Specification for the book of courses

Study program	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	Computer Network Security		
Lecturer (for lectures)	Milovanović I. Emina, Ćirić M. Vladimir		
Lecturer/associate (for exercises)	Dimitrijević M. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites	Computer networks		
Course objectives	The aim of the course is for the students to gain insight into the potential security weaknesses and obtain the basic knowledge to enhance the security, as well as to gain the knowledge and skills to apply security techniques in order to increase the security of computer networks.		
Course outcomes	It is expected for the students to be able to analyse the security aspects of computer networks, and to be able to plan the strategy to increase security. It is also expected that the student has a knowledge to use tools, as well as to implement security protocols in order to increase security of the network		
Course outline			
Theoretical teaching	The objectives of security: data protection, data integrity, authentification. Cryptographic algorithms: public and shared keys. Key exchange protocols. Digital signature. The security aspects of different network layers. Protocols and techniques for protection against specific types of attacks. Application of security protocols in data protection. Protecting data integrity and authentication (Kerbos, SSL / TLS. IPSec, VPN, PK). Application tools and firewall for system level protection. Attacks. Computer viruses. Security of wireless networks.		
Practical teaching (exercises, OFE, study and research	Work through the examples set of laboratory exercises. Protection of network equipment. RADIUS and AAA servers. Firewall. Configuration of virtual private networks (VPN). Security of wireless networks. Typical attacks.		
Textbooks/references			
1	William Stallings, “Cryptography and Network Security: Principles and Practice (6th Edition)“, Prentice hall, 2013		
2	Michael Watkins, Kevin Wallace, "CCNA Security", Cisco Press, 2008, ISBN 9781587202209		
3			
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Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods				

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

Specification for the book of courses

Study program		Computing and Informatics		
Module		Computer Systems Security		
Type and level of studies		Master studies		
The name of the course		Secure Software Design		
Lecturer (for lectures)		Janković S. Dragan		
Lecturer/associate (for exercises)		Rajković J. Petar		
Lecturer/associate (for OFE)				
Number of ECTS	4	**Course status (obligatory/elective)**	Elective	
Prerequisites				
Course objectives	The main course objective is introducing students with basic concepts and applied techniques used for secure code development			
Course outcomes	The students have to be able to identify the main problems related to software solutions security and to apply learned resolution techniques.			
Course outline				
Theoretical teaching	1. Introduction 2. Passwords 3. Pseudorandom numbers 4. Pseudorandom generators 5. Buffer Overflow 6. Safety increase techniques 7. Shared resources deadlock problems 8. Input validation 9. Cryptography 10. Authentication protocols 11. Software configurability 12. Processing sensitive data 13. Memory management			
Practical teaching (exercises, OFE, study and research	1. Weak points in shell scripts 2. Password coding 3. Pseudorandom numbers based applications 4. Implementation of random generators 5. Methods for the Buffer Overflow problem overcoming 6. Access control matrix implementation 7. Thread management 8. Methods against file level deadlocks 9. Input validation 10. Authentication protocols 11. Using cryptographic algorithms in software 12. Configurations - design and using 13. Problems with memory allocation and de-allocation			
Textbooks/references				
1	Anderson, Ross. Security engineering. John Wiley & Sons, 2008.			
2	Richardson, Theodor, and Charles N. Thies. Secure software design. Jones & Bartlett Publishers, 2012.			
3	Michael Howard, David LeBlanc: Writing Secure Code, ISBN 073561722-8, Microsoft Press, 2002.			
4	Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security, Private Communication in a Public World, Prentice-Hall, 2002.			
5	Fernandez-Buglioni, Eduardo. Security patterns in practice: designing secure architectures using software patterns. John Wiley & Sons, 2013.			

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

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	Digital Forensics		
Lecturer (for lectures)	Rančić D. Dejan, Predić B. Bratislav		
Lecturer/associate (for exercises)	Predić B. Bratislav		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introduction to the process of identification, preservation and analysis of digital evidence, as well as preparing them for presentation in a court of proper forensic procedure on the correct way.		
Course outcomes	Theoretical and practical knowledge of the process of identification, preservation and analysis of digital evidence. Knowledge of software and hardware tools for digital forensics. Knowledge of the legal components of digital forensics. Knowledge of basic principles, policies and methodologies of digital forensics.		
Course outline			
Theoretical teaching	Identification, preservation and analysis of digital evidence. Basic principles, policies and methodologies of digital forensics. The legal component of digital forensics. Preparation and presentation of digital evidence in court in a proper procedure in forensic properly. Recover lost data. Password cracking and decryption of data. Forensics software. Forensics of operating system and file system. Forensics of digital devices. Network forensics. Forensics of mobile devices. Software and hardware tools for digital forensics (EnCase, Toolkit - FTK, VMware, ...).		
Practical teaching (exercises, OFE, study and research	Getting to know the software and hardware tools for digital forensics		
Textbooks/references			
1	Kanellis, Panagiotis. Digital crime and forensic science in cyberspace. IGI Publishing , 2008.		
2	Jones, Andrew. Building a Digital Forensic Laboratory. Butterworth-Heinemann, 2008.		
3			
4			
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Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, exercises, individual student work on projects.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	Cloud Computing		
Lecturer (for lectures)	Stojanović M. Natalija, Ćirić M. Vladimir		
Lecturer/associate (for exercises)	Stojanović M. Natalija		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The goal of this course is to give an insight to the students into the concepts of virtualization and cloud systems, as well as insight into service-oriented principles.		
Course outcomes	It is expected for the students to acquire the knowledge needed to plan, design and implement virtual and cloud service system, as well as to implement virtualization concepts based on the solutions offered by different vendors. Students will also acquire the necessary theoretical and practical skills to develop applications on cloud computing.		
Course outline			
Theoretical teaching	Objectives and concepts of virtualization. Virtualization technologies. Hypervisor-based virtualization. Container-based virtualization. Docker. Kubernetes. Virtual services and applications. Service-oriented architectures. Methods, technologies and applications of cloud computing. Software as a Service (SaaS), platform as a service (PaaS), infrastructure as a service (IaaS). Data storage in the cloud computing. Virtual file systems. Security of cloud computing. Techniques for implementing high-reliability cloud computing. Data backup techniques. Migration of services. Resource planning. Application development in the cloud computing and open source solutions. High-performance computing on the cloud (Hadoop, MapReduce, HDFS). Hadoop open technologies: Hive, Pig, HBase, Mahout.		
Practical teaching (exercises, OFE, study and research	Laboratory exercises. Installation and management of virtual machines in different environments. Migration. Data backup. Container-based virtualization. Docker. Kubernetes. Planning and implementation of techniques for reliability increasing. Development of computer applications in the cloud. Open Technologies: Hive, Pig, HBAs, Mahout.□		
Textbooks/references			
1	Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, “Cloud Computing: A Practical Approach”, Mc. Graw Hill, 2010, ISBN: 978-0-07-162695-8		
2	Kris Jamsa, “Cloud Computing: SaaS, PaaS, IaaS, Virtualization”, Jones & Bartlett, 2013, ISBN: 978-1-44-96-4739-1		
3	Karl Matthias, Sean Kane, "Docker Up and Running", O'Reilly, 2015.		
4	Tom White, Hadoop: The Definitive Guide, 4th Edition, O’Reilly Media, 2015.		
5	Thilina Gunarathne, Srinath Perera, Hadoop MapReduce Cookbook, Packt Publishing Ltd., 2013.		

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

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	Virtualization		
Lecturer (for lectures)	Tošić B. Milorad		
Lecturer/associate (for exercises)	Tošić B. Milorad		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introducing students to the fundamentals of virtualization, virtualization types and technologies for their implementation.		
Course outcomes	Upon completion of the course the student should be able to use the virtualization process in everyday practice, including the virtualization of servers, storage space, networks and applications.		
Course outline			
Theoretical teaching	What is virtualization: history, conceptualization and fundamental principles; Types of virtualization and technologies : Server virtualization, storage space virtualization, network virtualization, application virtualization; Operating system level virtualization; Containers; Virtual Network Functions; Virtual machines and hypervisors; Resource management systems in virtulized systems. Virtualized system architectures.		
Practical teaching (exercises, OFE, study and research	Comparative analysis of the existing open-source software solutions for virtualizations; Virtualization software installation; Virtual machine creation; Virtual network creation; Connecting two virtual machines using LAN; Internal virtual machine routing and internet connection; Proof-of-concept implementation of application based on microservices and virtualized infrastructure.		
Textbooks/references			
1	Radez, Dan. OpenStack Essentials. Packt Publishing Ltd, 2015.		
2	Zhang, Ying. Network Function Virtualization: Concepts and Applicability in 5G Networks. John Wiley & Sons, 2017.		
3	Murugesan, San, and Irena Bojanova, eds. Encyclopedia of cloud computing. John Wiley & Sons, 2016.		
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Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Auditive exercises; Laboratory exercises; Computer-based exercises; Consultations; Independent research activities; Oral presentations on selected topics; Active student participation via interactive course Website.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	System Administration		
Lecturer (for lectures)	Tošić B. Milorad		
Lecturer/associate (for exercises)	Tošić B. Milorad		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introduction to fundamental procedures of system administration in Linux-based operating systems.		
Course outcomes	Upon completion of the course the student should be able to administer Linux-based operating systems to the level needed for operation of medium-size development teams.		
Course outline			
Theoretical teaching	Linux operating system: Fundamentals of Linux operating system from system administration perspective. Overview of the available open-source Linux distributions. Commands and languages for writing script programmes. User management. File system management. Operating system vulnerabilities. Server management - configuration documents. Activity tracking - logs. Basics of Techical Support: Technical Support basic principles, Workflows - Level 1, Level 2, Level 3 and management level. Remote location support. Virtualized system administration. Main types of virtualization and available technologies. Container-based system. Virtual machine-based systems. Virtualized network management.		
Practical teaching (exercises, OFE, study and research			
Textbooks/references			
1	Nemeth E. UNIX and Linux System Administration Handbook, 4/e. Pearson Education India; 2011.		
2	T. Adelstein, F. Timme, and B. Lubanovic.LinuxSystem Administration. O'Reilly Media, Inc.,2007		
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Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures and auditory exercises supported by e-learning platform. Laboratory exercises. Practical exercises involving remote virtual machine access and individual computers.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	Cryptography		
Lecturer (for lectures)	Rančić D. Dejan, Vučković V. Vladan		
Lecturer/associate (for exercises)	Dimitrijević M. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course	Introduction to the field of cryptography in terms of basic principles, algorithms and standards.		
Course outcomes	Students will gain knowledge on basic principles, algorithms, and standards used in the field of cryptography. They will also learn how to apply that knowlegde in real-world applications.		
Course outline			
Theoretical teaching	History and overview of cryptography. Mathematical background. Basic symmetric-key encryption. Stream ciphers. Block ciphers. DES – The Data Encryption Standard. AES – The Advanced Encryption Standard. Asymmetric cryptography using public-private key pair. Hash Functions and Data Integrity. Digital signature schemes. RSA signatures. The "Hash-and-Sign" Paradigm. Certificates and Public-Key Infrastructures. Secure Socket Layer (SSL) and Transport Layer Security (TLS) standards.		
Practical teaching (exercises, OFE, study and research	Practical work on the programming cryptographic elements using OpenSSL library.		
Textbooks/references			
1	J. Katz, Y. Lindell, Introduction to Modern Cryptography, CRC Press, 2007.		
2	A. Menezes, P. van Oorschot, S. Vanstone, Handbook of Applied Cryptography, CRC Press, 1996.		
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		
Teaching methods	Lectures, exercises, individual student work on projects.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	High-performance Computing		
Lecturer (for lectures)	Stojanović M. Natalija, Milentijević Z. Ivan		
Lecturer/associate (for exercises)	Dimitrijević M. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Acquiring knowledge to develop high performance applications that require intensive computation and processing large amounts of data on modern computer architectures (GPU, multicore PCs, network of workstations, cluster, grid, etc.) in different domains.		
Course outcomes	Understanding the concepts and technologies of high-performance computing as well as acquiring the theoretical and practical knowledge for the development and analysis of high performance applications on modern computer architectures.		
Course outline			
Theoretical teaching	Overview of advanced concepts, methods and techniques in high-performance computing (HPC High Performance Computing). High-performance computing in distributed environment on the network of workstations (cluster), grid and cloud computing. High-performance computing on multi-core computers with shared memory and many-core architectures, such as graphics processing unit (GPU). High-performance computing on hybrid architectures. Modern technologies to achieve high performance (CUDA/OpenCL, OpenACC, Thrust biblioteka, OpenMP, Intel TBB, MPI, Hadoop MapReduce). Performance analysis, assessment and improvement (execution time, energy consumption and programming effort for program parallelization) of HPC systems using appropriate tools. HPC applications in geographical information systems (GIS), image processing, environmental protection, business systems, bioinformatics, etc.		
Practical teaching (exercises, OFE, study and research	Work through the HPC examples over the set of laboratory exercises. CUDA application development and performance analysis. OpenMP application development and performance analysis.		
Textbooks/references			
1	Programming Massively Parallel Processors: A Hands-on Approach, David Kirk, Wen-mei W. Hwu, Wen-mei Hwu, Elsevier, 2017.		
2	CUDA by example: an introduction to general-purpose GPU programming, Jason Sanders, Edward Kandrot, Addison-Wesley Professional, 2011		
3	Using OpenMP : portable shared memory parallel programming / Barbara Chapman, Gabriele Jost, Ruud van der Pas, MIT Press 2008.		
4	Intel Threading Building Blocks Outfitting C++ for Multi-core Processor Parallelism, James Reinders, O' Reilly Media,2007		
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		
Teaching methods	Lectures. Lab. exercises. Homeworks, and projects, student seminars (presentation and discussion of students' work).			

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

Specification for the book of courses

Study program		Computing and Informatics		
Module		Computer Systems Security		
Type and level of studies		Master studies		
The name of the course		Management of IT Resources and Services		
Lecturer (for lectures)		Milentijević Z. Ivan		
Lecturer/associate (for exercises)		Milentijević Z. Ivan		
Lecturer/associate (for OFE)				
Number of ECTS	4	**Course status (obligatory/elective)**	Elective	
Prerequisites				
Course objectives	To enable students to acquire knowledge about the role of computer resources and services in companies, and about how to provide high-quality and reliability of IT services.			
Course outcomes	After the course, students will be able to organize IT resources and services within the specific organization, as well as to plan providing of IT services.□			
Course outline				
Theoretical teaching	IT resources magement, management methods and systems. Criteria and requirements for IT resources and services in the organization (the required functionality, quality, safety, performance, cost). Capacity planning of IT resources, technical, operation and budget planning. Capacity control: methods and tools for control of technical aspects (capacity and performance of networks, servers, workstations, software licenses, human resources). Information security, operational procedures, standards and tools for information security. Operational and IT risk and compliance with regulatory requirements. IT control and audit, process level standardization: CMMI, ITIL, PSP/TSP and others. IT service life cycle, service managment, planning and management in the multiservice environment.□			
Practical teaching (exercises, OFE, study and research	IT resources and services requirement development (collecting, organizing and analyzing requirements). Capacity planning of IT resources, service planning, IT budget planning - capital, service costs and amortization. Testing and performance control of IT resources – tools and methodologies. Examples and templates of standard operating procedures. Tools for testing information security. The process of IT audit, external and internal audit, examples of standards.			
Textbooks/references				
1	Taylor S., Service Intelligence, Prentice Hall, 2012.			
2	IT Service Management: An Introduction, Van Haren Publishing, 2007			
3	Robert R. Moeller, IT Audit, Control, and Security, John Wiley & Sons, 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	0		
Teaching methods	Lectures, auditive excercises, consultations, homework, team projects. Project presentations and group discussion.			

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	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	Fault Tolerant Systems		
Lecturer (for lectures)	Milovanović I. Emina, Milentijević Z. Ivan		
Lecturer/associate (for exercises)	Milovanović I. Emina		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course	The main objective is to present methods and techniques for fault tolerant system design.		
Course outcomes	Students are expected to understand and be able to develop and implement various fault tolerant techniques.		
Course outline			
Theoretical teaching	Need analysis for fault tolerant systems. Reliability, availability, security, performance, sustainability, testability. Basic definitions. Failure models. Error models. Redundancy techniques for fault tolerance. Hardware redundancy (passive, active, hybrid). Information redundancy (parity, m of n, duplication, checksums, etc.). Time redundancy. Software redundancy (consistency checks, functionality, N-version programming). Fault tolerance in cloud computing		
Practical teaching (exercises, OFE, study and research	Exercises through students' projects.		
Textbooks/references			
1	I. Koren and C. Krishna, "Fault-Tolerant Systems", Morgan Kaufmann, San Francisco, US, 2007.		
2	E. Dubrova, Fault-Tolerant Design, Springer-Verlag New York, 2013.		
3	Dhiraj K. Pradhan, Fault-tolerant computer system design, Prentice Hall PTR, New Jersey, 1995		
4	scientific articles		
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		
Teaching methods	Lectures, exercises, individual research			

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	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	Algorithms and Architectures of Dedicated Computer Systems		
Lecturer (for lectures)	Milentijević Z. Ivan, Ćirić M. Vladimir		
Lecturer/associate (for exercises)	Vojinović M. Oliver		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The main objective is adoption of hardware design techniques and hardware implementation of DSP algorithms.		
Course outcomes	Student is expected to design and implement DSP algorithms.		
Course outline			
Theoretical teaching	Typical DSP algorithms. Presentation of algorithms. Mapping DSP algorithms into special-purpose hardware. Timing. Folding and unfolding of architectures. Systolic architectures. Compromise techniques and their application in hardware accelerators for digital signals. Power management. Consumption analysis and reduction estimations. Streaming processors. Multimedia data processing.		
Practical teaching (exercises, OFE, study and research	The design and description of stream processors in Maxeler environment using Java programming language. Dataflow computational model. Dataflow description in Java.		
Textbooks/references			
1	High-Performance Computing Using FPGAs, Vanderbauwhede W., Benkrid K. (Eds.), Springer, 2013.		
2	FPGAs for Software Programmers, Koch D., Hanning F., Ziener D. (Eds.), Springer, 2016.		
3	Dataflow Programming with MaxCompiler, Maxeler Technologies Inc, 2012.		
4	Keshab K. Parhi, "VLSI Digital Signal Processing Systems: Design and Implementation", Wiley, 1999, ISBN 0471241865.		
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		
Teaching methods	Lectures, auditive excercises, student project			

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	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	Blockchain Technologies		
Lecturer (for lectures)	Janković S. Dragan, Ćirić M. Vladimir, Stanimirović S. Aleksandar		
Lecturer/associate (for exercises)	Davidović P. Nikola		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The aim of the course is to gain knowledge on advance distributed algorithms and data structures, which enable the understanding of blockchain concepts, as well as with the advanced technologies used for the implementation of such a systems.		
Course outcomes	It is expected for the students to be able to understand the principles and concepts of the blockchain technology, as well as to apply available tools and development environments to design and implement private and public blockchain systems. Also, students should be able to use technologies to develop and implement distributed applications using Ethereum platform.		
Course outline			
Theoretical teaching	Basic blockchain concepts. Decentralization. Communication within the decentralized system. Elements of cryptography, cryptographic primitives. Public key cryptography, PKI, RSA, ECC. Hash functions, SHA-1, SHA-2, MD5. OpenSSL. Fault tolerance and consensus algorithms. Cryptocurrencies and cryptoeconomics. Public and private blockchains. Bitcoin. Digital keys and address. Transactions. Mining, CPU, GPU, FPGA, ASIC. Alternative currencies. Ethereum. Smart contracts. Programming in Ethereum. Developer Tools. Hyperlegder. Blockchain applications.		
Practical teaching (exercises, OFE, study and research	Digital wallet. The difference between the main Ethereum network and the test network. Programming in Solidity. Programming smart contract. Remix development environment. Basics of programming language Node.js and npm package manager. EC6 Javascript. Truffle tools. Setting up a smart object to blockchain. Web3.js and interaction with smart contract. Testing smart contract. React Basics of Web technology. Web applications.		
Textbooks/references			
1	Imran Bashir, “Mastering Blockchain: Distributed ledger technology, decentralization, and smart contracts explained”, 2nd Edition, 978-1788839044		
2	Andreas Antonopoulos, Gavin Wood, “Mastering Ethereum: Building Smart Contracts and DApps”, 978-1491971949		
3	Chris Dannen, “Introducing Ethereum and Solidity: Foundations of Cryptocurrency and Blockchain Programming for Beginners”, 1st ed. Edition, 978-1484225349		
4	Arshdeep Bahga, Vijay Madisetti, “Blockchain Applications: A Hands-On Approach”, 978-0996025553		
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		
Teaching methods	Lectures, exercises, team projects, seminar.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Computer Systems Security		
Type and level of studies	Master studies		
The name of the course	Computer Based Sensor Systems		
Lecturer (for lectures)	Denić B. Dragan, Radenković N. Dragan, Dinčić R. Milan		
Lecturer/associate (for exercises)	Dinčić R. Milan		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introduction of students with operating principles, significance and application of sensors and sensor systems; with techniques for acquisition, processing and analysis of measurement data; with topical sensor systems (telemetry systems, wireless sensor networks, IoT systems); with programming in LabVIEW software; with the realization of sensor systems based on current hardware-software platforms (LabVIEW, Raspberry Pi, FPGA).		
Course outcomes	Students will obtain theoretical and practical knowledge of modern sensor technologies and systems. Also, students will master knowledge of hardware-software realization of sensor systems using LabVIEW, Raspberry Pi and FPGA platforms.		
Course outline			
Theoretical teaching	Sensors and sensor systems. Principles of work, importance and application sensors. General structure of computer-based sensor systems. Acquisition of measurement data. Acquisition cards. Protocols for connecting cards to computer. Computer software for Data Acquisition. LabVIEW software package - features, applications, programming. Concept of virtual instrumentation. Realization of sensor systems based on LabVIEW, Raspberry Pi and FPGA platform. Analysis and processing of measurement data. Telemetry systems. Wireless sensor networks. IoT systems.		
Practical teaching (exercises, OFE, study and research	Practice, laboratory exercises, realization of project and seminar tasks, with the aim to enable students to acquire practical knowledge related to programming in LabVIEW and to design and implement sensor systems using LabVIEW, Raspberry Pi and FPGA technologies.		
Textbooks/references			
1	D. Denić, I. Randjelović, D. Živanović, "Computer-based measurement systems in industry", Faculty of Electronic Engineering Niš and WUS Austria, script, 2005 (in Serbian).		
2	D. Stanković, "Physical-technical measurements - sensors", University of Belgrade, 1997 (in Serbian).		
3	Robert Bishop, "Learning With LabVIEW", Pearson, 2015.		
4	National Instruments, "Data Acquisition and Signal Conditioning Course Manual", 2012.		
5	John Shovic, "Raspberry Pi IoT Projects", 2015.		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures with application of modern presentation tools, discussion of student solutions, consultations, calculation exercises, laboratory exercises.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Computer Simulation		
Lecturer (for lectures)	Vučković V. Vladan		
Lecturer/associate (for exercises)	Vučković V. Vladan		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Mastering basic knowledge necessary for the use of basic procedures and procedures in computer modeling and simulation.		
Course outcomes	Theoretical knowledge: mastering mathematical techniques for computer modeling and simulation; 3D modeling and programming simulations on a computer.		
Course outline			
Theoretical teaching	Basics of computer simulation. General approach to system simulation. Mathematical basics of the simulation system. Mathematical modeling of physical processes and sensor data. Stochastic and deterministic approach in simulation. Continuous and discrete simulations. Efficient data structures and simulation algorithms. Access via differential algebraic equations. Local and distributed simulations. Discrete event simulation (DES). Aggregate Level Simulation Protocol (ALSP), Distributed Interactive Simulation (DIS), High Level Architecture (HLA). Introduction to 3D software. 3D simulations in real time. Parallel algorithms in simulation systems. Optimization of hardware for simulation machines.		
Practical teaching (exercises, OFE, study and research work)	Hierarchies in 3D software and animation with expressions. Practical 3D modeling on a computer. Use of modern 3D modeling software. Basic simulation procedures. Keyframe animation - rotations and sizes (squash and stretch). NURBS modeling - lines. NURBS modeling-shapes. Introduction to polygonal modeling. Quad modeling. Polygonal modeling of a simple character. Polygonal modeling of a character by task. Torzo. Polygonal modeling of a character by task. Head: eyes, lips, ear. UV mapping. Digital driving. Basics of 3D materialization. Riging - Introduction to skeletal systems. The term driven key. Creating and selecting attributes. Programming various simple simulator classes.		
Textbooks/references			
1	Modeling and Simulation in Engineering, Edited by Catalin Alexandru, ISBN 978-953-51-0012-6, Hard cover, 298 pages, Publisher: InTech, Published: March 07, 2012 under CC BY 3.0 license.		
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Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, exercises on the board, laboratory exercises, students' independent work on homework assignments and projects, consultations.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Application of Multiple Valued Logic in Representation and Processing of		
Lecturer (for lectures)	Radmanović M. Miloš		
Lecturer/associate (for exercises)	Radmanović M. Miloš		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Students will acquire theoretical and practical knowledge in filed of multiple-valued logic and its application in digital system design and signal processing.		
Course outcomes	Students will learn fundamentals of multiple-valued logic, related algebraic structures, and multiple-valued functions, their representation and implementation on the different technological platforms. They will learn fundamental methods for calculation of multiple-valued functions for use in digital system design and signal processing.		
Course outline			
Theoretical teaching	Multiple-Valued Logic Functions and Applications. Functional Expressions for Multiple-Valued Functions. Spectral Representations of Multiple-Valued Functions. Decision Diagrams for Multiple-Valued Functions. Fast Calculation Algorithms. Algorithms for Calculations of Multiple-Valued functions Transforms on Graphical Processors.		
Practical teaching (exercises, OFE, study and research	Work with the specific software and tools for multiple-valued logic. Program implementation of the fundamental algorithms for multiple-valued functions on the graphical processors.		
Textbooks/references			
1	R.S. Stankovic, J.Astola, C. Moraga, Representations of Multiple- Valued Logic Functions , Morgan & Claypool Publishers, 2012.		
2	D. Michael Miller, Mitchell Thornton, Multiple Valued Logic: Concepts and Representations, Morgan & Claypool Publishers, 2008. ISBN 1598291904		
3	Documents on Web site: http://cs.elfak.ni.ac.rs/nastava//		
4			
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Presentations by use of slides, seminars and projects.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Semantic Web		
Lecturer (for lectures)	Tošić B. Milorad, Nejković M. Valentina		
Lecturer/associate (for exercises)	Bogdanović D. Miloš, Nejković M. Valentina		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites	Exams passed: Information Systems, Web Programming, Databases and Artificial Intelligence. □		
Course objectives	The acquisition of basic theoretical knowledge and possible areas of application for the Semantic Web. Conquering the basic programming techniques for developing semantic web applications in the current stage of technology development. Building creative attitudes towards the possible directions for further development of technology in this area.□		
Course outcomes	Developed and adopted a systematic approach to Semantic Web applications in current areas of application. Conquered the theoretical knowledge about applications of semantics and reasoning in information technologies. Students know what they are and are able to effectively work with ontologies, and apply them in solving complex problems including Big Data.		
Course outline			
Theoretical teaching	Introduction: structure, syntax and semantics; need for semantics on the Web. Meta-programming: Metadata, XML Schema, XSLT, RDF. Semantics: The semantics and knowledge, Ontologies, Logic; Reasoning; Domain modeling; Context. Distributed Knowledge: Classification; Knowledge based protocols; Technologies: Tools for working with ontologies; software (API) for working with ontologies, OWL, Methodologies: Methodologies for ontology engineering methodologies of the introduction of knowledge management, semantic systems development methodology; semantic systems: semantic Web Services and semantic Web Portals, Semantic Wiki, Semantic Multi-agent systems, Semantic Web browsers, ... Applications: Big Data analytics and search, Business intelligence, Intelligence in Web application development, Intelligent virtualization of computing infrastrucures.		
Practical teaching (exercises, OFE, study and research			
Textbooks/references			
1	DuCharme, Bob. Learning SPARQL: querying and updating with SPARQL 1.1. " O'Reilly Media, Inc.", 2013.		
2	Allemang, Dean, and James Hendler. Semantic web for the working ontologist: effective modeling in RDFS and OWL. Elsevier, 2011.		
3	Keet, CM. An Introduction to Ontology Engineering. v1.0, July 2018, 270p.		
4	Materials available on the Internet		
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		
Teaching methods	Lectures, Auditorial exercises, Laboratory exercises; Consultations, Independent students' research; students' oral presentation to the selected / given topics; Active students' participation in the classroom using online code and documents repository available in the Laboratory.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Methods and Techniques of the Image Processing		
Lecturer (for lectures)	Vučković V. Vladan, Nejković M. Valentina		
Lecturer/associate (for exercises)	Radmanović M. Miloš		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Learning about image processing techniques and training a student for independent application of learned techniques for solving real problems in image processing.		
Course outcomes	Upon completion of this course, students should be familiar with the methods and techniques applied in the field of image processing and to acquire enough knowledge to independently realize applications based on image processing.		
Course outline			
Theoretical teaching	Principles of image digitization. Quantity of the image in the original and transformation domain. Statistical models of picture and noise. Transformation of the image. Discrete representations of image transformations. Methods for filtering in the original and transformation domain. Quantification. Image restoration: Linear filters. Image restoration and segmentation: nonlinear filters. Methods for improving the image quality. Image compression. Efficient algorithms for image processing. Processing scanned documents. OCR systems.		
Practical teaching (exercises, OFE, study and research	Study research work: preparation of seminar papers in the field of advanced image processing techniques and oral presentations and defense of work.		
Textbooks/references			
1	L. Yaroslavsky, Digital Holography and Digital Image Processing: Principles, Methods, Algorithms, Kluwer Academic, 2004.		
2	Yaroslavsky, L., Advanced Lab in Image Processing, teaching material based on the book Digital Holography and Digital Image Processing: Principles, Methods, Algorithms, Kluwer Academic, 2004.		
3	B. Jahne, Digital Image Processing, Springer, 2002.		
4	Material on the site: http://cs.elfak.ni.ac.rs/nastava/		
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, students' independent work on homework assignments and projects, consultations.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Medical Information Systems		
Lecturer (for lectures)	Janković S. Dragan		
Lecturer/associate (for exercises)	Rajković J. Petar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The course objectives are introducing students in specifitiicies of medical information system development, deployment and project management. The students will get the knowledge about different types of medical software as well as related standards and legislature.		
Course outcomes	After the course completion, the students will be able to participate in medical information system development process using theoretical and practical knowledge obtained through lectures and software project development.		
Course outline			
Theoretical teaching	1. Introduction to medical information systems 2. Data quality 3. Standards and legislature 4. Comparison of existing systems 5. Medical information system design specificities 6. Aspects of system implementation 7. System and data security 8. Overview on implementation technologies 9. System installation and deployment phase 10. System exploitation phase 11. System interoperability 12. Telemedicine 13. Decision support systems 14. Medical information system project management		
Practical teaching (exercises, OFE, study and research work)	1. Defining main elements of the future information system 2. Designing database structure and electronic patient record 3. Medical examination support software components 4. Patient scheduling software module 5. Report generation module 6. Privileges within medical information system 7. Data security 8. Designing the data access Web service 9. Personal health Web portals 10. Composite electronic health records 11. Document management systems 12. Medical information system taxonomy 13. Data exchange standards 14. Data synchronization techniques		
Textbooks/references			
1	Karen A. Wager, Frances W. Lee, John P. Glaser, Health Care Information Systems: A Practical approach for Health Care Management, John Wiley, Jossey-Bass; 2 edition, 2009.		
2	Joseph Tan, Fay Cobb Payton: Adaptive Health Management Information Systems: Concepts, Cases, and Practical Applications, Third Edition, Jones & Bartlett Publishers; 3 edition (May 21, 2009), ISBN-10: 0763756911, ISBN-13: 978-0763756918		
3	Dean F. Sittig, Joan S. Ash: Clinical Information Systems: Overcoming Adverse Consequences (Jones and Bartlett Series in Biomedical Informatics), ones & Bartlett Publishers; 1 edition (November 23, 2009), ISBN-10: 0763757640, ISBN-13: 978-0763757649		
4	Scott Coplan, David Masuda: Project Management for Healthcare Information Technology, McGraw-Hill Professional; 1 edition (February 1, 2011), ISBN-10: 0071740538, ISBN-13: 978-0071740531		
5	Lectures in a form of Power Point presentations		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, Auditive exercises, Laboratory exercises. Student project realization.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Advanced Learning Technologies		
Lecturer (for lectures)	Milentijević Z. Ivan, Ćirić M. Vladimir		
Lecturer/associate (for exercises)	Vojinović M. Oliver		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	To enable students to acquire knowledge about advanced approaches to learning and education, learn how to apply information technologies in order to enhance learning, and learn pedagogical and cognitive effects of applied technology.		
Course outcomes	After successfully passing the course the student will be able to analyze the specific educational objectives and environment, and to design technology environment to support learning.		
Course outline			
Theoretical teaching	Learning paradigms; instructivist and constructivist approach. Instructional design and use of technology resources in instructional design. Formal and non-formal learning environments – games, e-learning, computer supported collaborative learning, problem-based and project-based learning, learning through social interaction. Computerized testing – standardized, adaptive and informal testing. Standard formats for presentation of learning material.		
Practical teaching (exercises, OFE, study and research	Analysis of learning approaches, analysis of educational objectives, setting of educational environment and mapping to appropriate technology. Design and development of software resources to support learning.		
Textbooks/references			
1	M. Hannafin, M. Land, The foundations and assumptions of technology-enhanced student-centered learning environments, Springer, 2004.		
2	M. S. Khine, I. M. Saleh, New Science of Learning: Cognition, Computers and Collaboration in Education, Springer, 2010.		
3	The Future of Ubiquitous Learning, Kinshuk B.G., Maina M. (Eds.), Springer, 2016.		
4	Collection of sellected academic papers		
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		
Teaching methods	Lectures, consultations, homeworks, student projects, student seminars (presentation of student projects, group discussion).			

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	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Command and Control Information Systems		
Lecturer (for lectures)	Rančić D. Dejan, Predić B. Bratislav		
Lecturer/associate (for exercises)	Predić B. Bratislav		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introduction to the basic characteristics and application areas of command & control information systems. Learning how participate in the process of design, development, implementation, operation and maintenance of command & control information systems.		
Course outcomes	Theoretical and practical knowledge of the command &control information systems. Capability to program and use existing command & control information systems. Mastering the basics of the theory and techniques of communication in command & control information systems. Mastering fundamentals of the analysis and security of command & control information systems.		
Course outline			
Theoretical teaching	Historical overview of the development of command & control information systems (C2IS). The basic functionality of C2IS. C2IS architecture. Standards in the area of C2IS. Communication in C2IS. Integration with GIS. The use of GPS technology in C2IS. Sensor integration. Data fusion. Tracking of mobile objects. Reporting in C2IS. Support for decision making. Application areas of C2IS. Military C2IS. C2IS for weather modification.		
Practical teaching (exercises, OFE, study and research	Practical implementation of some parts of command & control systems.		
Textbooks/references			
1	Giles Ebbutt, Jane's C4I Systems 2011-2012, Janes Information Group, 2012.		
2	Committee To Review Dod C4i Plans And Programs, Realizing The Potential Of C4i: Fundamental Challenges, National Academy Press, 1999.		
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Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, exercises, individual student work on projects.			

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	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Spectral Techniques		
Lecturer (for lectures)	Radmanović M. Miloš		
Lecturer/associate (for exercises)	Radmanović M. Miloš		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The main objective of the course is to provide students with theoretical and practical knowledge in the field of application of spectral techniques in the design, analysis and implementation of digital systems.		
Course outcomes	Students will be introduced to various methods of representation of discrete functions, techniques and methods for calculating the discrete transform and some applications of spectral techniques in the analysis and implementation of digital systems.		
Course outline			
Theoretical teaching	Walsh, Haar, arithmetic transform, Reed-Muller transform for binary-valued functions and Vilenkin-Chrestenson transform, generalized Haar, and other related transforms for multiple-valued functions Polynomial expressions and decision diagram representations for switching and multiple-value functions. Spectral analysis of Boolean functions. Spectral synthesis and optimization of combinational and sequential devices. Spectral methods in analysis and synthesis of reliable devices. Spectral techniques for testing computer hardware		
Practical teaching (exercises, OFE, study and research	Work with specialized software packages and tools. Program implementation of the algorithms for calculation of digital transforms and its application.		
Textbooks/references			
1	M. Karpovsky, R. Stankovic, J. Astola, Spectral Logic and Its Applications for the Design of Digital Devices, John Wiley & Sons, 2008.		
2	Documents on Web site: http://cs.elfak.ni.ac.rs/nastava/I		
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Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Presentations by use of slides, seminars, projects.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Advanced Techniques in 3D Modeling and Animation		
Lecturer (for lectures)	Vučković V. Vladan		
Lecturer/associate (for exercises)	Vučković V. Vladan		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Mastering the basic knowledge necessary to use advanced procedures and procedures in computer 3D modeling and animation.		
Course outcomes	Theoretical knowledge: mastering advanced techniques for computer 3D modeling and animation; 3D modeling, programming the path of cameras and generating animations on the computer.		
Course outline			
Theoretical teaching	3D Layout - Scenes in 3D software. Basics of rendering. Mental Ray - Antialiasing, GI, Final Gather. Mental ray Shaders: Mia X Pass, SSS, Illumination Shaders, Displacement, Ambient Occlusion. Mental Ray - Render Layers, Render Passes, Contribution maps. Hardware render. Lighting. Optimizing rendering. The basics of computer animation. Rendering animation. Modeling the camera path. Digital Directing Animation. Planning and organizing the project of digitally generated and animated film. Technical development of the project.		
Practical teaching (exercises, OFE, study and research	Exercises; Preparation of seminar papers. Getting acquainted with advanced modeling and animation methods. Practical 3D modeling and animation on the computer. Use of modern 3D animation software. Generating various simple animations.		
Textbooks/references			
1	“Computer Animation, Second Edition: Algorithms and Techniques”, Morgan Kaufmann; 2 edition (October 11, 2007); ISBN-10: 0125320000 ISBN-13: 978-0125320009		
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Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, consultations, independent work of students in the preparation of domestic tasks and projects.			

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	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Intelligent Information Systems		
Lecturer (for lectures)	Tošić B. Milorad		
Lecturer/associate (for exercises)	Bogdanović D. Miloš		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites	Exams passed: Information Systems, Web Programming and Artificial Intelligence.		
Course objectives	Gaining practical programming skills, theoretical knowledge and systematic approach required for the design, implementation and operation of systems in which information technologies, computers, the Internet, and humans act in concert to achieve results that are characterized as intelligent.		
Course outcomes	Students are able to identify areas of usage, specific problems and relevant theoretical concepts needed to solve them, possess practical programming skills needed to implement specific examples of usage.		
Course outline			
Theoretical teaching	Common conceptual foundations: data models, information and knowledge, the basic technologies (Internet, databases, artificial intelligence, information retrieval), business aspects, mathematical basics. Intelligent databases, deductive and active databases, intelligent information retrieval. Reasoning. Web and Intelligent Information Systems: Ontologies, Linked Data, Semantic Web, Social Networks, Collaborative Systems, and expandable network of small diameter. Programming at the level of the end user. Architecture of intelligent information systems: service-oriented and multi-agent architectures. Knowledge based systems. Information retrival and navigation: Web agents, data collection from the web "crawling" Intelligent Web Tools, Web search engines and issue of semantics. Information management, information flow, integration and semistructured information resources, XML and RDF based information presentations.		
Practical teaching (exercises, OFE, study and research			
Textbooks/references			
1	Online materials for lectures and exercises		
2	Existing source code repository in the Laboratory		
3	Dietz, Jan LG. What is Enterprise Ontology?. Springer Berlin Heidelberg, 2006.		
4	Keet, CM. An Introduction to Ontology Engineering. v1.0, July 2018, 270p.		
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		
Teaching methods	Lectures, Auditorial exercises, Laboratory exercises; Consultations, Independent students' research; students' oral presentation to the selected / given topics; Active students' participation in the classroom using online code and documents repository available in the Laboratory.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Information Technologies for Development of E-Government Systems		
Lecturer (for lectures)	Stoimenov V. Leonid, Stanimirović S. Aleksandar		
Lecturer/associate (for exercises)	Veljković Ž. Nataša		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Getting acquainted with the basic concepts of e-Government system and mastering technologies for designing and implementing various aspects of such systems.		
Course outcomes	Theoretical and practical knowledge of the concepts, design and implementation of e-Government systems		
Course outline			
Theoretical teaching	Getting acquainted with the basic concepts of e-Government system. History of e-government development. Analysis of key aspects of e-Government: data, e-services, applications, infrastructure. Data management in e-government systems: models and databases, data mining techniques, ontologies, semantic analysis. Open data and open data platforms. Analysis of the open data portals in e-Government. Aspects of integration of information: service-oriented architecture, Web services. Development of back-office and front-office applications. Current issues of e-Government infrastructure development: cloud technology.		
Practical teaching (exercises, OFE, study and research	Practical classes: Exercises, Research work		
Textbooks/references			
1	Mahmood, Z. (2013). E-Government Implementation and Practice in Developing Countries (pp. 1-348). doi:10.4018/978-1-4666-4090-0		
2	Reddick, C. & Aikins, Stephen K. (2012). Political, Policy and Management Implications Series: Public Administration and Information Technology (pp. 1- 275), Vol. 1, Springer.		
3	Vitvar, T., Peristeras, V., & Tarabanis, K. (2010). Semantic Technologies for E-Government. XVI, (pp. 1 - 320), ISBN 978-3-642-03507-4, Springer.		
4	Garson, G. D. (2006). Public Information Technology and E-Governance: Managing the Virtual State. Boston: Jones & Bartlett. 2006.		
5	Milić, P., Veljković, N., & Stoimenov, L. (2018). Semantic technologies in e-government: Toward openness and transparency. In Smart Technologies for Smart Governments (pp. 55-66). Springer, Cham.		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Classes, lab works, research work, homework			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Information Systems and Technologies		
Type and level of studies	Master studies		
The name of the course	Fuzzy Logic		
Lecturer (for lectures)	Radmanović M. Miloš		
Lecturer/associate (for exercises)	Radmanović M. Miloš		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Students should acquire fundamentals of Fuzzy Logic and its applications in computing, automatic control and related areas.		
Course outcomes	At the end of this course students should know what are Fuzzy systems, what are their characteristics, descriptions methods and implementation techniques. Students should learn how to implement simple Fuzzy systems.		
Course outline			
Theoretical teaching	Introduction, evolution from classical to Fuzzy logic, types of predicates. T-norms, t-conorms and negations. Fuzzy subsets. Logic consistency and inconsistency in F (E). Linguistic modifiers. Possibility measures. Aggregation functions. Fuzzy implications. Compositional Rule of Inference. Fuzzy quantifiers. Fuzzy reasoning. An Introduction to Fuzzy Control		
Practical teaching (exercises, OFE, study and research	Seminars and project related to the application of Fuzzy logic. □		
Textbooks/references			
1	M. Mukaidono, Fuzzy Logic for Beginners, World Scientific, 2001.		
2	Documents on Web site: Moraga. C., et all. Intorduction to Fuzzy Logic, video lectures.		
3	Documents on Web site: http://cs.elfak.ni.ac.rs/nastava/		
4			
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Self studing by use of video lectures on the Internet. □			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Data Mining Techniques and Methods		
Lecturer (for lectures)	Stojković R. Suzana		
Lecturer/associate (for exercises)	Marković M. Ivica		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The goal of this course is to introduce students to major data mining tasks and with special emphasis on the using the data mining techniques and methods into text analysis and information retrieval systems.□		
Course outcomes	After completing this course, students should acquire theoretical knowledge of the principles of the work of the data mining tools and to be able to use existing datamining open source tools and to develop new.□		
Course outline			
Theoretical teaching	Data mining goal and application. Types of datasets and attributes. Data quality problems. Data preprocessing. Exploratory data analysis, summary statistics, data visualization. Classification of data mining algorithms. Linear regression. Classification algorithms: decission trees, Naive Bayes algorithm, SVM. Classificator evaluation. Clustering algorrithms: K-means, hierarchical clausterization. Associative analysis. Algorithms for associative rules generation.		
Practical teaching (exercises, OFE, study and research	Data mining by using visual tools. Implementation of data mining algorithms in programming languages R and Python.		
Textbooks/references			
1	P.-N.Tan, M. Steinbach, A. Karpatne, V. Kumar: Introduction to data mining, Addison Wesley, Second edition, 2017.		
2	D. T. Larose: Data mining methods and models", JONN WILEY & SONS, 2006		
3	ppt prezentations from lectures		
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		
Teaching methods	Lectures, auditoral exercises, consultations			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Big Data Systems		
Lecturer (for lectures)	Stojanović H. Dragan, Stojanović M. Natalija		
Lecturer/associate (for exercises)	Stojanović M. Natalija		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Acquiring knowledge, methods and technologies for design and implementation of systems for large-scale data processing and analysis (Big Data).		
Course outcomes	Theoretical and practical knowledge about principles, methods, software tools, libraries and platforms for design, implementation and evaluation of software systems for large-scale data processing and analysis (Big Data), both offline as well as fast and large data streams originated from Internet of Things		
Course outline			
Theoretical teaching	Introduction to Big Data. Fundamental principles, methods and technologies for storage, processing, and analysis of large-scale data (Big Data), as well as machine learning and mining over Big Data. Distributed file systems and distributed databases for Big Data storage. Software frameworks and platforms for management, processing and analysis of Big Data. Data stream and complex event management and processing systems. Big Data visualization and visual analysis. Big Data management and analysis in Internet of Things and ubiquitous computing. Cloud computing and Big Data processing in cloud, fog and edge. Open source technologies and software platforms for distributed processing and analysis of Big Data. Analysis, design, implementation and evaluation of systems and applications for Big Data processing and analysis. Contemporary applications based on Big Data systems for in smart cities, intelligent transportation, Internet of Things, social networks/media, geo-spatial systems, etc.		
Practical teaching (exercises, OFE, study and research	Practical work on design and implementation of systems and applications for big data stoage, processing and analysis, as well as fast data streams, and evaluation of such systems and applications on real big dataset in contemporary application domains over the set of lab exercises and development of a software project. □		
Textbooks/references			
1	Nathan Marz, James Warren: Big Data Principles and best practices of scalable realtime data systems. Manning Publications Co., 2015.		
2	Petar Zečević, Marko Bonaći, Spark in Action, Manning publications, 2017		
3	Kai Hwang, Min Chen, Big-Data Analytics for Cloud, IoT and Cognitive Computing, Wiley, 2017.		
4	Dean Wampler, Fast Data Architectures for Streaming Applications, 2nd edition, O'Reilly Media, 2019.		
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		
Teaching methods	Lectures, auditive exercises, lab practicing, independent student work on assignments and projects, student seminars.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Web Mining		
Lecturer (for lectures)	Stojković R. Suzana, Bogdanović D. Miloš		
Lecturer/associate (for exercises)	Stojković R. Suzana		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Obligatory
Prerequisites			
Course objectives	During this course, students will acquire specific knowledge regarding the process of analyzing Web documents and unstructured data. They will also be introduced to the specific possibilities of using Web mining technologies.		
Course outcomes	Students will acquire theoretical and practical knowledge in the field of analyzing the content of documents, classification and clustering of Web documents. Also, they will get familiar with basic techniques and tools for analyzing the structure and access methods of the Web.		
Course outline			
Theoretical teaching	Introduction to Web mining. Web Document specifics. Techniques for analyzing the content of Web documents. Identify the document theme and document term rank. Classification and clustering of documents. Analysis of Web structure, ranking documents by relevance. Website ranking improvement techniques. Web access analysis. Detection of Web site user behavior patterns. Recommendation systems. Web visualization.		
Practical teaching (exercises, OFE, study and research	Introduction to basic web mining tools and their usage. Document Classification Tools, Log Files Structure Analysis and Log Analysis Tools.		
Textbooks/references			
1	Bing Liu, Web Data Mining-Exploring Hyperlinks, Contents, and Usage Data, Second Edition, July 2011, Springer		
2	Wouter de Nooy, Andrej Mrvar, Vladimir Batagelj, Exploratory Social Network Analysis with Pajek, Cambridge University Press, 2011		
3	Zdravko Markov, Daniel Larose,Data mining the Web:Uncovering patterns in Web content, structure and usage		
4	Materials from lectures and exercises available on the course website.		
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		
Teaching methods	Lectures and exercises using presentations and interactive work on a computer. Research and implementation projects.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Pattern Recognition		
Lecturer (for lectures)	Vučković V. Vladan, Radmanović M. Miloš		
Lecturer/associate (for exercises)	Radmanović M. Miloš		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The objective of the course is to familiarize students with basic methods and techniques for identifying samples and acquiring knowledgeable skills for independent research work in this field and practical implementation of sample recognition applications.		
Course outcomes	Students will gain knowledge on the methods and techniques from this course areas for identifying patterns that will enable them to solve problems and independent research work in the field of pattern recognition.		
Course outline			
Theoretical teaching	Systems for identifying samples, registering and measuring object characteristics. Data acquisition, preprocessing and signal representation. Reducing complexity and classification. Statistic methods for pattern recognition. Classification based on minimal error. Classification based on maximum similarity. EM-algorithm. SVM (Support Vector Machine) classifiers. Stochastic finite automata and discrete Markov models. Hidden Markov models. Real-time visual recognition systems. Systems for processing and recognizing digital images and scanned documents. OCR systems. Examples of applying pattern recognition.		
Practical teaching (exercises, OFE, study and research	Study research work: Preparation of seminar papers in the field of pattern recognition and oral presentation and defense of works.		
Textbooks/references			
1	S. Pal, A. Pal, Pattern Recognition From Classical to Modern Approaches, World Scientific, 2001.		
2	S. Bow, Pattern Recognition and Image Preprocessing, CRC Press, 2002.		
3	R. Duda, P. Hart, D. Stork, Pattern Classification, Wiley, 2000.		
4	Teaching materials on the site: http://cs.elfak.ni.ac.rs/nastava/		
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures and demonstration exercises using slides and demo examples. Independent research work of students, creation, presentation and defense of seminar papers. Realization of projects.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Data Visualization		
Lecturer (for lectures)	Janković S. Dragan		
Lecturer/associate (for exercises)	Rajković J. Petar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introduction to students with the principles on which data and information visualization is according on the purpose and scope. Enable students to use different ways to visualize data. Getting to know existing tools and environments for visual representation of data.		
Course outcomes	Students should be introduced to ways of presenting data and the fields of their application. Upon completion of the course, students should be able to choose an appropriate visual representation that they can implement in one of the existing tools or develop their own visual representation for a specific problem.		
Course outline			
Theoretical teaching	Types of data. Data visualization principles. Perception. Optical illusions. Tables, charts, trees, graphs, treemap. Visualization of multivariate data. Animations, multimedia presentations. Visualization of social networks. Visualization of medical data, Visualization of economic data. Weather series. Visualization of GIS data. Visualization of the process. Visualization tools and environments (Excel, Tableau, R). Visualization and data analysis. BI environments.		
Practical teaching (exercises, OFE, study and research	Practical teaching of visualization of different types of data using: Excel, Tableau, D3.js. Integration of data visualisation into software solutions. Software realization of some data visualization algorithms.		
Textbooks/references			
1	Tamara Munzner, Visualization Analysis and Design, CRC Press, 2014.		
2	Scott Murray, “Interactive Data Visualization for the Web”, O’Reilly Media, 2013		
3	Lectures in a form of Power Point presentations		
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		
Teaching methods	Lectures, Exercises, Laboratory Exercises, Consultations,			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Methods of optimization		
Lecturer (for lectures)	Marinković D. Slađana		
Lecturer/associate (for exercises)	Jovančić S. Vladan		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Gaining basic mathematical knowledge of multivariable functions and optimization theory including different optimization methods. Developing skills of mathematical modelling of real problems of practice, as well as solving them.		
Course outcomes	Students' competence to put the gained knowledge into practice. Competence to identify and define the optimization problems of practice, develop mathematical models, choose the appropriate methods for their solving and the application of methods.		
Course outline			
Theoretical teaching	Real multivariable functions. Partial derivatives, gradient, hessian. Local, constrained and global extrema.Taylor formula. Elements of convex analysis. General optimization problem. Linear programming. Duality. Simplex method. Nonlinear programming. Searching and gradient methods. Constrained optimization: optimality conditions. Penalty functions method.		
Practical teaching (exercises, OFE, study and research	Exercises of knowledge gained in the lectures. Impementation of optimization algorithms by the appropriate software.		
Textbooks/references			
1	Lj. M. Kocić, G. V. Milovanović, S. D. Marinković, Operational research, University of Niš, Faculty of electronic engineering, Niš, 2007.(in Serbian.)		
2	Lj.M. Kocić, Functions of several variables, University of Niš, Faculty of Electronic Engineering, Niš, 2008. (Serbian).		
3	G.V. Milovanović, P.S. Stanimirović, Symbolic Implementation of Nonlinear Optimization, University of Niš, Faculty of Electronic Engineering, Niš, 2002 (Serbian).		
4	G.B. Dantzig, M.N.Thapa,Linear Programming: Introduction,Springer, 1997.		
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		
Teaching methods	Lecture, exercises, consultations.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Machine Learning		
Lecturer (for lectures)	Stoimenov V. Leonid		
Lecturer/associate (for exercises)	Stoimenov V. Leonid		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Provide students with knowledge regarding machine learning, its meaning and its role in implementing intelligent systems, in analyzing data from various domains in engineering and science. Provide students with insights into the fundamental methods of modern machine learning. Provide information on how to implement and apply individual machine learning techniques.		
Course outcomes	An insight into the fundamental methods of modern machine learning. Acquiring knowledge regarding the role of machine learning for the realization of intelligent systems. Theoretical knowledge regarding machine learning basics, the most important algorithms for supervised and unsupervised learning. Practical application and implementation of machine learning algorithms and / or the use of existing open source libraries.		
Course outline			
Theoretical teaching	Introduction to machine learning, approaches and types of machine learning. The role of machine learning for the realization of intelligent systems, the role in the big data analysis. Algorithmic learning models. Statistical approaches. Classifiers, functions, relationships, probability models. Bayesian environments. Decision trees, neural networks, support vector machines, Bayesian networks, bag of words classifiers, N-gram models, Markov and Hidden Markov models. Associative rules, nearest neighbor classifiers. Reduction of dimensionality and visualization. Clustering, k-means clustering, hierarchical clustering, distribution clustering. Reinforcement learning. Learning from heterogeneous distributed data and knowledge sources.		
Practical teaching (exercises, OFE, study and research	Practical implementation of systems based on machine learning or systems using machine learning. Implementation of selected applications related to data mining, automated knowledge acquisition, pattern recognition, program synthesis, text and language processing, internet-based information systems, human-machine interaction, bioinformatics etc.		
Textbooks/references			
1	S. Russel, P. Norvig, Artificial intelligence - A Modern Approach, Pearson, 3rd edition, (2016), ISBN-10: 1292153962, ISBN-13: 978-1292153964		
2	G. Hulten, Building Intelligent Systems: A Guide to Machine Learning Engineering, 1st ed. edition (2018), ISBN-10: 1484234316, ISBN-13: 978-1484234310		
3	C. Sammut (Editor), G. I. Webb (Editor), Encyclopedia of Machine Learning and Data Mining, Springer, 2nd ed. (2017), ISBN-10: 148997685X, ISBN-13: 978-1489976857		
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		
Teaching methods	Lectures, exercises, independent homework and projects			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Natural Language Processing		
Lecturer (for lectures)	Stojković R. Suzana		
Lecturer/associate (for exercises)	Marković M. Ivica		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The goal of this course is to introduce students to the basic concepts and ideas of the Natural Language Processing (NLP) and with applications of these concepts in information extraction, information retrieval systems, sentiment analysis, question answering systems, text summarization ...		
Course outcomes	After completing this course the student acquires theoretical and practical knowledge necessary for development of applications based on natural language processing.		
Course outline			
Theoretical teaching	Introduction to NLP. Text tokenizing. Word normalization: stemming and lematization. Type errors correcting, minimum edit distance algorithm. Sentence segmentation. Statistical language models. N-gram model. Part-of-speach tagging. Syntax analisys. CKY algorithm. Semantic analysis. Syntax-directed semantic analysis. Semantic grammars. Information extraction. Applications based on natural language processing. Sentiment analysis. Question answering systems. Machine translation. Text summarization.		
Practical teaching (exercises, OFE, study and research	Introduction to existing open-source tools for processing the data written in a natural language and for data conversion from unstructural form (text) to structural convenient for further processing.		
Textbooks/references			
1	D. Jurafsky and J. H. Martin: Speach and Language Pprocessing: An Introduction to Natural Language Processing, Computational Linguistic and Speach Recongnition, Second Edition, McGraw Hill, 2009.		
2	S. Bird, E. Klein, E.: Natural Language Processing With Python, O'REILLI 2009.		
3	ppt prezentations from lectures		
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		
Teaching methods	Lectures, auditory exercises, consultations			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Social Networks Analysis		
Lecturer (for lectures)	Tošić B. Milorad		
Lecturer/associate (for exercises)	Nejković M. Valentina		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites	Exams passed: Information Systems, Graph theory, Web Programming and Artificial Intelligence. □		
Course objectives	Gaining practical programming skills, theoretical knowledge and systematic approach required for the design, implementation and operation of systems in which information technologies, computers, the Internet, and humans act in concert to form complex strucutres that are commonly characterized as social netowrks.□		
Course outcomes	Students are able to identify areas of usage, specific problems and relevant theoretical concepts needed to solve them, possess practical programming skills needed to implement specific examples of usage.□		
Course outline			
Theoretical teaching	Common conceptual foundations: data models, basic technologies, mathematical basics. HITS and PageRank based algorithms. Similarity and communities in social networks. Information extraction and analysis in social networks (Social tagging, extraction from content, blog search, intellignet web crowling). Intelligent search. Recommendation, filtering and ranking. Characteristics identification. Advanced classification on social networks. □		
Practical teaching (exercises, OFE, study and research			
Textbooks/references			
1	Online materials for lectures and exercises		
2	Materials available on the Internet		
3	Segaran, Toby. Programming collective intelligence: building smart web 2.0 applications. O'Reilly Media, Incorporated, 2007.		
4	Alag, Satnam. Collective intelligence in action. Manning, 2009.		
5	Zhang, Yanchun, Jeffrey Xu Yu, and Jingyu Hou. Web communities analysis and construction. Springer-Verlag, 2012		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, Auditorial exercises, Laboratory exercises; Consultations, Independent students' research; students' oral presentation to the selected / given topics; Active students' participation in the classroom using an interactive course Web site□			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Business Intelligence		
Lecturer (for lectures)	Janković S. Dragan		
Lecturer/associate (for exercises)	Stanimirović S. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The basic principles of business intelligence. History, importance and scope of business intelligence. Multidimensional database. OLAP cubes creation. Data extraction. Data cleansing. Transform and import data into OLAP cubes. BI analytics. MDX (Multidimensional Expressions) - the language of multi-dimensional expressions. Methods and types of reporting. Data visualization.		
Course outcomes	Practical work in the two development environments: commercial development environment Microsoft Business Intelligence Studio and noncommercial environment Pentaho Open Source (Data Integration, Mondrian, Design Studio - Eclipse). Practical work on the development of OLAP cubes and BI analytics to end users.		
Course outline			
Theoretical teaching	The basic principles of business intelligence. History, importance and scope of business intelligence. Multidimensional database. OLAP cubes creation. Data extraction. Data cleansing. Transform and import data into OLAP cubes. BI analytics. MDX (Multidimensional Expressions) - the language of multi-dimensional expressions. Methods and types of reporting. Data visualization.		
Practical teaching (exercises, OFE, study and research	Practical work in the two development environments: commercial development environment Microsoft Business Intelligence Studio and noncommercial environment Pentaho Open Source (Data Integration, Mondrian, Design Studio - Eclipse). Practical work on the development of OLAP cubes and BI analytics to end users.		
Textbooks/references			
1	Turban Sharda, Delen King, Business Intelligence: A managerial Approach, Prentice Hall, 2011.		
2	Gordon Linoff, Michael Berry, Data mining techniques for marketing, sales, and customer relationship management, Wiley, 2011.		
3	N. Balaban, Ž. Ristić, Business Intelligence, (in serbian), Faculty of Economics, Subotica, 2006.		
4	Lectures in a form of Power Point presentations		
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		
Teaching methods	Lectures, Auditive exercises, Laboratory exercises. Student project realization.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Data Science		
Type and level of studies	Master studies		
The name of the course	Deep Learning		
Lecturer (for lectures)	Milosavljević Lj. Aleksandar		
Lecturer/associate (for exercises)	Milosavljević Lj. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introduce students to the field of deep learning. Getting acquainted with basic concepts, training techniques, and deep neural network architectures.		
Course outcomes	Getting to know basic architectures, techniques, and algorithms used in the training of deep neural networks. Understanding the benefits of deep learning versus traditional approaches. Getting to know the domains where deep learning techniques are applicable and produce good results.		
Course outline			
Theoretical teaching	Introduction to the deep learning and historical context. A model of the artificial neuron and artificial neural networks. Neural network training, loss function and parameter optimization. Backpropagation algorithm. Convolutional neural networks. Activation functions, initialization of parameters, dropout, batch normalization. Updating training parameters, network ensembles and voting, data augmentation, transfer learning. Hardware and software for deep learning. Architectures of Convolutional Neural Networks (AlexNet, VGG, GoogLetNet, ResNet, ...). Recurrent neural networks. Semantic segmentation, object detection, separation of instances. Generative models, auto-encoders, Generative Adversarial Networks (GAN). Visualization and understanding of deep neural networks. Deep reinforcement learning.		
Practical teaching (exercises, OFE, study and research	Practical work on the implementation of deep neural networks using TensorFlow and Keras libraries.		
Textbooks/references			
1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learining, MIT Press, 2016.		
2	Francois Chollet, Deep Learning with Python, Manning, 2018.		
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		
Teaching methods	Lectures, auditory exercises, independent student work on a project.			

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

Specification for the book of courses

Study program		Computing and Informatics		
Module		Software Engineering		
Type and level of studies		Master studies		
The name of the course		Advanced Software Engineering		
Lecturer (for lectures)		Rančić D. Dejan, Milosavljević Lj. Aleksandar		
Lecturer/associate (for exercises)		Mihajlović T. Vladan		
Lecturer/associate (for OFE)				
Number of ECTS	4	**Course status (obligatory/elective)**	Elective	
Prerequisites				
Course objectives	Mastering advanced methods for the development and evolution of software and methods for measuring the quality of software products and processes.			
Course outcomes	Theoretical and practical knowledge of advanced methods, techniques, and tools for developing and evolving software products and measuring the quality of software products and processes.			
Course outline				
Theoretical teaching	A brief overview and history of software engineering. Software evolution. Software metrics. Software cost estimation. Quality management. Improving the software process. Agile methods for software development. Introduction to Scrum. User stories. Agile planning and evaluation. Configuration management. Code control systems. Software reuse. Software engineering based on components. Prototype. Developing security-sensitive software. Real-time software development.			
Practical teaching (exercises, OFE, study and research	Getting acquainted with technologies and tools to support software engineering.			
Textbooks/references				
1	I. Sommerville, Software Engineering, 9th ed., Addison-Wesley, 2011.			
2	K. Rubin, Essential Scrum: A Practical Guide to the Most Popular Agile Development Process, Addison-Wesley, 2012.			
3	M. Cohn, Agile Estimating and Planning, Prentice Hall, 2005.			
4	R. Pressman, Software Enginnering A Practitioner's Approach, 7th ed., McGraw-Hill, 2010.			
5	C. Jones, Software Engineering Best Practices, McGraw-Hill, 2010.			
Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, auditory exercises, independent student work on a project.			
Grade (maximum number of points 100)				
Pre-exam duties	**Points**	**Final exam**	**Points**	
Activity during lectures		**Written exam**		
Exercises	30	**Oral exam**	40	
Colloquia				
Projects	30			

Specification for the book of courses

Study program	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Intelligent Systems		
Lecturer (for lectures)	Stoimenov V. Leonid, Stanimirović S. Aleksandar		
Lecturer/associate (for exercises)	Stoimenov V. Leonid, Stanimirović S. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective

Prerequisites	
Course objectives	Providing students an insight into advanced artifical intelligence techniques. Presenting actual problems and possible solutions for intelligent systems realization. Theoretical and practical knowledge as well as the importance of computing vision, communication and planning for intelligent systems implementation. Introducing students with inference problems related to unreliabale knowledge sources. Presenting possible applications of intelligent systems in business systems. Using ontologies for solving problems related to semantical information integration.□
Course outcomes	By the end of the course, a student will be able to understand actual intelligent systems' implementaiton issues, as well as future research and development trends in the field of artifical inteliggence. A student will be able to succesfully resolve challenges related to choosing and designing parts of intelligent systems. Student will also be capable of recognizing challenges regarding realization of distributed intelligent systems and semantic information integration, and finally implementing some solutions based on ontologies.
Course outline	
Theoretical teaching	Artifical intelligence systems. Complete Turing test. Inference based on unreliabale data: non-monolit inferencing, statistical methods. Bayesian networks: syntax and semantics, precise and approximate infering. Computing vision. Communication: natural language processing. Speach recognition. Natural language recognition. Speach generation. Planning and planning algorythms. Probabilistic inference. Machine learning and algorithms for machine learning. Distributed intelligence and distributed inferring systems. Application of intelligent systems in business. Business intelligence, multi-databases and OLAP. Semantic representation and commonsense knowledge. Ontologies. Examples of ontology based systems (intelligent information integration, Semantic Web).□
Practical teaching (exercises, OFE, study and research	Implementation of systems with unreliabale inferring. Algorythms and methods for computing vision. Algorythms and methods for natural language processing. Algoriythms and methods for maschine learning. neural networks implementation. Decision trees and bussiness intelligence. Ontologies and semantics representation. Ontologies standards. Application of intelligent systems with examples. Examples of open source code and libraries for implementation of intelligent systems.
Textbooks/references	
1	S. Russell, P. Norvig: Artificial Intelligence: A Modern Approach, Prentice Hall Series in AI, 2010.
2	L.Stoimenov, A.Milosavljević, Artificial intelligence labwork manual (in serbian), Faculty of Electronic Engineering, Niš, 2004.
3	D.Bojić, D.Velasevic, V.Misic, Expeert systems, solved examples (in serbian), Naucna knjiga, Belgrade, 1996.
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Number of classes of active education per week during semester/trimester/year

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

Teaching methods	Lectures, laboratory exercises, laboratory sessions, students work on assignments and projects, student seminars.

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	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Geographic Information Systems		
Lecturer (for lectures)	Stojanović H. Dragan, Stojanović M. Natalija		
Lecturer/associate (for exercises)	Predić B. Bratislav		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Acquiring knowledge, methods and technologies required for design and implementation of geographic information systems (GIS).		
Course outcomes	Theoretical and practical knowledge about principles, methods, software tools, omponents and frameworks for design and implementation of geographic information systems (GIS).		
Course outline			
Theoretical teaching	Introduction to geographic information systems (GIS). Geographic and cartographic foundations of GIS. Architecture and design GIS-a. Methods and systems for positioning. Satellite systems for global positioning - GPS (Global Positioning System). System for positioning based on wireless networks in indoor environment. Geospatial data models. Geospatial data representations and algorithms for processing. Index structures and access methods. Spatial databases. GIS architecture and design. Geo-visualization and GIS interfaces. Methods and algorithms for geospatial data analysis. Time in GIS and spatio-temporal data management. Processing and analysis of Big geospatial data. Specification and standards in geospatial and GIS domains (OGC, ISO TC 211, etc.). Web GIS and distributed GI services. Mobile GIS and location-based services.		
Practical teaching (exercises, OFE, study and research	Work on design and implementation of geographic information system using commercial and open source software components, frameworks and platforms. Spatial database design and implementation. Implementation of GIS functionalities for storage, processing, search, analysis, and visualization of geospatial and spatio-temporal data. Implementation of Web GIS applications and Web services based on OGC standards and specifications. Implementation of mobile GIS applications.		
Textbooks/references			
1	M. Worboys, M. Duckham, GIS: A Computing perspective, second edition, CRC Press, 2004.		
2	P. A. Longley, M. F. Goodchild, D. J. Maguire, D. W. Rhind, Geographic Information Systems and Science, 3rd edition, John Wiley & Sons, 2010.		
3	P. Rigaux, M. Scholl, A. Voisard, Spatial Databases: With Application to GIS, Morgan Kaufmann,2002		
4	Kang-tsung Chang, Introduction to Geographic Information Systems, 6th Ed, McGraw-Hill Science, 2011		
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, auditive exercises, lab practicing, independent student work on assignments and projects, student seminars.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Advanced Web Technologies		
Lecturer (for lectures)	Petković M. Ivan		
Lecturer/associate (for exercises)	Petković M. Ivan		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The goal of the course is to familiarize students with modern Web technologies that contribute to the efficient use of the Internet as a global resource, which means working with different types of data, structured and unstructured, and the development of Web applications that are accessible to a large number of users using different client applications.		
Course outcomes	Students should know how to use XML and Web services to integrate applications and data. Also they know technologies for development of Web 2.0 applications as well as applications with elements of Semantic Web and they will be be able to implement projects that integrates advanced Web technology.		
Course outline			
Theoretical teaching	Internet as a global resource, advanced techniques for on-line searching. Working with unstructured data. A formal description and processing XML documents (DTD, XML Schema, XML DOM, SAX, XSLT). XML and RDF specifications. Web services and SOA applications. Rest services. Choreography and orchestration of Web services. Scalability, reliability and security of Web applications. Personalizing the Web. Web 2.0 technologies. Internet as a platform. Web and mobile applications. Web management.		
Practical teaching (exercises, OFE, study and research	AJAX, HTML 5, CSS3. EcmaScript 6. Typescript. Front end frameworks (Vue, Angular, React). ASP.NET MVC Core. Linq. Dependency Injection. Repository pattern. ASP.NET Web API. Domain Driven Design.		
Textbooks/references			
1	Elliotte Rusty Harold, W. Scott Means, XML in a Nutshell, 2nd Edition, O'Reilly, 2002.		
2	A Freeman, Pro ASP.NET Core MVC, Sixth Edition, Apress, September 2016		
3	Eric Evans, Domain-Driven Design: Tackling Complexity in the Heart of Software, Addison-Wesley Professional 2003		
4			
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures by use of slides, seminars, projects.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Advanced Operating Systems		
Lecturer (for lectures)	Stanimirović S. Aleksandar, Stojanović H. Dragan		
Lecturer/associate (for exercises)	Stanimirović S. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Comprehension of technologies, development directions, as well as design and implementation of contemporary operating systems and system software.		
Course outcomes	Theoretical and practical knowledge about advanced concepts, internal design and implementation of contemporary operating systems and system software.		
Course outline			
Theoretical teaching	Advanced concepts, algorithms, technologies and implementation of contemporary operating systems components, such as process/thread management, process synchronization and communication, memory management, U/I device drivers, file system and network services. Multimedia operating systems. Security and protection in operating systems. Distributed operating systems. System software and platforms for Bug Data processing and analysis. Operating system of mobile and embedded computers and Internet of Things systems. Operating systems for multiprocessor and parallel computing systems. Special purpose operating systems. Design and implementation of contemporary operating systems and system software. System programming of contemporary operating systems.		
Practical teaching (exercises, OFE, study and research	Practical work on design and implementation of operating system components and apropriate system software over the set of lab exercise and practical project.		
Textbooks/references			
1	William Stallings, Operating Systems: Internals and Design Principles, 7th edition (Translation in Serbian), CET (Pearson), 2013.		
2	A.S. Tanenbaum, Modern Operating Systems, 4th edition, Pearson Education/Prentice-Hall, 2014		
3	W. Richard Stevens, Stephen A. Rago, Advanced Programming in the UNIX Environment, 3rd edition, Addison-Wesley Professional, 2013.		
4	Robert Love, Linux Kernel Development (3rd Edition), Addison-Wesley Professional; 2010		
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		
Teaching methods	Lectures, auditive exercises, lab practicing, independent student work on assignments and projects, student seminars.			

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

Specification for the book of courses

Study program		Computing and Informatics	
Module		Software Engineering	
Type and level of studies		Master studies	
The name of the course		Interoperability and Information Integration	
Lecturer (for lectures)		Stoimenov V. Leonid, Nejković M. Valentina	
Lecturer/associate (for exercises)		Bogdanović D. Miloš	
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	The need for information integration and the need for realization of applications and systems interoperability. Introduction to problems regarding information integration and learning technologies for realization of system integration and interoperability.		
Course outcomes	Theoretical and practical knowledge regarding concepts, methods of solving, designing and implementation of basic elements of system interoperability and information integration.		
Course outline			
Theoretical teaching	Introduction to the problem of information integration. Heterogeneity problems and solving methods: technical, syntax, semantic. Architecture for information integration. Ontology and semantic heterogeneity. Ontology construction. Semantic heterogeneity, ontology types used for information integration, ontology mapping. Interoperability of applications and systems. Approaches and platforms for the implementation of interoperability. Interoperability implementation Technologies: Enterprise Service Bus, Service-Oriented Architecture. Standards and their importance regarding the implementation of interoperability. Ontologies of Open Data and Web Portals used as access points towards integrated information. Open data and semantic interoperability of systems based on open data.		
Practical teaching (exercises, OFE, study and research work)	Practical implementation of simple examples of information integration that demonstrate the existence of heterogeneity problems and their resolution at the technical and syntax level. Usage of open ESB systems for implementation of heterogeneity solution at syntax and technical level (Mule ESB). Implementation of the mapping between ontologies. Implementation of mechanisms for determining the semantic similarity of ontologies. Implementation of mechanisms for determining the semantic heterogeneity based on data analysis and data structure used within the system. Implementation of the interoperability of the ESB-based system and service-oriented architecture. Usage of open data for the integration of heterogeneous systems. Determining the semantic similarity of the open data ontologies.		
Textbooks/references			
1	V. E. Ferraggine, J.H. Doorn, L.C. Rivero (Eds.) Handbook of Research on Innovations in Database Technologies and Applications: Current and Future Trends (2-volumes), ISBN: 978-1-60566-242-8, Publisher: Information Science Reference, February 2009, Pages: 1,124, pp. 491-507.		
2	R. Emasri, S. Navathe, Fundamentals of Database Systems, Addison-Wesley; 6 edition (2010), ISBN-10: 0136086209, ISBN-13: 978-0136086208		
3	A. Sheth, Semantic Services, Interoperability and Web Applications: Emerging Concepts, 2011, ISBN: 978-1609605933, Publisher: IGI Global		
4	J. T. Pollock, R. Hodgson, Adaptive Information: Improving Business Through Semantic Interoperability, Grid Computing, and Enterprise Integration, 2004, ISBN: 978-0471488545, Publisher: John Wiley & Sons, Inc., New Jersey		
5	Scientific papers available on the Web		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, exercises, homework assignments and projects			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Computer Animation		
Lecturer (for lectures)	Rančić D. Dejan, Milosavljević Lj. Aleksandar		
Lecturer/associate (for exercises)	Dimitrijević M. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course	Getting to know basic algorithms and techniques for computer animation.		
Course outcomes	Theoretical and practical knowledge of algorithms and techniques for computer animation. Ability to independently develop graphics applications as well as to use ready-made software for computer animation.		
Course outline			
Theoretical teaching	Algorithms and programming techniques of computer animation. Algorithms and approaches to behavior animation and animation based on object physics. 2D and 3D animation. Sprites. Key Frame Technique. Animation of the face and mimics. Direct and inverse kinematics. Capture the movement. Animation in video games. Animation of the particle system. Clothing animation.		
Practical teaching (exercises, OFE, study and research	Getting acquainted with software tools for computer animation.		
Textbooks/references			
1	Rick Parent et al., Computer Animation Complete, Morgan Kaufmman Publ., 2009.		
2	Marcia Kuperberg et al., A Guide to Computer Animation for TV, Games, Multimedia and Web, Focal Press, 2002.		
3	The Complete Guide to Blender Graphics, Blender 2.50, John M. Blain, CRC Press, 2012.		
4	Blender 2.5 Character Animation Cookbook, Blender 2.50, Virgilio Vasconcelos, Packt Publishing, 2011.		
5	Introducing Character Animation with Blender 2nd ed, Blender 2.50, Tony Mullen, Sybex, 2011.		

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, consultations, independent study research.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Requirements Engineering		
Lecturer (for lectures)	Rančić D. Dejan, Milosavljević Lj. Aleksandar		
Lecturer/associate (for exercises)	Mihajlović T. Vladan		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introduce students to the field of requirements engineering. Getting aquainted with principles of requirements management as well as with the basic models of requirements engineering.		
Course outcomes	Getting to know the basic principles and models of requirements engineering.		
Course outline			
Theoretical teaching	Introduction and a brief history of requirements engineering. Requirements management. Functional and non-functional requirements. Problems in the requirements specification. Use of standards in the requirements specification. Spiral model for requirement management process. Requirements elicitation. Requirements analysis. Requirements validation. Types of the requirements. Characteristics of the requirements. Fake requirements. Requirements engineering methods. DFD diagrams. Relational methods. Object-oriented methods. Formal methods. Methods based on system behavior. Use-case specification. Viewpoint-based methods. Software tools for requirements engineering.		
Practical teaching (exercises, OFE, study and research	Getting acquainted with software tools for requirements engineering.		
Textbooks/references			
1	Klaus Phol, Requirements Engineering - Fundamentals, Principles, and Techniques., Springer, 2010.		
2	Klaus Phol, Chriss Rupp, Requirements Engineering Fundamentals - A Study Guide for the Certified Professional for Requirements Engineering Exam - Foundation Level - IREB compliant, RockyNock, 2013.		
3	E. Hull, Ken Jackson, Jeremy Dick, Requirements Engineering, Springer, 2005.		
4			
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, auditory exercises, independent student work on a project.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Database Management Systems		
Lecturer (for lectures)	Stoimenov V. Leonid, Stanimirović S. Aleksandar		
Lecturer/associate (for exercises)	Stanimirović S. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Obtaining knowledge about basic concepts and principles of database management systems (DBMS) and their components. Obtaining knowledge on advanced DBMS usage techniques (triggers, security, query optimization). Obtaining knowledge on basic concepts and principles of advanced database systems functioning.□		
Course outcomes	Teoretical knowledge on DBMSs, their components and usage patterns; practical knowledge on advanced DBMS usage techniques, administration, performance tunning and data maintainance.		
Course outline			
Theoretical teaching	Introduction to database management systems (DBMS). The role and responsibilities of database administrator. Database management system: architecture, basic modules nad functions, examples of such systems. Physical database design and tuning. Stored procedures. Triggers: term, purpose and trigger usage, syntax of command for creating trigger, trigger types and granularity, row level and expression level triggers, timetable of trigger executions. Query processing and optimization: the term of query optimization, statical and dynamical optimization, system catalogue, database statistics and optimization, index structures and multidimensional indices. DBMS security: the term of DBMS security, user privilegies - assigning and deprivation (GRANT and REVOKE commands), privilegies propagation, securityat view level, statistical databases, DAC and MAC security mechanisms. Database recovery. Modern DBMS trends: cloud databases, distributed databases and big data.		
Practical teaching (exercises, OFE, study and research	The role of database administrator, practical usage of DBMS and adminstration tools - practical examples and tasks. Database performance tunning, indices creation. Query optimization - practical examples, problems, DBMS tools utilization. DBMS security and role of database administrator, security on operating system level, network level, hardware level etc. - practical examples and tasks. Modern DBMS challenges and example of new technologies utilization and tools.		
Textbooks/references			
1	R. Emasri, S. Navathe, Fundamentals of Database Systems, Pearson; 7 edition (2016), ISBN-13: 9780133970777		
2	R.Ramakrishnan, J. Gehrke, Database Management Systems,Third Edition, 2002, ISBN-13: 978-0072465631, McGraw-Hill.		
3	T. M. Conolly, C. E. Begg, Database Systems: A Practical Approach to Design, Implementation and Management, 5th edition, 2009		
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		
Teaching methods	Lectures, laboratory exercises, laboratory sessions, students work on assignments and projects, student seminars.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Intelligent Transportation Systems		
Lecturer (for lectures)	Rančić D. Dejan, Predić B. Bratislav		
Lecturer/associate (for exercises)	Predić B. Bratislav		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Gaining practical programming skills, theoretical knowledge and systematic approach required for the design, implementation and operation of systems in which information technologies, computers, the Internet, and humans act in concert to achieve results that are characterized as intelligent.		
Course outcomes	Students are able to identify areas of usage, specific problems and relevant theoretical concepts needed to solve them, possess practical programming skills needed to implement specific examples of usage.		
Course outline			
Theoretical teaching	Common conceptual foundations: data models, information and knowledge, the basic technologies (Internet, databases, artificial intelligence, information retrieval), business aspects, mathematical basics. Intelligent databases, deductive and active databases, intelligent information retrieval. Web and Intelligent Information Systems: Web 2.0, Semantic Web, Social Networks, Collaborative Systems, and expandable network of small diameter. Programming at the level of the end user. Architecture of intelligent information systems: service-oriented and multi-agent architectures. Information retrival and navigation: Web agents, data collection from the web "crawling" Intelligent Web Tools, Web search engines and issue of semantics. Information management, information flow, integration and semistructured information resources, XML and RDF based information presentations.		
Practical teaching (exercises, OFE, study and research	Design and implementation of specific modules of Intelligent Information Systems.		
Textbooks/references			
1	Joseph S. Sussman, Perspectives on Intelligent Transportation Systems (ITS), Springer, 2010.		
2	Mashrur A. Chowdhury, Adel W. Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, (2003)		
3	Pablo Luque, Johan Wideberg, Daniel Mantaras, An intelligent transportation system to improve safety and efficiency OBD-II and smartphone apps., CreateSpace Independent Publishing Platform, 2012.)		
4	Asvin Goel, Fleet Telematics - Real-time management and planning of commercial vehicle operations, Springer, 2007		
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		
Teaching methods	Lectures, Auditorial exercises, Laboratory exercises; Consultations, Independent students' research; students' oral presentation to the selected / given topics; Active students' participation in the classroom using an interactive course Web site			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Ubiquitous Computing		
Lecturer (for lectures)	Stojanović H. Dragan, Stojanović M. Natalija		
Lecturer/associate (for exercises)	Predić B. Bratislav, Davidović P. Nikola		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Acquiring theoretical and practical knowledge in ubiquitous computing and Internet of Things domains, as well as methods, technologies and software tools for design and implementation of mobile and ubiquitous systems, applications and services.		
Course outcomes	Theoretical and practical knowledge about principles, methods, technologies and software tools for development of mobile and ubiquitous systems, applications and services in Internet of Things.		
Course outline			
Theoretical teaching	Introduction to mobile and ubiquitous computing. Contemporary mobile and ubiquitous computing, communication and sensor systems and devices. Wireless and ad-hoc networks and wireless network protocols. Internet of Things (IoT) and Web of Things (WoT). Acquisition and processing of sensor data. Mobile positioning technologies and location-based systems applications. Context recognition and development of ubiquitous context-aware systems and services. Smart objects, spaces and adaptive systems. Management and analysis of Big data in mobile and ubiquitous systems. IoT systems and services on edge, fog and cloud computing. Privacy and security ion mobile and ubiquitous systems and IoT. Advanced mobile and ubiquitous applications and IoT systems: smart home, smart and autonomous vehicles, ubiquitous health care, smart mobility and traffic, smart industry, etc.		
Practical teaching (exercises, OFE, study and research	Work on design and implementation of ubiquitous system components and application over the set of lab exercise and practical project that follows topics covered at theoretical classes.		
Textbooks/references			
1	John Krum (Ed.): Ubiquitous Computing Fundamentals. CRC Press, October 2009.		
2	Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, Internet of Things: Architectures, Protocols and Standards, Wiley 2018.		
3	Perry Lea, Internet of Things for Architects, Packt Publishing, 2018		
4	Stefan Poslad, Ubiquitous Computing: Smart Devices, Environments and Interactions, Wiley, 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	0		
Teaching methods	Lectures, auditive exercises, lab practicing, independent student work on assignments and projects, student seminars.			

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

Specification for the book of courses

Study program	Computing and Informatics		
Module	Software Engineering		
Type and level of studies	Master studies		
The name of the course	Virtual and Augmented Reality Systems		
Lecturer (for lectures)	Rančić D. Dejan, Milosavljević Lj. Aleksandar		
Lecturer/associate (for exercises)	Dimitrijević M. Aleksandar		
Lecturer/associate (for OFE)			
Number of ECTS	4	**Course status (obligatory/elective)**	Elective
Prerequisites			
Course objectives	Introduce students to the field of virtual and augmented reality and getting acquainted with basic devices, algorithms, and techniques used in the realization of these systems.		
Course outcomes	Getting to know basic principles, devices, techniques, and algorithms used in the realization of the virtual and augmented reality system.		
Course outline			
Theoretical teaching	Introduction to the field of virtual and augmented and historical context. System architecture for virtual reality. Input and Output Devices for Virtual Reality. Gesture and haptic interface. Geometric modeling of virtual objects. Kinematic and physical modeling. Virtual worlds. Positioning the augmented reality in the continuum between the real world and the virtual reality. Classification of the augmented reality system. Techniques for estimating the viewer's pose in the augmented reality system. Augmented virtual environments. Application domains and examples of the virtual and augmented reality system.		
Practical teaching (exercises, OFE, study and research	Practical work on programming the elements of virtual and augmented reality using Unity development environment and Google Cardboard, Vuforia, and ARCore libraries.		
Textbooks/references			
1	K. Stanney, Handbook of Virtual Environments: Design, Implementation, and Applications, Lawrence Erlbaum Associates, 2002.		
2	G. Burdea, P. Coiffet, Virtual Reality Technology, Wiley-IEEE, 2003.		
3	O. Bimber, R. Raskar, Spatial Augmented Reality: Merging Real and Virtual Worlds, A K Peters, 2005.		
4	T. Mullen, Prototyping Augmented Reality, John Wiley & Sons, 2011.		
5			

Number of classes of active education per week during semester/trimester/year				
Lectures	**Exercises**	**OFE**	**Study and research work**	**Other classes**
2	1	0		
Teaching methods	Lectures, auditory exercises, independent student work on a project.			

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

Subject specification for book of subjects

Study program	Computing and Informatics		
Module	Joint		
Type and level of study	Master studies		
Subject title	Study and Research Work		
Teacher (for lectures)			
Teacher/assistant (for practice)			
Teacher/assistant (for other types of t			
Number of ECTS	10	**Subject status (obligatory/elective)**	Obligatory
Condition			
Subject goal	Application of basic, theoretical-methodological, scientific-professional and expert-applied knowledge and methods on solving of a specific problem. The student studies the topic, its structure and complexity, and on the basis of conducted analyzes, derives the possible ways of solving of aspecific problem. By studying literature students learn about methods that are developed for solving similar problems, and about engineering practice in their solving.		
Learning outcome	Оспособљавање студената да самостално примењују претходно стечена знања из различитих подручја које су изучавали, ради сагледавања структуре задатог проблема и његовој системској анализи у циљу извођењу закључака о могућим правцима његовог решавања. Кроз самостално коришћење литературе, студенти проширују знања проучавањем различитих метода и радова који се односе на сличну проблематику. На тај начин, код студената се развија способност да спроводе анализе и идентификују проблеме у оквиру задате проблематике. Практичном применом стечених знања код студената се развија способност да сагледају место и улогу инжењера у изабраном подручју, потребу за сарадњом са другим струкама и тимским радом.		
Subject content			
Theoretical lectures	It is performed individually, in accordance with requirements of a specific master thesis, its complexity and structure. According to student's preferences and inclinations, he / she chooses the field of study and the subject teacher from the list of teachers in the study program. The chosen teacher defines the topic and the specific task for a student. The student studies literature, professional and scientific papers dealing with similar topics, performs analyses in order to find a solution for the specific problem, or performs certain experiments in the laboratory. The study includes active monitoring of primary knowledge, organization and performance of experiments, numerical simulations and statistical data processing, preparation of seminar paper from the field to which the topic of the study and research work belongs.		
Practical lectures (practice, other types of teaching, research)			
Literature			
1			
2			
3			
4			
5			

Number of classes of active teaching weekly during semester/trimester/year				
Lectures	**Practice**	**OTT**	**Research work**	**Other classes**
			15	
Types of teaching				

Assessment (maximum 100 points)			
Pre-exam requirements	**Points**	**Final exam**	**Points**
Activities during lectures		**Written exam**	
Practical		**Oral exam**	50
Colloquium			
Seminar papers	50		

Subject specification for book of subjects

Study program	Computing and Informatics		
Module	Joint		
Type and level of study	Master studies		
Subject title	Professional Practice		
Teacher (for lectures)	Head of study programme		
Teacher/assistant (for practice)			
Teacher/assistant (for other types of t			
Number of ECTS	3	**Subject status (obligatory/elective)**	Obligatory

Condition	
Subject goal	Introduction to the process of work in the company in which the professional practice is carried out. Understanding objectives and organizational units of the company. Getting to know the team and the project in which the students are involved within their professional practice. Understanding the process of the enterprise, business processes, understanding of the risks in their work, participate in the design, documentation and quality control, in accordance with the process of working environment and opportunities.
Learning outcome	Improving students' ability to get involved in the work process after the graduation. Developing responsibility, professional attitude to work, communication skills within the team. Complementing the theoretical knowledge acquired within the study program with solving of practical issues. Using the experience of experts working at the facility where the practice is carried out to extend the practical knowledge and motivation of students. Gaining a clear insight into the possibility of applying the acquired knowledge and skills covered by the study program in practice.
Subject content	
Theoretical lectures	
Practical lectures (practice, other types of teaching, research)	The student learns about basic structure of the company and its business goals. Student fulfills its work obligations in accordance with the duties and responsibilities of a company's employee. Student describes his own involvement in professional practice and provides a critical review on his own experience, knowledge and skills gained during the professional practice.
Literature	
1	
2	
3	
4	
5	

Number of classes of active teaching weekly during semester/trimester/year

Lectures	Practice	OTT	Research work	Other classes
				6

Types of teaching	Студент по правилу самостално бира предузеће из државног, приватног или јавног сектора у коме ће обавити стручну праксу. Стручна пракса се може обавити и у иностранству, у ком случају студент поред осталог усавршава и страни језик. На предлог студента, руководилац изборног подручја-модула одобрава да се пракса обави у жељеној установи и на захтев издаје писмени упут за стручну праксу особи надлежној за извођење праксе у датој установи. По обављеној пракси, а на основу извештаја студента и потврде одговорног лица које потписом и печатом предузећа потврђује да је пракса обављена, студенту се додељује 3 ЕСПБ бода за обављену стручну праксу.

Assessment (maximum 100 points)

Pre-exam requirements	Points	Final exam	Points
Activities during lectures		**Written exam**	
Practical	70	**Oral exam**	30
Colloquium			
Seminar papers			

Subject specification for book of subjects

Study program	Computing and Informatics		
Module	Joint		
Type and level of study	Master studies		
Subject title	Master Thesis		
Teacher (for lectures)			
Teacher/assistant (for practice)			
Teacher/assistant (for other types of t			
Number of ECTS	15	**Subject status (obligatory/elective)**	Obligatory
Condition			
Subject goal	Preparation of master thesis aims to bring together, validation and practical application of the knowledge acquired during master studies. The student will have the opportunity to demonstrate the capacity to carry out a project individually, which can be of practical, research or theoretical-methodological character. Students also gain experience in the presentation of their work in the form of a written and oral presentation.		
Learning outcome	Ability to conduct an individual project, formulate and analyze a problem and carry out a critical review of possible solutions. The application of the acquired engineering and design knowledge and skills to problem solving, having in mind the complexity, cost, reliability and efficiency of solutions. Ability to write the thesis in the given form. The ability of a clear explanation of the completed project through the oral presentation of the work.		
Subject content			
Theoretical lectures	Master thesis is an individual research, practical, or theoretical-methodological work of the student in accordance with the level of studies, in which he / she becomes familiar with a certain field through a literature review, and adopts research and design methodology, necessary for the creation of the thesis. Developing the thesis, the student applies the practical and theoretical knowledge acquired during the studies. In the written form, the thesis contains an introductory chapter, the problem definition, an overview of the field and of existing solutions, a proposal and a description of the solution, the conclusion and references. Public thesis defense is organized in front of a commission of three members, where one is mentor of the thesis. During the oral presentation, the candidate explains the results of his work, and answers questions of the commission members, by which the candidate demonstrates the ability of oral presentation of his project.		
Practical lectures (practice, other types of teaching, research)			
Literature			
1			
2			
3			
4			
5			

Number of classes of active teaching weekly during semester/trimester/year				
Lectures	**Practice**	**OTT**	**Research work**	**Other classes**
Types of teaching				

Assessment (maximum 100 points)			
Pre-exam requirements	**Points**	**Final exam**	**Points**
Activities during lectures		**Written exam**	70
Practical		**Oral exam**	30
Colloquium			
Seminar papers			

Subject specification for book of subjects

Study program	Computing and Informatics		
Module	Joint		
Type and level of study	Master studies		
Subject title	Master Thesis – Study and Research Work		
Teacher (for lectures)			
Teacher/assistant (for practice)			
Teacher/assistant (for other types of t			
Number of ECTS	4	**Subject status (obligatory/elective)**	Obligatory
Condition			
Subject goal	Application of basic, theoretical-methodological, scientific-professional and expert-applied knowledge and methods on solving of a specific problem. The student studies the topic, its structure and complexity, and on the basis of conducted analyzes, derives the possible ways of solving of aspecific problem. By studying literature students learn about methods that are developed for solving similar problems, and about engineering practice in their solving.		
Learning outcome	Training students to apply previously acquired knowledge from different areas they have studied, in order to comprenhend the structure of the given problem, in order to draw conclusions about possible directions of its solving. Through the use of literature, students expand their knowledge by studying various methods and papers concerning similar problems. In this way, students develop the ability to perform analyses and identify problems within the frame of the given task. Practical application of acquired knowledge among students develops the ability to understand the position and role of engineers in the chosen field, and to understand the importance of teamwork and cooperation with other professions.		
Subject content			
Theoretical lectures	It is performed individually, in accordance with requirements of a specific master thesis, its complexity and structure. According to student's preferences and inclinations, he / she chooses the field of study and the subject teacher from the list of teachers in the study program. The chosen teacher defines the topic and the specific task for a student. The student studies literature, professional and scientific papers dealing with similar topics, performs analyses in order to find a solution for the specific problem, or performs certain experiments in the laboratory. The study includes active monitoring of primary knowledge, organization and performance of experiments, numerical simulations and statistical data processing, preparation of seminar paper from the field to which the topic master thesis belongs.		
Practical lectures (practice, other types of teaching, research)			
Literature			
1			
2			
3			
4			
5			

Number of classes of active teaching weekly during semester/trimester/year				
Lectures	**Practice**	**OTT**	**Research work**	**Other classes**
			6	
Types of teaching				

Assessment (maximum 100 points)			
Pre-exam requirements	**Points**	**Final exam**	**Points**
Activities during lectures		**Written exam**	
Practical		**Oral exam**	50
Colloquium			
Seminar papers	50		