

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master 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)				
Number of ECTS	5	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	Students will acquire advanced knowledge about the principles of operation of modern telemetry systems, as well as about methods for transmitting measurement data via wired and wireless communication technologies; They will understand the application of various modulation techniques, standard communication interfaces and network protocols in telemetry, as well as the integration of IoT concepts into modern industrial telemetry systems; They will be qualified to design, analyze and optimize telemetry solutions for various applications, including automation, remote monitoring and predictive maintenance of technical systems.			
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.			
Textbooks/references				
1	F. Carden, R. Henry, R. Jedlicka, "Telemetry systems engineering", Artech House, Boston, MA, 2002.			
2	D. Barculo, J. Daniels, "Telemetry: Research, Technology and Applications", Nova Science Publishers, Incorporated, 2009.			
3	W. Stallings, "Wireless Communications and Networking", Prentice Hall, 2002.			
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	2	0	0	0
Teaching methods	Lectures; Computational 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	5	Oral exam		20
Colloquia	40			
Projects	10			

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Numerical Solution of Equations		
Lecturer (for lectures)		Rančić Z. Lidija		
Lecturer/associate (for exercises)		Stanković M. Hranislav		
Lecturer/associate (for OFE)				
Number of ECTS	5	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	Introduction to different methods of numerical mathematics and mastering their application in solving nonlinear, ordinary differential and partial differential equations. Training for numerical solving systems of linear, nonlinear and differential equations			
Course outcomes	Students' ability to apply acquired knowledge in practice. Ability to recognize the type of problem from practice, select the appropriate method and its implementation for finding a solution.			
Course outline				
Theoretical teaching	Numerical solving of nonlinear equations. Numerical solving of the system of linear and nonlinear equations. Numerical differentiation and integration. Classification of methods for numerical solving of ordinary differential equations of the first order. Methods for solving the Koshi problem (Euler method, Runge-Kutta method, multi-step method). Methods for solving a contour problem (probing and error method, finite difference method, variation-projection method, finite element method). Translation of a higher order ODE to the first-order ODE system. Numerical integration of the first-order ODE system. Partial differential equations (classification of equations and problem classification) and their numerical solving by the finite difference method and the finite element method. Accuracy and stability of numerical methods.			
Practical teaching (exercises, OFE, study and research work)	Identifying and solving problems that follow the theoretical part of the course.			
Textbooks/references				
1	Kendal Atkinson, Weimin Han, David Stewart, Numerical solution of ordinary differential equations, John Wiley and Sons Inc Publication 2009			
2	Gwynne Evans, J.M. Blackledge, P. Yardley, Numerical methods for partial differential equations, Springer, London, 2000.			
3	M.K.Jain, S.R.K. Iyengar, R. K. Jain, Numerical Methods (Problems and Solutions), New age international publishers, New Delhi			
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, auditory 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		Communications and Information Technologies / Communications and Information Processing Electronics and Embedded Systems		
Type and level of studies		Master Academic Studies		
The name of the course		Embedded System Design		
Lecturer (for lectures)		Jovanović D. Milica, Đorđević Lj. Goran		
Lecturer/associate (for exercises)		Đošić M. Sandra		
Lecturer/associate (for OFE)		Jovanović D. Milica		
Number of ECTS		5	Course status (obligatory/elective)	Obligatory / Elective
Prerequisites	None			
Course objectives	Aim of this course is ability to design embedded system according to the application requirements and implementation limitations, focusing on the fundamental principles of embedded designing. Introduction to advanced methods and tools for embedded system design with emphasis on hardware/software co-design for FPGA platforms: modeling techniques, specification and analysis of alternative solutions, hardware/software partitioning with synthesis, understanding trade-offs between performance, consumption and resource utilization.			
Course outcomes	By the end of the course a student should be able to: a) model and specify embedded systems at high level of abstraction using standard methods and tools; b) design hardware/software system on FPGA platform; c) analyze hardware/software tradeoffs, algorithms and architectures to optimize the embedded systems based on requirements and implementation constraints; d) analyze modern embedded design trends			
Course outline				
Theoretical teaching	Introduction to embedded system design: application areas and examples, common characteristics, and challenges in embedded systems; traditional design flow, platform-based design. Specifications and modeling: requirements, models of computation, communicating finite state machines, data flow models, process networks, discrete-event based languages, levels of hardware modeling; comparison of models of computation. Evaluation and validation: performance evaluation, energy and power models, simulation, emulation, formal verification. Application mapping: problem definition, scheduling in real-time systems, hardware/software partitioning, mapping to heterogeneous multi-processors.			
Practical teaching (exercises, OFE, study and research work)	Practical classes cover work with the FPGA development platforms. Several laboratory exercises and small-scale projects focus on unified designing of hardware and software as well as performance evaluation. Practical classes include the following activities: a) designing a complete microprocessor based on the available IP core of standard peripheral units, b) developing software under the operating system using available device drivers, c) designing a dedicated IP core, and d) developing a software driver for the projected IP core and its integration into the microprocessor system			
Textbooks/references				
1	P. Marwedel, Embedded System Design: Foundations of Cyber-Physical Systems, and the Internet of Things, Springer, 2018.			
2	M. Wolf, High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing, Morgan Kaufmann, 2014.			
3	L. H. Crockett, R. A. Elliot, M. A. Enderwitz, R. W. Stewart, The Zynq Book : Embedded Processing with the Arm Cortex-A9 on the Xilinx Zynq-7000 All Programmable SoC, Strathclyde Academic Media, 2014			
4				
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, labs, homework, colloquia, consultations.			
Grade (maximum number of points 100)				
Pre-exam duties	Points	Final exam		Points
Activity during lectures		Written exam		25
Exercises	30	Oral exam		25
Colloquia	20			
Projects				

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing Electronics and Embedded Systems		
Type and level of studies		Master Academic Studies		
The name of the course		DSP Algorithms and Programming		
Lecturer (for lectures)		Nikolić R. Tatjana		
Lecturer/associate (for exercises)		Nikolić R. Tatjana		
Lecturer/associate (for OFE)		Nikolić R. Tatjana		
Number of ECTS		5	Course status (obligatory/elective)	Obligatory / Elective
Prerequisites		None		
Course objectives		The objective of the course is to enable students to master the theoretical and practical knowledge necessary for the implementation of fundamental digital signal processing algorithms using digital signal processors (DSP). The studied material includes the design, simulation, and implementation of key signal processing algorithms using the C programming language and MATLAB tools, as well as their integration into real systems.		
Course outcomes		After successful completion of the course, the student will be able to: a) explain the basic concepts and mathematical foundations of digital signal processing, b) analyze and apply signal processing techniques, c) develop and optimize DSP algorithms in the C programming language, d) implement algorithms on DSP platforms or via simulators, e) use MATLAB for signal analysis, system simulation, and verification of implementation accuracy, f) realize practical solutions in applications such as sensor signal processing.		
Course outline				
Theoretical teaching		Overview of digital signal processing theory. Signal discretization. Sampling, quantization, and codec operations. A/D and D/A converters. Frequency-domain signal analysis. Specific features and architectures of DSP processors. Data representation in fixed-point and floating-point formats and arithmetic; effects of finite word length. Instruction set. Development and implementation of computationally efficient algorithms on DSP platforms: convolution, correlation, digital filters (IIR, FIR, LMS, DFT, FFT, IFFT). Audio, speech, and image processing using DSP processors. Programming DSP processors in assembly and high-level languages. Development tools: assembler, linker, simulator, debugger. Efficient code creation: optimization, data type effects, memory mapping. Implementation in embedded environments.		
Practical teaching (exercises, OFE, study and research work)		1) Signal generation and analysis in MATLAB. 2) Manipulation of fixed-point and floating-point numbers. 3) Introduction to the capabilities of modern development tools for design – using the Code Composer Studio software and DSP development system. 4) Implementation of FIR and IIR filters using MATLAB and FDATool. 5) Implementation of the FFT algorithm in the C programming language. 6) Generation of sinusoidal and noise signals, DTMF generator and tone detector. 7) Audio signal processing, sound source localization, and application in speech recognition. 8) Echo cancellation. 9) Digital image processing, histogram, filtering, application of JPEG standard and DCT. 10) Medical image processing, filtering of electrocardiogram (ECG) and electroencephalogram (EEG) signals.		
Textbooks/references				
1	Kuo, S., Lee, B., Tian, W., Real-Time Digital Signal Processing: Fundamentals, Implementations and Applications, 3rd Edition, John Wiley & Sons Ltd., 2013.			
2	T. B. Welch, C. H.G. Wright, M. G. Morrow, Real-Time Digital Signal Processing from MATLAB to C with the TMS320C6x DSPs, 3th Edition, CRC Press, 2017.			
3	Kuo, S., Gan, W. S., Digital Signal Processors: Architectures, Implementations, and Applications, Pearson Educaton Inc., 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	2	1	0	0
Teaching methods		Lectures; classroom exercises; laboratory exercises; homework assignments; 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		20		
Projects		20		



Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Next generation mobile systems		
Lecturer (for lectures)		Milović M. Daniela, Đorđević T. Goran, Milić N. Dejan		
Lecturer/associate (for exercises)		Panajotović S. Aleksandra		
Lecturer/associate (for OFE)				
Number of ECTS		5	Course status (obligatory/elective)	Elective
Prerequisites	None			
Course objectives	The present course provides advanced knowledge in modern mobile systems and services.			
Course outcomes	Students will learn to: 1) implement software models of modern mobile system channels; 2) implement software in modulation procedures; 3) analyze and plan telecommunication traffic in modern mobile systems; 4) plan the cellular structure.			
Course outline				
Theoretical teaching	Mobile system development – historical overview. Overview and analysis of existing mobile systems. The propagation characteristics of the mobile channel. Modems for mobile systems – modulation and demodulation techniques, diversity techniques. Channel coding for mobile systems. Cellular system design including cell structure. Multiple access techniques. Principles of positioning. Telecommunication traffic and queing systems. Services of mobile systems. User Mobility and Handover. Routing of traffic. Interconnections of different networks and convergence. Dimensioning the capacity of hardware and transport routes. Requirements for new generation networks.			
Practical teaching (exercises, OFE, study and research work)	Auditory and computer exercises.			
Textbooks/references				
1	Molisch, Wireless Communications, John Wiley & Sons, Ltd.,2005.			
2	M.Shankar, Introductuon to Wireless Systems, Wiley, 2017.			
3	E. Bjornson, J. Hoydis, L. Sanguinetti, Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency, 2017.			
4	G. L. Stuber, Principles of Mobile Communications, Springer, 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	0	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	10	Written exam		20
Exercises		Oral exam		20
Colloquia	20			
Projects	30			

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Intelligent Audio Algorithms		
Lecturer (for lectures)		Ćirić G. Dejan		
Lecturer/associate (for exercises)		Ćirić G. Dejan		
Lecturer/associate (for OFE)				
Number of ECTS	5	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	To understand the principles and tools used in digital audio signal processing. To convey the knowledge of intelligent algorithms in audio field. To introduce the concepts of machine based learning applications in audio field. To master audio signal characterization by means of features. To train students to use intelligent algorithms in practice (e.g. audio signal classification).			
Course outcomes	Identification of the appropriate algorithm approaches in audio field. Selection, application and evaluation of intelligent algorithms for audio signals. Mastering the techniques of analysis, decomposition and transformation of audio signals as well as classification of audio contents, forming of spatial audio, and generating virtual environment.			
Course outline				
Theoretical teaching	Audio signals and systems. Machine based learning and artificial intelligence methods in audio field. Harmonic model (harmonic detection, fundamental frequency detection, pitch detection algorithm). Extracting descriptors (features) from audio signals (energy, spectral, time and perceptual features). Decomposition of audio signals. Clustering and classification algorithms. Speech technologies in modern communication devices. Audio signal classification. Auditory scene analysis. Sound transformation. Spatial audio (binaural audio, wavefield synthesis, Ambisonics). Virtual auditory environment. Sound detection using microphone arrays (forming of directivity, source location evaluation). Advanced algorithms for audio effect applications.			
Practical teaching (exercises, OFE, study and research work)	Computational and practical exercises: analogue and digital audio signals; audio signal processing (normalisation, segmentation, visualisation); cancelation of noise and its effects; extraction of audio descriptors-features; analysis and classification of audio signals; speech technologies in modern communication devices; spatial audio; virtual auditory environment; sound acquisition by microphone arrays.			
Textbooks/references				
1	T. Virtanen, M. D. Plumbley, D. Ellis: Computational analysis of sound scenes and events, Springer, Cham, Switzerland, 2018.			
2	A. Lerch: An Introduction to audio content analysis, Applications in signals processing and music informatics, IEEE Press and Willey, New Jersey, 2012.			
3	I. McLoughlin: Applied speech and audio processing: with Matlab examples, Cambridge University Press, Cambridge, 2009.			
4	T. Giannakopoulos, A. Pirkakis: Introduction to audio analysis - A Matlab approach, Elsevier (Academic Press), Oxford, 2014.			
5	B. Rafaely: Fundamentals of spherical microphone array processing, Springer, Berlin, 2015.			
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; Laboratory sessions; 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		35
Colloquia				
Projects	30			

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Computational Electromagnetics - Selected Chapters		
Lecturer (for lectures)		Raičević B. Nebojša, Perić T. Mirjana		
Lecturer/associate (for exercises)		Jovanović B. Dejan		
Lecturer/associate (for OFE)				
Number of ECTS		5	Course status (obligatory/elective)	Elective
Prerequisites	None			
Course objectives	The aim of the course is to expand existing knowledge and acquire new skills necessary for active participation in the development of new technologies through the application of numerical electromagnetics methods, with a particular focus on their role in telecommunications. Students will be introduced to the principles of implementing these methods in software tools for solving electromagnetic problems, as well as their practical application for simulation and modeling of electromagnetic phenomena.			
Course outcomes	Students will master the methodology of numerical solutions to Maxwell's equations and be qualified to apply appropriate numerical methods and software tools in the analysis and characterization of electromagnetic fields. They will also be able to interpret the obtained results, draw conclusions, and apply the acquired knowledge in the research and development of modern telecommunications systems.			
Course outline				
Theoretical teaching	General theory of electromagnetic fields (Maxwell's equations, boundary conditions, electromagnetic field potentials). Classification of electromagnetic problems with respect to time dependence. Application of numerical methods in electromagnetics. Finite difference method. Finite-difference time-domain (FDTD) method. Finite element method. Boundary element method. Equivalent source method. Hybrid boundary element method. Application of software tools for electromagnetic field analysis.			
Practical teaching (exercises, OFE, study and research work)	The exercises encompass the topics taught during theoretical lessons and are performed using both the board and computer-based methods.			
Textbooks/references				
1	F. T. Ulaby, "Fundamentals Applied Electromagnetics", Pearson, Prentice Hall, New York, 2010.			
2	M. Sadiku, „Numerical techniques in Electromagnetics“, CRC Press, 2001.			
3	D. M. Veličković, F. H. Uhlmann, K. Brandisky, R. D. Stancheva, H. Brauer, "Fundamentals of Modern Electromagnetics for Engineering", TU Ilmenau, Germany, 2005.			
4	H. Neff, "Introductory Electromagnetics", John Wiley & Sons, 1991.			
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		Written exam		
Exercises		Oral exam		50
Colloquia	20			
Projects	30			

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Advanced Coding Techniques		
Lecturer (for lectures)		Perić H. Zoran, Jovanović Ž. Aleksandra		
Lecturer/associate (for exercises)		Vučić J. Nikola		
Lecturer/associate (for OFE)				
Number of ECTS		4	Course status (obligatory/elective)	Elective
Prerequisites	None			
Course objectives	To familiarize students with advanced techniques in source and channel coding, and to develop their skills in solving related problems.			
Course outcomes	The student will master advanced techniques in source and channel coding. They will be capable of analytically analyzing problems within this domain and subsequently solving them through software implementation.			
Course outline				
Theoretical teaching	Recapitulation of the fundamentals of source coding. Switch-adaptive coding of continuous information sources. Differential predictive coding of continuous information sources. Coding of speech and audio signals. Coding of image and video signals. Vector quantization: polar, geometric, and lattice quantization. Recapitulation of the fundamentals of error-correcting coding. Decoding of block and convolutional codes representable by trellises: BCJR decoding algorithm. Iterative decoding algorithms for codes on graphs (LDPC codes): Sum-product decoding algorithm. Min-sum decoding algorithm. Gallager decoding algorithms A and B. Polar codes.			
Practical teaching (exercises, OFE, study and research work)	Solving specific problems from lecture modules. Mentoring students on project assignments.			
Textbooks/references				
1	K. Sayood, Introduction to Data Compression, Elsevier, Morgan Kaufmann; 5th edition, 2018.			
2	D. Salomon, Variable-length Codesfor Data Compression, Springer, 2007.			
3	W. E. Ryan, S. Lin, Channel Codes - Classical and Modern, Cambridge University Press, 2009.			
4	Silvio A. Abrantes, From BCJR to turbo decoding: MAP algorithms made easier, https://paginas.fe.up.pt/~sam/textos/From%20BCJR%20to%20turbo.pdf			
5	E. Arikan, Channel Polarization: A Method for Constructing Capacity-Achieving Codes for Symmetric Binary-Input Memoryless Channels, in IEEE Transactions on Information Theory, vol. 55, no. 7, pp. 3051-3073, July 2009, doi: 10.1109/TIT.2009.2021379.			
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, hands-on exercises, computer-based practical training, project assignments, and 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				
Projects		35		

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Measurement Systems in Industry 5.0		
Lecturer (for lectures)		Dinčić R. Milan, Jovanović R. Jelena		
Lecturer/associate (for exercises)		Randelović S. Ivana, Stojanović S. Milica		
Lecturer/associate (for OFE)				
Number of ECTS		4	Course status (obligatory/elective)	Elective
Prerequisites	None			
Course objectives	Empowering students to apply modern industrial measurement systems by integrating advanced technologies such as artificial intelligence, IoT/IIoT, and predictive maintenance — with a strong emphasis on improving the reliability, accuracy, and energy efficiency of these systems.			
Course outcomes	Students will gain comprehensive theoretical and practical knowledge essential for the implementation of modern measurement systems in industrial settings. They will be equipped to integrate artificial intelligence, IoT/IIoT technologies, and predictive maintenance into advanced measurement solutions. Additionally, they will learn to apply smart sensors, digital twins, and sensor fusion techniques. Students will also master methods for enhancing the accuracy, reliability, and energy efficiency of measurement systems, thereby preparing them to work effectively in cutting-edge industrial environments.			
Course outline				
Theoretical teaching	The course explores modern measurement systems with applications in industry, including the fundamental principles of Industry 4.0 and 5.0, measurement systems based on artificial intelligence, as well as the basic concepts of the Internet of Things (IoT) and the Industrial Internet of Things (IIoT). Students will also become familiar with smart sensors, digital twins, predictive maintenance techniques, sensor fusion, and energy harvesting techniques for powering autonomous sensor modules. Through this approach, students gain the knowledge necessary to apply the latest technologies in modern industrial environments.			
Practical teaching (exercises, OFE, study and research work)	Problem-solving exercises, project assignments, and seminar papers designed to equip students with practical skills and knowledge for the application of modern measurement systems in industrial environments.			
Textbooks/references				
	1	Dan Zhang (editor), Xuechao Duan (editor), "Smart Sensors and Devices in Artificial Intelligence", Mdpi AG, 2021.		
	2	Halit Eren, "Artificial Intelligence in Wireless Sensors and Instruments: Networks and Applications", CRC Press, 2024.		
	3	Bhagirathi Nayak, Monika Mangla, Sachi Nandan Mohanty, Suneeta Satpathy, "Integration of Cloud Computing with Internet of Things: Foundations, Analytics and Applications", Wiley, 2021.		
	4	Guangrui Wen, Zihao Lei, Xuefeng Chen, Xin Huang, "New Generation Artificial Intelligence-Driven Diagnosis and Maintenance Techniques: Advanced Machine Learning Models, Methods and Applications", Springer, 2024.		
	5	Alice James, Avishkar Seth, Subhas Chandra Mukhopadhyay, "Smart Sensors, Measurement and Instrumentation: lot System Design: Project Based Approach", Springer, 2022.		
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, problem-solving exercises, consultations, project work, real-world industrial case studies, teamwork, educational games and simulations — all delivered through personalized learning approaches tailored to students' individual needs and interests.			
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		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Speech Synthesis and Recognition		
Lecturer (for lectures)		Čirić G. Dejan, Perić H. Zoran, Nikolić R. Jelena		
Lecturer/associate (for exercises)		Eferica M. Predrag		
Lecturer/associate (for OFE)				
Number of ECTS	4	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	Acquiring theoretical knowledge within the field of speech synthesis, speech and speaker recognition. Student qualifications for application of acquired knowledge in solving real-life issues in the mentioned fields. Mastering skills for usage of models, algorithms and software tools in speech synthesis and speech/speaker recognition.			
Course outcomes	Theoretical and practical knowledge in speech communications and speech technology based on speech synthesis (e.g., application of speech automated devices), that is, speech and speaker recognition (e.g., man-to-machine communications and speech commands related applications).			
Course outline				
Theoretical teaching	Chronology of development of speech synthesis from text. Importance and applications of speech synthesis. Advantages of man-machine speech communications. Applications of speech technologies in smart houses. Technologies based on language. Prosodic features of speech. Generating speech basis for speech/speaker recognition and synthesis. Basic system structure for automated speech synthesis. Speech synthesis from text (linguistic processing of text, synthesis). Formant speech synthesis. Concatenative synthesis method. Parametric speech synthesis. Neural-based speech synthesis (WaveNet, Tacotron, FastSpeech). Quality estimation of synthesized speech. Applications of speech synthesis. Automated speech and speaker recognition (acoustic and language models). Metrics for evaluating automatic speech recognition performance (WER, CER, MOS). Systems for automated speech recognition. Emotion recognition in speech signals. Development directions in speech technologies.			
Practical teaching (exercises, OFE, study and research work)	In computational and practical exercises, students will work on algorithms and software (solutions) tools for speech synthesis and speech/speaker recognition. Within practical exercises, students will work on projects whose topics are covered by the course themes. Practical teaching is related to applications of available systems (platforms) for speech synthesis and speech/speaker recognition.			
Textbooks/references				
1	J. Benesty, M. M. Sondhi, Y. Huang: Springer handbook of speech processing, Springer, Berlin, 2008.			
2	G. Fant: Speech acoustics and phonetics, Kluwer Academic Publishers, Dordrecht, Netherlands, 2004.			
3	I. McLoughlin: Applied speech and audio processing with Matlab examples, Cambridge University Press, Cambridge, 2009.			
4	D. Yu, L. Deng: Automatic speech recognition: A deep learning approach, Springer, London, 2015.			
5	J. Holmes, W. Holmes: Speech synthesis and recognition, 2nd edition, Taylor and Fransis, Londond, 2001.			
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; Laboratory sessions; 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		35
Colloquia				
Projects	30			

Specification for the book of courses

Study program			Communications and Information Technologies / Communications and Information Processing		
Type and level of studies			Master Academic Studies		
The name of the course			Principles of Software Radio		
Lecturer (for lectures)			Milošević D. Nenad, Ćirić G. Dejan, Panajotović S. Aleksandra		
Lecturer/associate (for exercises)					
Lecturer/associate (for OFE)			Eferica M. Predrag		
Number of ECTS		6	Course status (obligatory/elective)		Obligatory
Prerequisites	None				
Course objectives	Introduction to software radio and devices that can be programmed to work with different standards. Description of software radio elements and receiver analysis.				
Course outcomes	Theoretical knowledge. Knowledge of software radio elements and work principles. Laboratory work on some hardware platforms for software radio.				
Course outline					
Theoretical teaching	Introduction. Basic principles. Overview of signals, systems, error probability and digital transmission. Applications of software-defined radio. Hardware platforms for software-defined radio. Implementation of transmitters and receivers based on the software-defined radio principle. Receiver structure and waveform generation in the transmitter and receiver. Multi-carrier modulation and two-way transmission. Introduction to spectrum sensing techniques.				
Practical teaching (exercises, OFE, study and research work)	Computational exercises are performed from all thematic units. Laboratory exercises are performed from Laboratory exercises: Generating basic signals using an FPGA-based platform, Creating a simple communication chain based on the USRP platform, Analyzing the performance of complex communication systems using a development environment based on the USRP platform.				
Textbooks/references					
	1	J. Mitola III, Software Radio Architecture, John Wiley & Sons, 2000.			
	2	T. Collins, R. Getz, Di Pu, A. Wyglinski, Software-Defined Radio for Engineers, Artech House Publishers, 2018.			
	3	E. Grayver, Implementing Software Defined Radio, Springer-Verlag New York, 2013.			
	4	Di Pu, A. Wyglinski, Digital Communication Systems Engineering with Software-Defined Radio, Artech House, 2013.			
	5	J. H. Reed, Software Radio: A Modern Approach to Radio Engineering, Prentice Hall PTR, 2002.			
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, laboratory exercises and 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		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Artificial Intelligence - Chosen Chapters		
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		6	Course status (obligatory/elective)	Obligatory
Prerequisites				
Course objectives		To provide fundamental knowledge of artificial neural networks, their architecture, training algorithms, and optimization methods. To gain insight into possible applications of artificial intelligence, with special emphasis on applications in signal processing within modern communications and resource-constrained systems.		
Course outcomes		Students will be able to: understand the fundamental concepts of neural networks and their role in artificial intelligence; distinguish between different types of neural networks and understand their applications; implement and train basic neural networks using modern tools and libraries; optimize model performance using techniques such as pruning and quantization; understand and apply convolutional and recurrent neural networks; analyze and evaluate the performance of neural networks using appropriate metrics.		
Course outline				
Theoretical teaching		Introduction to artificial intelligence and neural networks. Artificial neuron and activation functions. Learning in artificial neural networks. Network structure and architecture. Multilayer perceptron network. Neural network training algorithms (Gradient Descent, Momentum-based algorithms, Adam, Root Mean Square Propagation, Nesterov Accelerated Gradient, AdaGrad). Backpropagation algorithm. Overfitting problem and regularization techniques. Normalization techniques. Evaluation of neural network performance. Convolutional neural networks. Recurrent neural networks and their variants (LSTM and GRU). Model complexity reduction through pruning. Quantization of neural network parameters and model acceleration. Transformers and self-attention.		
Practical teaching (exercises, OFE, study and research work)		In the exercises, theoretical knowledge is reinforced and skills are developed through studying Python code, including: training and evaluating a simple MLP network; working with convolutional networks on datasets (MNIST, CIFAR-10); implementing and optimizing recurrent neural networks for sequence processing; applying pruning and quantization techniques.		
Textbooks/references				
1		F. Chollet, Deep Learning with Python, 2nd Edition, MANNING PUBLICATIONS, 2021.		
2		I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016.		
3		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.		
4		S. Russell, P. Norvig, Artificial Intelligence: A Modern Approach, 4th ed., Pearson, 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, practical exercises, practical training on computers, 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				
Projects		35		

Specification for the book of courses

Study program		Communications and Information Technologies		
Type and level of studies		Master 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 conducted, its objectives, and organizational units. Getting to know the team and the project the student will join as part of their internship, selected in accordance with the study elective area (module) chosen by the student. Understanding the company's workflow, business processes, awareness of work-related risks, participation in design, documentation preparation, or quality control, in accordance with the workflow and possibilities of the work environment.			
Course outcomes	Enhancing the student's ability to enter the workforce upon graduation. Developing responsibility, a professional approach to work, and communication skills within a team. Supplementing the theoretical knowledge acquired through the study program with practical insights into the issues studied within the chosen field. Using the experience of professionals employed at the institution where the internship takes place to expand practical knowledge and increase student motivation. Gaining a clear understanding of how the knowledge and skills acquired through the study program can be applied in practice.			
Course outline				
Theoretical teaching				
Practical teaching (exercises, OFE, study and research work)	The content of the professional internship is fully aligned with the goals of the internship. The student becomes familiar with the company's structure and its business objectives, aligns their engagement with the chosen field of study, and duly fulfills work obligations in accordance with the duties of employees within the company. The student describes their own involvement during the internship and provides a critical reflection on their experience, as well as the knowledge and skills acquired during 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 generally independently chooses a company from the public, private, or state sector in which to complete the professional internship. The internship can also be completed abroad, in which case the student additionally improves their foreign language skills. Upon the student's proposal, the head of the elective area (module) approves the internship at the desired institution, based on which a written referral is issued for the person responsible for supervising the internship at that institution. Upon completion of the internship, and based on the student's report and a confirmation signed and stamped by the responsible person at the company, the student is awarded 3 ECTS credits for the completed professional 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		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Computing for IoT Communications		
Lecturer (for lectures)		Milić N. Dejan		
Lecturer/associate (for exercises)		Anastasov A. Jelena		
Lecturer/associate (for OFE)				
Number of ECTS	4	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	Introduce telecommunication students to basic computing skills required for IoT applications.			
Course outcomes	- Understand the basics of IoT concept and M2M communications - Recognize modern communication and computing concepts and terminology used within IoT ecosystem - Acquire practical experience in designing communication and basic software side for an IoT platform - Ability to realize a simple practical IoT project on available hardware platforms and identify strong sides and possible problems - Estimate what can be done easily at the software level to test and debug an IoT system, and what requires help of skilled programing professionals			
Course outline				
Theoretical teaching	Computing in general, and communication specifics. Internet. Things. M2M communications- Internet of Things. Protocols and interfaces for M2M communications. Sensor/actuator networks. Handling and analyzing data. Context. Smart environments. Security. Surviving in Java. Integrated Development Environments for Things. Basics of Linux and shell scripting. Application examples and case studies of existing and future systems.			
Practical teaching (exercises, OFE, study and research work)	Practical topics/tasks are going to be performed in the laboratory.			
Textbooks/references				
1	Vijay Madisetti, Arshdeep Bahga, Internet of Things, A Hands-on-Approach, VPT, 2014.			
2	Francis daCosta, Byron Henderson, Rethinking the Internet of Things: a scalable approach to connecting everything, Apress, 2014			
3	Adeel Javed, Building Arduino Projects for the Internet of Things, Apress Media, 2016			
4	Stephen Chin, James Weaver, Raspberry Pi with Java: Programming the Internet of Things (IoT), McGraw Hill Professional, 2015			
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	Course will be based on a hands-on methodology that keeps classroom sessions to a minimum. Most of the learning activities will be based on laboratory work, and open discussions with students. Practical application of learning-by-doing principle.			
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		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Nonlinear Fiber Optics		
Lecturer (for lectures)		Milović M. Daniela		
Lecturer/associate (for exercises)		Anastasov A. Jelena		
Lecturer/associate (for OFE)				
Number of ECTS	4	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	This course offers a fundamental understanding of nonlinear optics and its practical applications in fiber optic communication systems. It is designed to equip students with the analytical and design skills needed to model, dimension, and evaluate the performance of optical fiber-based transmission systems. Emphasis is placed on the impact of nonlinear effects on signal propagation and system performance, preparing students to address challenges in high-capacity, long-distance optical networks.			
Course outcomes	Students will be well acquainted with the principles of nonlinear optics and to use numerical tools for designing and simulating fiberoptic transmission. Students will be able to dimension and design WDM high bit-rate fibre optic communication systems; analyse, model and implement advanced optical communication systems; use optical communications simulation tools to assess the results obtained from theoretical studies.			
Course outline				
Theoretical teaching	Wave propagation in optical fibers. Chromatic and Polarization Mode Dispersion. Fiber nonlinear effects: self-phase modulation, cross-phase modulation, four-wave mixing, stimulated Raman scattering, and stimulated Brillouin scattering. Compensation (optically and electrically) of propagation effects. Pulse propagation and soliton formation in fibers. Multimode and multicore fibers for enhancing the capacity of optical communication systems through a new type of multiplexing known as the mode-division or space-division multiplexing (SDM).			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises introduce students to fundamental concepts of nonlinear optics. Design and evaluation of optical systems using Optiwave.			
Textbooks/references				
1	G. Agrawal, Nonlinear Fiber Optics, Academic Press; 5 edition, 2013.			
2	Biswas Anjan, Milovic Daniela, Edwards Matthew, Mathematical theory of dispersion-managed optical solitons, 2010, Springer Verlag, New York, NY. USA. ISBN 978-3-642-10219-6			
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	0	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	10	Written exam		20
Exercises	30	Oral exam		20
Colloquia				
Projects	20			

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Telecommunications and information technologies in telemedicine		
Lecturer (for lectures)		Đorđević T. Goran, Milović M. Daniela, Milić N. Dejan		
Lecturer/associate (for exercises)		Đorđević T. Goran		
Lecturer/associate (for OFE)				
Number of ECTS		4	Course status (obligatory/elective)	Elective
Prerequisites		None		
Course objectives		Acquisition of knowledge in the application of telecommunication and information technologies for the needs of telemedicine.		
Course outcomes		Students will learn to model wireless in- and on-body networks and will know which error-correcting codes can be applied in these channels. Students will be trained to implement data transmission between body-attached sensors and gateways. They will become familiar with the basic standards for digitizing medical signals. Students will be informed about the fundamental statistical algorithms used for decision-making regarding patient conditions based on the available data in the data storage center.		
Course outline				
Theoretical teaching		Development of telemedicine. Medical signals and their digitization. Standards for communication, storage, and use of digital images in medicine. Systems for archiving and exchanging medical data. External and internal wireless networks in the context of the human body. Internet of intelligent objects in the healthcare system. Communication techniques for information transfer along the path: 'sensor–gateway–access network–data storage center' – channel modeling, modulation and demodulation techniques, error-correcting coding, cryptographic protection. Security of medical data. Basic statistical algorithms for data analysis and decision-making in data storage centers.		
Practical teaching (exercises, OFE, study and research work)		Exercises will be organized for all methodological units covered in the lectures.		
Textbooks/references				
1		P. Singh, et all. Networking Technologies in Smart Healthcare: Innovations and Analytical Approaches, CRC Press, Boca Raton, USA, 2024.		
2		J. Wang, Q. Wang, Body Area Communications: Channel Modeling, Communication Systems, and EMC, John Wiley & Sons, Singapore, 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	1	0	0	0
Teaching methods		Lectures. Exercises. Consultations. Seminar.		
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			Communications and Information Technologies / Communications and Information Processing		
Type and level of studies			Master Academic Studies		
The name of the course			Cognitive Radio		
Lecturer (for lectures)			Milošević D. Nenad		
Lecturer/associate (for exercises)			Panajotović S. Aleksandra		
Lecturer/associate (for OFE)					
Number of ECTS		4	Course status (obligatory/elective)		Elective
Prerequisites		None			
Course objectives		Introducing students to the principles of cognitive radio and the improvements that cognitive radio brings in terms of more efficient spectrum use and better user experience.			
Course outcomes		Students will be able to understand and implement basic techniques for examining spectrum occupancy, as well as understand the importance of software-defined radio and the cognitive approach in the field of radio technologies.			
Course outline					
Theoretical teaching		Evolution towards cognitive radio: Development of wireless communications and the need for more intelligent spectrum use. Historical development of cognitive radio and key technological milestones. Basic principles of cognitive radio: Flexible and dynamic spectrum management. Spectral efficiency and adaptation mechanisms. Ideal cognitive radio: Characteristics of an ideal system, autonomous adaptation and optimization of communication. Dynamic spectrum use in cognitive radio: Techniques for identifying available frequency bands. Optimization of spectrum use in real time. Techniques for analyzing spectrum availability in cognitive radio: Spectral scanning, radio monitoring techniques and spectrum availability prediction. Primary user detection methods. Impact of mobility on cognitive radio networks.			
Practical teaching (exercises, OFE, study and research work)		Laboratory exercises in the field of spectrum occupancy testing.			
Textbooks/references					
1		X. Fernando, A. Sultana, S. Hussain, L. Zhao, Cooperative Spectrum Sensing and Resource Allocation Strategies in Cognitive Radio Networks, Springer International Publishing, 2019			
2		S. Haykin, P. Setoodeh, Fundamentals of cognitive radio, Wiley, 2017			
3		A. Bagwari, J. Kanti, G. Tomar, Introduction to cognitive radio networks and applications, Chapman and Hall/CRC, 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	0	0		0
Teaching methods		Lectures, laboratory exercises, colloquiums and exams.			
Grade (maximum number of points 100)					
Pre-exam duties		Points	Final exam		Points
Activity during lectures		10	Written exam		
Exercises			Oral exam		30
Colloquia		20			
Projects		40			

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Advanced MIMO Systems		
Lecturer (for lectures)		Milović M. Daniela, Panajotović S. Aleksandra		
Lecturer/associate (for exercises)		Panajotović S. Aleksandra		
Lecturer/associate (for OFE)				
Number of ECTS	4	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	To become familiar with modern broadband systems based on MIMO (Multiple Input Multiple Output) technologies, their performances, limitations and challenges.			
Course outcomes	Acquire fundamental knowledge about how antenna arrays can be used to achieve the most efficient transmission in wireless communication systems, such as Wi-Fi, 4G, and 5G. Ability to design and implement MIMO, multi-user MIMO, and massive MIMO systems in MATLAB, i.e. ability to apply theoretical knowledge in practical implementation.			
Course outline				
Theoretical teaching	Introduction - advantages of a multi-antenna system - spatial diversity vs spatial multiplexing. MIMO channel. MIMO channel capacity. MIMO transmitter. MIMO receiver. MIMO channel estimation and its impact on MIMO system performance. Multi-user MIMO systems. Precoding techniques in multi-user MIMO systems. User selection algorithms in multi-user MIMO systems. Massive MIMO systems. MIMO systems in combination with other techniques (IRS-MIMO, NOMA-MIMO, etc.).			
Practical teaching (exercises, OFE, study and research work)	Solving practical problems existing in MIMO systems. Independent research of the latest trends in the field of MIMO systems through study and research work.			
Textbooks/references				
1	A. Goldsmith, Wireless Communications, Cambridge University Press, 2012.			
2	T. Brawn, E. De Carvalho, P. Kyritsi, Practical Guide to the MIMO Radio Channel with MATLAB Examples, Wiley, 2022.			
3	T. L. Marzetta, E. G. Larson, H. Yang, H. Q. Ngo, Fundamentals of Massive MIMO, 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	1	0	0	0
Teaching methods	Lectures (ppt presentation, animation and practical examples), auditory exercises, laboratory exercises, projects.			
Grade (maximum number of points 100)				
Pre-exam duties		Points	Final exam	Points
Activity during lectures			Written exam	25
Exercises		30	Oral exam	25
Colloquia				
Projects		20		

Specification for the book of courses

Study program		Communications and Information Technologies / Communications and Information Processing		
Type and level of studies		Master Academic Studies		
The name of the course		Big data analysis		
Lecturer (for lectures)		Milović M. Daniela, Đorđević T. Goran, Milić N. Dejan		
Lecturer/associate (for exercises)		Anastasov A. Jelena		
Lecturer/associate (for OFE)				
Number of ECTS		5	Course status (obligatory/elective)	Obligatory
Prerequisites	None			
Course objectives	This course provides a comprehensive introduction to the end-to-end pipeline of big data analysis, with a focus on processing and analyzing large-scale data generated from wireless communication networks and IoT sensor systems. explore modern methods of data acquisition from distributed sensor networks, preprocessing and cleansing techniques, and cloud-based storage and processing frameworks. Emphasis is placed on data exploration, visualization, and hypothesis formulation using real-world datasets. A key component of the course is the application of advanced analytical and machine learning techniques—including dimensionality reduction and pattern recognition—to extract actionable insights. Practical use cases from smart infrastructure, mobile networks, and edge-to-cloud systems are highlighted throughout.			
Course outcomes	Ability to extract and analyze large sets of data from different sources. Design and implementation of statistical models and neural networks in solving communication problems. Programming in statistical packages: R, Python.			
Course outline				
Theoretical teaching	Introduction to the analysis of large data sets, programming in statistical packages: R, Python. Probabilistic generative model, graphic models, neural networks. Methods for reducing the dimensionality of large data sets - PCA. Classification - Bayes Classifier, multidisciplinary classification. Regression - SVM regression. Mechanical learning algorithms and applications prediction models.			
Practical teaching (exercises, OFE, study and research work)	Programming and data analysis exercises using R and Python.			
Textbooks/references				
1	J. Izenman. Modern Multivariate Statistical Techniques. Springer 2008.			
2	Elements of Statistical Learning by Hastie, Tibshirani & Friedman			
3	Jure Leskovec, Anand Rajaraman, Jeffrey David Ullman (2014.), Mining of Massive Datasets, Cambridge University Press			
4	Statistical Inference, Learning and Models in Big Data Franke et al, 2016			
5	Python Machine Learning, Sebastian Raschka, Packt Publishing, 2015			
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, homeworks, consultations.			
Grade (maximum number of points 100)				
Pre-exam duties	Points	Final exam		Points
Activity during lectures		Written exam		25
Exercises	30	Oral exam		25
Colloquia				
Projects	20			

Specification for the book of courses

Study program		Communications and Information Technologies		
Type and level of studies		Master Studies		
The name of the course		Master Thesis – Study and Research Work		
Lecturer (for lectures)				
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)				
Number of ECTS		7	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 the literature, the student becomes familiar with methods intended for solving similar tasks and with engineering practices used 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 a given problem and conduct a systematic analysis to draw conclusions about possible directions for its resolution. Through independent use of literature, students expand their knowledge by studying various methods and papers related to similar issues. In this way, students develop the ability to conduct analyses and identify problems within the given subject matter. Through the practical application of acquired knowledge, students develop the ability to understand the role and position of engineers in the chosen field, the need for collaboration with other professions, and the importance of teamwork.		
Course outline				
Theoretical teaching		It is formed individually in accordance with the needs of the specific undergraduate or master's thesis, its complexity, and structure. The student, according to their interests and preferences, selects the area of study or a supervising professor from the list of faculty members in the study program, who then defines a specific task. The student studies professional literature, technical and scientific papers related to similar topics, performs analyses aimed at finding solutions to the given task, or conducts specific experiments in a laboratory. The study work also includes active monitoring of primary findings, organization and execution of experiments, numerical simulations and statistical data processing, as well as the preparation of a seminar paper within the narrower scientific-teaching field to which the topic of the independent research work 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
			14	
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		Communications and Information Technologies		
Type and level of studies		Master Studies		
The name of the course		Master Thesis		
Lecturer (for lectures)				
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)				
Number of ECTS	15	Course status (obligatory/elective)	Obligatory	
Prerequisites				
Course objectives	The purpose of preparing the Master's thesis is to unify, confirm, and practically apply the knowledge acquired during the Master's academic studies. The student is given the opportunity to demonstrate the ability to independently carry out a project, which can be practical, research-oriented, or theoretical-methodological in nature. The student also gains experience in presenting their work both in written form and through oral defense.			
Course outcomes	The ability to lead an independent project, the ability to formulate and analyze problems, critically review possible solutions, and survey literature in the given field. Application of acquired engineering and design knowledge and skills to problem-solving, taking into account complexity, costs, reliability, and efficiency of the solution. The ability to write the thesis in the prescribed format. The ability to clearly explain the completed project through an oral defense.			
Course outline				
Theoretical teaching	The Master's thesis represents an independent research, practical, or theoretical-methodological work of the student, aligned with the level of study, in which the student familiarizes themselves with a narrower field through a literature review and adopts the research or design methodology necessary for preparing the thesis. Through the preparation of the thesis, the student applies practical and theoretical knowledge acquired during their studies. The written thesis typically contains an introductory chapter, problem definition, review of the field and existing solutions, proposal and description of the solution, conclusion, and references. The public oral defense of the thesis is organized before a committee of three members, one of whom is the thesis mentor. During the oral defense, the candidate explains the results of their work and then answers questions from the committee members, thereby demonstrating the ability to orally present 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				
Grade (maximum number of points 100)				
Pre-exam duties	Points	Final exam	Points	
Activity during lectures		Written exam	70	
Exercises		Oral exam	30	
Colloquia				
Projects				

Specification for the book of courses

Study program			Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies			Master Academic Studies		
The name of the course			Microwave and Millimeter Wave Circuit Design		
Lecturer (for lectures)			Pronić-Rančić R. Olivera, Maleš-Ilić P. Nataša		
Lecturer/associate (for exercises)			Atanasković S. Aleksandar, Stošić P. Biljana		
Lecturer/associate (for OFE)			Atanasković S. Aleksandar, Stošić P. Biljana		
Number of ECTS		6	Course status (obligatory/elective)		Elective
Prerequisites		None			
Course objectives		Acquiring theoretical and practical knowledge in the analysis and design of microwave and millimeter-wave circuits. Training students to analyze design trade-offs and identify optimal solutions.			
Course outcomes		Acquisition of theoretical and practical knowledge in the analysis and design of microwave circuits. Training students for efficient and competent use of modern CAD tools. Developing skills in critical analysis of design trade-offs, finding optimal solutions, and measuring relevant parameters of planar microwave and millimeter-wave circuits to verify design correctness.			
Course outline					
Theoretical teaching		Modern approach to circuit design - modeling, simulation and optimization in the design process. Design of passive microwave and millimeter-wave components. Microwave transistor amplifiers. Linear transistor amplifiers. Low-noise transistor amplifiers. Harmonic balance analysis. Power amplifiers - basic characteristics and applications. Power amplifier classes. Microwave oscillators. Detectors. Mixers. Design of the input stage of microwave transceivers.			
Practical teaching (exercises, OFE, study and research work)		Computational exercises include solving problems in areas covered by the course content. Research work involves individual and/or team work on designing specific circuits, their implementation, and verification of results through measurement procedures.			
Textbooks/references					
1		Charles E. Free, Colin S. Aitchison: RF and Microwave Circuit Design: Theory and Applications, John Wiley & Sons Ltd, 2021.			
2		George D. Vendelin, Anthony M. Pavo, Ulrich L. Rohde, Matthias Rudolph: Microwave Circuit Design Using Linear and Nonlinear Techniques ,3rd Edition, John Wiley & Sons, 2021.			
3		A. Georgiadis, H. Rogier, L. Roselli, P. Arcioni, Microwave and Millimeter Wave Circuits and Systems: Emerging Design, Technologies and Applications 1st Edition, John Wiley & Sons, Ltd. 2013.			
4		D. Pozar, Microwave Engineering, 3rd 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	1	2	0		0
Teaching methods		Lectures, auditory exercises, laboratory 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		25			
Projects					

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Design of Telecommunication Systems and Networks		
Lecturer (for lectures)		Marinković D. Zlatica		
Lecturer/associate (for exercises)		Atanasković S. Aleksandar, Mladenović M. Ksenija		
Lecturer/associate (for OFE)		Atanasković S. Aleksandar		
Number of ECTS		6	Course status (obligatory/elective)	Elective
Prerequisites	None			
Course objectives	Getting to know the content and preparation of technical documentation for telecommunication networks and systems. Introduction to the legal and technical regulations. Training for the design of telecommunication networks and systems.			
Course outcomes	Getting to know the content and preparation of technical documentation for telecommunication networks and systems. Introduction to the legal and technical regulations. Training for the design of telecommunication networks and systems.			
Course outline				
Theoretical teaching	Procedures for the state professional exam and for obtaining a license for certified designer of telecommunication networks and systems. The legal regulation for the design of telecommunication networks and systems in Serbia. The content and process of making technical documentation. Technical documentation control, control of construction/installation of telecommunication objects and control of built objects. Planning, design and technical regulations for typical telecommunication networks and systems (wireless radio links, optical and HFC networks, telecommunication and signal installations). Case studies of actual projects of telecommunication networks and systems. Software support for design of telecommunication networks and systems. Fundamentals of project management in telecommunications.			
Practical teaching (exercises, OFE, study and research work)	Exercises: Examples of calculations in the considered telecommunications systems and networks. Analysis and discussion of actual projects. Practical work with software packages for the design of telecommunication networks and systems. Design and preparation of a particular networks or a system and preparing the corresponding technical documentation.			
Textbooks/references				
	1	Harry R. Anderson, Fixed broadband wireless system design, Wiley, 2003.		
	2	Roger L. Freeman, Telecommunication System Engineering, Wiley, 2004.		
	3	National regulations related to the process of making technical documentation. National and international standards and recommendations for specific telecommunications networks and systems.		
	4	Technical documentation of actual telecommunication networks and systems. Additional material given by the teachers.		
	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; Project; Consultations			
Grade (maximum number of points 100)				
Pre-exam duties	Points	Final exam		Points
Activity during lectures	5	Written exam		30
Exercises	10	Oral exam		20
Colloquia				
Projects	35			

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Broadband Access Networks		
Lecturer (for lectures)		Dončov S. Nebojša, Stanković Ž. Zoran		
Lecturer/associate (for exercises)		Dimitrijević Ž. Tijana, Mladenović M. Ksenija		
Lecturer/associate (for OFE)		Dimitrijević Ž. Tijana, Mladenović M. Ksenija		
Number of ECTS		5	Course status (obligatory/elective)	Elective
Prerequisites		None		
Course objectives		Acquisition of basic knowledge of access technologies for distribution of broadband interactive services. Getting familiar with possible types and architectures of broadband access networks and standards and recommendations.		
Course outcomes		Knowledge of the main characteristics of broadband access technologies. Ability to choose the optimal architecture of access network for an efficient distribution of broadband interactive services.		
Course outline				
Theoretical teaching		Introduction to access networks and their architecture. Overview of transmission media characteristics. Evolution of access technologies. xDSL access technologies: VDSL and VDSL2 - architecture and equipment (DSLAM, modems); Performance optimization of xDSL networks. Optical access networks: Architecture of passive optical networks (GPON, EPON, XGS-PON, NG-PON2); Topologies and components (OLT, ONT and optical splitters). Cable access: Modern HFC systems and DOCSIS 3.1/4.0 standards; CMTS, cable modems and bidirectional communications. Wireless access technologies: Fixed and mobile access (4G/5G, Wi-Fi 6/6E/7, mmWave); Hybrid access networks architecture – FiWi. IoT integration in broadband networks. SDN/NFV applications in access networks. QoS, SLA and security. Case studies – implementation of access networks.		
Practical teaching (exercises, OFE, study and research work)		Practical work with measuring instruments for the characterization of access networks at the physical level and IP level.		
Textbooks/references				
1	S. Gorshe, Broadband Access - Wireline and Wireless - Alternatives for Internet Services, 1st edition, John Wiley & Sons Inc, 2014.			
2	L. G. Kazovsky et al., Broadband Optical Access Networks, John Wiley and Sons Inc., 2011.			
3	P. Golden et al., Fundamentals of DSL technology, Auerbach Publications, Taylor & Francis Group, 2006.			
4	A. Shami et al.,Broadband Access Networks: Technologies and Deployments, Springer, 2009.			
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, practical work, consultations, seminar paper.		
Grade (maximum number of points 100)				
Pre-exam duties		Points	Final exam	Points
Activity during lectures		5	Written exam	
Exercises		30	Oral exam	30
Colloquia				
Projects		35		

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Wireless computer networks and Internet access		
Lecturer (for lectures)		Dončov S. Nebojša, Stanković Ž. Zoran		
Lecturer/associate (for exercises)		Milijić R. Marija		
Lecturer/associate (for OFE)		Milijić R. Marija		
Number of ECTS		6	Course status (obligatory/elective)	Elective
Prerequisites		None		
Course objectives		The acquisition of theoretical and practical knowledge of the standard methods and techniques for implementation of wireless computer networks for Internet access.		
Course outcomes		Knowledge of current techniques of Internet access using wireless computer networks. Knowledge of the practical implementation of various network architectures for Internet access.		
Course outline				
Theoretical teaching		Overview of wireless computer networks and corresponding standards used for Internet access. Wireless networks and Internet access based on the IEEE 802.15 standard. Wireless sensor networks. Personal networks (PAN). Bluetooth technology in data transfer. Wireless networks and Internet access based on the IEEE 802.11 standard. Wi-Fi. PLCP and PMD layers of data transfer. Data security in Wi-Fi networks. Roaming in wireless networks and mobile IP protocol. Architecture of IEEE.802.16 network for Internet access. Wi-Max. Internet Access via mobile telephony system. WAP. Satellite Internet.		
Practical teaching (exercises, OFE, study and research work)		Practical work related to the work operation analysis and adjustment of components for wireless Internet access. Practical work related to the implementation of various network architectures and service sets for wireless Internet access in a laboratory environment.		
Textbooks/references				
1		A. Tanenbaum, D. Wetherall, Computer Networks, 6th edition, Pearson, 2020.		
2		C. Beard, W. Stallings, Wireless Communication Networks and Systems, Pearson, 2015.		
3		M. Beaulieu, Wireless Internet Applications and Architecture, Addison-Wesley, 2001.		
4		J. Kim, M.Fischer, 802.11ac Wireless Computer Networking Standard, Willey, 2012.		
5		P. Roshan, 802.11 Wireless LAN Fundamentals, 1st edition, Cisco Press, 2009.		
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		25	Oral exam	20
Colloquia		30		
Projects				

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Multimedia systems and interactive services		
Lecturer (for lectures)		Joković J. Jugoslav, Maleš-Ilić P. Nataša		
Lecturer/associate (for exercises)		Joković J. Jugoslav, Maleš-Ilić P. Nataša		
Lecturer/associate (for OFE)		Joković J. Jugoslav		
Number of ECTS	6	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	Introduction to techniques, standards and architecture of modern systems for the production, processing and transmission of multimedia content. Introduction to the process of creating and developing interactive video services.			
Course outcomes	Acquiring the knowledge necessary for the production, transmission and analysis of multimedia content in communication systems. Acquiring the ability to optimally use multimedia devices and services, with an emphasis on understanding modern interactive services.			
Course outline				
Theoretical teaching	Multimedia - basic concepts, data sources. Recording formats and processing of multimedia signals - audio, text, image, video. Multimedia content - production, integration and synchronization. Compression standards. Content adaptation and scaling. Content search and protection. Multimedia communications - wireless systems, IP networks. Convergence technologies. Cloud-based interactive and multimedia services. Multimedia IoT systems. Formation and implementation of interactive services in smart systems. User interface for interactive communication. Multimedia devices – displays, acquisition, mobile and portable devices. QoS and QoE in multimedia.			
Practical teaching (exercises, OFE, study and research work)	Auditive exercises that follow the lecture content. Laboratory exercises with simulations of multimedia applications.			
Textbooks/references				
1	B. Furht, ed., Encyclopedia of multimedia. Springer Science & Business Media, 2008.			
2	G.Iwacz, A.Jajszczyk, M.Zajackowski, Multimedia Broadcasting and Multicasting in Mobile Networks, Wiley, 2008.			
3	Ze-Nian Li, Mark S. Drew, Jiangchuan Liu; Fundamentals of Multimedia; Springer Nature; 2021.			
4	Ralf Steinmetz, Klara Nahrstedt, Multimedia Systems; Springer Science & Business Media; 2013.			
5	Yun Q. Shi, Huifang Sun; Image and Video Compression for Multimedia Engineering; CRC 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, 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		40
Exercises		Oral exam		30
Colloquia				
Projects	20			

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Radar Systems and Radiolocation		
Lecturer (for lectures)		Stanković Ž. Zoran, Maleš-Ilić P. Nataša		
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		Acquiring theoretical and practical knowledge about radar systems and radiolocation.		
Course outcomes		Knowledge of the theory and basic principles related to radar system architecture and radiolocation. Knowledge of technical and technological solutions applied in modern radar systems. Knowledge of technical specifics of SAR, meteorological and military radars.		
Course outline				
Theoretical teaching		The basic principles of radiolocation and radar arhitecture. Classification and application of modern radar systems. The radar equation. RCS. MTI and pulse Doppler radar. Detection of radar signals in noise. Processing of radar signals. Extraction of radar information. Radar clutter. RHI and PPI radar display. Tracking the target with a radar system.Other types of radar: SAR radars, weather radars, military radar systems, radar for smart (autonomous) vehicles. Radar equipment (transmitters, receivers, antennas).		
Practical teaching (exercises, OFE, study and research work)		Auditory exercises involve solving problems in areas that are covered by the content of the subject.		
Textbooks/references				
1		M. I. Skolnik, Introduction to radar systems, Mc Graw-Hill, 2001.		
2		B. Mahafza, Radar systems analysis and design using MATLAB, 3rd Edition, Chapman and Hall/CRC, 2013.		
3		M. Richards, W. Holm, J. Scheer, Principles of Modern Radar: Basic Principles, IET, 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	1	1	0	0
Teaching methods		Lectures, auditory exercises, seminar work, 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		Communications and Information Technologies / System Engineering and Radio-Communications Electronics and Embedded Systems		
Type and level of studies		Master Academic Studies		
The name of the course		Distributed Embedded Systems		
Lecturer (for lectures)		Đorđević Lj. Goran, Đošić M. Sandra, Jovanović D. Milica		
Lecturer/associate (for exercises)		Jovanović D. Milica		
Lecturer/associate (for OFE)		Đorđević Lj. Goran		
Number of ECTS		5	Course status (obligatory/elective)	Obligatory / Elective
Prerequisites		None		
Course objectives		Understand the principles of distributed embedded systems, with a special emphasis on wireless communication. Master key wireless technologies and protocols used in embedded systems (e.g., Bluetooth Low Energy, Zigbee, LoRa). Explore advanced topics, including wireless localization, time synchronization, and the design of low-power networked embedded systems. Develop practical skills in designing, implementing, and evaluating wireless embedded systems. Analyze typical applications and contemporary trends in distributed embedded systems (e.g., IoT, sensor networks).		
Course outcomes		By the end of this course, students will be able to acquire theoretical knowledge and practical skills necessary for: a) understanding the principles of design, analysis, and implementation of distributed embedded systems, b) designing and developing real-world distributed embedded systems based on wireless communication, c) evaluating the advantages and limitations of different technologies used in the design and implementation of wireless embedded systems.		
Course outline				
Theoretical teaching		Introduction to distributed embedded systems: definition, architecture, challenges. Wireless communication protocols: short-range protocols (IEEE 802.11, Bluetooth Low Energy, Zigbee), long-range protocols (LoRa/LoRaWAN, NB-IoT). Time synchronization in distributed embedded systems: clock drift , synchronization protocols (NTP, PTP, TSN). Wireless localization : principles (RSSI, ToA, TDoA, AoA), algorithms (trilateration, multilateration, fingerprinting), technologies (UWB, BLE, GPS, WiFi). Energy management: low-power design and energy-efficient communication protocols. Applications: smart cities, Industrial IoT, healthcare, autonomous systems. Modern trends and emerging technologies: 5G/6G , AI and Machine Learning in wireless embedded systems, Edge and Fog computing for distributed processing.		
Practical teaching (exercises, OFE, study and research work)		Practical teaching is organized through several mini-projects focused on: 1) Establishing a simple wireless communication link via Wi-Fi, and implementing basic client-server communicatio; 2) Sensor data transmission using BLE: setting up BLE-enabled sensors, transmitting and receiving sensor data; 3) Implementation of a simple TDMA-based communication protocol: designing a basic TDMA scheme, testing multi-node communication with synchronized time slots; 4) Time synchronization using NTP: configuring NTP on embedded systems, measuring and compensating for clock drift; 5) RSSI-based localization using BLE technology: estimating distance from RSSI, implementing trilateration for position tracking; 6) Experimentation with UWB for high-precision localization: setting up UWB modules, testing ToA and TDoA methods; 7) Energy consumption measurement & optimization of a wireless sensor node: profiling power usage, implementing sleep modes and duty cycling.		
Textbooks/references				
1		H. Karl and A. Willig, Protocols and Architectures for Wireless Sensor Networks, Wiley, 2007.		
2		I. Sharp and K. Yu, Wireless Positioning: Principles and Practice, Springer, 2019		
3		Additional course materials, such as lecture notes and tutorial documents, will be available on the faculty website		
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, 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	35
Exercises	30	Oral exam	35
Colloquia			
Projects			

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Electromagnetic Compatibility		
Lecturer (for lectures)		Dončov S. Nebojša, Stanković Ž. Zoran		
Lecturer/associate (for exercises)		Dimitrijević Ž. Tijana, Joković J. Jugoslav		
Lecturer/associate (for OFE)		Dimitrijević Ž. Tijana, Joković J. Jugoslav		
Number of ECTS		5	Course status (obligatory/elective)	Elective
Prerequisites	None			
Course objectives	Introduce students to the basic terms and concepts of electromagnetic compatibility (EMC), practical EMC problems and techniques and procedures to solve them. Acquisition of fundamental knowledge of the methods for designing circuits and devices that ensure the fulfillment of EMC standards.			
Course outcomes	Understanding the principles and techniques of electromagnetic compatibility. Ability to solve EMC problems by using electromagnetic simulations on computer and to perform EMC measurements. Ability to design circuits and devices that meet EMC standards.			
Course outline				
Theoretical teaching	Introduction to electromagnetic compatibility. Sources of electromagnetic interference. Penetration through shields and apertures. Shielding theory. Aperture theory. Propagation, conductive penetrations and general multipath coupling. Electromagnetic susceptibility. Signal integrity. Electromagnetic interference control techniques. Basic principles of EMC design. Review of numerical simulation techniques and software tools for solving EMC problems on computer. EMC standards. EMC measurement methods. EMC aspect in IoT and wireles devices.			
Practical teaching (exercises, OFE, study and research work)	Auditory exercises. Practical work with software tools for EMC problem solving. Measurements in laboratory.			
Textbooks/references				
1	C. Christopoulos, Principles and Techniques of Electromagnetic Compatibility, 3rd edition, CRC Press, 2022.			
2	C. R. Paul, Robert C. Scully, Mark A. Steffka, Introduction to Electromagnetic Compatibility, 3rd edition, Wiley, 2022.			
3	T. Williams, EMC for Product Designers, 5th edition, Newness, 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	1	1	0	0
Teaching methods	Lectures, auditory exercises, work in a lab and on computer, consultations, project (seminar) task.			
Grade (maximum number of points 100)				
Pre-exam duties		Points	Final exam	Points
Activity during lectures		5	Written exam	30
Exercises		35	Oral exam	
Colloquia				
Projects		30		

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		IoT services		
Lecturer (for lectures)		Maleš-Ilić P. Nataša, Pronić-Rančić R. Olivera		
Lecturer/associate (for exercises)		Atanasković S. Aleksandar, Dimitrijević Ž. Tijana		
Lecturer/associate (for OFE)		Atanasković S. Aleksandar, Dimitrijević Ž. Tijana		
Number of ECTS		5	Course status (obligatory/elective)	Elective
Prerequisites		None		
Course objectives		Introducing students with architecture and operation principles of IoT-platforms, as well as with technologies for their networking, security and principles of data processing. Training students to develop software for different applications of IoT (smart grid, e-health, smart houses, smart cities).		
Course outcomes		Understanding the architecture and way of functioning of the Internet of Things. Knowledge of network technologies and communication protocols necessary for IoT applications. Application of acquired knowledge for the development of IoT solutions for different application areas: smart grid, e-health, smart homes, smart cities.		
Course outline				
Theoretical teaching		Internet of Things: basic concepts, architecture and application. Circuits and devices in the IoT environment: sensors, actuators, gateway, M2M communication. RFID, NFC, EPC architecture. Device communication protocols: IEEE 802.15.4, 802.11ah, ZigBee. LoRaWAN, LTE-M, NB-IoT. Network layer optimization protocols: 6LoWPAN, 6TiSCH. Application layer: MQTT, CoAP, HTTP. Security aspects. Standards. IoT-platforms. Localization algorithms. Indoor localization. Low power and Lossy network-LLN. Embedded apps for working in cloud. Application of IoT: smart grid, e-health, smart home, smart cities.		
Practical teaching (exercises, OFE, study and research work)		Solving selected problems in auditory exercises. Practical work in the laboratory. Work on project and presentation of results.		
Textbooks/references				
1	D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, and J. Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, 2017.			
2	P. R. Gunjal, S. R. Jondhale, J. L., K. Agrawal: Internet of Things: Theory to Practice, CRC Press, 2024			
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	F. Behmann, and K. Wu, Collaborative Internet of Things (C-IoT): For Future Smart Connected Life and Bussines, John Wiley & Sons Ltd., 2015.			
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, practical laboratory work, consultations		
Grade (maximum number of points 100)				
Pre-exam duties		Points	Final exam	Points
Activity during lectures		10	Written exam	
Exercises		30	Oral exam	40
Colloquia				
Projects		20		

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications Electron Devices and Microsystems		
Type and level of studies		Master Academic Studies		
The name of the course		Techno-economic and ecological aspects of communication systems		
Lecturer (for lectures)		Joković J. Jugoslav, Aleksić M. Sanja		
Lecturer/associate (for exercises)		Dimitrijević Ž. Tijana		
Lecturer/associate (for OFE)		Mladenović M. Ksenija		
Number of ECTS		5	Course status (obligatory/elective)	Obligatory / Elective
Prerequisites		None		
Course objectives		Introduction to techno-economic aspects of the sustainability of communication systems and their impact on health and the environment. Understanding of mechanisms for managing energy consumption, frequency spectrum resources and the risks of RF and microwave radiation to human health. Introduction to relevant legislation and standards.		
Course outcomes		Understanding the techno-economic aspects of the operation of communication systems and their impact on health; Knowledge of regulations in the field of spectrum management and protection from electromagnetic (EM) radiation; Knowledge of the physics of the interaction between EM fields and tissue and the effects that arise - the ability to identify types and sources of RF and microwave radiation that have a harmful effect and to perform a risk assessment and take appropriate safety measures. Training in the design, analysis, optimization and integration of photovoltaic (PV) systems into communication systems.		
Course outline				
Theoretical teaching		Overview of communication systems, techno-economic aspects and environmental impact issues (spectrum, energy consumption, health). Factors in the analysis of electronic communications, convergence of technologies. Frequency spectrum - limitations, allocation, spectrum management in the RF, microwave and millimeter wave bands. EM field radiation and public safety - regulatory aspects. Interaction of EM fields and the human body. Exposure and dosimetry of RF and microwave radiation – parameters, measurements and protection. Energy needs and sustainability aspects in the infrastructure of modern communication systems. Design, implementation and optimization of photovoltaic (PV) systems for powering elements of communication systems. PV integration into communication systems. Smart energy management.		
Practical teaching (exercises, OFE, study and research work)		Calculations related to the of electromagnetic fields exposure to living organisms and the absorption of electromagnetic energy. Introduction to devices and methods for experimental determination of RF and microwave radiation levels. Introduction to methods for designing, analyzing and optimizing photovoltaic (PV) systems that used in powering elements and devices in telecommunications, as well as their integration into communication systems.		
Textbooks/references				
	1	Handbook of Telecommunications Economics, Vol.1 & Vol.2; S. Majumdar, M. Cave, I. Vogelsang; North Holland; 2002; ISBN: 978-0444514233		
	2	Essentials of Modern Spectrum Management; Martin Cave, Chris Doyle, William Webb; Cambridge University Press; 2007; ISBN: 978-0521876698.		
	3	Biological Effects and Health Implications of Radiofrequency Radiation; James C. Lin, Sol M. Michaelson; Springer Science & Business Media; 2013; ISBN: 9781475746143,		
	4	Energy-Efficient Computing and Communication, Sangheon Park. MDPI, 2020, ISBN 978-3-03936-149-6		
	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, seminar, practical work		
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				
Projects		20		

Specification for the book of courses

Study program		Communications and Information Technologies		
Type and level of studies		Master 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 conducted, its objectives, and organizational units. Getting to know the team and the project the student will join as part of their internship, selected in accordance with the study elective area (module) chosen by the student. Understanding the company's workflow, business processes, awareness of work-related risks, participation in design, documentation preparation, or quality control, in accordance with the workflow and possibilities of the work environment.			
Course outcomes	Enhancing the student's ability to enter the workforce upon graduation. Developing responsibility, a professional approach to work, and communication skills within a team. Supplementing the theoretical knowledge acquired through the study program with practical insights into the issues studied within the chosen field. Using the experience of professionals employed at the institution where the internship takes place to expand practical knowledge and increase student motivation. Gaining a clear understanding of how the knowledge and skills acquired through the study program can be applied in practice.			
Course outline				
Theoretical teaching				
Practical teaching (exercises, OFE, study and research work)	The content of the professional internship is fully aligned with the goals of the internship. The student becomes familiar with the company's structure and its business objectives, aligns their engagement with the chosen field of study, and duly fulfills work obligations in accordance with the duties of employees within the company. The student describes their own involvement during the internship and provides a critical reflection on their experience, as well as the knowledge and skills acquired during 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 generally independently chooses a company from the public, private, or state sector in which to complete the professional internship. The internship can also be completed abroad, in which case the student additionally improves their foreign language skills. Upon the student's proposal, the head of the elective area (module) approves the internship at the desired institution, based on which a written referral is issued for the person responsible for supervising the internship at that institution. Upon completion of the internship, and based on the student's report and a confirmation signed and stamped by the responsible person at the company, the student is awarded 3 ECTS credits for the completed professional 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		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Satellite Systems and Services		
Lecturer (for lectures)		Pronić-Rančić R. Olivera, Joković J. Jugoslav		
Lecturer/associate (for exercises)		Milijić R. Marija		
Lecturer/associate (for OFE)				
Number of ECTS		4	Course status (obligatory/elective)	Elective
Prerequisites	None			
Course objectives	Introduction to architecture, working principles and basic services of modern satellite telecommunication systems.			
Course outcomes	Understanding the operating principles and the most important services of modern satellite systems. Ability to solve practical problems in the field of satellite system design.			
Course outline				
Theoretical teaching	Types of satellite systems. Satellite orbits. Satellite system architecture. Satellite link budget. Modulation techniques in satellite links. Multiple access techniques in satellite communications. Earth station architecture. Communication satellites. Satellite television. VSAT systems. Satellite navigation systems. GPS – architecture, services, working principle, GPS receivers. Remote sensing satellites. Meteorological and military satellites.			
Practical teaching (exercises, OFE, study and research work)	Computational exercises; seminar paper			
Textbooks/references				
1	T. Pratt, C. Bostian, J. Allnutt, "Satellite Communications", J.Wiley & Sons, 2003.			
2	A. K. Maini, V. Agrawal, "Satellite technology – principles and applications", Second edition, J.Wiley & Sons, 2011.			
3	Minoli, Daniel: Innovations in satellite communication and satellite technology : the industry implications of DVB-S2X, high throughput satellites, Ultra HD, M2M, and IP, John Wiley & Sons, 2015			
4	G. Maral, M. Bousquet, "Satellite Communications Systems – systems, techniques and technology", fifth edition, J.Wiley & Sons, 2009.			
5	S. K. Sharma, S. Chatzinotas, P.-D. Arapoglou: Satellite Communications in the 5G Era, Institution of Engineering & Technology, 2018.			
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, classroom exercises, seminar papers, consultations			
Grade (maximum number of points 100)				
Pre-exam duties	Points	Final exam		Points
Activity during lectures	5	Written exam		30
Exercises		Oral exam		30
Colloquia	20			
Projects	15			

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Advanced Communication Technologies and Services		
Lecturer (for lectures)		Marinković D. Zlatica, Maleš-Ilić P. Nataša, Joković J. Jugoslav		
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)		Joković J. Jugoslav, Dimitrijević Ž. Tijana		
Number of ECTS		4	Course status (obligatory/elective)	Elective
Prerequisites	None			
Course objectives	Getting to know the trends in the development of modern communication technologies and systems, system architectures and services based on new technologies.			
Course outcomes	Knowledge about the current state-of-the-art in the development of communication systems and technologies. The ability to use independently literature, to critically examine and compare certain technologies and systems and services.			
Course outline				
Theoretical teaching	Theoretical teaching consists of an overview of the latest trends in the development of communication systems and technologies and related services. Selected topics in the field of development of wireless communication systems, cable and optical communication systems, as well as smart systems will be discussed in more details. The current program includes:5G mobile networks, technologies towards 6G systems, communication systems in millimeter wave range, the latest generation of optical networks, smart systems and IoT, convergence of communication technologies, etc. The content will be adjusted every year in line with the development of communication systems, technogies and services.			
Practical teaching (exercises, OFE, study and research work)	Budget examples related to the discussed communication systems. Practical work with software packages for simulation and analysis of the certain systems. Preparation of seminar paper.			
Textbooks/references				
1	Abdulrahman Yarali , “From 5G to 6G: Technologies, Architecture, AI, and Security”, IEEE, 2023.			
2	P. R. Gunjal, S. R. Jondhale, J. L., K. Agrawal: Internet of Things: Theory to Practice, CRC Press, 2024.			
3	B. Mukherjee, I. Tomkos, Optical Networks, Springer 2019.			
4	M. G. Sanchez, Millimeter-Wave (mmWave) Communications, MDPI, 2020.			
5	Selected scientific articles published in international journals			
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. Seminar project. Consultations.			
Grade (maximum number of points 100)				
Pre-exam duties	Points	Final exam		Points
Activity during lectures		Written exam		20
Exercises		Oral exam		20
Colloquia				
Projects	60			

Specification for the book of courses

Study program			Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies			Master Academic Studies		
The name of the course			Adaptive antennas and MIMO systems		
Lecturer (for lectures)			Dončov S. Nebojša, Stanković Ž. Zoran		
Lecturer/associate (for exercises)			Dimitrijević Ž. Tijana		
Lecturer/associate (for OFE)					
Number of ECTS		4	Course status (obligatory/elective)		Elective
Prerequisites	None				
Course objectives	The acquisition of theoretical and practical knowledge about transmission techniques and spatial signal processing in wireless communications which are based on the use of adaptive antennas and MIMO (Multiple Input - Multiple Output) systems.				
Course outcomes	Knowledge of the basic techniques of signal spatial processing and working principles of the adaptive antennas. The ability to apply basic methods of shaping the antenna array radiation pattern in the construction of adaptive antennas. Knowledge of techniques of signal transmission using MIMO (multiple-input and multiple-output) antennas (MIMO systems). The ability to apply adaptive antennas and MIMO systems in practice.				
Course outline					
Theoretical teaching	Electromagnetic waves characterization in the space-time domain. Spatial filtering of the signal and SDMA concept. Antenna arrays with controllable radiation patterns. Butler's matrix. Scanning antenna arrays. Algorithms for determining the direction of arrival (DoA) of EM radiation (MUSIC, ESPRIT). Adaptive antenna arrays. Adaptive beamforming in the temporal and spatial domain. Wiener solution. MIMO systems. (architecture, spatial communication channel, processing in the space-time domain). Application of antenna arrays and MIMO systems in wireless communications.				
Practical teaching (exercises, OFE, study and research work)	Solving practical problems related to antenna array beamforming. Solving practical problems related to DoA estimation of the electromagnetic signals using antenna arrays.				
Textbooks/references					
1	B. Allen, M. Ghavami, Adaptive Array Systems: fundamentals and applications, Wiley, 2005.				
2	S. Chandran, Adaptive Antenna Arrays: trend and applications, Springer, 2004.				
3	F. Gross, Smart Antennas with MATLAB, Second Edition: Principles and Applications in Wireless Communication, McGraw Hill Professional, 2015.				
4	G. Thoulos, MIMO System Technology for Wireless Communications, CRC Taylor & Francis Group, 2006.				
5	J. S. Seybold, Introduction to RF Propagation, Wiley, 2005.				
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, auditory exercises, seminar paper, homework, 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		30			
Projects		25			

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Computer Communications		
Lecturer (for lectures)		Stanković Ž. Zoran, Dončov S. Nebojša		
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)		Milijić R. Marija		
Number of ECTS	4	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	Acquiring theoretical and practical knowledge related to the use of of computers in the realization of network protocols and services as well as modern communication architectures for Internet access.			
Course outcomes	Knowledge of current methods and techniques for establishing communication and reliable data transfer at different levels of OSI and TCP / IP communication model. Knowing the practical realization of various communication protocols and services. Knowledge of the network architectures and basic equipment used in Internet access.			
Course outline				
Theoretical teaching	Computer as a communication device. OSI and TCP / IP communication models. The physical level of data transfer in computer communications. Modem communications and broadband Internet access. Internet PPP protocol. Communication systems based on IEEE 802.3 standard. Ethernet network architecture and devices. IP communications. IPv4 and IPv6. NAT communication infrastructure. RIP and EGP. IP communication infrastructure for Internet access. Devices for realization of Internet access. Transport layer and UDP and TCP communications. RTP and transfer of multimedia data. Application layer in telecommunications for Internet access. Modern telecommunication services and the Internet.			
Practical teaching (exercises, OFE, study and research work)	Laboratory exercises: Solving practical problems related to data transmission between communication devices at different levels of OSI and TCP/IP communication models and in the Internet environment. Working with simulators of the network communication environment.			
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	0	1	0	0
Teaching methods	Lectures, 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		Artificial Intelligence and Machine Learning Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Artificial Intelligence and Machine Learning for Communication Systems		
Lecturer (for lectures)		Marinković D. Zlatica, Stanković Ž. Zoran		
Lecturer/associate (for exercises)		Marinković D. Zlatica, Stanković Ž. Zoran		
Lecturer/associate (for OFE)				
Number of ECTS		4	Course status (obligatory/elective)	Elective
Prerequisites	None			
Course objectives	Acquiring theoretical and practical knowledge about the principles of artificial intelligence and machine learning as well as the possibilities of their application in communication systems. Training students to independently solve given problems using the methods of artificial intelligence and machine learning.			
Course outcomes	Knowledge of AI-based model architectures suitable for application in modern communication systems. Ability to analyze specific problems in communication systems, select an appropriate machine learning method and a suitable model for building a solution for a given problem. Ability to independently develop and implement models.			
Course outline				
Theoretical teaching	Application areas of artificial intelligence and machine learning in modern communication systems. AI methods and techniques for use in the design and performance analysis of communication systems. Application of machine learning for developing models of components and circuits in communication systems. Use of artificial neural networks for analyzing signal propagation in wireless communication systems. Design and intelligent beamforming of smart antenna systems. Application of artificial intelligence for performance evaluation of communication systems. Integration of domain-specific knowledge into neural models (knowledge-based models, space mapping models, hybrid empirical-neural models, hierarchical models).			
Practical teaching (exercises, OFE, study and research work)	Exercises: Application of artificial intelligence and machine learning methods in the design and analysis of components and circuits in communication systems. Project: Development of individual projects on the application of artificial intelligence and machine learning in communication 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	F.-L. Luo (Editor), Machine Learning for Future Wireless Communications, Wiley- IEEE Press, 2020			
4	Sebastian Raschka, Machine Learning with PyTorch and Scikit-Learn, Packt, 2022.			
5	Selected scientific papers from international journals			
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. Project development.			
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		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Wireless and efficient energy transfer		
Lecturer (for lectures)		Dončov S. Nebojša, Maleš-Ilić P. Nataša		
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)		Stošić P. Biljana		
Number of ECTS	4	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	Acquisition of basic knowledge of techniques for wireless and efficient energy transfer. Introduction to systems for a wireless energy transfer in the near- and far-field of radiation and systems for an efficient use of microwave radiation.			
Course outcomes	Knowledge of the main characteristics of systems for wireless and efficient energy transfer. Ability to design basic systems for wireless power transfer and fundamental microwave rectifiers.			
Course outline				
Theoretical teaching	Propagation of electromagnetic waves in the near- and far-field of radiation. Systems for propagation of electromagnetic waves in the near-field of radiation (inductive coupling, coupling based on magnetic resonance). Wireless energy transfer in the far-field of radiation. Systems for an efficient use of microwave radiation energy. Use of Schottky diode in rectifiers. Voltage doubler and multipliers. Microwave rectifier circuits. Microwave rectenna devices used for wireless and efficient transfer of microwave radiation. Data transfer and efficient use of microwave radiation by using six-port receiver. Applications of systems for wireless and efficient energy transfer.			
Practical teaching (exercises, OFE, study and research work)	Modeling of the Schottky diode used in rectifiers circuits. Design and analyzes of voltage doubler and microwave rectenna device. Design of fundamental systems for wireless power transfer and fundamental microwave rectifiers.			
Textbooks/references				
1	H. Sun, Far-Field Wireless Power Transmission and Ambient RF Energy Harvesting Concepts, Designs, Applications, Scholars' Press, 2015.			
2	E. Coca, Wireless Power Transfer - Fundamentals and Technologies, InTech, 2016.			
3	A. Triviño-Cabrera and J. A. Aguado, Emerging Capabilities and Applications of Wireless Power Transfer, IGI Globa, 2019.			
4	N. Shinohara, Wireless Power Transfer: Theory, technology, and applications, Institution of Engineering and Technology, 2018.			
5	N. Bizon at al, Energy Harvesting and Energy Efficiency-Technology, Methods, and Applications, Springer, 2017.			
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, practical work, consultations, team project.			
Grade (maximum number of points 100)				
Pre-exam duties	Points	Final exam		Points
Activity during lectures	5	Written exam		
Exercises	30	Oral exam		30
Colloquia				
Projects	35			

Specification for the book of courses

Study program		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Data Exchange in IoT and Web Systems		
Lecturer (for lectures)		Maleš-Ilić P. Nataša, Pronić-Rančić R. Olivera		
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)		Atanasković S. Aleksandar		
Number of ECTS		5	Course status (obligatory/elective)	Elective
Prerequisites		None		
Course objectives		To introduce students to fundamental and advanced techniques for data-exchange in distributed systems, with emphasis on IoT, cloud and Web services. Through lectures and laboratory work students learn to design efficient, secure and optimised data-exchange solutions using modern protocols (MQTT, REST, gRPC, CoAP, AMQP...) and data formats (JSON, XML, CBOR, Protobuf, Avro...).		
Course outcomes		After successfully completing the course, students will be able to: understand and implement multiple data-exchange protocols in IoT and Web applications; design REST APIs, MQTT clients and gRPC services; choose and optimise suitable data-serialisation formats for real-world use-cases; apply security measures (TLS, OAuth 2.0, JWT, encryption) to protect data in transit; benchmark and compare the performance of different data-exchange approaches.		
Course outline				
Theoretical teaching		Introduction to data exchange (Core concepts – HTTP, WebSockets; Transport protocols – TCP, UDP, TLS/SSL); Message-oriented protocols (MQTT fundamentals; Advanced MQTT and alternative protocols – AMQP, CoAP); Request-response protocols (REST API basics; Advanced REST topics – caching, authentication (OAuth 2.0, JWT); gRPC – service definition and comparison with REST); Data formats and serialisation (JSON and XML; Protobuf and Avro; CBOR and MessagePack); Security and performance (Securing MQTT and REST communication – TLS, OAuth, encryption; Performance comparison of REST, MQTT and gRPC)		
Practical teaching (exercises, OFE, study and research work)		Guided exercises solving selected problems on PCs and micro-controllers (ESP32 / Arduino); Hands-on labs: building MQTT brokers (Mosquitto), REST/gRPC services, Postman & Node-RED integration; Team project: design and demonstration of a complete IoT data-exchange solution.		
Textbooks/references				
1		Gary Smart, Practical Python Programming for IoT - Build advanced IoT projects using a Raspberry Pi 4, MQTT, RESTful APIs, WebSockets, and Python 3, Packt Publishing, 2020.		
2		Robert Thas John, Arduino Data Communications - Learn how to configure databases, MQTT, REST APIs, and store data over LoRaWAN, HC-12, and GSM, Pact Publishing, 2023.		
3		Sivaraj Selvaraj, Mastering REST APIs - Boosting Your Web Development Journey with Advanced API Techniques, Apress, 2024.		
4		D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, and J. Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, 2017.		
5		Justin Richer and Antonio Sanso, OAuth 2 in Action, Manning Publications, 2017.		
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, exercises, practical laboratory work, team project and 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		Communications and Information Technologies / System Engineering and Radio-Communications		
Type and level of studies		Master Academic Studies		
The name of the course		Application of electromagnetic software in engineering		
Lecturer (for lectures)		Dončov S. Nebojša, Joković J. Jugoslav		
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)		Dimitrijević Ž. Tijana		
Number of ECTS	4	Course status (obligatory/elective)	Elective	
Prerequisites	None			
Course objectives	Familiarizing students with state-of-the-art numerical methods and software tools for electromagnetic modeling. Acquiring fundamental knowledge for the simulation and analysis of practical electromagnetic problems.			
Course outcomes	Knowledge of the main characteristics of state-of-the-art electromagnetic software. Ability to independently model and analyze various microwave structures (filters, couplers, resonators, antennas, etc.).			
Course outline				
Theoretical teaching	Introduction to electromagnetic simulations. Overview of numerical methods (FEM, FDTD, MoM, TLM, hybrid methods) and available software tools (WIPL-D, CST, FEKO, COMSOL, IE3D, ADS) for electromagnetic simulations. Steps in using electromagnetic software (geometry and spatial discretization, excitation, boundary conditions, definition of electromagnetic parameters). Optimization and parametric analysis. Examples of using electromagnetic software in engineering. Development of in-house code for electromagnetic simulations. Applications of electromagnetic software in interdisciplinary fields in combination with other software (thermal, mechanical, etc.). Trends in the development of tools for electromagnetic simulations.			
Practical teaching (exercises, OFE, study and research work)	Practical use of electromagnetic software for solving specific engineering problems. Writing and testing code for electromagnetic simulations in one of the following environments: MATLAB, Mathematica, Fortran, C/C++, Python. Verification and processing of simulation results.			
Textbooks/references				
1	M. N.O. Sadiku, Computational Electromagnetics with MATLAB, 4th edition, CRC Press, 2018.			
2	D. B. Davidson, Computational Electromagnetics for RF and Microwave Engineering, 2nd edition, Cambridge University Press, 2010.			
3	J. E. Houle, D. M. Sullivan, Electromagnetic Simulation Using the FDTD Method with Python, 3rd edition, Wiley-IEEE Press, 2020.			
4	B.M. Kolundzija et al., WIPL-D Microwave: Circuit and 3D EM simulation for RF & Microwave Applications, Software and User's Manual, Artech House, Norwood, 2005.			
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, practical work, consultations, team project			
Grade (maximum number of points 100)				
Pre-exam duties	Points	Final exam		Points
Activity during lectures	5	Written exam		
Exercises	35	Oral exam		30
Colloquia				
Projects	30			

Specification for the book of courses

Study program		Communications and Information Technologies		
Type and level of studies		Master Studies		
The name of the course		Master Thesis – Study and Research Work		
Lecturer (for lectures)				
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)				
Number of ECTS		7	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 the literature, the student becomes familiar with methods intended for solving similar tasks and with engineering practices used 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 a given problem and conduct a systematic analysis to draw conclusions about possible directions for its resolution. Through independent use of literature, students expand their knowledge by studying various methods and papers related to similar issues. In this way, students develop the ability to conduct analyses and identify problems within the given subject matter. Through the practical application of acquired knowledge, students develop the ability to understand the role and position of engineers in the chosen field, the need for collaboration with other professions, and the importance of teamwork.		
Course outline				
Theoretical teaching		It is formed individually in accordance with the needs of the specific undergraduate or master's thesis, its complexity, and structure. The student, according to their interests and preferences, selects the area of study or a supervising professor from the list of faculty members in the study program, who then defines a specific task. The student studies professional literature, technical and scientific papers related to similar topics, performs analyses aimed at finding solutions to the given task, or conducts specific experiments in a laboratory. The study work also includes active monitoring of primary findings, organization and execution of experiments, numerical simulations and statistical data processing, as well as the preparation of a seminar paper within the narrower scientific-teaching field to which the topic of the independent research work 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
			14	
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		Communications and Information Technologies		
Type and level of studies		Master Studies		
The name of the course		Master Thesis		
Lecturer (for lectures)				
Lecturer/associate (for exercises)				
Lecturer/associate (for OFE)				
Number of ECTS	15	Course status (obligatory/elective)	Obligatory	
Prerequisites				
Course objectives	The purpose of preparing the Master's thesis is to unify, confirm, and practically apply the knowledge acquired during the Master's academic studies. The student is given the opportunity to demonstrate the ability to independently carry out a project, which can be practical, research-oriented, or theoretical-methodological in nature. The student also gains experience in presenting their work both in written form and through oral defense.			
Course outcomes	The ability to lead an independent project, the ability to formulate and analyze problems, critically review possible solutions, and survey literature in the given field. Application of acquired engineering and design knowledge and skills to problem-solving, taking into account complexity, costs, reliability, and efficiency of the solution. The ability to write the thesis in the prescribed format. The ability to clearly explain the completed project through an oral defense.			
Course outline				
Theoretical teaching	The Master's thesis represents an independent research, practical, or theoretical-methodological work of the student, aligned with the level of study, in which the student familiarizes themselves with a narrower field through a literature review and adopts the research or design methodology necessary for preparing the thesis. Through the preparation of the thesis, the student applies practical and theoretical knowledge acquired during their studies. The written thesis typically contains an introductory chapter, problem definition, review of the field and existing solutions, proposal and description of the solution, conclusion, and references. The public oral defense of the thesis is organized before a committee of three members, one of whom is the thesis mentor. During the oral defense, the candidate explains the results of their work and then answers questions from the committee members, thereby demonstrating the ability to orally present 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				
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				