multi-agent reinforcement learning: Foundations and modern approaches. MIT Press, 2024.			
4	Soldatos, John. Artificial intelligence in manufacturing: enabling intelligent, flexible and cost-effective production through AI. Springer Nature, 2024.			
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, independent work of students on homework and projects

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	50	**Oral exam**	40
Colloquia			
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Internet of Things and Services	
Lecturer (for lectures)			Stojanović H. Dragan, Stojanović M. Natalija	
Lecturer/associate (for exercises)			Stojnev Ilić I. Aleksandra	
Lecturer/associate (for OFE)			Stojnev Ilić I. Aleksandra	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Mastering the knowledge necessary for the development of large-scale distributed software systems and Internet of Things (IoT) applications on the distributed infrastructure of the edge-fog-cloud computing continuum, based on methods and technologies of service-oriented computing and microservices.			
Course outcomes	Upon successful completion of the course, the student understands the principles of developing large-scale distributed software systems and IoT applications in edge–fog–cloud computing environments. The student is able to explain and apply service-oriented and microservice architectures, including communication models such as REST, gRPC, and related technologies. The student is capable of designing and implementing microservice-based IoT systems with synchronous and asynchronous, event-driven communication using message brokers. The student understands and applies technologies for containerization, serverless computing, orchestration, and monitoring of distributed microservice systems. Through practical work, the student is able to develop and analyze IoT microservice systems that process and integrate large-scale data streams in modern smart environments.			
Course outline				
Theoretical teaching	Introduction to the Internet of Things (IoT) and Large-Scale Distributed Software Systems IoT — architecture, technologies, and communication protocols. SOA concepts and technologies, “Everything-as-a-Service” (XaaS). Web services and synchronous communication: SOAP, REST/OpenAPI, gRPC, GraphQL. Microservices and microservice architecture. Reactive microservices, asynchronous message-based communication, and event-driven architecture. Patterns for developing microservice systems and service mesh. IoT services on edge and fog infrastructure. IoT platforms and cloud services. Virtualization and containers in microservice development and deployment. Serverless computing, Function-as-a-Service (FaaS). Microservice orchestration, monitoring, and adaptation. Processing and analysis of large data streams in IoT microservice systems. Development of modern IoT microservice software systems in smart environments, including smart cities, traffic management, healthcare, industry, and agriculture.			
Practical teaching (exercises, OFE, study and research work)	Introduction to technologies for developing IoT systems as large-scale distributed systems. Development of Web services using SOAP and REST/OpenAPI. Synchronous Web service communication using the gRPC protocol and GraphQL. Design of microservice architectures. Development of reactive microservices with asynchronous communication using message exchange and message brokers (MQTT broker, NATS, Kafka, etc.). Application of design patterns in microservice system development. Implementation of IoT microservices at the edge and in the fog. Deployment of IoT services in the cloud in the context of IoT microservice system development. Implementation and deployment of IoT microservices through container-based virtualization (Docker). Implementation of IoT microservices using Function-as-a-Service (FaaS) technologies. Microservice orchestration using the Kubernetes platform. Implementation of monitoring and adaptation in IoT microservice systems. Processing and analysis of large data streams in IoT microservice systems (Pulsar, Flink, Spark, Kafka Streams). Implementation of modern IoT microservice systems using the above-mentioned platforms, technologies, and tools.			
Textbooks/references				
1	Perry Lea, IoT and Edge Computing for Architects, 2nd Edition, Packt Publishing, 2020			
2	Sam Newman, Building Microservices: Designing Fine-Grained Systems, O'Reilly Media; 2nd edition, 2021			
3	Ronnie Mitra and Irakli Nadareishvili, Microservices: Up and Running, O'Reilly Media, 2021.			
4	Milan Milenkovic, Internet of Things: Concepts and System Design, Springer, 2020			
5	Morgan Bruce, Paulo A Pereira, Microservices in Action, Manning Publications, 2019.			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, auditory and laboratory exercises, independent student work on assignments and projects, student seminars.		
Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	40
Exercises	20	**Oral exam**	
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microcomputer-Based Measurement Systems		
Lecturer (for lectures)	Jovanović R. Jelena, Živanović B. Dragan		
Lecturer/associate (for exercises)	Jovanović R. Jelena		
Lecturer/associate (for OFE)	Jovanović R. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introducing students to hardware design and the development of real-time data acquisition systems based on the C, C++, and Java programming languages. Understanding and implementing functional interactions between software and hardware peripherals. Implementation of systems for real-time operation.		
Course outcomes	Upon successful completion of the course, the student will be able to: analyze and select appropriate analog and digital sensors for different measurement system applications; apply signal conditioning methods and analog-to-digital conversion techniques in the process of measurement data acquisition; design and implement microcomputer-based real-time data acquisition systems using Arduino and Raspberry Pi platforms; develop and optimize software solutions in C, C++, and Java programming languages for hardware control and data acquisition; apply appropriate communication interfaces for connecting sensors and peripheral devices; integrate systems for measurement data collection, storage, processing, and visualization using Cloud services; test and evaluate the performance of implemented microcomputer-based measurement systems.		
Course outline			
Theoretical teaching	Analog sensors; Signal conditioning and A/D conversion; Digital sensors; Types of data transmission; Arduino microcontrollers and interfacing with sensors and additional electronics (shields); Types of communication interfaces between Arduino microcontrollers and sensors; Raspberry Pi microcomputers and their application in the development of real-time data acquisition systems; Raspberry Pi hardware; Raspberry Pi software; Connecting peripherals to the Raspberry Pi microcomputer; C, C++ and Java programming on the Raspberry Pi microcomputer; General Purpose Input/Outputs (GPIO); Enhancing input/output interfaces on the Raspberry Pi microcomputer; Real-time measurement data acquisition using Raspberry Pi microcomputers and Arduino microcontrollers; Raspberry Pi microcomputer as an IoT sensor and web server.		
Practical teaching (exercises, OFE, study and research work)	The practical training includes the design and software implementation of modern measurement and data acquisition systems based on Arduino microcontroller and Raspberry Pi microcomputer platforms. Through laboratory exercises in C, C++, and Java, students master methods of connecting analog and digital sensors for measuring physical quantities such as temperature, pressure, humidity, distance, and gas concentration, with the use of external A/D converters. Special emphasis is placed on actuator control, the use of RFID technology, implementation of communication protocols such as I2C, SPI, and serial interfaces, as well as data visualization on LCD, OLED, and LED displays. By the end of the course, students are trained to integrate complete devices into IoT systems based on Cloud platforms such as ThingSpeak, enabling real-time remote monitoring and data storage. The practical work is rounded off through testing and analysis of the performance of implemented systems within laboratory and project assignments.		
Textbooks/references			
1	V. Ziemann, "A Hands-On Course in Sensors Using the Arduino and Raspberry Pi", 2nd Edition, CRC Press, Boca Raton, USA, 2023.		
2	C. Bell, "Beginning IoT Projects: Breadboard-less Electronic Projects", Apress, Berkeley, USA, 2021.		
3	G. R. Kanagachidambaresan, "Internet of Things Using Single Board Computers: Principles of IoT and Python Programming", Apress, Berkeley, USA, 2022.		
4	S. Chin, J. L. Weaver, "Raspberry Pi with Java, Programming the Internet of Things (IoT) ", McGraw-Hill Education, New York, USA, 2016.		
5	R. Singh, A. Gehlot, L. R. Gupta, B. Singh, M. Swain, "Internet of Things with Raspberry Pi and Arduino", United States: CRC Press, 2019.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures; Computational exercises; Laboratory exercises; Consultations; Project task implementation.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	15	**Oral exam**	10
Colloquia	40		
Projects	10		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Data and Knowledge engineering		
Lecturer (for lectures)	Stoimenov V. Leonid, Stanimirović S. Aleksandar		
Lecturer/associate (for exercises)	Frtunić-Gligorijević B. Milena		
Lecturer/associate (for OFE)	Frtunić-Gligorijević B. Milena		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	None
Course objectives	The goal of the course is for students to acquire knowledge about the fundamental principles of data and knowledge engineering, as well as data science and techniques for data processing. Through instruction, students will understand the importance of data collection, storage, and analysis, along with various models and approaches for creating and managing data warehouses. Special focus will be placed on knowledge representation and discovery, as well as the application of knowledge in decision-making. In addition to traditional relational databases, modern data warehousing systems will be covered, enabling students to understand current trends and challenges in this field.
Course outcomes	Upon successful completion of the course, the student is able to analyze and model data storage and processing systems, design data warehouses and ETL/ELT processes, apply methods for data integration, processing, and large-scale data analytics, utilize modern tools and platforms for data engineering and knowledge discovery, and assess the quality and applicability of the obtained results in real-world applications.
Course outline	
Theoretical teaching	Introduction to data engineering and data science. Data processing, storage, and analysis. Tools and technologies for data processing in various environments. Architectures and models of data warehouses. Traditional data warehouse models and their applications. Dimensional modeling. Modern approaches to data storage (Data Lake, Data Vault). OLTP, OLAP, and HTAP. Big Data technologies and architectures. Implementation and management of data warehouses. ETL and ELT processes. Modern trends in data management. Distributed data processing systems. Knowledge discovery from data and predictive analytics. Architecture of knowledge discovery systems. Techniques for data preprocessing. Machine learning techniques for data analysis: classification, regression, clustering, and data segmentation. Modern applications for knowledge discovery.
Practical teaching (exercises, OFE, study and research work)	Dimensional modeling. Implementation of data warehousing systems. Using modern tools for implementing ETL processes and creating data warehouses – example: Apache NiFi. Using modern tools for utilizing data warehouses and creating Data Cubes – example: Microsoft Power BI. Real-time data processing. Using modern environments for real-time data processing – example: Apache Spark Structured Streaming. Using modern tools for implementing ELT processes – example: Apache Spark Structured Streaming. Using modern tools for creating data warehouses – example: Google BigQuery. Introduction to and implementation of algorithms and approaches for knowledge discovery – example: Weka Machine Learning Workbench. Application of data preprocessing techniques: cleaning, normalization, and transformation. Imputation of missing values and anomaly detection. Data balancing. Application of classification and regression algorithms. Application of clustering and segmentation algorithms. Designing knowledge discovery systems. Examples of knowledge discovery systems in semi-structured and unstructured data (text, multimedia data, etc.).
Textbooks/references	
1	M. Kleppmann, Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, O'Reilly Media, 2017, ISBN: 978-1449373320
2	W. H. Inmon, Building the Data Warehouse, 5th Edition, Wiley, 2016.
3	R. Kimball, M. Ross, The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, 3rd edition, Wiley, 2013
4	H. Karau, R. Warren, Learning Spark: Lightning-Fast Data Analytics, 2nd Edition, O'Reilly Media, 2020.
5	J. Han, M. Kamber, J. Pei, Data Mining: Concepts and Techniques, 4th edition, Morgan Kaufmann, 2022

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures, whiteboard exercises, lab exercises, independent student work on homework assignments and projects, student seminars (presentations of student work followed by discussions).

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	30	**Oral exam**	30
Colloquia			
Projects	30		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Machine Intelligence in Logic Games		
Lecturer (for lectures)	Vučković V. Vladan		
Lecturer/associate (for exercises)	Veljanovski D. Aleksandar		
Lecturer/associate (for OFE)	Veljanovski D. Aleksandar		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Mastering basic artificial intelligence techniques and algorithms used in logic games, as well as techniques for their application in the implementation of various logic games.		
Course outcomes	Students' ability to understand the principles of operation of machines and programs that autonomously play logic games, as well as the application of basic methods of mathematical game theory and artificial intelligence in the development of realistic algorithms and procedures.		
Course outline			
Theoretical teaching	Mathematical basis of games. Basic algorithms of logic games. Combinatorial explosion. Forward-pruning technique. Analysis of basic algorithms for processing trees in logic games. Alpha-Beta, PVS-NegaScout, Null-Move. Algorithms for processing terminal positions in a tree. Auxiliary procedures and heuristics. Principles of parallelization of logic algorithms on multiple cores – Multithreading. Zobrist-hash system. Construction of the evaluation function. Incorporation of heuristic knowledge into the evaluation function. Automatic adjustment of evaluation parameters. Client-Server architecture as the basis for implementing logic games on the Internet. Examples and analysis of systems for remote playing of logic games (facebook games, playchess server). Application of machine learning principles in logic games - training the database of opening chess programs.		
Practical teaching (exercises, OFE, study and research work)	Topic 1: Throughout the course, theoretical principles will be applied in the implementation of some simpler logic games or segments of more complex logic games. An application that plays a logic game will be gradually developed. Topic 2: Choosing a data structure. Organizing matrix and bitboard data structures. Methods of encoding moves. Topic 3: Construction of a move generator. Experiments with generating a list of moves based on different positions. Topic 4: Decision tree and machine stack as basic structures for implementing a logic game. Connection with data structure (from topics 2 and 3). Topic 5: Selection of algorithms for tree processing. Implementation of a simple minimax algorithm that processes the tree constructed in topic 4. Topic 6: Extension of the minimax algorithm from topic 5 to alpha-beta. Principles of operation of the alpha-beta algorithm and performance comparison with the basic minimax algorithm from topic 5. Topic 7: Extension of alpha-beta algorithm to PVS. Comparison of two algorithms. Topic 8: Implementation of transposition table and connection with Alpha-Beta-PVS algorithm. Addition of history heuristic. Adjustment of specific weights of moves in the list for maximum performance increase compared to algorithms that do not use tables. Topic 9: Extension of the algorithm from topic 8 to null-move. Comparison of the r=2 and r=3 variants of the algorithm. Comparison with basic algorithms. Topic 10: Evaluation function as a central function of a logic game. Construction and basic functional units. The importance of machine learning in automatic training and tuning of evaluation function parameters. Adding evaluation to the null-move algorithm. Topic 11: Development or adaptation of a simple graphical user interface (GUI) and connection to the developed engine model (from Topic 10). Topic 12: Completion of all components of the logic game developed in topics 1-11. Testing of the final application. Possibilities for further development through the implementation of database opening and connection to Internet servers.		
Textbooks/references			
1	Dixit A., and Skeath S., Games of Strategy, 2nd edition, Norton, New York, 2004.		
2	Lsat Logic Games, Robert Webking, Clayton Holland, Jerry McLain, Daniel Avelar, Research & Education Assoc., 2005. ISBN 073860111X, 9780738601113		
3	Chess Skill in Man and Machine edited by Peter W. Frey, Springer, New York 1977, 1978 ISBN: 0-387-07957-2, ISBN: 0-387-90815-3 2nd Edition 1983, ISBN: 0-387-90790-4 / 3-540-90790-4.		

4	R. Duncan Luce and Howard Raiffa, Games and Decisions: Introduction and Critical Survey, Dover Books on Mathematics, Courier Corporation, 1989.
5	Johan van Benthem and Fernando R. Velazquez Quesada, Logic in Games, DOI: https://doi.org/10.7551/mitpress/9674.001.0001, The MIT Press, 2014.

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

Teaching methods	Lectures, blackboard exercises, laboratory exercises, independent student work on homework and projects, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	40
Colloquia	30		
Projects	10		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Information Retrieval		
Lecturer (for lectures)	Stojković R. Suzana		
Lecturer/associate (for exercises)	Marković M. Ivica		
Lecturer/associate (for OFE)	Marković M. Ivica		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The goal of this course is to introduce students to information retrieval systems (their architecture, structures of the data used for the representation of documents and queries, and algorithms for manipulating the structures).		
Course outcomes	After completing this course, students should should be able to: explain the fundamental principles and architecture of information retrieval systems, analyze and evaluate the effectiveness of keyword-based and neural retrieval models, design and implement search systems for web and other types of unstructured data, apply open-source information retrieval frameworks and libraries to develop and evaluate search applications.		
Course outline			
Theoretical teaching	Information retrieval definition. The components of the information retrieval system. Boolean retrieval model. Inverted index. Tokenization, word normalization (stemming and lematization). Algorithms for inverted index generation. Inverted index compresion. Vector retrieval model. Measures of importance of a word in a document: term frequency, normalized term frequency, tf-idf. Methods for search algorithm optimization in vector retrieval model. BM25 algorithm. Semantic (neural) and hybrid search. Evaluation of information retrieval systems. Basics of web search. Web crawling. Link analysis, page rank and HITs algorithms. Page ranking using machine learning algorithms.		
Practical teaching (exercises, OFE, study and research work)	Lucene - installation and creation of indexing and retrieval projects. Implementing an application for indexing. Structure of Lucene's inverted index, Luke application. Implementing a retrieval application using the query object model, and built-in parser. Different query types: Boolean queries, wildcard queries, range queries, phrase queries. Retrieval of numeric data with Lucene. Ranked retrieval: tf-idf and BM25 scoring. Parsing different document types with Tika. Development of Information retrieval system using Solr. Development of an information retrieval system using ElasticSearch. Implementing neural search: creating document ebedding vectors using the BERT SentenceTransformer.		
Textbooks/references			
1	C. D. Manning, P. Raghavan, H. Schutze: An Introduction to Information Retrieval, Cambridge University Press, Cambridge, England, 2009.		
2	S. Buttcher, C. L. A. Clarke, G.V. Cormack: Information Retrieval: Implementing and Evaluating Search Engines, MIT Press, 2016.		
3	T. Grainger, D. Turnbull, M. Irwin: AI-Powered Search, Manning Publications, 2025.		
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	0	0

Teaching methods	Lectures, demonstration exercises, individual laboratory exercises

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Computer Science and Informatics	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Methods and Systems for Signal Processing	
Lecturer (for lectures)			Radmanović M. Miloš	
Lecturer/associate (for exercises)			Radmanović M. Miloš	
Lecturer/associate (for OFE)			Petrović N. Nenad	
Number of ECTS	5		**Course status (obligatory/elective)**	Elective
Prerequisites	None			
Course objectives	Mastering the knowledge and principles of digital signal processing and the possibilities of their application in solving practical problems.			
Course outcomes	Students are introduced to the methodology for digital signal processing and are able to independently solve problems and implement applications in this field.			
Course outline				
Theoretical teaching	1. Introduction to error-correcting codes and data compression, 2. Error correction using BCH code, 3. Error correction using Reed-Solomon code, 4. Error correction using Golay code, 5. Error correction using CRC code, 6. Data compression using Golomb coding, 7. Data compression using Shannon-Fano coding, 8. Data compression using LZ77 coding, 9. Data compression using arithmetic coding, 10. Image compression, 11. Video compression, 12. Audio compression, 13. Other compression methods.			
Practical teaching (exercises, OFE, study and research work)	Project development includes a review of the theoretical basis of the problem, as well as the appropriate practical implementation of signal processing methods and systems in the C/C++ programming language. Demonstration exercises: 1. Error correction using BCH code, 2. Error correction using Reed-Solomon code, 3. Error correction using Golay code, 4. Error correction using CRC code, 5. Data compression using Golomb coding, 6. Data compression using Shannon-Fano coding, 7. Data compression using LZ77 coding, 8. Data compression using arithmetic coding, 9. Image compression, 10. Video compression, 11. Audio compression, 12. Preparation for project development.			
Textbooks/references				
1	Moon, T. K., Error Correction Coding - Mathematical Methods and Algorithms, John Wiley & Sons, 2005.			
2	Solomon, D., Data Compression - The Complete Reference, Springer, 2004.			
3	Carrasco, R., Johnston, M., Non-Binary Error Control Coding for Wireless Communication and Data Storage, John Wiley & Sons, 2008.			
4	Stankovic, R. S., Moraga, C., Astola, J. Fourier Analysis On Finite Groups With Applications In Signal Processing And System Design, John Wiley And Sons Ltd, 2005.			
5	Material on the website: http://cs.elfak.ni.ac.rs/nastava/			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures and demonstration exercises using slides and demo examples. Project development using the C/C++ environment. Independent study work on project preparation and development.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microcontroller-Based Systems		
Lecturer (for lectures)	Marjanović B. Miloš, Danković M. Danijel		
Lecturer/associate (for exercises)	Marjanović B. Miloš, Mitrović I. Nikola		
Lecturer/associate (for OFE)	Mitrović I. Nikola		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The course objectives are defined so that the student will: become familiar with microcontroller architectures (PIC, AVR, ARM, RISC-V) and various hardware and software development environments (Arduino, STM32 Nucleo, Arduino IDE, Cube MX, Keil uVision); understand the principles of designing and implementing microcontroller-based systems, including working with various peripheral units (GPIO, UART, ADC, timers) and communication interfaces (I2C, SPI); develop skills in the practical application of microcontrollers, as well as in using various electronic components and modules (LEDs, buttons, displays, motors, sensors); learn how to connect and configure microcontrollers.		
Course outcomes	The learning outcomes specific to the course are defined so that the student will: know microcontroller architectures and various hardware and software development platforms; understand and apply microcontroller peripheral units such as GPIO, UART, ADC, timers, and communication interfaces (I2C, SPI); be capable of independently designing, implementing, and testing microcontroller-based systems, including working with various electronic components and modules.		
Course outline			
Theoretical teaching	Microcontroller architectures. Hardware development environments. Software development environments. Prototyping microcontroller-based systems (using breadboards, laboratory power supplies, oscilloscopes). Working with general-purpose pins (using buttons, LEDs). Working with the UART peripheral (communication between microcontroller and computer). Working with timers (interrupts, pulse-width modulation). Working with ADC (analog-to-digital converter). Working with the I2C communication interface and its applications. Working with the SPI communication interface and its applications. Creating and using libraries (e.g., for display usage).		
Practical teaching (exercises, OFE, study and research work)	Practical connection of electronic components in a microcontroller-based system, writing and compiling corresponding microcontroller software, and practical demonstration of the system operation through exercises: LED control, working with buttons, data transfer between the microcontroller and the computer, interrupts (using RGB and servo motors), analog-to-digital conversion (using potentiometers, measuring physical quantities), use of hardware modules communicating via I2C and SPI protocols, working with displays. Practical classes are conducted in the laboratory, where students complete tasks independently and in teams.		
Textbooks/references			
1	Dimosthenis E. Bolanakis, Microcontroller Prototypes with Arduino and a 3D Printer, Wiley, 2021.		
2	Ying Bai, „Practical Microcontroller Engineering with ARM Technology“, Wiley, 2016.		
3	Bert van Dam, „Microcontroller Systems Engineering: 45 Projects for PIC, AVR and ARM“, Elektor Electronics Publishing, 2009.		
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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	0	0

Teaching methods	Theoretical lectures. Practical exercises. Independent and team work by students through homework assignments and a final project. Consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Stochastic processes and modeling		
Lecturer (for lectures)	Džunić S. Jovana		
Lecturer/associate (for exercises)	Džunić S. Jovana		
Lecturer/associate (for OFE)	Stanković M. Hranislav		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	Probability and statistics		
Course objectives	The aim of the course is for students to acquire theoretical and practical knowledge in the field of multidimensional random variables and stochastic processes, with an emphasis on applications in data analysis, artificial intelligence, and machine learning. Through the integration of theoretical teaching and practical work in the Python environment (Jupyter Notebook), students will master fundamental techniques of modeling, simulation, and inference, using modern stochastic models such as Markov chains, Gaussian processes, hidden Markov models, GMMs, and Monte Carlo methods.		
Course outcomes	The outcome of the course is for students to gain an understanding of multidimensional random variables and stochastic processes, as well as the ability to apply this knowledge in data analysis and solving concrete problems. Upon completion of the course, students will be qualified to formally describe and analyze basic stochastic models. They will be able to use Python and the Jupyter Notebook environment for algorithm implementation, simulation, visualization, and data analysis. Additionally, they will develop critical thinking skills in selecting and applying appropriate methods.		
Course outline			
Theoretical teaching	Multidimensional random variables, joint and marginal distributions, correlation and covariance. Multidimensional normal distribution. Introduction to stochastic processes with examples of applications in artificial intelligence and data analysis. Markov chains: definition, properties, stationary and limiting distributions, applications and algorithms, simulation. Poisson processes: definition, properties, and models in queueing theory. Gaussian processes, kernel methods, and applications in regression and data modeling. Gaussian mixture models and the EM algorithm. Hidden Markov models, Viterbi and Baum-Welch algorithms. Monte Carlo methods, simulations, and applications. Stochastic graphical models including Bayesian and Markov networks and basic inference algorithms.		
Practical teaching (exercises, OFE, study and research work)	Practical teaching includes computational exercises and computer-based exercises focused on the application of the Python software package in the Jupyter Notebook environment. Through weekly assignments (mandatory weekly homework), students systematically work through key concepts from lectures and acquire skills in implementing and applying stochastic models. The emphasis is on developing practical skills needed to solve real-world problems in the fields of artificial intelligence, machine learning, data analysis, and networks.		
Textbooks/references			
1	S. M. Ross, Introduction to Probability Models, Academic Press, 2010		
2	Murphy, Machine Learning: A Probabilistic Perspective, The MIT Press, 2012		
3	D. Koller, N. Friedman, Probabilistic Graphical Models, The MIT Press, 2009		
4	Relevant research papers and tutorials in the fields of AI, data analysis, and network analysis.		
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	0	0

Teaching methods	Lectures. Calculation exercises. Computer-based exercises. Project-based learning.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures		Written exam	
Exercises		Oral exam	40
Colloquia			
Projects	60		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Distributed Systems		
Lecturer (for lectures)	Milovanović I. Emina, Stojanović M. Natalija		
Lecturer/associate (for exercises)	Veljanovski D. Aleksandar, Drašković S. Vukadin, Stojnev Ilić I. Aleksandra		
Lecturer/associate (for OFE)	Veljanovski D. Aleksandar, Drašković S. Vukadin, Stojnev Ilić I. Aleksandra		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The course focuses on the fundamentals of distributed systems. It mainly concentrates on the layer of software that needs to be built on top of computer networks to enable the development of distributed applications.		
Course outcomes	Students will learn the core concepts underlying distributed systems designs. They will understand the system constraints, trade-offs and techniques in distributed systems to best serve the computing needs for different types of data and applications. Examine state-of-the-art distributed systems, such as Google File System. Design and implement simple distributed systems.		
Course outline			
Theoretical teaching	Introduction. Design goals of distributed systems (DS). Taxonomy and examples of DS. DS architecture. Symmetric (peer-to-peer) and hybrid (cloud, fog, edge, blockchain) DS architectures. Middleware models. Processes, threads and virtualization in DS. Communication in DS. Remote procedure calls (Sun RPC, DCE, gRPC). Remote object calls. (Java RMI). Message-based communication. Message queue systems. Publish/subscribe messaging systems. JMS. Message brokers. Naming in DS. Synchronization. Synchronization of physical clocks. NTP protocol. Logical clocks. Election algorithms. Mutual exclusion. Distributed transactions. Consistency and replication. Consistency models. Protocols. Fault tolerance. Reliable client-server communication. Reliable group communication. Distributed file system. Google DFS. Hadoop DFS.		
Practical teaching (exercises, OFE, study and research work)	The exercises follow the lecture programm in full. Topics include programming with gRPC, Java RMI; MPI file functions; parallel I/O; WCF (Windows Communication Foundation). A cycle of 5 laboratory exercises is also planned.		
Textbooks/references			
1	Maarten van Steen, Andrew S. Tanenbaum, Distributed Systems, fourth edition, 2023		
2	G. Coulouris, J. Dollimore, T. Kindberg , G. Blair, Distributed Systems: Concepts and Design, 5th Edition, Pearson, 2012.		
3	Leraning material available at https://cs.elfak.ni.ac.rs/nastava/course/view.php?id=155		
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	0	0

Teaching methods	Lectures, exercises, laboratory exercises.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Computer Science and Informatics		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Computer Science Seminar		
Lecturer (for lectures)	Stojanović H. Dragan, Milentijević Z. Ivan, Stojanović M. Natalija		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)	Stojanović M. Natalija		
Number of ECTS	4	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Familiarization with the rules and procedure for completing the final thesis, as well as with the objectives, structure, and presentation of the final thesis.		
Course outcomes	Upon completion of this course, the student should have a prepared final thesis proposal. After completing the course, students will be able to precisely formulate a project assignment, write a functional specification, independently develop a medium-sized software project, and write the corresponding documentation. Students will also acquire the necessary knowledge to present their results in the required final thesis format and to adequately demonstrate their work through an oral presentation.		
Course outline			
Theoretical teaching	The concept of the final thesis. The format of the final thesis and the requirements it must meet. Current topics in computer science, software engineering, and related disciplines from which final theses can be selected. Selection and types of possible topics. Development of an original project, a survey paper with comparative analysis and evaluation. Planning and writing a functional specification and report. Literature search and proper referencing methods. The concept of plagiarism. Presentation of quantitative results and different types of diagrams. Preparation and delivery of the oral presentation. Potential elements of the final thesis for further research and publication.		
Practical teaching (exercises, OFE, study and research work)	Exercises are not planned; instead, students independently work on their final thesis based on the knowledge acquired. ECTS credits for the course are awarded upon submission of the final thesis.		
Textbooks/references			
1	Regulations on Undergraduate Academic Studies, Faculty of Electronic Engineering, University of Niš, 2024, and the Appendix concerning the format and guidelines for the preparation of the final thesis.		
2	K. Wiegers, More About Software Requirements: Thorny Issues and Practical Advice, Microsoft Press, 2003.		
3	Milutinovic, V., "A good method to prepare and use transparencies for research presentations," TCCA Newsletter, March 1997		
4	Filipi Matutinović, S., Scientific Information in Serbia – Flow, Availability, Evaluation, 2nd edition, October 2013.		
5	Clements, Paul, et al. Documenting software architectures: views and beyond. Pearson Education, 2002.		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
4	0	1	0	0

Teaching methods	Lectures are given ex-cathedra using modern teaching methods, with the aim of presenting students with solutions to various technical problems that introduce them to problem-solving techniques from software engineering practice. If necessary, part of the lecture is also given in the computer lab through demonstrations of the operation of certain software.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	30
Exercises		**Oral exam**	
Colloquia			
Projects	70		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electron Devices and Microsystems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Fundamentals of Object Oriented Programming	
Lecturer (for lectures)			Stojković R. Suzana	
Lecturer/associate (for exercises)			Marković M. Ivica, Đorđević D. Nikola	
Lecturer/associate (for OFE)			Marković M. Ivica, Đorđević D. Nikola	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	None			
Course objectives	Understanding the principles of object oriented paradigm in programming. Learning C++ as a representative object oriented language.			
Course outcomes	Upon completion of the course, students will be able to explain the principles of object-oriented programming, design object-oriented software solutions, and implement them in the C++ programming language.			
Course outline				
Theoretical teaching	Object-oriented programming paradigm. Class definition, attributes, methods, class member access. Inline functions. Static class members. Constructors. Destructors. Friend classes and functions. Operator overloading. Inheritance. Polymorphism, virtual functions. Pure virtual functions and abstract classes. Input and output streams. Template functions and template classes. Exception handling. Exception throwing. Exception catching. Namespaces. Standard class library.			
Practical teaching (exercises, OFE, study and research work)	Structural data types in C: arrays and structures. References, pointers, dynamic memory allocation in C++. Parameter passing in C++. Class definition, creation and use of objects. Inline functions. Statical class members. Constructors and destructors. Operator functions as class members. Global operator functions. Inheritance. Virtual methods. Pure virtual methods and abstract classes. File handling in C++: file openning, reading from a file, writing to a file, file closing.			
Textbooks/references				
1	B. Stroustrup: Programming: Principles and Practice Using C++. 2nd ed. Boston, MA: Addison-Wesley, 2014.			
2	B. Stroustrup: The C++ Programming Language. 4th ed. Boston, MA: Addison-Wesley, 2013.			
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	0	0

Teaching methods	Lectures, auditive excercises, lab practicing

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	30
Colloquia	50		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Modelling and Simulation of Dynamical Systems		
Lecturer (for lectures)	Milojković T. Marko, Spasić D. Miodrag		
Lecturer/associate (for exercises)	Milojković T. Marko, Spasić D. Miodrag		
Lecturer/associate (for OFE)	Đorđević D. Anđela, Dimitrijević G. Jelena, Milojković T. Marko, Spasić D. Miodrag		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Modeling and simulation of dynamic systems are indispensable today, both in everyday life and in all branches of technology and modern industry. The goal of the course is to train students in modeling dynamic systems, simulation of dynamic systems on a computer, modeling and simulation of various dynamic systems from technology and life		
Course outcomes	At the end of the course, students will have appropriate competencies related to the modeling methods for various dynamic systems from technology and every day life as well as their simulation on a computer.		
Course outline			
Theoretical teaching	The concept of a model of dynamic system. Model classification. Graphical modeling techniques. Principles of mathematical model design. Types of mathematical models. Examples of mathematical models. Design of mathematical models of mechanical, hydraulic, thermal, chemical and technological processes. Linearization of nonlinear elements. Model validation and verification techniques. Simulation methods. Design of simulation models. Simulation tools. Mathematical basis of digital simulation. Simulation errors and methods for overcoming them. Application of simulation in the identification, design and optimization of SAU. Modeling and simulation of the work of artificial intelligence and intelligent systems.		
Practical teaching (exercises, OFE, study and research work)	Introduction to the Matlab programming environment; Introduction to Simulink; Models given by differential equations, models in state space, models given by input-output equations and transfer functions; Modeling and simulation of mechanical systems; Modeling and simulation of electrical systems; Modeling and simulation of electro-mechanical systems; Modeling and simulation of systems in the automotive industry; Modeling and simulation of thermal systems; Modeling and simulation of hydraulic systems.		
Textbooks/references			
1	Charles M. Close, Dean K. Frederick, “Modeling and Analysis of Dynamic Systems”, Wiley, 1993.		
2	Payam Zarafshan, “Modeling and Simulation of Dynamical Systems”, Academic Press, 2024.		
3	Robert L. Woods, Kent L. Lawrence, “Modeling and Simulation of Dynamical Systems”, Pearson, 1997.		
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	0	0

Teaching methods	Lectures; Classroom exercises; Laboratory exercises; Computer exercises; Consultations

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	35
Exercises		**Oral exam**	35
Colloquia	30		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Mathematical Methods	
Lecturer (for lectures)			Marinković D. Slađana, Rančić Z. Lidija, Marjanović M. Zvezdan	
Lecturer/associate (for exercises)			Denić Z. Anđa	
Lecturer/associate (for OFE)				
Number of ECTS	6	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Mastering basic knowledge and principles of numerical mathematics and training for their application in engineering practice.			
Course outcomes	Understanding the concept of numerical mathematics, its possibilities and limitations. Students' ability to recognize practical problems, select an appropriate method for solving them, apply the methods and interpret the results.			
Course outline				
Theoretical teaching	Concept and types of errors. Iterative processes. Numerical solution of nonlinear equations and systems of nonlinear equations. Numerical solution of systems of linear equations (direct and iterative methods). Concept and types of approximation of functions. Polynomial interpolation. Least squares approximation. Numerical differentiation. Numerical integration. Basic methods for approximate solution of ordinary differential equations and systems of differential equations.			
Practical teaching (exercises, OFE, study and research work)	Solving problems that follow the content presented in the theoretical classes. Implementation of numerical algorithms through symbolic computing software packages, especially MATLAB and Wolfram Mathematica. Through the creation of homework problems and the analysis of their solutions, the application of mathematical and software tools in the context of numerical mathematics is gradually mastered.			
Textbooks/references				
1	R.L. Burden, J.D. Faires, Numerical Analysis, MA : Brooks/Cole, Cengage Learning, Boston, 2011.			
2	L. Ridgway Scott, Numerical Analysis, Princeton University Press, 2011.			
3	J. Kiusalaas, Numerical methods in engineering with MATLAB, Cambridge University Press, 2016.			
4				
5				

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	2	0	0	0

Teaching methods	Lectures, computational exercises, computer exercises, homework, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	40
Exercises	10	**Oral exam**	10
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Mathematical Introduction to System Theory		
Lecturer (for lectures)	Ranđelović M. Branislav, Nikolić S. Saša, Marjanović M. Zvezdan		
Lecturer/associate (for exercises)	Stanković M. Hranislav		
Lecturer/associate (for OFE)			
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Mastering basic theoretical mathematical knowledge and application through examples.		
Course outcomes	Students are able to apply acquired knowledge in their professional activities.		
Course outline			
Theoretical teaching	Matrices (Permanent, Block-based matrices, Square matrix factorization, Eigenvalues and eigenvectors of matrices, Norms of vectors and matrices, Special classes of matrices), Systems of differential equations, Recurrence sequences (Recurrence sequences and relations, Differential equations), Numbers (Integers, Diophantine equations, Congruent equations and systems), Complex analysis (Analytic functions, Complex integration), Transformations (Laplace transform. Fourier transform. Z-transform). Applications in system theory.		
Practical teaching (exercises, OFE, study and research work)	During computational exercises classes, tasks are explained in a manner that follow the content presented in the theoretical part and enable succesfull practice of the presented methods. The exercises cover topics from the fields of Matrices, Systems of Differential Equations, Recurrent Sequences, Numbers, Complex Analysis, Transformations and Applications in Systems Theory.		
Textbooks/references			
1	B. Randjelovic, S.Nikolic, D.Simjanovic, M.Spasic, Matematical Intriduction to System Theory, Faculty of Electrical Engineering, Nis, 2025, ISBN: 978-86-6125-286-0 192 pp		
2	Anderson, J.A., Lewis, J.L. (2004). Discrete Mathematics with Combinatorics. 978-0130457912, https://books.google.rs/books?id=gXULBQAACAAJ Pearson Education, USA		
3	João P. Hespanha (2009) Linear Systems Theory, ISBN-: 978-0691140216, Princeton University Press, USA		
4	John J. Watkins, Number Theory: A Historical Approach (2013) 978-0691159409, Princeton University Press		
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	2	0	0	0

Teaching methods	Verbal-textual, illustrative-demonstrative, presentation, dialogue, graphic displays.

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	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital Electronics		
Lecturer (for lectures)	Đorđević Lj. Goran, Đošić M. Sandra, Jovanović D. Milica		
Lecturer/associate (for exercises)	Jovanović D. Milica, Đošić M. Sandra		
Lecturer/associate (for OFE)	Jovanović D. Milica, Veljković J. Milijana		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory

Prerequisites	None
Course objectives	Acquisition of fundamental knowledge in the field of digital electronics and the integration of theoretical knowledge with practical aspects of analyzing and designing combinational and sequential digital circuits using programmable digital components and hardware description languages. Understanding the principles of memory circuit construction, programmable digital components, and data converters.
Course outcomes	The outcome of the course is the student's ability to: (a) analyze and design combinational and sequential digital circuits by applying formal minimization methods and fundamental principles of digital engineering; (b) develop and behavioral and structural hardware description language models for low-complexity digital subsystems. (c) synthesize, optimize, and implement low-complexity digital systems onto modern field-programmable gate array (FPGA) platforms.
Course outline	
Theoretical teaching	Logic Circuits and Combinational Networks: Elementary logic circuits, logic expressions and combinational networks, Boolean algebra. Implementation Technologies: MOSFET transistor as a switch, CMOS inverter and logic circuits, programmable logic components (PLA, PAL, ROM). Standard Combinational Circuits: Decoder, multiplexer, encoder, demultiplexer. Arithmetic Circuits: Full adder, ripple-carry adder, carry-lookahead adder, multipliers. Latch Circuits and Flip-Flops: Latches, master-slave flip-flops, edge-triggered flip-flops. Register Components: Data and shift registers, counter synthesis (asynchronous and synchronous). Sequential Circuits: Analysis and synthesis, algorithmic state machines. Memory Circuits: RAM (SRAM, DRAM), ROM. D/A and A/D Conversion: Basic architectures of digital-to-analog and analog-to-digital converters.
Practical teaching (exercises, OFE, study and research work)	Practical instruction consists of a cycle of six laboratory exercises. Each exercise represents an independent engineering design task in which students apply theoretical principles using specialised electronic design automation software and programmable logic platforms. The practical programme is structured as follows: 1) Introduction to the digital system design environment and the stages of implementation using programmable logic devices. 2) Implementation and structural modelling of medium-scale integration combinational modules. 3) Hardware implementation of basic arithmetic circuits (a full adder and a binary adder). 4) Hardware implementation of complex arithmetic circuits (a binary multiplier). 5) Design and implementation of basic asynchronous and synchronous sequential circuits (latches, flip-flops, and registers). 6) Design and hardware implementation of synchronous counter registers.
Textbooks/references	
1	R.J. Tocci, N. S.Widmer, G. L. Moss, Digital Systems: Principles and Applications, 11th ed., Pearson, July 17, 2010.
2	S.Brown, Z.Vranesic, Fundamentals of Digital Logic with VHDL Design, 3th ed.,McGraw-Hill Education, April 14, 2008.
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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, consultations, quizzes, and midterm exams.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Organization of Computer Systems	
Lecturer (for lectures)			Milentijević Z. Ivan	
Lecturer/associate (for exercises)			Vojinović M. Oliver, Milošević S. Marija	
Lecturer/associate (for OFE)			Vojinović M. Oliver, Milošević S. Marija	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	None			
Course objectives	The aim is to provide students with a basic knowledge of the computer architecture and organisation.			
Course outcomes	Students should be trained to design computer systems based on simple architectures and mid-level complexity assembly programs, and to master the efficient use of assembly techniques.			
Course outline				
Theoretical teaching	Basic components of a computer system. Instruction set. Addressing modes. Synthesis of a hypothetical processor. Processor structure and its functions. Register set. Control unit. ALU. Fetching and executing. Examples of simple computer architecture design. CPU programming model. Macro commands. Principles of assembly programming. Procedures and parameter passing. Bus. Interconnection of computer system elements. Memory subsystem. Interrupt system. Interrupt programs. Interrupt hierarchy. Input/output organization. Parallel and serial I/O. I/O devices, classification. Programmable I/O. Interrupt-driven I/O. Memory-mapped I/O. Dedicated I/O. Direct Memory Access - DMA technique.			
Practical teaching (exercises, OFE, study and research work)	Basic structure of microcomputers; instruction execution cycle. Intel family of processors; register set. Classification of assembler instructions; MOV, addition instructions; signed arithmetic; subtraction instructions. Multiplication and division; bit manipulation instructions; complex arithmetic expressions. Flow control; algorithmic structures. Elements of assembly language; memory allocation directives; assembly program; immediate and direct addressing. Indirect addressing; arrays. Stack; procedures; parameter passing via registers and the stack. Nested loops; matrices. Combining assembly language with a higher-level programming language. Laboratory exercises: a cycle of seven exercises.			
Textbooks/references				
1	W. Stallings, Computer Organization and Architecture: Designing for Performance, 11th Ed. Pearson Education, 2022.			
2	Noam Nisan, Shimon Schocken, "The Elements of Computing Systems: Building a Modern Computer from First Principles", The MIT Press, 2005.			
3	Kip Irvine, Assembly Language for x86 Processors, 8th edition, Prentice-Hall, 2019.			
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	0	0

Teaching methods	Lectures, practical and laboratory sessions

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	40
Colloquia	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Linear Control Systems	
Lecturer (for lectures)			Veselić R. Boban	
Lecturer/associate (for exercises)			Mitić M. Vladimir, Sibinović D. Vladimir	
Lecturer/associate (for OFE)			Mitić M. Vladimir, Sibinović D. Vladimir, Jovanović M. Anđela	
Number of ECTS		6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None			
Course objectives	The purpose of this course is to give the theoretical and practical knowledge related to the linear continuous-time control systems.			
Course outcomes	Students acquire the ability to model and analyze the most important linear components and automatic control systems in the continuous-time domain. They develop the competence to assess system stability in both the complex and frequency domains, and to evaluate system dynamic performance and steady-state accuracy. The acquired fundamental theoretical and practical knowledge provides a basis for attending advanced courses and successfully mastering the curriculum of specialized subjects in higher years of study.			
Course outline				
Theoretical teaching	Definition, importance and examples of linear feedback control systems. Structure and components of linear control systems. Mathematical models, characteristics and responses of components and systems. The importance of feedback. Block diagrams and signal flow graphs in feedback control systems. State-space representation and characteristics of linear control systems. Stability analysis techniques. Characterization of the performance of linear control systems and criteria for synthesis. Classical methods for the linear control systems analysis and synthesis.			
Practical teaching (exercises, OFE, study and research work)	Laplace transformation, mathematical models of elements and systems, determination of transfer functions of linear electrical, mechanical, and electro-mechanical elements and systems, determination of characteristic transfer functions, algebra of structural block diagrams, signal flow graph, responses of elements and systems, system state-space and its transformations, system controllability and observability, stability of linear control systems, algebraic and grapho-analytical stability criteria, root locus, assessment of system behavior in steady state.			
Textbooks/references				
1	G. F. Franklin, J. D. Powell, and A. Emami-Naeini, Feedback Control of Dynamic Systems, Prentice-Hall, 2010.			
2	R.C. Dorf, and R.H. Bishop, Modern Control Systems, Prentice-Hall, 2004.			
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	0	0

Teaching methods	Lectures; Exercises; Laboratory work; 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	40		
Projects	0		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Dynamics of Mechanisms and Machines	
Lecturer (for lectures)			Veselić R. Boban	
Lecturer/associate (for exercises)			Mitić M. Vladimir	
Lecturer/associate (for OFE)			Jovanović M. Anđela, Mitić M. Vladimir	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Introduction to problems of statics, kinematics and dynamics of elements and systems, as well as methods of their solution. Application to modeling devices of importance for automatic control systems.			
Course outcomes	Acquired necessary theoretical knowledge that enables successful solution of various problems of mechanics, with emphasis on motion and interaction. Ability to form differential equations of motion and solve them. Ability to analyze the dynamics of motion of rigid body systems and model the dynamics of transmission assemblies in machines.			
Course outline				
Theoretical teaching	Statics of a rigid body. Principal force vector and principal moment. Equilibrium conditions. Kinematics of a material point. Kinematics of a rigid body: translational, rotational and planar motion. Compound motion of a material point and a rigid body. Dynamics of a material point. General laws of dynamics of a material point. Basic laws of dynamics of a system and a rigid body. Mechanical ties. Holonomic and non-holonomic constraints, degrees of freedom of a mechanical system with constraints, generalized coordinates. Dynamics of a system with constraints. Elements of the theory of mechanisms. Kinematic pairs and chains. Machine, tool and robot as kinematic chains. Dynamics of mechanisms.			
Practical teaching (exercises, OFE, study and research work)	Basic concepts and axioms of statics, system of concurrent forces, planar system of parallel forces and couples, general planar force system, general spatial force system, spatial couples, center of gravity, rectilinear and curvilinear motion of a material point, translational and rotational motion of a rigid body, planar motion of a rigid body, compaund motion of a material point and a rigid body, general laws of a material point dynamics, dynamics of systems and rigid bodies, general laws of dynamics for systems and rigid bodies.			
Textbooks/references				
1	F.P. Beer, E.R.,Jr.Johnston, Mechanics for Engineers: Statics and Dynamics, McGraw-Hill, 1987, ISBN-13: 978-0070045842			
2				
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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	0	0

Teaching methods	Lectures; Auditory exercises, laboratory exercises; Consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	40
Exercises	15	**Oral exam**	20
Colloquia	20		
Projects	0		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Software for the Simulation of Dynamical Systems	
Lecturer (for lectures)			Antić S. Dragan, Danković B. Nikola	
Lecturer/associate (for exercises)			Đorđević D. Anđela, Dimitrijević G. Jelena	
Lecturer/associate (for OFE)			Dimitrijević G. Jelena	
Number of ECTS	6	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Introduction to the basics of computer simulation using various software packages. Training students to simulate real dynamic systems.			
Course outcomes	Upon completion of the course, the student is able to model and simulate dynamic systems using modern software packages, analyze the results obtained, and develop simple simulation applications.			
Course outline				
Theoretical teaching	The need for simulation. Advantages and limitations of simulation. Simulation techniques. Overview of simulation applications. Design of simulation models. ODE solvers. Historical overview of software for simulation. Simulation software oriented to system models in the form of equations. Simulation tools oriented to block diagrams. User interface of the simulation environment. Simulation of continuous linear, discrete and nonlinear systems. Monte Carlo simulation. Application of knowledge-based systems in modeling and simulation. Simulation errors and methods for overcoming them. Specialized software for simulating certain classes of systems. Modeling and simulation in practice.			
Practical teaching (exercises, OFE, study and research work)	Introduction to programming environments of Matlab, LabView, Dymola, SciLab, Wolfram System Modeler. Working with software modules oriented towards block modeling (Simulink, Control, Design and Simulation, Scicos). Development of simple applications. Dataflow programming. Virtual instruments. Setting up controls and indications. Creating a graphical user interface. Creating submodels and upgrading existing models. Modeling and simulation of different types of dynamic systems (mechanical, electrical, thermal, hydraulic) in different software packages. Using templates and demo examples. Designing complete applications.			
Textbooks/references				
1	R. Bitter, T. Mohiuddin, M. Nawrocki, “LabView Advanced Programming Techniques”, CRC Press,			
2	M. Otter, “Modeling, Simulation and Control with Modelica 3.0 and Dymola 7“, 2009.			
3	S.L. Campbell, J.P. Chancelier, R. Nikounkhah, “Modeling and Simulation in Scilab/Scicos“, Springer Science, 2006.			
4	F. Stratulat, F. Ionescu, “Linear Control Systems“, Steinbeis Edition, 2009.			
5	V. Ryzhov, T. Fedorova, K. Safronov, S. A. Sulaiman, M. Ovinis, V. Perumal, “Modeling and Simulation of Complex Dynamical Systems: Virtual Laboratory Approach based on Wolfram SystemModeler“, Springer, 2021.			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

Teaching methods	Lectures, Laboratory exercises, Computer 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**	40
Colloquia			
Projects	40		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Communications and Information Technologies - System Engineering and Radio-Communications Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electron Devices and Microsystems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Introduction to Databases		
Lecturer (for lectures)	Bogdanović D. Miloš		
Lecturer/associate (for exercises)	Bogdanović D. Miloš		
Lecturer/associate (for OFE)	Bogdanović D. Miloš		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Introduction to basic terminology, data models, the process of designing and using databases. Gaining theoretical knowledge about the relational model. Gaining practical knowledge related to designing using entity and relationship models, implementing relational databases and using data via the SQL query language.		
Course outcomes	Theoretical and practical knowledge of database design and ER data model. Theoretical and practical knowledge of the relational data model and database implementation. Practical knowledge of the SQL language, as well as the implementation, persisting and retrieval of data in relational databases.		
Course outline			
Theoretical teaching	1. Introduction to databases 2. Basic database concepts - data, information, database, database management system, database system, database applications 3. History of database development 4. Data processing: conventional processing and database-based processing 5. Database users: categorization, advantages and disadvantages, responsibilities 6. Data models: the concept of a data model and its components 7. Levels of abstraction in DBMS, 3 schema architecture 8. Database design process 9. Conceptual database design, entity-relationship model - ER data model 10. ER model concepts, graphical notation (ER diagram), database design using ER data model 11. Examples of database design based on requirements 12. Relational model fundamentals		
Practical teaching (exercises, OFE, study and research work)	1. ER diagrams (entities, relationships, attributes) 2. Tutorials for the database design process 3. Requirements-based design - examples 4. Relational model: concepts of the relational model, structural and integrity components, relation schema, relation instances, keys, constraint specification 5. Translation of the ER model into a relational model 6. Examples of ER models and translation into a relational model 7. SQL DDL commands (CREATE TABLE command, data types), creating tables for a previously designed database 7. SQL DDL commands for defining constraints 8. Queries and SQL SELECT statement (basic form of statement) 9. Joining tables, types of joins 10. Advanced form of SELECT statement, aggregate operations, nested queries 11. SQL statements for updating data (INSERT, UPDATE, DELETE) 12. SQL statements for working with views 13. SQL statements for working with indexes 14. Examples of data manipulation		
Textbooks/references			
1	R. Elmasri, S. Navathe, Fundamentals of Database Systems, Addison-Wesley; seventh edition (2016), ISBN-10: 0-13-397077-9, ISBN-13: 978-0-13-397077-7		

2	Л. Стоименов, Увод у базе података, Едиција: Уџбеници, Универзитет у Нишу, Електронски факултет, 2013/2014, ISBN (електронско издање) 978-86-6125-099-6, ISBN (Print): 978-86-6125-111-5
3	А. Станимировић, М. Богдановић, М. Фртунић Глигоријевић, Л. Стоименов, Практикум за вежбе на рачунару из База података, Едиција: Помоћни уџбеници, 2020, ISBN: 978-86-6125-207-5
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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	0	0

Teaching methods	Lectures, auditory exercises, laboratory exercises, 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			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electrical Machines	
Lecturer (for lectures)			Mitrović N. Nebojša, Stajić P. Zoran	
Lecturer/associate (for exercises)			Banković G. Bojan	
Lecturer/associate (for OFE)			Banković G. Bojan	
Number of ECTS	6	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Acquisition of basic knowledge in the field of electromechanical energy conversion, electrical machines, and electrical drives.			
Course outcomes	Understanding the basic principles of electromechanical energy conversion. Understanding the fundamental characteristics and operation of rotating machines and transformers.			
Course outline				
Theoretical teaching	Fundamental laws and principles of electromechanical energy conversion. Magnetic and electric circuits of electrical machines. Power balance in general-purpose machines. Equations of motion and electromagnetic torque. Examples of single and multiple excitation systems. Operating principles of basic types of electrical machines. Magnetic fields in DC and AC machines. Magnetic forces. Windings in electrical machines. Electromotive forces. Mechanical characteristics. DC machines, synchronous machines, induction machines, and power transformers.			
Practical teaching (exercises, OFE, study and research work)	Practical work is conducted in the laboratory, including: - Identification of various types of machines. - Basic components and structures. - Commissioning of different types of machines. - Mechanical characteristics of electric machines.			
Textbooks/references				
1	S.A. Nasar, "Electric machines: steady-state operation",New York : Hemisphere Pub. Corp.1990.			
2	G. R. Slemon, A. Straughen, “Electric Machines”, Adison-Wesley publishing Company, 1980.			
3	Stephen D. Ulmans, “Electric machinery”, McGraw-Hill, 2014.			
4	Paul Krause, Oleg Wasynczuk, Scott Sudhoff, Steven Pekarek, "Analysis of Electric Machinery and Drive Systems", Institute of Electrical and Electronics Engineers, 2013.			
5	Slobodan N. Vukosavic, "Electrical machines", Springer Science & Business Media, 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	0	0

Teaching methods	Classes are held through lectures and exercises. Lectures employ modern teaching methods. In-class exercises, supported by numerous examples, encourage students to independently solve engineering problems. Part of the exercises is performed in the laboratory to obtain steady-state characteristics of electric machines.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	15	**Oral exam**	30
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Data Acquisition and Conversion Techniqes		
Lecturer (for lectures)	Nikolić S. Goran		
Lecturer/associate (for exercises)	Nedeljković N. Jelena		
Lecturer/associate (for OFE)	Nedeljković N. Jelena		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective

Prerequisites	None
Course objectives	The course on data acquisition and conversion techniques covers the principles and methods of converting real-world signals into digital data for further processing, storage, or transmission via communication networks. Its goal is to familiarize students with the principles of converting signals from the analog to the digital domain and vice versa, as well as to provide practical knowledge about modern circuits designed for these purposes. It includes an introduction to basic methods of acquiring electrical and non-electrical quantities, understanding the role of sensors, transducers, and the challenges in processing their signals. The course also examines the fundamental principles of integrating data acquisition systems.
Course outcomes	The student acquires basic theoretical and practical knowledge in the field of data acquisition and conversion. They understand the architecture and operating principles of analog-to-digital and digital-to-analog converters, as well as sensor systems. They are capable of independently applying the acquired knowledge to the implementation of simple data acquisition and processing systems in modern electronic devices.
Course outline	
Theoretical teaching	Definition and basic structures of data acquisition systems. General measurement principles, data domains. Types of acquisition systems. Basic building blocks of the system. Sensors and transducers. Calibration and linearization techniques. Analog multiplexers, signal conditioning. Encoding and quantization. Sampling theory. Converter errors. Converter architecture (ADC, DAC, Sigma-Delta). Converter testing. Coupling circuits. Reference sources, clock signal generators. Examples of applications of data acquisition and signal conversion systems.
Practical teaching (exercises, OFE, study and research work)	Working with basic types of analog and digital sensors (temperature, pressure, force) Application of analog and digital filters Practical exercises with DA converters: weighted, ladder, capacitive Working with different types of ADCs: SAR, flash, sigma-delta Writing programs for the C8051Fxxx microcontroller in the Keil uVision IDE software environment and simulating the operation of built-in AD and DA converters Designing and implementing data acquisition systems, including interfacing with microcontrollers and computers Implementation of wireless systems for measuring physical parameters
Textbooks/references	
1	The Data Conversion Handbook, Edited by Walt Kester, Newnes, 2005, ISBN 0-7506-7841-0. Also published as Analog-Digital Conversion, Analog Devices, Inc. 2004, ISBN 0-916550-27-3. https://www.analog.com/en/resources/technical-books/data-conversion-handbook.html
2	Practical Data Acquisition for Instrumentation and Control Systems, John Park and Steve Mackay, ISBN-10:0750657960, ISBN-13:978-0750657969, Newnes, 2003
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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	1	1	0	0

Teaching methods	Auditory and interactive instruction using computers and a projector Laboratory exercises with real sensors and converters Homework assignments and seminar papers Midterm exams 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			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Introduction to Telecommunications	
Lecturer (for lectures)			Perić H. Zoran, Milić N. Dejan	
Lecturer/associate (for exercises)			Anastasov A. Jelena, Eferica M. Predrag	
Lecturer/associate (for OFE)			Eferica M. Predrag	
Number of ECTS	6	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Acquisition of knowledge necessary for the understanding of the principles of telecommunications.			
Course outcomes	Theoretical knowledge; Mastering the use of appropriate software simulation.			
Course outline				
Theoretical teaching	The transmission of information. Signals. Digitization of the signals. Fundamentals of modulation techniques. Transmission of spread spectrum signals. Multiplex signal transmission. Fundamentals of signal compression. Information recording. Fundamentals of coding techniques. Wireless communication systems. Satellite communications. Optical telecommunication systems. Internet. Global Positioning System (GPS).			
Practical teaching (exercises, OFE, study and research work)	Solving selected problems in computational exercises. Practical work in the laboratory.			
Textbooks/references				
1	J. Proakis, M. Salehi, Digital Communications, McGraw-Hill Education, 5th edition, 2007.			
2	S. Haykin, M. Moher, Introduction to Digital and Analog Communications, John Wiley, 2007.			
3	N.S. Jayant, P. Noll, Digital Coding of Waveforms, Prentice-Hall, New Jersey, 1984.Publishers, 1992.			
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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	0	0

Teaching methods	Oral teaching sessions in the classroom, 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**	20
Colloquia	20		
Projects	20		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electrical Circuits	
Lecturer (for lectures)			Vučković N. Ana, Živaljević U. Dragana	
Lecturer/associate (for exercises)			Vukić B. Dragana, Ivković V. Natalija, Jovanović N. Isidora	
Lecturer/associate (for OFE)			Ivković V. Natalija, Jovanović N. Isidora	
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Acquiring fundamental theoretical knowledge in the analysis and synthesis of electrical circuits and gaining proficiency in using software tools to solve circuits.			
Course outcomes	Upon completion of the course, the student is able to: identify and mathematically model basic and controlled elements of electric circuits; apply methods for the analysis of linear circuits in the time and frequency domains; determine parameters and characteristics of two-port networks and analyze their interconnections; solve transient regimes using the classical method and the Laplace transform; use signal-flow graphs and Mason's rule in circuit analysis; carry out basic procedures for the synthesis of two-port networks; independently use software tools for electric circuit simulation, interpret the obtained results, and relate them to theoretical calculations.			
Course outline				
Theoretical teaching	Basic elements of electric circuits with one and two ports. Controlled sources. Two-port networks. Network parameters and interconnection of two-port networks. Characteristic parameters of a symmetrical network. Analysis of circuits in the frequency domain. Power in complex-periodic steady-state regime. Solving electric circuits in transient regime using the classical method and the Laplace transform. Analysis of electric circuits using signal-flow graphs. Mason's rule. Synthesis of two-port networks. Computer-aided analysis of electric circuits.			
Practical teaching (exercises, OFE, study and research work)	Calculation exercises include solving problems related to the analysis of one-port and two-port circuits, circuits with controlled sources, determination of two-port network parameters, and analysis of interconnected networks. Exercises include problems in frequency-domain analysis, calculation of power in complex-periodic steady-state regime, and transient regimes using the classical method and the Laplace transform. Practical instruction also includes computer modeling and simulation of electric circuits, verification of analytically obtained results, and analysis of the influence of circuit parameters.			
Textbooks/references				
1	Charles K. Alexander, Matthew N. O. Sadiku, Fundamentals of Electric Circuits, Published by McGraw-Hill, 2012.			
2	John Bird, Electrical Circuit Theory and Technology, Newnes is an imprint of Elsevier Science, 2007.			
3	Leonard S. Bobrow,Fundamentals of Electrical Engineering, Oxford University press, 1996.			
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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	0	0

Teaching methods	Lectures, classroom exercises, practical computer-based instruction, homework assignments, office hours.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	20	**Written exam**	30
Exercises		**Oral exam**	30
Colloquia	20		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Sensors, Transducers and Actuators	
Lecturer (for lectures)			Dinčić R. Milan	
Lecturer/associate (for exercises)			Pešić T. Miroljub	
Lecturer/associate (for OFE)			Đorđević-Kozarov R. Jelena, Stojanović S. Milica	
Number of ECTS	6	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	Acquiring essential knowledge for using sensors to electrically measure non-electrical quantities.			
Course outcomes	Acquisition of theoretical and practical knowledge necessary for the design and implementation of measurement and control systems, with emphasis on the effective use of appropriate sensors and electronic circuits.			
Course outline				
Theoretical teaching	Definition of sensors. Classification of sensors. Trends in sensor development. Static and dynamic characteristics of sensors. Resistive, capacitive, magnetic, inductive and optical sensors. Deformation, force, displacement, position, velocity, acceleration, pressure, flow, level, humidity and temperature sensors. Integrated and MEMS sensors. Electronic sensor interface. Connecting sensors to measurement bridges and amplifiers. Actuators and their characteristics. Implementation of measurement and control systems based on computers and microcontrollers. Application of sensors and actuators in industry.			
Practical teaching (exercises, OFE, study and research work)	Conducting problem-solving exercises, laboratory exercises and project-based assignments to develop proficiency in using sensors and actuators, and in designing measurement and control systems.			
Textbooks/references				
1	Ekbert Hering, Gert Schönfelder, “Sensors in Science and Technology: Functionality and Application Areas”, Springer, 2022.			
2	Walter Lang, “Sensors and Measurement Systems”, River Publishers, 2021.			
3	John Webster, „The Measurement, Instrumentation and Sensors Handbook“, CRC Press, 2014.			
4	Nathan Ida, “Sensors, Actuators, and Their Interfaces: A multidisciplinary introduction”, The Institution of Engineering and Technology, 2020.			
5	Patrick F. Dunn, “Fundamentals of Sensors for Engineering and Science”, CRC Press, 2019.			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	2	0	0

Teaching methods	Lectures, Tutorials, Problem-Solving Sessions, Laboratory Exercises, Project Assignments, Consultations

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	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Discrete Mathematics		
Lecturer (for lectures)	Matejić M. Marjan, Džunić S. Jovana		
Lecturer/associate (for exercises)	Stankov D. Stefan		
Lecturer/associate (for OFE)	Stankov D. Stefan		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The course aims to teach students to think logically and mathematically and how to apply these techniques to solving problems in other scientific and technical disciplines.		
Course outcomes	The student is ready to independently apply the acquired knowledge in computer and other technical subjects.		
Course outline			
Theoretical teaching	Mathematical logics. Propositional calculus. Propositional formulas. Coexistence and logical consequences. Normal forms. Sets. Sum principle. Inclusion-exclusion principle. Partitive set. Set decomposition. Placements. Cartesian product. Relations. Matrix representation. Closure of relations. Lexicographic ordering. Functions. Dirichlet's principle. Sequences. Generating functions. Recurrent sequences. Solving linear recurrent relations. Fibonacci, Catalan and Stirling numbers. Permanent. Systems of different representatives. Integers. Divisibility. Modular arithmetics. The least common multiple and the greatest common divisor. Euclid's algorithm. Diophantine equations. Modular equations. Euler's function. Chinese remainder theorem. Combinatorics: permutations, variations and combinations.		
Practical teaching (exercises, OFE, study and research work)	Propositional calculus. Propositional formulas. Coexistence and logical consequences. Normal forms. Sum principle. Inclusion-exclusion principle. Partitive set. Set decomposition. Placements. Cartesian product. Relations. Matrix representation. Closure of relations. Lexicographic ordering. Functions. Dirichlet's principle. Generating functions. Recurrent sequences. Solving linear recurrent relations. Fibonacci, Catalan and Stirling numbers. Permanent. Systems of different representatives. Integers. Divisibility. Modular arithmetics. The least common multiple and the greatest common divisor. Euclid's algorithm. Diophantine equations. Modular equations. Euler's function. Chinese remainder theorem. Combinatorics: permutations, variations and combinations.		
Textbooks/references			
1	James A. Anderson, Discrete Mathematics with Combinatorics, Second Edition, Prentice Hall, 2003.		
2	Susanna S. Epp, Discrete Mathematics with Applications, Fourth Edition, Brooks/Cole Cengage Learning, 2011.		
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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	0	0

Teaching methods	Lectures and exercises.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises		**Oral exam**	40
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Digital Control Systems		
Lecturer (for lectures)	Veselić R. Boban		
Lecturer/associate (for exercises)	Mitić M. Vladimir, Jovanović M. Anđela		
Lecturer/associate (for OFE)	Sibinović D. Vladimir, Jovanović M. Anđela		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The purpose of this course is to give the theoretical and practical knowledge related to the linear digital control systems.		
Course outcomes	Acquisition of knowledge and skills related to the modeling and analysis of signal sampling and reconstruction processes encountered in digital control systems. Development of competencies for formulating appropriate models of linear digital control systems and applying algebraic and graphical criteria for stability analysis. Ability to determine the dynamic and steady-state performance of digital control systems.		
Course outline			
Theoretical teaching	Introduction to digital control systems. System structure and its components. Discrete-time signal analysis. Signal sampling and reconstruction processes. Sampling theorem. Transform methods in discrete-time systems analysis. Discrete-time transfer function. State space representations of discrete-time control systems.Controllability and observability. Stability analysis techniques. Time response analyses. Steady-state accuracy.		
Practical teaching (exercises, OFE, study and research work)	Fourier and Z transformations, sampling and reconstruction of signals, determination of discrete transfer functions of elements and systems, responses of discrete-time control systems, implementation of digital controllers and filters, state-space representation of digital systems, controllability and observability, canonical forms in state-space and their transformations, stability of linear discrete-time control systems, influence of the sampling period on the stability and performance of a digital control system, determination of the critical gain and critical frequency of a digital control system, steady-state errors, root locus of a digital system.		
Textbooks/references			
1	K. Ogata, Discrete-time Control Systems. Prentice-Hall, Englewood Cliffs, N.J., 1995.		
2	C. L. Phillips, and H. T. Nagle, Digital Control System Analysis and Design, Prentice-Hall, Englewood Cliffs, N.J., 1995.		
3	R.C. Dorf, and R.H. Bishop, Modern Control Systems, Prentice-Hall, 2004.		
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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	0	0

Teaching methods	Lectures; Exercises; Laboratory work; 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	40		
Projects	0		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			System Identification	
Lecturer (for lectures)			Jovanović D. Zoran, Nikolić S. Saša, Milovanović B. Miroslav	
Lecturer/associate (for exercises)			Milovanović B. Miroslav, Dimitrijević G. Jelena	
Lecturer/associate (for OFE)			Nikolić S. Saša, Milovanović B. Miroslav, Đorđević D. Anđela	
Number of ECTS		5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None			
Course objectives	Gaining knowledge about modern system identification methods, iterative identification methods and getting acquainted with modern computer systems and identification software.			
Course outcomes	Knowledge of the application of modern computer systems and identification software in practice, as well as the application of identification in adaptively contoled systems.			
Course outline				
Theoretical teaching	Identification facilities and their classification. Identification algorithms. Convergence to identification algorithms. Active identification. Gradient identification method. One-dimensional and multi-dimensional regression models. Nonlinear regression method. Iterative identification methods. Passive identification methods. Planning the experiment. Parametric representation of a black-box system model. Non-parametric representation of a black-box system model. Methods for assessing the quality of identification. System dynamics recognition using visual analysis and semi-automatic identification. System identification using AutoML tools without programming. Data-based system identification. Identification in conditions of limited data quantity and quality. Modern cloud and edge platforms for identification in industry.			
Practical teaching (exercises, OFE, study and research work)	Introduction to MATLAB System Identification Toolbox and its application in identification of a real dynamic system. Application of orthogonal rational functions and orthogonal filters in system identification. Applying the acquired knowledge in identifying the following systems: The liquid flow control system G.U.N.T. Flow Control Trainer RT522, Liquid Level Management System G.U.N.T. Level Control Trainer RT512, Pressure regulating system G.U.N.T. Pressure control trainer RT532, Temperature control system G.U.N.T. Temperature control trainer RT542. Visual identification of the system dynamics in Matlab Gui environment. Application AutoMl and Drag-and-Drop Identification tools.			
Textbooks/references				
1	B. Codrons, "Process Modelling for Control-A Unified Framework Using Standard Black-box Techniques", Springer, 2006.			
2	P. Albertos, A. Sala, “Iterative Identification and Control”, Springer, 2002.			
3	Van Hee, K., van der Aalst, W. (2022). Process Mining: Data Science in Action (2nd ed.), Springer.			
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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	1	1	0	0

Teaching methods	Lectures; Laboratory Exercises; Computer Exercises; 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	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Artificial Intelligence Methods in Control Systems		
Lecturer (for lectures)	Milojković T. Marko, Milovanović B. Miroslav		
Lecturer/associate (for exercises)	Milojković T. Marko, Milovanović B. Miroslav, Đorđević D. Anđela		
Lecturer/associate (for OFE)	Đorđević D. Anđela		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Understanding the basic concepts of artificial intelligence, understanding the work of fuzzy logic and genetic algorithms, mathematical formulation and numerical realization of elementary types of artificial neural networks. Applications of artificial intelligence methods in systems control.		
Course outcomes	Students will be trained to design controllers based on artificial neural networks, genetic algorithms and fuzzy logic. Independent research work will be enabled within the appropriate Matlab toolboxes, which will represent the first professional steps in the fields of artificial intelligence and intelligent control.		
Course outline			
Theoretical teaching	Introduction to artificial intelligence. Intelligent agents. Fundamentals of neural networks. Classification of neural networks. Basic properties of neural networks. Training of neural networks. Learning algorithms of neural networks. Applications of neural networks. Control algorithms based on neural networks. Classification of search and optimization procedures. Genetic algorithms. Minimization of the objective function. Operators in genetic algorithms (selections, mutations, crossovers). Influence of various parameters on the performance of a genetic algorithm. Fuzzy sets. Fuzzy logic. Linguistic variables. Mechanism of fuzzy inference. Fuzzification and defuzzification. Mamdani and Takagi-Sugeno fuzzy systems. Fuzzy control systems. Examples of design and application of fuzzy control in industrial processes.		
Practical teaching (exercises, OFE, study and research work)	Working within the Matlab/Simulink software package and using toolboxes (Neural Network Toolbox, Fuzzy Logic Toolbox, Global Optimization Toolbox) for demonstrating, implementing and testing intelligent control structures.		
Textbooks/references			
1	M. Negnevitsky, "Artificial Intelligence – a Guide to Intelligent Systems", Addison Wesley, 2005.		
2	S. V. Kartalopoulos, "Understanding Neural Networks and Fuzzy Logic: Basic Concepts and Applications", Wiley-IEEE Press, 1996.		
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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	1	1	0	0

Teaching methods	Lectures, Classroom exercises, Computer laboratory exercises, Consultations

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Microcontrollers and Programming		
Lecturer (for lectures)	Nikolić S. Goran		
Lecturer/associate (for exercises)	Nedeljković N. Jelena		
Lecturer/associate (for OFE)	Nedeljković N. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introducing students to the architecture and fundamental operating principles of the C8051 microcontroller family, as well as acquiring basic knowledge necessary for their practical application in embedded systems. Enabling students to write programs in assembly and C language using available IDE software tools. Mastering the design and implementation of simple embedded devices in laboratory conditions.		
Course outcomes	Upon achieving the course objectives, students will possess a basic understanding of the C8051 microcontroller architecture and will be able to independently write programs to solve simple tasks, such as peripheral control, data processing, and basic process control.		
Course outline			
Theoretical teaching	Difference between microcontrollers and microprocessors Application of microcontrollers in industry and everyday life Architecture of the MCS-51 microcontroller family, with a special focus on the Silicon Labs C8051Fxxx series Overview of built-in microcontroller interfaces and memory model Input/Output lines (I/O pins and ports), timers, serial interfaces Interrupt system Instruction set and programming in A51 assembly language Basics of C programming for microcontrollers: memory models, variable types, pointers Program organization: modules, linking, directives		
Practical teaching (exercises, OFE, study and research work)	Introduction to development systems and software tools, assembly and compilation processes, and program uploading Programming in assembly and C language Number conversion Converting uppercase and lowercase letters presented in ASCII format Automatic climate control (a simple embedded system) Working with a seven-segment display Communication with a PC – establishing a serial connection via RS232 standard or VCOM port System simulation examples and real-time operation Working with a keypad Working with timers		
Textbooks/references			
1	C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie, https://www.amazon.com/Programming-Language-2nd-Brian-Kernighan/dp/0131103628		
2	Embedded C by Michael Pont, https://www.amazon.com/Embedded-C-Michael-J-Pont/dp/020179523X		
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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	0	0

Teaching methods	Auditory and interactive instruction using computers and a projector Examples of embedded systems in a simulator and on real hardware Laboratory exercises, midterm exams, homework assignments, seminar papers 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			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Measurement of Non-electrical Quantities	
Lecturer (for lectures)			Dinčić R. Milan, Denić B. Dragan	
Lecturer/associate (for exercises)			Pešić T. Miroljub	
Lecturer/associate (for OFE)			Jocić V. Aleksandar	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Acquisition of essential knowledge and skills for measuring non-electrical quantities through electrical methods.			
Course outcomes	Theoretical and practical knowledge essential for measuring non-electrical quantities. Proficiency in using suitable transducers, instruments, electronic circuits, and measurement techniques for accurate measurement of non-electrical parameters.			
Course outline				
Theoretical teaching	Direct and indirect conversion of non-electrical quantities into electrical signals. Definition and classification of measurement transducers. Static and dynamic characteristics of measurement systems for non-electrical quantities. Measurement of linear and angular displacements. Measurement of acceleration and vibrations. Measurement of force and torque. Measurement of pressure, fluid level, and flow rate. Temperature measurement using both contact and non-contact methods. Measurement of humidity.			
Practical teaching (exercises, OFE, study and research work)	Problem-solving exercises featuring solved problems and practical challenges related to the measurement of deformation, force, displacement, velocity, acceleration, pressure, fluid level, and temperature. Laboratory exercises with hands-on measurements of force, displacement, angular position, angular velocity, acceleration, vibrations, pressure, and temperature. The curriculum also covers the application of computer-based measurement systems using LabVIEW software, alongside measurement systems built on Arduino microcontroller platforms for monitoring non-electrical physical quantities.			
Textbooks/references				
1	Ambarish Paul, Mitradip Bhattacharjee, Ravinder Dahiya, “Solid-State Sensors”, IEEE Press, Wiley Blackwell, 2024.			
2	Ekbert Hering, Gert Schönfelder, “Sensors in Science and Technology: Functionality and Application Areas”, Springer, 2022.			
3	Walter Lang, “Sensors and Measurement Systems”, River Publishers, 2021.			
4	Patrick F. Dunn, “Fundamentals of Sensors for Engineering and Science”, CRC Press, 2019.			
5	John Webster, „The Measurement, Instrumentation and Sensors Handbook“, CRC Press, 2014.			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	1	0	0

Teaching methods	Lectures, Tutorials, Problem-solving exercises, Laboratory Exercises, Consultations

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	30
Exercises	15	**Oral exam**	30
Colloquia	20		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electronic Measurements	
Lecturer (for lectures)			Živanović B. Dragan	
Lecturer/associate (for exercises)			Pešić T. Miroljub	
Lecturer/associate (for OFE)			Đorđević-Kozarov R. Jelena, Stojanović S. Milica	
Number of ECTS		5	**Course status (obligatory/elective)**	Elective
Prerequisites	None			
Course objectives	Expanding knowledge of modern electronic measuring instruments and systems, as well as their application in laboratory work and industrial environments.			
Course outcomes	The student will be able to independently select appropriate measurement methods in engineering practice, choose and use electronic measuring instruments with the required specifications, and assess the achieved accuracy and limitations when working with instrumentation.			
Course outline				
Theoretical teaching	Characteristics of Measurement Systems. Waveform and Reference Signal Generators. Signal Generators. Pulse Generators. Process Calibrators. Measurement of Time, Frequency, Period, and Phase. Analog-to-Digital Converters. Electronic and Digital Measurement of DC and AC Voltages and Currents. Electronic Power Measurement. Analog and Digital Oscilloscopes. Oscilloscope Measurements. Spectrum Analyzers. Measurement of Impedance Parameters.			
Practical teaching (exercises, OFE, study and research work)	Practical exercises covering the lecture topics: signal generators, oscilloscopes, frequency measurement, analog-to-digital converters. Laboratory exercises using training kits and measuring instruments: testing generator characteristics, measuring signal parameters, working with digital oscilloscopes, frequency measurement, working with counters.			
Textbooks/references				
1	S. Tumanski „ Principles of Electrical Measurement“, Taylor&Francis, 2006.			
2	N. Kularatna, "Digital and Analogue Instrumentation testing and measurement", The Institution of Engineering and Technology, 2008.			
3	Clyde F. Coombs, "Electronic Instrument Handbook", Mc Graw-Hill, 1999.			
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	0	0

Teaching methods	Lectures using modern presentation tools, computational exercises, laboratory exercises, discussion of students’ solutions to assigned tasks, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	20
Exercises	20	**Oral exam**	20
Colloquia	35		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Advanced Techniques for Modeling of Dynamical Systems	
Lecturer (for lectures)			Mitić B. Darko, Danković B. Nikola	
Lecturer/associate (for exercises)			Đorđević D. Anđela, Jovanović M. Anđela	
Lecturer/associate (for OFE)			Đorđević D. Anđela	
Number of ECTS	6	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Training students to apply an indirect approach in modeling, based on the use of energy attributes of dynamical systems, to form mathematical models of different systems from technology and life. Introduction to the basics of system modeling with discrete events.			
Course outcomes	Students apply variational methods, Hamilton's principle, and Lagrange-Euler equations to model mechanical, electrical, and electromechanical systems, including incremental converters, electrical machines, and discrete-event systems.			
Course outline				
Theoretical teaching	Modeling of physical systems. Variation methods and energy functions. Variation principle for statics. Variation principle for dynamics. Hamilton's principle and Lagrange-Euler equations for mechanical, electrical and electromechanical systems. Incremental electromechanical converter models. Application of Lagrange-Euler equations in the modeling of electric machines. Introduction to system modeling with discrete events.			
Practical teaching (exercises, OFE, study and research work)	Practical teaching covers the application of variational calculus. Using Hamilton's principle and Lagrange-Euler equations, complex mechanical systems, electrical circuits, and electromechanical converters are mathematically modeled. Students derive nonlinear and incremental models for solenoids and electrical machines, and the exercises conclude with discrete-event system modeling using Petri nets.			
Textbooks/references				
1	R. G. Longoria, J. J. Beaman, Modeling of Physical Systems: Simulation and Control, Wiley, 2025.			
2	C. G. Cassandras and S. Lafortune, Introduction to Discrete Event Systems, Springer Science + Business Media, 2008.			
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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	0	0

Teaching methods	Lectures; Auditory 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		**Oral exam**	30
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	MATLAB and Applications in Control Systems		
Lecturer (for lectures)	Spasić D. Miodrag		
Lecturer/associate (for exercises)	Dimitrijević G. Jelena		
Lecturer/associate (for OFE)	Jovanović M. Anđela		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introduction to the basics of programming in MATLAB and the development of ability for its application for the needs of mathematical modeling and simulation of dynamical systems, design of control algorithms and optimization of control systems.		
Course outcomes	By the end of the course, students will gain basic knowledge about programming in MATLAB. Through resolving specific problems, it will be easier to understand the principles of control system and acquire knowledge of MATLAB applications in the analysis and design of automatic control systems.		
Course outline			
Theoretical teaching	MATLAB environment and terminology. MATLAB programming language syntax and basic programming elements. Operators in MATLAB. Formation of strings and matrices. Elements of object-oriented programming in MATLAB. Working with files. Recursion. Working with pictures. Graphical user interface. Working with sound. Program validation, Troubleshooting and help. Advanced programming in MATLAB. Other computer tools and MATLAB.		
Practical teaching (exercises, OFE, study and research work)	Introduction to MATLAB. Description of continuous systems in a time and frequency domain. State-space description of continuous systems. Negative feedback. Stability of linear control systems. Control of stable continuous systems. PID regulator. State feedback. Polynomial approach to regulator design. Analysis of discrete systems. Design of discrete regulators. Delay compensation - Smith's predictor and other methods. Designing a discrete PID regulator. State feedback design of discrete systems. Polynomial approach to the design of discrete regulators.		
Textbooks/references			
1	M. Weeks, "Programming Fundamentals Using MATLAB", Mercury Learning and Information, 2020.		
2	L. Keviczky, R. Bars, J. Hetthéssy, C. Bányász, “Control Engineering: MATLAB Exercises”, Springer Nature Singapore Pte Ltd. 2019.		
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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	1	2	0	0

Teaching methods	Lectures; Auditory 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**	25
Exercises	10	**Oral exam**	25
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Telemetry		
Lecturer (for lectures)	Denić B. Dragan, Jovanović R. Jelena		
Lecturer/associate (for exercises)	Miljković S. Goran		
Lecturer/associate (for OFE)	Jovanović R. Jelena		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The course aims for students to acquire advanced knowledge of modern telemetry systems and technologies for the transmission of measurement data.		
Course outcomes	Upon successful completion of the course, the student is able to: distinguish, classify, and critically analyze the architectures of analog and digital telemetry systems; independently select and apply appropriate modulation techniques, communication interfaces, and network protocols for a given engineering application; design, configure, and software-implement algorithms for data acquisition and wireless telemetry transmission using modern microcomputer platforms; Integrate IoT concepts and Cloud services into systems for remote monitoring and predictive maintenance of industrial and technical systems; evaluate the performance of telemetry channels in the presence of noise and optimize real-time data transmission reliability.		
Course outline			
Theoretical teaching	Analog and digital telemetry systems; A/D conversion in telemetry; Wired and wireless telemetry; Multichannel telemetry and signal multiplexing; Modulation methods (amplitude, frequency, phase, pulse-width, delta, pulse-code); Modems; Digital phase and frequency modulation; Standard communication interfaces; Transmission of measurement signals over power lines; Fiber-optic systems; LAN and WiFi-based telemetry systems; Telemetry systems based on radio modems; Telemetry systems with GSM/3G/4G/5G technologies; Application of IrDA and Bluetooth technologies in telemetry; Industrial telemetry systems; Internet of Things (IoT) in modern telemetry systems; New trends in telemetry systems and their application in industry.		
Practical teaching (exercises, OFE, study and research work)	Demonstration of the operating principles of telemetry systems based on Arduino and Raspberry Pi platforms through various examples of measuring environmental parameters and their transmission over short or long distances; Writing programs in the C programming language for data acquisition using Arduino and Raspberry Pi platforms; Transmission of measurement data using wired media and wireless technologies; Introduction to and connection of the basic hardware of telemetry systems for real-time data collection and transmission; Display of data collected in real-time and their storage using Cloud services; Implementation of project tasks; Practical teaching is demonstration-based.		
Textbooks/references			
1	C. Siu, "IoT and Low-Power Wireless: Circuits, Architectures, and Techniques", 1st Edition, CRC Press, 2018.		
2	D. Barculo, J. Daniels, "Telemetry: Research, Technology and Applications", Nova Science Publishers, Incorporated, 2009.		
3	A. Rayes, S. Salam, "Internet of Things from Hype to Reality: The Road to Digitization", 2nd Edition, Springer, 2022.		
4	O. Krejcar, "Modern Telemetry", InTech, 2011.		
5	M. Milenkovic, "Internet of Things: Concepts and System Design", Springer International Publishing, 2020.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	1	2	0	0

Teaching methods	Lectures; Computational exercises; Laboratory exercises; Consultations; Project task implementation.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	15	**Oral exam**	10
Colloquia	40		
Projects	10		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Low Voltage Electrical Installations		
Lecturer (for lectures)	Kostić Z. Vojkan, Petronijević P. Milutin		
Lecturer/associate (for exercises)	Filipović R. Filip		
Lecturer/associate (for OFE)	Filipović R. Filip		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Acquisition of basic knowledge necessary for preparing and interpreting technical documentation related to low-voltage electrical installations and lightning protection installations, and the application of various devices and equipment used in low-voltage electrical installations.		
Course outcomes	At the end of the course, students will be able to independently prepare and interpret technical documentation related to low-voltage electrical installations and lightning protection installations. Additionally, students will be capable in the execution, supervision, verification, and maintenance of electrical and lightning protection installations.		
Course outline			
Theoretical teaching	Technical regulations. Technical documentation. Devices and equipment used in low-voltage electrical installations. Basic calculations. Conditions and requirements for the execution and use of electrical installations. Technical protection measures against electric shock; overcurrent; overvoltage; voltage drop and voltage interruption; by disconnection, switching off and functional switching on and off of the electrical circuit; fire protection. Procedures and methods for inspecting and verifying the features, characteristics, and quality of electrical installations. Design and execution of lightning protection installations. Maintenance and verification of lightning protection installations.		
Practical teaching (exercises, OFE, study and research work)	Numerical exercises cover examples of wiring diagrams for various devices and equipment used in electrical installations, as well as calculation examples that are an integral part of the technical documentation (calculation of the maximum instantaneous current, selection and verification of power cables, voltage drop calculation, short-circuit current calculations, selection and verification of protective devices for short-circuit current, calculation of protection against electric shock in case of indirect contact, calculation of lightning protection installations, earthing system calculation). Laboratory experiments include: The wiring of a circuit with single-phase and three-phase loads, The wiring of a circuit with installation switches, The wiring of a doorbell circuit, The wiring of a circuit with a residual current circuit breaker, The wiring of a staircase lighting circuit, The wiring of a distribution board.		
Textbooks/references			
1	Günter G. Seip; "Electrical Installations Handbook"; Third Edition; John Wiley & Sons; 2000.		
2	Geoffrey Stokes; "Handbook of Electrical Installation Practice"; Fourth Edition; Blackwell Science; 2003.		
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	0	0

Teaching methods	Lectures with application of demonstrative aids – slides and details of devices and equipment used in electrical and lightning protection installations, as well as appropriate examples of technical documentation from engineering practice. Numerical exercises with example problems guide students in independently solving engineering practice problems. Laboratory exercises are conducted with the aid of Laboratory Exercise manuals and lecturer advice. Students independently wire the laboratory exercises and then test them under voltage with the permission and in the presence of the lecturer's assistant.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	5	**Written exam**	35
Exercises	25	**Oral exam**	35
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Applied Electromagnetics		
Lecturer (for lectures)	Raičević B. Nebojša, Vučković N. Ana		
Lecturer/associate (for exercises)	Jovanović N. Isidora		
Lecturer/associate (for OFE)	Jovanović N. Isidora		
Number of ECTS	6	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	The objective of the course is to deepen knowledge in the field of electromagnetics, with emphasis on the application of analytical and numerical methods in modeling electromagnetic fields and waves, as well as to enable students to independently analyze and simulate electromagnetic phenomena using modern software tools in engineering systems.		
Course outcomes	Upon successful completion of the course, the student is qualified to analyze and solve basic and moderately complex problems in electromagnetics using Maxwell's equations, apply analytical methods such as the separation of variables method, the method of images, and conformal mapping, analyze the propagation of plane electromagnetic waves in different media, and use numerical methods and software tools for modeling and simulation of electromagnetic phenomena, as well as interpret the obtained results.		
Course outline			
Theoretical teaching	Maxwell's equations in integral and differential forms. Maxwell's equations in the complex domain. Electromagnetic properties of media. Boundary conditions. Electrostatics. Stationary and time-varying electromagnetic fields. Analytical methods for calculating electromagnetic fields – method of images, use of complex variable functions. Electromagnetic field potentials in homogeneous media. Poynting's theorem. Plane electromagnetic waves (in vacuum, dielectrics, imperfect conductors, ferrites, and layered media). Field polarization. Propagation of electromagnetic waves. Fresnel coefficients.		
Practical teaching (exercises, OFE, study and research work)	Computational exercises: Application of Maxwell's equations in integral and differential forms. Electrostatic fields and potentials. Application of boundary conditions. Separation of variables method, method of images, and conformal mapping in electromagnetic field analysis. Plane electromagnetic waves in different media. Fresnel coefficients, reflection and refraction of waves. Laboratory exercises: Application of FEMM 4.2 software for modeling and simulation of electromagnetic fields, analysis of electrostatic and magnetostatic systems, modeling of current-carrying conductors and magnetic circuits, as well as comparison of analytical and numerical results.		
Textbooks/references			
1	F. T. Ulaby, "Fundamentals Applied Electromagnetics", Pearson, Prentice Hall, New York, 2010.		
2	J. Vanderlinde, "Classical Electromagnetic Theory", Kluwer Academic Publishers, 2004.		
3	H. Neff, "Introductory Electromagnetics", John Willey & Sons, 1991.		
4	D. M. Veličković, F. H. Uhlmann, K. Brandisky, R. D. Stancheva, H. Brauer, "Fundamentals of Modern Electromagnetics for Engineering", TU Ilmenau, Germany, 2005.		
5	E. Rothwell, M. Cloud, "Electromagnetics", CRC Press, 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	0	0

Teaching methods	Lectures, auditory exercises, homework, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Probability and Statistics	
Lecturer (for lectures)			Milošević M. Dušan, Džunić S. Jovana	
Lecturer/associate (for exercises)			Rajković P. Jovan	
Lecturer/associate (for OFE)			Rajković P. Jovan	
Number of ECTS	6	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Mastering basic knowledge of probability and statistics.			
Course outcomes	Students' capability to draw conclusions under conditions of uncertainty and to analyze real-world data.			
Course outline				
Theoretical teaching	Definition of probability. Conditional probability and independence of events. Total probability rule and Bayes' formula. Distribution function. Numerical characteristics of random variables. Mathematical expectation, moments, dispersion, standard deviation. Chebyshev's inequality. Characteristic function. Distributions of random variables. Limit theorems. Central theorem of mathematical statistics. Some distributions important in statistics. Point estimates of parameters and efficiency of estimation. Confidence intervals. Testing statistical hypotheses. Pearson's chi-square test. Linear regression and correlation.			
Practical teaching (exercises, OFE, study and research work)	Definition of probability. Conditional probability and independence of events. Total probability rule and Bayes' formula. Distribution function. Numerical characteristics of random variables. Mathematical expectation, moments, dispersion, standard deviation. Chebyshev's inequality. Characteristic function. Distributions of random variables. Limit theorems. Central theorem of mathematical statistics. Some distributions important in statistics. Point estimates of parameters and efficiency of estimation. Confidence intervals. Testing statistical hypotheses. Pearson's chi-square test. Linear regression and correlation.			
Textbooks/references				
1	Arak M. Mathai, Hans J. Haubold, Probability and Statistics, De Gruyter, Berlin/Boston, 2017.			
2	Murray R. Spiegel, John J. Schiller, R. Alu Srinivasan, Probability and Statistics, McGraw-Hill, 2009.			
3	Joseph K. Blitzstein, Jessica Hwang, Introduction to Probability, Chapman & Hall, 2019.			
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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	0	0

Teaching methods	Lectures, computational exercises, computer exercises, consultations.

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Process Control	
Lecturer (for lectures)			Jovanović D. Zoran, Nikolić S. Saša	
Lecturer/associate (for exercises)			Nikolić S. Saša, Danković B. Nikola	
Lecturer/associate (for OFE)			Perić Lj. Staniša, Danković B. Nikola	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Gaining knowledge about industrial processes, classical control methods and computer process control.			
Course outcomes	Upon completion of the course, the student will be able to analyze, design, and implement industrial process control systems, using traditional and modern methods and computer tools.			
Course outline				
Theoretical teaching	General concepts about processes. Types of processes. Features of processes. Economic aspects of process control. Classical control methods. Program control. Sequential process control. Application of computer technology in process control. Real-time computer controlled systems. Application of programmable logic controllers. Application of computers in complex process automation. Hierarchical process control. Types of controllers. Methods of adjusting PID controller parameters. Application of orthogonal polynomials and filters in testing the sensitivity of various dynamic real systems.			
Practical teaching (exercises, OFE, study and research work)	Process self-regulation and sensitivity. On-off control. Pulse proportional control. Control using programmable logic controllers. Design and tuning of industrial PID controllers. Application of orthogonal filters in process control. Work with the MATLAB Control Systems Tollbox software package, as well as application of acquired knowledge in controlling real processes on laboratory equipment.			
Textbooks/references				
1	G. Kalani, “Industrial Process Control”, Elsevier, 2002.			
2	J. Romagnoli, A. Palazoglu, “Introduction to Process Control”, CRC Press, 2006.			
3	K. J. Åström, R. M. Murray, Feedback Systems: An Introduction for Scientists and Engineers, Princeton University Press, Princeton, 2021.			
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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	0	0

Teaching methods	Lectures; Auditory 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	20	**Oral exam**	30
Colloquia	20		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Nonlinear Control Systems		
Lecturer (for lectures)	Mitić B. Darko, Perić Lj. Staniša		
Lecturer/associate (for exercises)	Mitić B. Darko, Đorđević D. Anđela, Dimitrijević G. Jelena		
Lecturer/associate (for OFE)			
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to the basic concepts and classification of nonlinear control systems, as well as to the main methods for their analysis and synthesis.		
Course outcomes	Theoretical knowledge in nonlinear control systems. Implementation of nonlinear system theory in analysis and synthesis of control systems.		
Course outline			
Theoretical teaching	Nonlinear control systems. Concept, classification and typical nonlinearities. Methods for analyzing nonlinear control systems. Stability of nonlinear control systems. Definition of stability, local stability. Indirect Lyapunov method. Direct Lyapunov method. Concept of absolute stability of nonlinear control systems. Lurie's problem. Popov's frequency method. Process stability. Examples of nonlinear control systems. Systems with natural nonlinearities. Systems with intentionally introduced nonlinearities (relay systems; variable structure control systems), Examples of analysis and synthesis of nonlinear control systems. Feedback linearization.		
Practical teaching (exercises, OFE, study and research work)	Analysis of nonlinear control systems in the phase plane. Phase portraits of second-order linear systems. Harmonic linearization methods. Application of Mihailov's criterion for determining self-oscillations. Application of Nyquist's criterion for determining self-oscillations. First Lyapunov method. Second Lyapunov method. Lurie's problem. System stability analysis using Popov's frequency method. Two-position regulators. Variable structure control systems. Sliding mode control design. Feedback linearization.		
Textbooks/references			
1	A. Isidori, "Nonlinear control systems", Springer, 1995.		
2	H.K. Khalil: “Nonlinear Systems”, Prentice Hall, 1996.		
3	I. Karafyllis, Z. Jiang, "Stability and Stabilization of Nonlinear Systems", Springer London, 2011.		
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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	0	0	0

Teaching methods	Lectures; Auditory exercises

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Communications and Information Technologies - Communications and Information Processing Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies
Type and level of studies	Undergraduate Academic Studies
The name of the course	Mechatronics
Lecturer (for lectures)	Perić Lj. Staniša, Antić S. Dragan
Lecturer/associate (for exercises)	Perić Lj. Staniša, Sibinović D. Vladimir, Dimitrijević G. Jelena
Lecturer/associate (for OFE)	Sibinović D. Vladimir, Dimitrijević G. Jelena

Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory / Elective

Prerequisites	None
Course objectives	The aim of the course is to provide students with an interdisciplinary understanding of mechatronic systems by connecting knowledge from mechanical engineering, electronics, control systems, and software engineering. Students will become familiar with the key components and operating principles of mechatronic systems, as well as the basics of applying artificial intelligence in modern technical solutions.
Course outcomes	Upon completion of the course, students will acquire the knowledge and skills necessary to understand and analyze the basic components and operating principles of mechatronic systems. They will be capable of independently designing simple systems that integrate sensors, actuators, microcontrollers, and control algorithms. Additionally, they will be able to identify and apply fundamental concepts of artificial intelligence to enhance the functionality and intelligent behavior of mechatronic systems.
Course outline	
Theoretical teaching	Introduction to mechatronics and the interdisciplinary approach in engineering. Sensors and measurement systems in mechatronic applications. Actuators and drive mechanisms: theory and application. Analog signal processing and data acquisition systems. Microcontrollers and fundamentals of embedded systems programming. Basics of control in mechatronics. Mechanical components and kinematics in mechatronic systems. Modeling and simulation of electromechanical systems. Design and integration of components into mechatronic systems. Overview of artificial intelligence applications in modern mechatronic systems. Case studies and current trends in industrial mechatronics.
Practical teaching (exercises, OFE, study and research work)	Identification and analysis of the basic elements of mechatronic systems. Communication between mechatronic systems and users. Application of sensors and real-time data reading. Drive systems. Microcontroller programming. General and special-purpose digital inputs/outputs. Analog inputs. Modeling and simulation of simple mechatronic systems in a software environment. Integration of individual components into a closed control loop. Implementation of a PID controller in a microcontroller environment. Application of intelligence at the microcontroller level. Case studies: Analysis and evaluation of a real mechatronic system and possibilities for its improvement through modern technologies.
Textbooks/references	
1	Robert H. Bishop, "The Mechatronics Handbook", CRC Press, 2002.
2	Clarence W. De Silva, "Mechatronics: An Integrated Approach", CRC Press, 2005.
3	Sabri Cetinkunt, "Mechatronics", John Wiley & Sons Inc., 2007.
4	David G. Alciatore, Michael B. Histand, ""Introduction to Mechatronics and Measurement Systems"", McGraw-Hill, 2012.
5	Biswanath Samanta, "Introduction to Mechatronics: An Integrated Approach", Springer International Publishing, 2023.

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures; Auditory 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		**Oral exam**	30
Colloquia	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Optimal Control	
Lecturer (for lectures)			Veselić R. Boban	
Lecturer/associate (for exercises)			Mitić M. Vladimir	
Lecturer/associate (for OFE)				
Number of ECTS	5	**Course status (obligatory/elective)**	Elective	
Prerequisites	None			
Course objectives	The goal of this course is to master the basic theoretical knowledge necessary for the application of different optimization methods and their aplication in control systems.			
Course outcomes	Students acquire the ability to identify optimization problems arising in specific control applications, formulate them mathematically through appropriate performance criteria, and select suitable methods for obtaining optimal solutions. They develop competencies in solving static optimization problems, designing Kalman controllers, performing system parameter optimization, and applying variational methods to the solution of optimization problems.			
Course outline				
Theoretical teaching	Introduction to optimal control. Formulation of optimal control task. Cost functions. Necessary and sufficient conditions for optimality. Unconstrained optimization methods. Optimization with constraints. Lagrange multipliers and Hamiltonian function. Classical calculus of variations. The Euler-Lagrange equation and transversality conditions. Maximum principle. Principle of optimality and dynamic programming. Continuous-time LQR problem. Separation principle and observers in optimal control systems. Examples.			
Practical teaching (exercises, OFE, study and research work)	Formulation of the optimal control problem and optimality conditions, bilinear and quadratic forms, static optimization problems with and without constraints, variational method, optimization problems with specified final time, optimization problems with unspecified final time, optimization problems with constraints, parametric optimization, Kalman controller.			
Textbooks/references				
1	F. L. Lewis, V. L. Syrmos: Optimal Control, John Wiley&Sons. Inc., New York, 1995.			
2	J. B. Burl: Linear Optimal Control – H2 and H∞ methods, Addison-Wesley, 1999.			
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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	0	0	0

Teaching methods	Lectures; Exercises; Consultations.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	0	**Oral exam**	20
Colloquia	40		
Projects	15		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Fundementals of Predictive Control	
Lecturer (for lectures)			Antić S. Dragan, Mitić B. Darko, Spasić D. Miodrag	
Lecturer/associate (for exercises)			Mitić B. Darko, Spasić D. Miodrag	
Lecturer/associate (for OFE)			Mitić B. Darko, Spasić D. Miodrag	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Introduction to the basics of predictive control with the aim of training students to design controllers from the family of predictive controllers, which are currently very popular for application in industry.			
Course outcomes	After completing the course, students will acquire basic knowledge of predictive control, as well as the accompanying elements necessary for the design of predictive controllers. In addition to the acquired theoretical knowledge, students will be able to independently design several types of predictive controllers, the use of which they will be able to simulate using the MATLAB software package.			
Course outline				
Theoretical teaching	Optimal systems. Criterion functions. Parametric optimization. Design of a linear quadratic controller. Linear quadratic controller with a predetermined degree of exponential stability. Design of an observer. Digital linear quadratic controller. Kalman estimator. The concept of predictive control. Linear quadratic controller and predictive control - comparison. Main components of predictive control (prediction, moving horizon, system models, performance index, constraints). Predictive model of a system in the state space. Predictive model of a system in the form of a transfer function. Generalized predictive control (GPC). Dynamic Matrix Control (DMC). Constraints and optimization.			
Practical teaching (exercises, OFE, study and research work)	Design of a linear quadratic regulator. Formation of various predictive models of the system (state space and transfer function) for designing a predictive controller. Definition of performance indices. Design of controllers using the MATLAB software package. Design of a generalized predictive controller (GPC). Tuning of predictive controller parameters and analysis of system response. Design of predictive controllers using the Model Predictive Control toolbox.			
Textbooks/references				
1	J. A. Rossitr, A First Course in Predictive Control, Second Edition, CRC Press (2018)			
2	Eduardo Camacho, Carlos Bordons, Model Predictive Control, Springer (2007)			
3	Jan Maciejowski, Predictive Control with Constraints, Prentince Hall (2000)			
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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	0	0

Teaching methods	Lectures, classroom 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	10	**Oral exam**	20
Colloquia	40		
Projects			

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Servo Systems	
Lecturer (for lectures)			Mitić B. Darko, Veselić R. Boban	
Lecturer/associate (for exercises)			Sibinović D. Vladimir	
Lecturer/associate (for OFE)			Sibinović D. Vladimir	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Familiarize students with the tasks and principles of servo control, as well as with the ways of design and realization of modern servo systems.			
Course outcomes	Students analyze servo system structure and accuracy, design PID and phase compensators in the frequency domain, and discretize and practically implement control algorithms using digital signal processors.			
Course outline				
Theoretical teaching	The concept and definition of a servo system. Types and structures of servo systems. Accuracy of servo systems. Transfer compensation. Methods of estimation and compensation of disturbances. Design of servo systems in the frequency domain using phase compensators and PID controllers. Digital implementation of control algorithms. Methods of numerical integration. Discrete equivalents of linear analog controllers and filters. Implementations of digital controllers and filters. Digital signal processors (DSPs) and their architecture. DSP peripherals necessary for the implementation of servo systems.			
Practical teaching (exercises, OFE, study and research work)	Solving various practical problems of servo system analysis and design. Introduction to the TMS320F/C24xx DSP family, which is specialized for control engineering tasks. Designing a specific position or speed servo system and its practical implementation on the MCK2407 development system within the framework of an independent study and research work project.			
Textbooks/references				
1	G.W. Younkin, Industrial Servo Control Systems - Fundamentals and Applications, Marcel Dekker Inc., 2002.			
2	TMS320F243/F241/C242 DSP Controllers Reference Guide - System and Peripherals, Texas Instruments, 2000.			
3	MSK2407 &MCK2407, TMS320LF2407 Motion Starter Kits & Motion Control Kits – User Manual, DSP Motion Solutions, Technosoft, 2001			
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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	0	0

Teaching methods	Lectures; Auditory and laboratory exercises; Consultations. Every student is required to do an individual project assignment.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	25	**Oral exam**	20
Colloquia			
Projects	25		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Electrical Drives	
Lecturer (for lectures)			Mitrović N. Nebojša, Petronijević P. Milutin	
Lecturer/associate (for exercises)			Banković G. Bojan	
Lecturer/associate (for OFE)			Banković G. Bojan	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Introducing students to the role and importance of electric drives, including their types, structures, and methods for analyzing static characteristics in practical applications.			
Course outcomes	Understanding the fundamental principles and structure of electric drives. Developing the ability to analyze complex electromechanical systems through the functional integration of power converters, electric machines, and the mechanical load. Familiarity with steady-state characteristics.			
Course outline				
Theoretical teaching	The importance of electric drives. Selection of electric motors. Drive characteristics of DC motors. Mathematical models, steady-state characteristics, and equivalent circuits. Methods of electric braking. Control techniques, including combined voltage and flux control. Application of power converters in DC drives. Drives using induction and synchronous motors: basic equations, equivalent circuits, and the influence of voltage, parameter variations, and frequency. Electric braking methods. Voltage and current converters for AC motor drives. Steady-state characteristics. Inverter applications and control methods.			
Practical teaching (exercises, OFE, study and research work)	Laboratory experiments on real machines provide practical training, including: - Drives with DC motors (analysis of operating modes, control methods, and braking modes). - Drives with induction and synchronous machines (analysis of operating modes, control methods, and braking modes). - Application of converters in DC and AC drives.			
Textbooks/references				
1	Paul Krause, Oleg Wasynczuk, Scott Sudhoff, Steven Pekarek, "Analysis of Electric Machinery and Drive Systems", Institute of Electrical and Electronics Engineers, 2013.			
2	Andre Veltman , Duco W.J. Pulle , Rik W. De Doncker, "Fundamentals of Electrical Drives", Springer, 2016.			
3	Ion Boldea, Syed A. Nasar "Electrical Drives", CRC Press, 3rd edition 2022.			
4	R. Krishnan, "Electric Motor Drives" Virginia Tech, Prantice Hall 2001.			
5	Piotr Watch, "Dynamics and Control of Electrical Drives", Springer, 2011.			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Classes are conducted through lectures and exercises. Lectures employ modern teaching methods. Tutorial sessions with numerous examples guide students to independently solve problems from engineering practice. Part of the exercises is carried out in the laboratory to obtain the steady-state characteristics of electric drives.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	30
Exercises	15	**Oral exam**	20
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Engineering Ethics		
Lecturer (for lectures)	Bojkov S. Vanče		
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS	2	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Acquiring knowledge on the mechanism of gaining moral and values in a legal system.		
Course outcomes	The adopted knowledge should help students of electronics to identify the theory of engineering issues; to analyze problems of professional ethics in engineering; to adopt moral responsibility in forming credibility of profession as a moral resource in work and the aspects of ethical behavior in the era of digital revolution.		
Course outline			
Theoretical teaching	Engineering, engineerng ethics and the relevance of ethics in technics and society. Ethical education of engineers. Assumptions of engineering ethics. Social norms, moral and law. Ethical aspect of team work. Ethical codex and engineering moral practice. Forming engineering ethics and moral responsibility. Tesla's engineering ethics. Ethical codex of IEEE members.		
Practical teaching (exercises, OFE, study and research work)			
Textbooks/references			
1	Martin, M. W., & Schinzinger, R. (2021). *Ethics in engineering* (5th ed.). McGraw-Hill Education.		
2	Harris, C. E., Pritchard, M. S., & Rabins, M. J. (2019). *Engineering ethics: Concepts and cases* (6th ed.). Cengage Learning.		
3	Fleddermann, C. B. (2017). *Engineering ethics* (4th ed.). Pearson Education.		
4	Vesilind, P. A. (2016). *Engineering, ethics, and the environment* (1st ed.). Cambridge University Press.		
5	Whitbeck, C. (2011). *Ethics in engineering practice and research* (2nd ed.). Cambridge University Press.		

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

Teaching methods	Lectures, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises		**Oral exam**	20
Colloquia	40		
Projects	10		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Control System Design		
Lecturer (for lectures)	Veselić R. Boban		
Lecturer/associate (for exercises)	Mitić M. Vladimir, Jovanović M. Anđela		
Lecturer/associate (for OFE)	Mitić M. Vladimir, Jovanović M. Anđela		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The purpose of this course is to give the theoretical and practical knowledge related to the design of control systems and to prepare students for the rapid development of different control algorithms in real-time.		
Course outcomes	Students acquire the knowledge and skills required to formulate and solve practical engineering problems related to the design of automatic control systems, both continuous-time and digital. They develop the ability to design various control structures and controller types in accordance with specified technical requirements in the complex and frequency domains. Students also gain proficiency in applying methods for addressing challenges encountered during the practical implementation of the control subsystem.		
Course outline			
Theoretical teaching	General principles of control system design. Technical specifications for tracking and regulation control system design. System identification. System frequency response. Design of conventional controllers. Various structures of analog and digital PID controllers, some methods of their tuning and examples. Cascade compensators design. Controller design for time-delayed systems, Smith's predictor. Design of disturbance-invariant control systems. Feedforward compensation. State feedback control design. State variables estimation and state observer design. Digital simulation of the designed control system.		
Practical teaching (exercises, OFE, study and research work)	Solving of practicle design problems during exercises, homework assignments and design projects will make it easier for students to master method units that are studied through theoretical lectures. The following project tasks will be considered: design of a positional servosystem with a digital PD controller, design of a positional servosystem with a digital I-P controller, design of a positional servosystem with a digital I-PD controller, design of a positional servosystem with a digital compensator, design of a velocity servosystem with a digital PI controller, tuning of a digital I-P controller for a velocity servosystem using the Takahashi procedure, temperature control of a thermal process using a digital PI controller and an anti-windup structure.		
Textbooks/references			
1	G. Goodwin, G. Stefan, and M. Salgado, Control System Design, Prentice-Hall, 2000.		
2	R.C. Dorf, and R.H. Bishop, Modern Control Systems, Prentice-Hall, 2004.		
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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	0	0
Teaching methods	Lectures; Exercises; Laboratory work; 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	40		
Projects	0		

Specification for the book of courses

Study program		Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electrical Power Engineering Electrical Engineering and Computer Science / Electron Devices and Microsystems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies		Undergraduate Academic Studies		
The name of the course		Programmable Logic Controllers		
Lecturer (for lectures)		Jovanović D. Zoran, Nikolić S. Saša, Spasić D. Miodrag		
Lecturer/associate (for exercises)		Spasić D. Miodrag, Nikolić S. Saša		
Lecturer/associate (for OFE)		Jovanović M. Anđela, Dimitrijević G. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective	
Prerequisites	None			
Course objectives	Adopting basic knowledge about structure, mode, programming and practical application of PLC in industry.			
Course outcomes	Theoretical and practical knowledge of PLC systems. Design of control systems based on PLC.			
Course outline				
Theoretical teaching	Introduction to Programmable Logic Controllers (PLC). Input output devices. Processing of input-output signals. Programming programmable logic controllers. Scan cycle-execute program. Leder diagrams, list of commands, function blocks. Logical functions. Examples. PLC Components. Internal relays. Timers. Counters. Shift registers. Data processing. Development phase of programs for PLC. Testing and troubleshooting. Application of current PLC systems of various manufacturers (Simens, Omron, Micubisi, Alen Bredli, Schnieder Electric). Communication protocols. Examples of PLC applications in the control of real systems in industry.			
Practical teaching (exercises, OFE, study and research work)	Practical introduction of the PLC structure. PLC programming modes; Introduction to the operation and application of PLC-Siemens and Step7 development software. Totally Integrated Automation Portal V13 (TIA Portal V13). Working with PLC-Omron and development software CX One. Application of PLC in Distributed Management Systems. Application of PLC in dosing systems, transport systems, water supply systems. Application of PLC in the management of thermal processes.			
Textbooks/references				
1	D. Collins, E. Lane, “Programmable Controllers: A Practical Guide”, McGraw-Hill, 1995.			
2	W. Bolton, “Programmable Logic Controllers”, Newnes, 2003.			
3	M. T. White, "PLCs for Beginners: An Introductory Guide to Building Robust PLC Programs with Structured Text", Packt Publishing, 2024.			
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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	1	1	0	0

Teaching methods	Lectures; Laboratory Exercises; Computer Exercises; Consultations

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	30
Exercises	30	**Oral exam**	30
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Introduction to Robotics		
Lecturer (for lectures)	Nikolić N. Milutin		
Lecturer/associate (for exercises)	Mitić M. Vladimir, Sibinović D. Vladimir		
Lecturer/associate (for OFE)			
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to the fundamental topics of modern industrial robotics and applications of industrial robots.		
Course outcomes	Analyzes the geometric configurations of robots, workspace limitations, and the concept of singularity. Explains the difference between forward and inverse kinematics. Identifies the specifics of control in internal and external coordinates. Evaluates the operating principles of modern sensor systems and the methodology of robot integration in an industrial environment. Creates mathematical models of robot kinematics and dynamics using homogeneous transformations and Denavit-Hartenberg notation. Derives the Jacobian matrix, and performs calculations and mathematical synthesis of trajectories for given engineering problems. Independently analyzes a complex production task and transforms it into functional robotic operations. Participates in projects for the modernization and automation of production facilities through the successful introduction of robotics.		
Course outline			
Theoretical teaching	Basic concepts and definitions. Robot geometries. Homogeneous transformations. Robot kinematics (forward and inverse problem). Denavit-Hartenberg notation. Jacobian. Trajectory synthesis. Robot dynamics. Robot control in internal coordinates. Robot control in external coordinates. Position and force control. Robot programming. Sensors in robotics and their application. Application of robots in industrial tasks. Introduction of robots into production.		
Practical teaching (exercises, OFE, study and research work)	Homogeneous transformations. Denavit-Hartenberg notation. Jacobian. Inverse kinematics.		
Textbooks/references			
1	John Craig, Introduction to Robotics: Mechanics and Control, Pearson, 2017, ISBN: 978-0-13-348979-8		
2	Thomas R. Kurfess, Robotics and Automation Handbook, CRC Press, 2004, ISBN: 0849318041		
3	B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Robotics Modelling, Planning and Control, Springer, 2009, ISBN: 978-1-84996-634-4		
4	B. Siciliano, O. Khatib, Springer Handbook of Robitcs, Springer, 2016, ISBN: 978-3319325507		
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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	0	0	0

Teaching methods	Lecture notes and slides (will be posted on the Faculty website). Auditory lectures and demonstration exercises.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises		**Oral exam**	50
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Computer Based Industrial Measurement Systems		
Lecturer (for lectures)	Denić B. Dragan, Jovanović R. Jelena		
Lecturer/associate (for exercises)	Miljković S. Goran		
Lecturer/associate (for OFE)	Jocić V. Aleksandar		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	None
Course objectives	The objective of the course is to introduce students to modern industrial systems based on computer applications. Furthermore, it aims to provide the necessary knowledge on how to connect conventional and intelligent sensors to a computer, implement virtual instruments, and explore the possibilities of connecting such measurement systems to the Internet.
Course outcomes	Upon successful completion of the course, the student is able to: analyze and select an appropriate architecture of a single-channel or multi-channel computer measurement and information system for a specific industrial application; design and implement electronic circuits for signal conditioning and processing, as well as for interfacing sensors with data acquisition hardware; independently develop complex applications for real-time data acquisition, visualization, and analysis within the LabVIEW software environment; configure smart sensors, intelligent measurement modules, and standard industrial communication interfaces within distributed measurement networks; apply noise-reduction techniques through proper grounding and shielding of measurement setups and implement internet connectivity for remote monitoring.
Course outline	
Theoretical teaching	Introduction to computer-based measurement and information systems. Single-channel and multi-channel measurement systems. Multiplexing of measurement signals. Sensors and transducers in modern industrial systems. Development trends. Integrated and smart sensors. Intelligent measurement modules. Sensor interfacing and signal processing circuits. Two-wire transmitters. Standard communication interfaces. Measurement devices for use in explosive environments. Grounding and shielding. Distributed measurement and information systems and Internet connectivity. Virtual instrumentation and LabVIEW software. Industrial telemetry systems. Fundamentals of test engineering.
Practical teaching (exercises, OFE, study and research work)	The exercises guide students from an introduction to LabVIEW basics, data types, programming structures, and user interface design, to developing software modules for signal processing and digital filtering. They progress through configuring single- and multi-channel data acquisition systems, designing signal conditioning circuits for temperature and resistive sensors, and interfacing smart sensors via RS-232, RS-485, and Modbus. Students then deploy virtual instruments for anomaly detection, build distributed measurement systems with LabVIEW web servers for remote monitoring, and conclude with independent projects that integrate hardware interfacing, software acquisition, statistical analysis, and automated reporting.
Textbooks/references	
1	R. Zurawski, “The Industrial Information Technology Handbook”, CRC Press, 2018.
2	D. C. Swanson, “Signal Processing for Intelligent Sensor Systems with MATLAB”, CRC Press, 2012.
3	W. Nawrocki, “Measurement Systems and Sensors”, 2nd Edition, Artech House, 2015.
4	R. Johnson, “LabVIEW Programming for Engineering Applications: Definitive Reference for Developers and Engineers”, HiTeX Press, 2025.
5	M. Bhuyan, “Intelligent instrumentation, principles and applications”, CRC Press, 2011.

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	1	1	0	0

Teaching methods	Lectures are delivered using modern presentation tools or with the use of free course materials in the form of a script provided to all students. Computational and laboratory exercises are conducted in a computer-equipped laboratory.

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	5	**Written exam**	20
Exercises	30	**Oral exam**	15
Colloquia	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Measurement of Electrical Power Quality		
Lecturer (for lectures)	Simić M. Milan		
Lecturer/associate (for exercises)	Jovanović R. Jelena, Ranđelović S. Ivana		
Lecturer/associate (for OFE)	Đorđević-Kozarov R. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	None
Course objectives	Education and introduction of students with basic theoretical and practical aspects of electrical power quality measurement.
Course outcomes	Students' training and ability to solve practical problems in the field of electrical power quality measurement, based on good knowledge of measurement methods and techniques, with the proper use of modern devices and equipment for electrical power quality measurement.
Course outline	
Theoretical teaching	Definition of the term electrical power quality. Basic measurement parameters and electrical power quality disturbances. Standards for electrical power quality measurement. Voltage and current measuring transformers. Measuring devices and equipment for electrical power quality measurement. Insulation and grounding in measurement systems. Safety in handling with measuring equipment. Methods and techniques for measurement of electrical power quality parameters. Methods and equipment for testing electrical power quality measuring devices. Application of virtual instrumentation in electrical power quality measurement systems.
Practical teaching (exercises, OFE, study and research work)	Computational and laboratory exercises: training students to solve computational problems and practical application of measurement methods and devices for measurement of electrical power quality parameters, through engagement in laboratory and demonstration exercises. The basic areas covered in the laboratory exercises are: basic methods for measuring three-phase voltages and currents, application of various types of current sensors, measurement of electrical power and energy, as well as the application of modern measuring devices for measuring electrical power quality parameters. According to the instructions for working on laboratory exercises, students submit an appropriate report on each completed laboratory exercise.
Textbooks/references	
1	J. G. Webster, "Measurement, Instrumentation and Sensors Handbook", CRC Press, 2014.
2	Ewald F. Fuchs, Mohammad A.S. Masoum, “Power quality in power systems and electrical machines”, Elsevier Inc., 2008.
3	Roger C. Dugan, Mark F. McGranaghan, Surya Santoso, H. Wayne Beaty, “Electrical power systems quality, Second Edition”, McGraw-Hill, 2003.
4	C. Sankaran, “Power quality”, CRC Press, LLC, New York, 2002.
5	S. Tumanski, "Principles of Electrical Measurements”, Taylor & Francis Group, 2006.

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	1	1	0	0

Teaching methods	Lectures (theoretical teaching) with graphical presentation of material in the form of slides. Computational exercises and practical teaching in the form of laboratory and demonstration exercises. Daily student consultations with teachers or associates. Individual work of students in the form of homework assignments and preparation of seminar papers

Grade (maximum number of points 100)

Pre-exam duties	Points	Final exam	Points
Activity during lectures	20	**Written exam**	20
Exercises	20	**Oral exam**	20
Colloquia	0		
Projects	20		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Control Systems in Automotive Industry	
Lecturer (for lectures)			Antić S. Dragan, Mitić B. Darko, Perić Lj. Staniša	
Lecturer/associate (for exercises)			Sibinović D. Vladimir	
Lecturer/associate (for OFE)			Jovanović M. Anđela	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	The course aims to provide students with fundamental knowledge on the application of control systems in the automotive industry, ranging from the production process to modern vehicle control functions. The course covers the design of control subsystems as well as numerical simulations of automotive subsystems such as the braking system, vehicle handling systems, and the powertrain system.			
Course outcomes	Upon completing the course, students will be able to identify and analyze basic control systems in the automotive industry, understand vehicle electronics architecture and the role of ECU units, as well as apply fundamental control methods to models of various automotive subsystems.			
Course outline				
Theoretical teaching	Introduction to the automotive industry and the stages of vehicle manufacturing. Control systems in automotive production (PLC, SCADA, robotics). Introduction to vehicle control systems; functional safety standards (ISO 26262). Architecture of automotive electronics and ECU units. Sensors and actuators in vehicles. Modeling the basic dynamics of automotive control subsystems. Overview of classical control methods (PID, stability). Throttle and braking control systems (Drive-by-wire, Brake-by-wire). Engine and emissions control. Transmission and powertrain control. Suspension and steering control. Introduction to traction systems and their control (ESP, ESC, DSC, ABS). Cruise control and adaptive cruise control (ACC). Advanced driver assistance systems (ADAS). Control in electric and hybrid vehicles.			
Practical teaching (exercises, OFE, study and research work)	Case study: Production line architecture and automation systems. Introduction to the MATLAB/Simulink environment for automotive applications. Analysis of CAN communication and ECU system architecture. Sensor signal processing and working with sensor models in Simulink. Modeling the basic dynamics of automotive control subsystems. Implementation and tuning of PID controllers in Simulink. Simulation of electronic throttle control. Modeling and control of internal combustion engines. Simulation of automatic transmission and gear shifting algorithms. Modeling and control of active suspension systems. ABS simulation (braking with and without control). Adaptive cruise control model – radar detection and distance control. Simulation of ADAS functions: lane recognition and steering assistance.			
Textbooks/references				
1	Uwe Kiencke, Lars Nielsen, ""Automotive Control Systems: For Engine, Driveline, and Vehicle"", Springer Verlag, 2005.			
2	Reza N. Jazar, "Vehicle Dynamics: Theory and Application", Springer Verlag, 2008.			
3	A. Galip Ulsoy, Huei Peng, Melih Çakmakci, "Automotive Control Systems", Cambridge University Press, 2012.			
4	Wuwei Chen, Hansong Xiao, Qidong Wang, Linfeng Zhao, Maofei Zhu, "Integrated Vehicle Dynamics and Control", Wiley, 2016.			
5	Jingsheng Yu, Vladimir Vantsevich, "Control Applications of Vehicle Dynamics", Taylor & Francis Group, 2024.			

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

Lectures	Exercises	OFE	Study and research work	Other classes
2	2	1	0	0

Teaching methods	Lectures; Auditory exercises; Laboratory exercises; Consultations

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			
Projects	30		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Measurements in Medicine		
Lecturer (for lectures)	Živanović B. Dragan, Simić M. Milan		
Lecturer/associate (for exercises)	Đorđević-Kozarov R. Jelena		
Lecturer/associate (for OFE)	Đorđević-Kozarov R. Jelena, Jocić V. Aleksandar		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective

Prerequisites	None
Course objectives	To enable students to apply the principles, methods, and instrumentation used for measuring physiological variables, as well as to acquire, analyze, and interpret biomedical signals in modern medical measurement systems.
Course outcomes	The student is able to apply and analyze measurement methods in medicine, use biomedical measurement systems for the acquisition of physiological signals, interpret measurement results, and evaluate the quality and reliability of measurement procedures.
Course outline	
Theoretical teaching	Bioelectric potentials, electrophysiological signals. Methods of measuring electrophysiological signals. Acquisition of electrophysiological signals and measurement-acquisition systems in electrophysiology. Recording in analog systems. Electrodes and sensors for electrophysiological measurements and electrical stimulation. Electrophysiological amplifiers, basic amplifier requirements - configuration, galvanic isolation, power supply. Digitization of electrophysiological signals, computer support for storage, presentation and digital processing of electrophysiological signals, digital interfaces. Artifacts in measuring electrophysiological signals. Grounding, protection of the patient and medical instruments. Methods and instrumentation for registering and measuring biopotentials: EMG, EEG, ERP, ECG, EOG, EGG. The flow and pressure measurement of body fluids and gases. The concentration of body gases and liquids measurement.
Practical teaching (exercises, OFE, study and research work)	Practical teaching includes laboratory exercises in the field of biomedical measurements and physiological signal acquisition, including the use of temperature, EMG, ECG, EOG, and other sensors. Students perform the measurement, acquisition, processing, and analysis of biomedical signals, become familiar with the operating principles of measurement and data acquisition systems, and develop practical skills in the use of biomedical measurement instrumentation. Through problem-solving sessions and a seminar paper, students develop the ability to analyze results and solve problems related to the course content.
Textbooks/references	
1	John E. Hall, Michael E. Hall, " Guyton and Hall Textbook of Medical Physiology (14 edition)“, Elsevier, 2020.
2	Joseph D. Bronzino (ed.), „Biomedical engineering fundamentals“, CRC Press Taylor & Francis Group, 2006.
3	Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, „Biomedical Instrumentation And Measurements (2nd Edition)“, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1980.
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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	1	2	0	0

Teaching methods	Teaching is carried out through lectures, tutorial sessions, and laboratory exercises. Practical problems in the field of biomedical measurements are solved during tutorial sessions, while laboratory exercises focus on the acquisition, measurement, and processing of biomedical signals using appropriate measurement and computer equipment.

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			
Projects	30		

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Testing in Production		
Lecturer (for lectures)	Živanović B. Dragan		
Lecturer/associate (for exercises)	Simić M. Milan, Stojanović S. Milica		
Lecturer/associate (for OFE)	Stojanović S. Milica		
Number of ECTS	5	**Course status (obligatory/elective)**	Elective
Prerequisites	None		
Course objectives	Introducing students with basic problems and methods of testing during the production and development of the device. Understanding the characteristics of devices that need to be tested. Gaining insight into modern test equipment and testing methods.		
Course outcomes	Students will facilitate the inclusion in test engineers' tasks, which could independently define the test plan, select the measuring equipment and conduct the necessary testing of the development and production devices.		
Course outline			
Theoretical teaching	Design and Manufacturing Cycle of Electronic Devices. Types of Measurement Systems. Measurement of Component and Circuit Characteristics. Measurement during the Development Phase. Device Calibration. EMC Certification, Safety. Design for Easier Testing. Testing of Analog, Digital, and Mixed-Signal Circuits. PCB Testing. Test Adapters. Analog Multiplexing, Switching Matrices. Modern Test Equipment (Automated Test Equipment – ATE). Communication Interfaces for Measurement Systems. Software Tools. Virtual Instrumentation. LabVIEW Software for Testing. Test Plan Examples.		
Practical teaching (exercises, OFE, study and research work)	Laboratory exercises with training kits and measuring instruments. Integration of programmable instruments into a measurement system and control via computer using the LabVIEW software package and DAQmx or VISA drivers. Instrument connection through GPIB, RS232, and USB interfaces. Use of SCPI commands. Communication with and configuration of intelligent measuring transducers. Project work in the field of electronic device testing. Preparation of seminar papers.		
Textbooks/references			
1	P. O'Connor, " Test Engineering: A Concise Guide to Cost-effective Design Development and Manufacture, John Wiley & Sons. 2001.		
2	Burns, M.,Roberts,G.W.,"Mixed-Signal IC Test and Measurement",Oxford Univ. Press, New York. 2012.		
3	H. Kularatna, "Digital and Analogue Instrumentation testing and measurement", The Institution of Engineering and Technology, 2008.		
4	M. Bhuyan , “Intelligent Instrumentation,Principles and Applications”, Taylor and Francis Group, 2011.		
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	0	0

Teaching methods	Lectures with application of modern presentation tools. Implementation of project tasks and discussions, consultations.

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			
Projects	25		

Specification for the book of courses

Study program			Electrical Engineering and Computer Science / Control Systems	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Cryptography in Industrial Control System Security	
Lecturer (for lectures)			Milović M. Daniela, Milić N. Dejan, Panajotović S. Aleksandra	
Lecturer/associate (for exercises)			Panajotović S. Aleksandra	
Lecturer/associate (for OFE)			Panajotović S. Aleksandra	
Number of ECTS	5	**Course status (obligatory/elective)**		Elective
Prerequisites	None			
Course objectives	Mastering the fundamental knowledge of modern cryptography required to realize secure communications in modern industrial systems.			
Course outcomes	Students will be able to apply modern cryptographic methods, make a clear difference between them and their characteristics, and depending on the industrial system, choose the most adequate one, all with the aim of enabling cyber security in the system.			
Course outline				
Theoretical teaching	Introduction to cryptography. Classical cryptography and basic cryptographic elements. Block and serial ciphers. Modern cryptography. Confidentiality, integrity and authentication. Symmetric and public key cryptography. Digital signature. Hash function. Hybrid cryptosystems. Public key infrastructure PKI - a system for creating, managing, distributing, storing and revoking digital certificates for verifying the identity of entities in electronic communications - especially relevant for the transport and the application layers of industrial automation and control systems. X. 509 protocol. TLS and IPsec protocols. Security mechanisms in application layer protocols MODBUS, OPC and DNP3. Security attacks in industrial systems.			
Practical teaching (exercises, OFE, study and research work)	Solving the determined problems in the field of classical cryptography, modern symmetric and asymmetric cryptography, digital signing and hash functions. In the laboratory work, the problems posed in the auditory exercises are checked in the CrypTool2 software. In addition, students solve more complex problems through independent work. Analysis of TLS and IPsec in WireShark.			
Textbooks/references				
1	AGA 12, Part 1 – Cryptographic Protection of SCADA Communications, Part 1: Background, Policies, and Test Plan, American Gas Association, 2006.			
2	N. Ferguson, B. Schneier, T. Kohno, Cryptography Engineering – Design, Principles and Practical Applications, Wiley, 2010.			
3	R. L. Krutz, Industrial Automation and Control System Security Princeples, International Society of Automation, 2016.			
4	J. –P. Aumasson, Serious Cryptography – A Practical Introduction to Modern Encryption, No Starch Press, 2017.			
5	J. Holden, The Mathematics of Secrets – Cryptography from Caesar to Digital Encryption, Princeton University Press, 2017.			

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

Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	2	1	0	0

Teaching methods	Lectures (ppt presentation, animation and practical examples), auditory exercises, laboratory exercises, homeworks, consultations.

Grade (maximum number of points 100)

Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	
Exercises	40	**Oral exam**	50
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems Electrical Engineering and Computer Science / Electronics - Electronic Circuits and Embedded Systems Electrical Engineering and Computer Science / Electronics - Multimedia technologies		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	SCADA Systems		
Lecturer (for lectures)	Jovanović D. Zoran, Nikolić S. Saša, Danković B. Nikola		
Lecturer/associate (for exercises)	Danković B. Nikola		
Lecturer/associate (for OFE)	Jovanović M. Anđela, Dimitrijević G. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory / Elective
Prerequisites	None		
Course objectives	Introduction to SCADA systems and gaining knowledge about the application of these systems in the monitoring and control of industrial processes.		
Course outcomes	The student can apply SCADA systems in solving practical problems in industry and distributed systems and has the knowledge to independently design application software in a SCADA development environment.		
Course outline			
Theoretical teaching	Introduction to SCADA systems. Definition and elements of SCADA systems. History of SCADA systems. Real-time systems. Remote control. Communication with SCADA systems. Methods of connecting to SCADA. Sensors, actuators and connectivity. Monitoring and control using SCADA systems. SCADA user interface. Economic indicators of SCADA application in industrial plants. Applications and practical examples (SCADA systems in the automotive industry, smart buildings, water supply systems, petrochemical industry, etc.).		
Practical teaching (exercises, OFE, study and research work)	Introduction and practical work with HMI software using Citect SCADA. Software installation and activation. Project concept - Citect SCADA (use level, compilation and startup, project information). Working with existing projects (backup, restore, add and remove link). Setting up communication with PLC, choosing a communication protocol, driver. Tag concept and tag types. Objects. Creating and editing graphic and control objects. Programming graphic objects. Alarm types and subtypes. Alarm tag settings. Trend system (defining trend tags, creating trend pages, settings and monitoring). Page and project animation. Cluster definition. Server definition. Creating user accounts and defining access rights and privileges. SCADA system security. Cicode editor, functions and scripts. Using templates. Practical project examples. SCADA software from other manufacturers (Siemens, Schneider Electric, Omron). Specialized software. Project task.		
Textbooks/references			
1	S. Boyer, “SCADA (Supervisory Control and Data Aquisition)“, ISA, 1999.		
2	D. Bailey, E. Wright, “Practical SCADA for Industry“, Newnes, 2003.		
3	G. Yadav, K. Paul, “Architecture and Security of SCADA Systems: A Review“, Int. J. Critical Infrastructure Protection, 2021.		
4	A. Wali, F. Alshehry, “A Survey of Security Challenges in Cloud-Based SCADA Systems“, Computers, 13(4), 2024.		
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	0	0

Teaching methods	Lectures; Computer exercises; Laboratory exercises; Consultations

Grade (maximum number of points 100)

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

Specification for the book of courses

Study program	Electrical Engineering and Computer Science / Control Systems		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Intelligent Systems		
Lecturer (for lectures)	Milojković T. Marko, Milovanović B. Miroslav		
Lecturer/associate (for exercises)	Milojković T. Marko, Milovanović B. Miroslav		
Lecturer/associate (for OFE)	Milojković T. Marko, Milovanović B. Miroslav, Đorđević D. Anđela, Dimitrijević G. Jelena		
Number of ECTS	5	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introducing students to the principles of intelligent systems and applications of advanced machine learning technologies in the design, analysis and optimization of industrial processes.		
Course outcomes	Mastering the Python programming language. Mastering knowledge in the field of design and development of intelligent systems. Ability to apply various machine learning techniques for the analysis and prediction of industrial process dynamics.		
Course outline			
Theoretical teaching	Introduction to intelligent agents and intelligent systems. Introduction to the basics of Industry 4.0. Working with large databases. Advanced machine learning techniques (decision tree, random forest, k nearest neighbors, naive Bayes, linear and logistic regression, support vector machine). Application of advanced machine learning techniques in the analysis, synthesis and optimization of industrial processes. Cloud computing. Introduction to the current problems and possible solutions for the practical implementation and application of intelligent systems.		
Practical teaching (exercises, OFE, study and research work)	Introduction to the Python programming language and programming environment. Application of advanced machine learning techniques in the analysis, synthesis and optimization of industrial processes. Design of intelligent systems and their application in practice on real analytical problems.		
Textbooks/references			
1	S. Russell, P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall Series in AI, 2009.		
2	G. Luger, "Artificial Intelligence, Structures and strategies for Complex Problem Solving", Addison Wesley, 2009.		
3	M. Lutz, "Learning Python 5ed", O'Reilly, 2009.		
4	T. Rashid, "Make Your Own Neural Network", CreateSpace Independent Publishing Platform, 2016.		
5	H. Geng, "Internet of Things and Data Analytics Handbook", Wiley, 2016.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	1	1	0	0

Teaching methods	Lectures, Classroom 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**	40
Exercises	20	**Oral exam**	30
Colloquia			
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Mathematics 1		
Lecturer (for lectures)	Džunić S. Jovana, Rančić Z. Lidija, Marinković D. Slađana, Matejić M. Marjan		
Lecturer/associate (for exercises)	Stankov D. Stefan, Damnjanović G. Ivan, Stanković M. Hranislav, Rajković P. Jovan, Denić Z. Anđa		
Lecturer/associate (for OFE)			
Number of ECTS	7	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The aim of the course is to provide students with a solid mathematical foundation necessary for understanding and applying modern methods in electrical engineering and computer science. The course develops abstract reasoning, logical and analytical thinking, as well as inductive and deductive forms of inference. Emphasis is placed on mastering and recognizing the advantages of working with vectors and matrices, which are key concepts for further study in electronics, computer science, and telecommunications. Preparing students to understand and master advanced linear algebra techniques that will be studied in later years.		
Course outcomes	Upon successfully completing the course, the student will be able to apply the covered concepts in the formalization and analysis of mathematical problems. They will understand and apply complex numbers and polynomials in algebraic and geometric contexts. They will acquire the knowledge needed for modeling and analysis using vector spaces, inner products, and orthogonalization methods. They will be capable of using matrices and determinants in the analysis of linear mappings and in solving systems of linear equations. The student will master the fundamentals of matrix spectral theory and analytic geometry in three-dimensional space.Upon successful completion of the course, the student will be able to apply fundamental concepts of mathematical logic, set theory, relations and functions, as well as basic elements of algebraic structures. They will understand and use complex numbers and polynomials in both algebraic and geometric problems. The student will acquire knowledge of vector spaces, inner products, and orthogonalization methods. They will be capable of using matrices and determinants to analyze linear transformations and solve systems of linear equations. Additionally, they will master the basics of matrix spectral theory and analytical geometry in three-dimensional space.		
Course outline			
Theoretical teaching	Logic and sets, relations, functions. Algebraic structures. Complex numbers: algebraic operations, geometric interpretation, and applications in plane geometry. Algebraic polynomials: divisibility, factorization, interpolation. Vector spaces: linear combinations, linear independence, basis, dimension, and coordinates. Inner product, norm, angles and orthogonality, orthonormal basis, Fourier coordinates, Gram-Schmidt process. Matrices: algebra, matrix types, linear transformations, fundamental subspaces, rank and nullity. Systems of linear equations: solvability criteria and solution algorithms. Determinants: properties and applications. Spectral theory of matrices: eigenvalues and eigenvectors, diagonalization, and applications. Analytic geometry: vector operations, equations of planes and lines in space.		
Practical teaching (exercises, OFE, study and research work)	Students actively apply the principles and methods introduced in the lectures through the solution of concrete problems. The exercises are designed to facilitate a deeper understanding of theoretical concepts and to develop analytical thinking by applying mathematics to real and abstract problems in geometry, linear algebra, electrical engineering, and computer science. The exercises encourage independent reasoning and prepare students to use mathematical tools in professional and engineering practice. Through solving problems and numerical examples, students actively apply and reinforce the material covered in the lectures. Special emphasis is placed on the vector-based approach and matrix notation. Students work on problems involving complex numbers and polynomials with applications in geometry, as well as on topics in linear algebra (vector spaces, orthogonalization, inner products, coordinates). In the matrix calculus component, students practice working with matrices and linear mappings, solving systems of equations, rank and determinants, as well as matrix spectral analysis. Additionally, the exercises include problems in analytic geometry in three-dimensional space, linking theoretical concepts with concrete computational examples.		
Textbooks/references			
1	Gilbert Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, 2023.		

2	J. Dzunic, H. Stankovic, Math 1 reading companion 2026, https://elfakrs.sharepoint.com/:b:/s/Mathematics1/IQDMN5VXyALmTYNsC-yRNCi3Ac6HSJ43QC2ga-UbtcYCHuA?e=SKY0iz
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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**
3	3	0	0	0

Teaching methods	Lectures, problem-solving sessions, 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	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Fundamentals of Theoretical Electrical Engineering 1		
Lecturer (for lectures)	Raičević B. Nebojša, Cvetković N. Nenad, Perić T. Mirjana, Vučković N. Ana, Živaljević U. Dragana		
Lecturer/associate (for exercises)	Perić T. Mirjana, Vučković N. Ana, Živaljević U. Dragana, Jovanović B. Dejan, Vukić B. Dragana, Ivković V. Natalija, Jovanović N. Isidora		
Lecturer/associate (for OFE)			
Number of ECTS	7	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The objective of the course is to develop understanding of the fundamental physical laws of electrostatics and the kinetics of steady-state electric currents, as well as to enable students to apply them in the analysis and solution of basic electrical engineering problems.		
Course outcomes	Upon successful completion of the course, the student is qualified to analyze and solve basic problems in electrostatics and steady-state electric currents. The student is able to calculate the capacitance of simple homogeneous and symmetric structures, analyze and solve basic and more complex DC electrical circuits, calculate currents, voltages, and power in circuits, and assess operating conditions of components in order to prevent overload.		
Course outline			
Theoretical teaching	Electrostatics (Charges and their distribution. Coulomb's law. Electric field strength vector. Gauss's law. Electric potential and voltage. Conductors in the electrostatic field. Capacitance and capacitors. Dielectrics in the electrostatic field. Boundary conditions. Energy and forces in the electrostatic field). Steady currents (Current density vector and current intensity. Ohm's law and resistors. Joule's law. Kirchhoff's laws. Generators. Maximum power transfer theorem. Methods for solving electrical circuits. Superposition theorem. Thévenin's theorem and Norton's theorem. Compensation theorem. Reciprocity theorem. Electric circuits with capacitors).		
Practical teaching (exercises, OFE, study and research work)	Application of Coulomb's and Gauss's laws. Determination of electric field, potential, and voltage. Capacitance and capacitor connections. Electric field energy. Ohm's law. Kirchhoff's laws. Methods for solving electrical circuits – direct application of Kirchhoff's laws, node-voltage method, and mesh-current method. Thevenin, Norton, and superposition theorems. Maximum power transfer condition. Analysis of circuits with resistors and capacitors.		
Textbooks/references			
1	L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 1996.		
2	F. T. Ulaby, "Fundamentals Applied Electromagnetics", Pearson, Prentice Hall, New York, 2010.		
3	B. Thide, "Electromagnetic field theory", Upsilon Books, 2001.		
4	J. Vanderlinde, "Classical Electromagnetic Theory", Kluwer Academic Publishers, 2004.		
5	Z. Popović, B. Popović, "Introductory Electromagnetics", Prentice-Hall, 2000.		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	3	0	0	0

Teaching methods	Lectures, auditory exercises, homework, consultations.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises		**Oral exam**	30
Colloquia	40		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science	
Type and level of studies		Undergraduate Academic Studies	
The name of the course		Physics	
Lecturer (for lectures)		Ristić S. Goran, Živanović N. Emilija	
Lecturer/associate (for exercises)		Marjanović B. Miloš, Mitrović I. Nikola, Stojanović D. Milan, Veljković Z. Sandra	
Lecturer/associate (for OFE)		Stojković S. Aleksandra, Vračar Zlatković M. Jana, Branković Lj. Neda, Stojanović D. Milan, Mitrović I. Nikola, Veljković Z. Sandra	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introducing students to the basic physical principles and laws to define the knowledge base for monitoring and mastering in the courses during the study.		
Course outcomes	Acquired necessary theoretical knowledge to successfully navigate in solving arithmetic problems and understanding and solving specific practical problems.		
Course outline			
Theoretical teaching	Theoretical lectures will be conducted within the following areas: Basic quantities and units. Kinematics, statics and dynamics of material point and rigid body. Elasticity. Fluid Mechanics. Heat and temperature. Fundamentals of Thermodynamics. Mechanical oscillations. Mechanical waves. Photometry. Geometric optics. Wave optics. Quantum optics. Fundamentals of atomic physics. Fundamentals of nuclear physics.		
Practical teaching (exercises, OFE, study and research work)	Practical lectures will be conducted through exercises, computer and laboratory. This will enable students to successfully master the areas covered in this course.		
Textbooks/references			
1	The Feynman Lectures on Physics, Vol. I, Edition by Richard P. Feynman, Robert Leighton, Matthew Sands, Basic Books, 2011.		
2	The Feynman Lectures on Physics, Vol. II, Edition by Richard P. Feynman, Robert Leighton, Matthew Sands, Basic Books, 2011.		
3	The Feynman Lectures on Physics, Vol. III, Edition by Richard P. Feynman, Robert Leighton, Matthew Sands, Basic Books, 2011.		
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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	0	0

Teaching methods	Lectures, calculus and laboratory exercises, 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		Electrical Engineering and Computer Science	
Type and level of studies		Undergraduate Academic Studies	
The name of the course		Introduction to Computing	
Lecturer (for lectures)		Stojanović M. Natalija, Predić B. Bratislav, Nejković M. Valentina	
Lecturer/associate (for exercises)		Jovanović D. Martin, Davidović P. Nikola, Veljanovski T. Marija, Ćojbašić Ž. Emilija	
Lecturer/associate (for OFE)		Jovanović D. Martin, Đorđević D. Nikola, Veljanovski T. Marija, Čikić D. Đorđe, Đorđević I. Anđelija	
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory

Prerequisites	None
Course objectives	Mastery of the fundamental concepts and principles of computing in accordance with the IEEE/ACM Computing Curricula recommendations.
Course outcomes	Upon successful completion of this course, students will acquire comprehensive theoretical and practical knowledge of the principles and methodologies underlying the operation of computer systems, encompassing both hardware and software components. Students will be able to apply different numeral systems, represent numerical values within computer systems, and perform basic arithmetic and logical operations. They will understand the principles of representing numerical, textual, audio, and video data in digital form, as well as the challenges and limitations associated with their storage, processing, and transmission. Students will develop competencies in the analysis and synthesis of combinational logic circuits, the minimization of switching functions, and the application of automata theory to the analysis, design, and implementation of sequential logic circuits. Furthermore, students will be able to explain the architecture and operational principles of the fundamental components of a computer system, including processors, memory subsystems, and input/output devices. They will also understand the basic concepts of machine-level programming and instruction execution within a processor. Students will gain an understanding of the core functions of operating systems, the fundamental principles of computer networks, the Internet, Web technologies, and computer security. They will be capable of designing and developing simple Web presentations. In addition, students will acquire practical skills in the use of software tools for the simulation of computer system components and will be able to apply acquired theoretical and practical knowledge to solve fundamental computing problems.
Course outline	
Theoretical teaching	Historical development of computing. Number systems. Data representation in computers. Boolean algebra. Switching functions. Methods for representing switching functions. Switching networks. Synthesis of combinational circuits. Standard combinational modules. Sequential switching networks. Computer architecture. Processor structure and machine-level programming. Computer software. Computer networks. Internet and the Web. Computer security. Programming languages and software development.
Practical teaching (exercises, OFE, study and research work)	Conversion of numbers between different numeral systems (binary, octal, decimal, hexadecimal). Performing operations in different numeral systems (binary, octal, hexadecimal). Representation of integer numbers. Addition and subtraction in sign-and-magnitude and two's complement formats. Representation of real numbers in fixed-point and floating-point formats. BCD codes and BCD arithmetic. Representation of switching functions. Minimization of switching functions. Synthesis of combinational circuits. Synthesis of characteristic switching function systems: decoders, adders, multiplexers, seven-segment displays, counters. Representation of finite-state machines (using graphs, transition/output tables, and matrices). Implementation of automata using switching functions. Paths in an automata. Acquiring practical knowledge about computer system components, their functions, and the operating principles of the central processing unit through simulation. Introduction to operating system functions, mastering the use of basic network software, and creating web presentations.
Textbooks/references	
1	Brookshear, J. G., & Brylow, D. Computer science: An overview,13th edition, Pearson., 2019.
2	Dale, N., & Lewis, J. Computer Science Illuminated. 8th ed., Jones & Bartlett Learning, 2023.
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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	0	0
Teaching methods	Lectures, exercises			
Grade (maximum number of points 100)				
Pre-exam duties		**Points**	**Final exam**	**Points**
Activity during lectures			**Written exam**	
Exercises		15	**Oral exam**	50
Colloquia		35		
Projects				

Specification for the book of courses

Study program			Electrical Engineering and Computer Science	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Introduction to Engineering	
Lecturer (for lectures)			Petronijević P. Milutin, Nikolić S. Saša, Milošević D. Nenad	
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)				
Number of ECTS	4	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Encouraging students to study engineering sciences and participate in solving practical problems. Introducing students to the engineering approach to problem solving, projects and the roles of engineers in them.			
Course outcomes	Students will gain insight into current knowledge in several technical areas used for the rational use of energy resources, intelligent system management, and information transfer.			
Course outline				
Theoretical teaching	Engineering approach to problem solving. The importance of innovation and innovative approach to problem solving. Fundamentals of engineering project management. Stages of an engineering project. Differences between engineering and software projects. Tools and methods for project management. Financial analysis of engineering projects. Basic financial concepts: revenue, cost, profit, depreciation. Methods of assessing the cost-effectiveness of engineering projects. Illustrative examples of the application of an engineering, multidisciplinary approach in solving specific problems in the field of new energy technologies, the application of automatic control and communication and information technologies. Presentation of examples from engineering practice.			
Practical teaching (exercises, OFE, study and research work)				
Textbooks/references				
1	Sullivan, William G., Elin M. Wicks, and C. Patrick Koelling, Engineering economy, Pearson, 2015.			
2	G. Rizzoni, J. A. Kearns, "Principles and Applications of Electrical Engineering",McGraw Hill, 2016.			
3	Galip Ulsoy, Huei Peng, Melih Çakmakci, Automotive Control Systems, Cambridge University Press, 2012.			
4	A. Huurdeman, The Worldwide History of Telecommunications, Wiley, 2003			
5				

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

Teaching methods	Lectures are delivered using slides, animations, and demonstrations of practical, engineering problems and applications.

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises		**Oral exam**	40
Colloquia	60		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Mathematics 2		
Lecturer (for lectures)	Matejić M. Marjan, Marinković D. Slađana, Rančić Z. Lidija, Džunić S. Jovana		
Lecturer/associate (for exercises)	Stankov D. Stefan, Damnjanović G. Ivan, Stanković M. Hranislav, Rajković P. Jovan, Denić Z. Anđa		
Lecturer/associate (for OFE)			
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Mastering the basic knowledge of mathematical analysis. Acquiring the ability to transform the presented theoretical considerations into functional knowledge. Establishing the foundations of iterations and approximations.		
Course outcomes	Students' ability to understand and use the language of mathematical analysis. Acquired knowledge necessary for continuing to study mathematics and engineering disciplines, as well as for modeling and solving problems in professional subjects and practice.		
Course outline			
Theoretical teaching	Metrics and basic topological concepts. Real sequences: convergence, properties of convergent sequences, Cauchy sequences. The limit of a function: Heine and Cauchy definitions, examples of function limits. Continuity of a function: properties, discontinuity of a function and types of discontinuities, continuous extension. Rate of convergence: symbols o and O. Differential calculus of functions of one variable: derivative of a function and geometric interpretation, rules of differentiation, differential. Fundamental theorems of differential calculus. Applications of differential calculus. Indefinite integral: methods of integration, integration of rational, irrational, trigonometric functions. Definite integral: definition and geometric interpretation, Newton-Leibniz formula. An improper integral. Applications of integrals. Solving some types of differential equations.		
Practical teaching (exercises, OFE, study and research work)	Real sequences: convergence and properties of convergent sequences. The limit of a function. Continuity of a function: properties, discontinuity of a function and types of discontinuities, continuous extension. Rate of convergence: symbols o and O. Differential calculus of functions of one variable: derivative of a function and geometric interpretation, rules of differentiation, differential. Fundamental theorems of differential calculus. Applications of differential calculus. Indefinite integral: methods of integration, integration of rational, irrational, trigonometric functions. Definite integral. Newton-Leibniz formula. Applications of integrals. Solving some types of differential equations.		
Textbooks/references			
1	Vladimir A. Zorich, Mathematical Analysis I, Springer-Verlag Berlin Heidelberg, 2004.		
2	Walter Rudin, Principles of Mathematical Analysis, McGraw-Hill Book Company, 1976.		
3	B. P. Demidovich, Problems in Mathematical Analysis, MIR Publishers, 1986.		
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**
3	3	0	0	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	40		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science	
Type and level of studies		Undergraduate Academic Studies	
The name of the course		Fundamentals of Algorithms and Programming	
Lecturer (for lectures)		Janković S. Dragan, Predić B. Bratislav, Ćirić M. Vladimir, Milenković M. Aleksandar	
Lecturer/associate (for exercises)		Milenković M. Aleksandar, Veljanovski T. Marija, Jovanović D. Martin, Veljanovski D. Aleksandar, Nikolić S. Mina, Đorđević I. Anđelija, Ćojbašić Ž. Emilija	
Lecturer/associate (for OFE)		Veljanovski T. Marija, Nikolić S. Mina, Puflović M. Darko, Čikić D. Đorđe, Milošević S. Marija, Ćojbašić Ž. Emilija, Drašković S. Vukadin, Đorđević I. Anđelija	
Number of ECTS	7	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	To enable students to acquire knowledge of algorithmic problem solving and structured programming. To introduce basic data types, basic programing structures, and programming in language C.		
Course outcomes	At the end of the course the student will be able to understand the algorithms and algoritmic representations, and to solve simple problems algorithmically. Students will be able to implement algorithmic solution to the problem in the programming language C.		
Course outline			
Theoretical teaching	Constants. Operators. Operators priority. The structure of C and the main function. Standard input and output. Flow control. Arrays and matrices. Decomposition and functions in the C-in. Functions and parameters. The parameters of the function main. Recursive functions. Standard C libraries. Derived data types: pointers, structures, nested structures, self-referencing structures, unions. Dynamic memory allocation. Preprocessor directives. Memory class identifiers. Strings. Arrays of pointers, a matrix of strings. Input, output. Files. Text and binary file types.		
Practical teaching (exercises, OFE, study and research work)	Programming in C. Working with C compilers and debugers. Variables and expressions. Flow control. Mathematical calculations. Arrays and strings. Multidimensional arrays. Functions. Files. Practical examples.		
Textbooks/references			
1	Kernighan, Brian W., and Dennis M. Ritchie. The C programming language. Pearson, 2nd edition, 2015.		
2	Herbert Schildt, C: The complete reference, Osborne/McGraw-Hill, 2000.		
3	Peter Prinz, C in a Nutshell, O'Reilly, 2nd edition, 2015.		
4	Peter van der Linden, Expert C Programming: Deep Secrets, Pearson, 1994.		
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
3	2	1	0	0

Teaching methods	Lectures. Lab. exercises. Homeworks, and projects, student seminars (presentation and discussion of students' work).

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures		**Written exam**	
Exercises	20	**Oral exam**	40
Colloquia	40		
Projects			

Specification for the book of courses

Study program		Electrical Engineering and Computer Science	
Type and level of studies		Undergraduate Academic Studies	
The name of the course		Fundamentals of Theoretical Electrical Engineering 2	
Lecturer (for lectures)		Raičević B. Nebojša, Cvetković N. Nenad, Perić T. Mirjana, Vučković N. Ana, Živaljević U. Dragana	
Lecturer/associate (for exercises)		Perić T. Mirjana, Vučković N. Ana, Živaljević U. Dragana, Jovanović B. Dejan, Vukić B. Dragana, Ivković V. Natalija, Jovanović N. Isidora	
Lecturer/associate (for OFE)		Perić T. Mirjana, Vučković N. Ana, Živaljević U. Dragana, Jovanović B. Dejan, Vukić B. Dragana, Ivković V. Natalija, Jovanović N. Isidora	
Number of ECTS	7	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	The objective of the course is to develop understanding of the fundamental laws of electromagnetism and to enable students to analyze and solve alternating current electrical circuits, as well as to apply basic methods of electromagnetic theory in engineering practice.		
Course outcomes	Upon successful completion of the course, the student is qualified to analyze and solve basic and moderately complex problems in electromagnetism and electrical circuits. The student is able to calculate the magnetic field and magnetic flux density of current-carrying conductors of various shapes, determine the inductance of simple structures with windings, analyze magnetic circuits and electromagnetic induction, and solve AC circuits with sinusoidal excitation using phasor analysis, complex impedances, and basic network theorems. The student applies methods for solving more complex AC circuits and analyzes resonant and inductively coupled systems.		
Course outline			
Theoretical teaching	Electromagnetism (Stationary magnetic field. Magnetic flux density vector. Magnetic flux. Biot-Savart law. Ampère's law. Ferromagnetic materials. Boundary conditions. Magnetic circuits. Electromagnetic induction. Faraday's law. Self and mutual inductances. Energy and loses in the magnetic field). Alternating currents circuits (Sinusoidal mode. Impedance. Phasors and complex representatives. Circuit solving in the complex domain. Complex power. Maximum power transfer theorem - impedance matching. Methods for circuit analysis. Theorems. AC bridges. Coupled circuits. Simple resonant circuits.		
Practical teaching (exercises, OFE, study and research work)	Computational exercises: Biot–Savart and Ampère's laws. Determination of magnetic field and flux density of current-carrying conductor systems. Magnetic flux and magnetic circuits. Faraday's law of electromagnetic induction. Inductance and mutual inductive coupling. Analysis of circuits in sinusoidal steady-state regime. Phasor analysis and complex impedances. Complex power. Methods for solving AC electrical circuits. Network theorems. AC bridge circuits. Resonant and anti-resonant circuits. Laboratory exercises: Laboratory safety rules. Use of measuring instruments and laboratory equipment. Verification of Ohm's and Kirchhoff's laws. Thevenin's and Norton's theorems and impedance matching between source and load. Introduction to modeling electrostatic and magnetostatic problems using FEMM 4.2 software. Phase relationships.		
Textbooks/references			
1	L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 1996.		
2	F. T. Ulaby, "Fundamentals Applied Electromagnetics", Pearson, Prentice Hall, New York, 2010.		
3	B. Thide, "Electromagnetic field theory", Upsilon Books, 2001.		
4	J. Vanderlinde, "Classical Electromagnetic Theory", Kluwer Academic Publishers, 2004.		
5	Z. Popović, B. Popović, "Introductory Electromagnetics", Prentice-Hall, 2000.		

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

Lectures	Exercises	OFE	Study and research work	Other classes
3	3	1	0	0

Teaching methods	Lectures, auditory exercises, homework, consultations.

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	30		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Electronic Devices		
Lecturer (for lectures)	Pantić S. Dragan, Prijić D. Zoran, Danković M. Danijel		
Lecturer/associate (for exercises)	Marjanović B. Miloš, Stojković S. Aleksandra, Vračar Zlatković M. Jana, Mitrović I. Nikola, Stojanović D. Milan, Branković Lj. Neda, Veljković Z. Sandra		
Lecturer/associate (for OFE)	Marjanović B. Miloš, Stojković S. Aleksandra, Vračar Zlatković M. Jana, Mitrović I. Nikola, Stojanović D. Milan, Branković Lj. Neda, Veljković Z. Sandra		
Number of ECTS	6	**Course status (obligatory/elective)**	Obligatory
Prerequisites	None		
Course objectives	Introduction to the principles of work, basic properties, construction, and parameters of passive (resistors, capacitors, inductors, transformers), semiconductor (diode, bipolar and MOS transistors) and optoelectronic (LED, solar cells, photodetectors) components.		
Course outcomes	The student acquires the necessary knowledge about the types, basic characteristics, the principle of operation and characteristic parameters of passive, semiconductor and optoelectronic components.		
Course outline			
Theoretical teaching	Introduction. Passive components. Through-hole and Surface Mount Components and Devices (SMD). Enclosures. Soldering components. One-layer printed circuit boards. Types and characteristics of resistors, capacitors and coils. Transformers and chokes. Electromechanical components. Switches, buttons, fuses, relays. Basic properties of a semiconductor and PN junction. Current-voltage characteristics of a diode. Diode types. Bipolar transistor. Structure, principle of operation, current-voltage characteristics and amplification. Operating modes and basic electrical model. Bipolar transistor as a switch and amplifier. MOS transistor. Structure and work principle. Current-voltage characteristics, operating modes and electrical model. MOS transistor as a switch and amplifier. CMOS inverter. Optoelectronic components. Photodetectors, LEDs, laser diodes, solar cells. Structures and electrical characteristics. Basic electrical models. Simple application examples. Fundamentals of integrated circuits (ICs). Principles of integration. Types of integrated circuits.		
Practical teaching (exercises, OFE, study and research work)	Using computational exercises, the student acquires the necessary theoretical and practical knowledge and is more closely acquainted with basic characteristics and characteristic parameters of passive, semiconductor and optoelectronic components.		
Textbooks/references			
1	T. Floyd "Principles of Electric Circuits", 10th ed., Pearson, 2019.		
2	T. Floyd "Electronic Devices", 10th Ed., Pearson, 2018.		
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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	0	0

Teaching methods	Lectures; Classroom exercises; Laboratory exercises; Consultations.

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			Electrical Engineering and Computer Science	
Type and level of studies			Undergraduate Academic Studies	
The name of the course			Introduction to Eelectronics	
Lecturer (for lectures)			Mančić D. Dragan, Dimitrijević A. Marko	
Lecturer/associate (for exercises)			Mirković D. Dejan, Radivojević S. Novak, Đorđević Z. Ivana, Špeletić M. Matija, Panić D. Aleksandar	
Lecturer/associate (for OFE)				
Number of ECTS	4	**Course status (obligatory/elective)**	Obligatory	
Prerequisites	None			
Course objectives	Introduction to the history, areas and trends of electronics development. Introduction to basic methods of analysis and synthesis of electronic circuits.			
Course outcomes	Students will learn basic concepts in electronics: the domain of electronics, its development and prospects. Students will be able to recognize electronic circuits and identify their elements, and gain basic knowledge of methods for analyzing electronic circuits.			
Course outline				
Theoretical teaching	History and development of electronics. Basic concepts of electrical signals (waveform, amplitude, frequency, phase, domains). Definition of linear and nonlinear element. Concept of electronic circuit, elements of electronic circuits. Basic concepts of quadrupoles, model and characteristics of a simple amplifier (characteristics, gain, bandwidth). Methods of analysis in electronics - simulation, verification, testing. Basic logic circuits, analysis of logic circuits. Basic concepts of complex electronic systems - integrated circuits, microcontrollers and microprocessors, FPGA.			
Practical teaching (exercises, OFE, study and research work)	Students will be demonstrated the operation of electronic circuits: the use of amplifiers, the use of diodes, the use of logic circuits and the use of microcontrollers. The operation of the presented circuits is comparatively analyzed using various methods in electronics in a visual and intuitive way - by simulating and measuring signals with a virtual instrument.			
Textbooks/references				
1	A.Sedra, K.Smith, Microelectronic Circuits, Oxford University Press, 2009.			
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**
1	1	0	0	1

Teaching methods	Lectrures, excercises

Grade (maximum number of points 100)			
Pre-exam duties	**Points**	**Final exam**	**Points**
Activity during lectures	10	**Written exam**	20
Exercises	10	**Oral exam**	20
Colloquia	40		
Projects			

Specification for the book of courses

Study program	Electrical Engineering and Computer Science		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Final paper -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 fundamental, theoretical-methodological, scientific-professional, and professionally-applicative knowledge and methods in solving specific problems. The student studies the problem, its structure and complexity, and based on conducted analyses, draws conclusions about possible ways to solve it. By studying literature, the student becomes familiar with methods designed for solving similar tasks and with engineering practice in their resolution.		
Course outcomes	Enabling students to independently apply previously acquired knowledge from various fields they have studied, in order to understand the structure of the given problem and perform systematic analysis aimed at drawing conclusions about possible approaches to its solution. Through independent use of literature, students broaden their knowledge by exploring different methods and works related to similar issues. This helps develop students' ability to perform analyses and identify problems within the assigned topic. Through the practical application of acquired knowledge, students cultivate the ability to recognize the role and position of engineers within their chosen field, the necessity for collaboration with other disciplines, and teamwork.		
Course outline			
Theoretical teaching	It is structured individually in accordance with the needs of the specific final thesis, its complexity, and organization. Based on their interests and inclinations, the student selects a field of study and a supervising professor from the list of faculty members in the study program, who then defines the specific task. The student studies relevant professional literature, scientific and expert papers on similar topics, performs analyses in order to find solutions to the assigned task, or conducts specific laboratory experiments. The research work also involves active monitoring of primary findings, organizing and conducting experiments, numerical simulations, and statistical data processing, as well as the creation of a seminar paper within the narrower scientific-teaching domain to which the topic of the independent research belongs.		
Practical teaching (exercises, OFE, study and research work)			
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**
			2	
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	Electrical Engineering and Computer Science		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Professional Practice		
Lecturer (for lectures)			
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS	3	**Course status (obligatory/elective)**	Obligatory
Prerequisites			
Course objectives	Familiarization with the work process in the company where the professional internship is carried out, its goals and organizational units. Getting acquainted with the team and project to which the student is assigned as part of the internship, selected in accordance with the student's chosen field of study (module). Understanding the company's workflow, business processes, recognition of workplace risks, and participation in design, documentation preparation, or quality control—aligned with the work process and possibilities of the working environment.		
Course outcomes	Enhancing the student's ability to integrate into the workforce upon completing their studies. Developing responsibility, a professional approach to work, and communication skills in a team setting. Supplementing the theoretical knowledge acquired during the academic program with practical understanding of the issues studied. Utilizing the experience of professionals employed at the institution where the internship is conducted to expand practical knowledge and motivate students. Gaining clear insight into the possibilities of applying the acquired knowledge and skills from the study program in real-world practice.		
Course outline			
Theoretical teaching			
Practical teaching (exercises, OFE, study and research work)	The content of the professional internship is fully aligned with its objectives. The student becomes familiar with the structure of the company and the goals of its operations, adapts their engagement to the chosen field of study, and diligently fulfills work responsibilities in accordance with the duties of the company's employees. The student describes their own involvement during the internship and provides a critical reflection on their experience, knowledge, and skills acquired throughout the 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	The student typically independently selects a company from the public, private, or government sector or a laboratory of the Faculty of Electronics in Niš where they will complete their professional internship. The internship can also be carried out abroad, in which case the student additionally improves their foreign language skills. Based on the student's proposal, the coordinator of the selected field/module approves the internship at the desired institution, upon which a written referral for professional internship is issued to the person responsible for conducting the internship at that institution. Upon completion, and based on the student's report and confirmation from the responsible person—verified by the company's signature and stamp—the student is awarded 3 ECTS credits for the completed practice.

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	Electrical Engineering and Computer Science		
Type and level of studies	Undergraduate Academic Studies		
The name of the course	Final paper		
Lecturer (for lectures)			
Lecturer/associate (for exercises)			
Lecturer/associate (for OFE)			
Number of ECTS	8	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The purpose of the final thesis is to consolidate, validate, and practically apply the knowledge acquired during studies. The student is given the opportunity to demonstrate the ability to independently carry out a simpler project, which may be of practical, research, or theoretical-methodological nature. The student also gains experience in presenting their work in written form and through oral defense during the final presentation.		
Course outcomes	It encompasses the ability to manage a basic independent project, formulate and analyze problems, critically assess possible solutions, and review relevant literature. The student applies acquired engineering and design knowledge and skills to solve problems, considering complexity, cost, reliability, and efficiency of solutions. They learn how to write the thesis according to prescribed format, and clearly and appropriately explain their project to a broad audience during oral defense.		
Course outline			
Theoretical teaching	The final thesis represents an independent research, practical, or theoretical-methodological work by the student aligned with their level of study, in which they explore a specific area through literature review and adopt research or design methodologies necessary for completing the project. In developing the thesis, the student applies both practical and theoretical knowledge acquired during their studies. A written thesis typically includes an introductory chapter, definition of the problem, overview of the field and existing solutions, proposal and description of the student's own solution, conclusion, and references. An oral public defense is organized before a committee of three members, one of whom is the thesis advisor. During the oral defense, the candidate presents the results of their work and answers questions from the committee, thereby demonstrating the ability to orally present and explain their project.		
Practical teaching (exercises, OFE, study and research work)			
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**
				2

Teaching methods	With the assistance of a faculty mentor, the student strives to solve the assigned task as independently as possible and to prepare the corresponding documentation and oral defense. The student's independent work is evaluated with 8 ECTS credits.

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			