

UNIVERSITY OF KRAGUJEVAC



Master academic studies

Master of Information Technologies

Study program Book of courses

Course Catalogue – Study Program Master of Information Technologies

No.	Course name	Narrow scientific field	Sem.	Status	L	P	DON	SRW	Other	ECTS
1.	IT innovation and entrepreneurship	Organization and management	1	Mandatory	2	2				6
2.	Selected chapters of statistics	Data analysis	1	Elective	2	2				6
3.	Introduction to data science	Data analysis	1	Elective	2	1	2			6
4.	Artificial intelligence	Data analysis	1	Elective	2	1	2			6
5.	Machine Learning	Data analysis	1	Elective	2	1	2			6
6.	Natural language processing	Data analysis	1	Elective	2	2				6
7.	Bioinformatics	Data analysis	1	Elective	2	2				6
8.	Electronic commerce	Business informatics	1	Elective	2	2				6
9.	IT projects management	Organization and management	1	Elective	2	1	1			6
10.	Internet of things	Distributed computing	1	Elective	2	2				6
11.	Big data processing	Distributed computing	1	Elective	2	1	1			6
12.	3D computer graphics	Interactive computing	1	Elective	2	2				6
13.	Programming of mobile applications	Interactive computing	1	Elective	2	2				6
14.	Software engineering	Organization and management	1	Elective	2	1	2			6
15.	English language in information technologies	English language	2	Mandatory	2	2				6
16.	Deep learning	Data analysis	2	Elective	2	1	1			6
17.	Biologically inspired computing	Data analysis	2	Elective	2	2				6
18.	Decision support systems	Data analysis	2	Elective	2	2				6
19.	Intelligent information systems	Data analysis	2	Elective	2	0	2			6
20.	Web mining	Data analysis	2	Elective	2	2				6
21.	Image processing	Data analysis	2	Elective	2	2				6
22.	Multimedia data analysis	Data analysis	2	Elective	2	2				6
23.	Software quality management	Organization and management	2	Elective	2	2				6
24.	DATAFLOW computers and their application	Computer systems	2	Elective	2	2				6
25.	Cloud computing	Distributed computing	2	Elective	2	1	2			6
26.	Computer system protection	Distributed computing	2	Elective	2	2				6
27.	Human computer interaction	Interactive computing	2	Elective	2	2				6
28.	Virtual reality systems	Interactive computing	2	Elective	2	2				6
29.	Users' interface design	Interactive computing	2	Elective	2	2				6
30.	Internship		3	Mandatory					10	5
31.	Study research work		3	Mandatory				10		10
32.	Final work		3	Mandatory						15

Study program: Master of information technologies		
Course title: IT INNOVATIONS AND ENTREPRENEURSHIP		
Teacher (s): Snežana B. Nestić		
Course status: Mandatory		
No. of ECTS: 6		
Prerequisites: enrolled in an adequate semester		
Course objective: The course is designed with the main aim to provide the education for students of computing and informatics in the fundamentals of entrepreneurship with both relevant aspects: 1) starting the new business and 2) development of entrepreneurial mind-set, skills, and personal qualities.		
Course learning outcome: At the end of the course, a student is expected to have: • Basic knowledge necessary for a clear understanding of the complex nature of entrepreneurship, entrepreneur's characteristics and entrepreneurial process concept; • Basic entrepreneurial skills necessary for successful starting of entrepreneurial career – whether it is starting a new business or an entrepreneurial behavior within the existing organization; • Awareness of problems in their environment, as well as the capacity to identify those problems and seeks solutions that can be the ground of innovative business; • Awareness of the significance of entrepreneurship and taking responsibility for their own destiny, abandoning the philosophy “to get a job” and accepting philosophy “create your own job”; • Awareness of the necessity of lifelong learning process in the area of entrepreneurship; • Knowledge of innovation management and technology transfer.		
Course contents: <i>Lectures</i> Entrepreneurship (the term and development of entrepreneurship, entrepreneurship types, the significance of entrepreneurship). Entrepreneur (the term, entrepreneur's characteristics and behavior, entrepreneur origins, motivation, and culture). Entrepreneurial process (characteristics, models, elements). Entrepreneurial performances. Innovation – a basic instrument of entrepreneurship (the term, sources of innovative behavior, innovation process, protection of intellectual property rights). Elements and characteristics of corporate entrepreneurship. <i>Practice</i> Practice sessions are auditory and they include preparation, development and defending the Team Project 1 (entrepreneur's interview) and Team Project 2 (written case study).		
Literature 1. Babić M., Preduzetništvo (Entrepreneurship), WUS Austria and Faculty of Mechanical Engineering Kragujevac, 2006. 2. Babić M., Ninković R., Preduzetništvo, teorija proces i praksa (Entrepreneurship, theory, process and practice), Faculty of Mechanical Engineering Kragujevac and Serbian Employers, 2007. 3. Bojović V., Šenk V., Rašković V., Mirosavljev M., Borocki J., Radovanović J., Vodič za inovativne preduzetnike (Guidelines for innovative entrepreneurs), Konekta konsalting, d.o.o., Novi Sad, 2004. 4. R. Grozdanović, Preduzetništvo (Entrepreneurship), University of Kragujevac – Faculty of Technical Sciences Čačak, 2005 5. Lean Startup, Erik Ris		
No. of active teaching hours	Lectures: 30	Practice: 30
Teaching methods Teaching consists of lectures and exercises. The non-classic teaching method that provides shifting the students from the position of passive consumers of served information to the position of active participants in the acquisition and creative exploitation of knowledge will be used. This method includes teaching using multimedia tools, guesting lecturers (successful entrepreneurs), case studies, mentorship, simulations of creating, starting and running a business, individual and group student activities, using internet resources and performing all student tasks during exercises with consultations of teachers and associates.		
Examination (maximum number of points 100)		

Exam prerequisites	70 points	Final exam	30 points
Student's participation during lectures	10	Written exam	30
practical exercises			
projects			
midterm(s)	30		
seminar(s)	30		

Study program : Master of information technologies			
Назив предмета: SELECTED FIELDS IN STATISTICS			
Teacher(s): Sladana B. Dimitrijević			
Course status: Elective			
Number of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective The goal of the course is deeper understanding of statistical methods; introduction to the elements of the theory of samples and experiment planning; introduction, understanding and adequate application of variance analysis, regressive analysis, as well as nonparametric tests; learning to use one of software packages for statistical analysis.			
Course learning outcomes Students should acquire knowledge on the elements of the theory of samples and experiment planning, as well as of variance analysis, regressive analysis and nonparametric tests. Students should acquire necessary theoretical knowledge and apply the methods of mathematical statistics in various research projects and process statistical data independently using a software package for that purpose.			
Course contents <i>Theory</i> Sample survey, sampling techniques and experiment planning. Variance analysis. Linear regression. Multiple regression. Binary logistic regression. Nonparametric tests. <i>Practice</i> Practical application of acquired theoretical knowledge through various assignments and through statistical data processing. Work on a specific research project, that is the processing of actual statistical data and making certain statistical conclusion.			
Literature 1. P. S. Mann, Introduction to statistics (Serbian translation), Faculty of Economics, Belgrade, 2009 2. Lj. Petrovic, Teorijska statistika (Theoretical statistics), Faculty of Economics, Belgrade 2006 3. Julie Pallanat, SPSS – Survival Manual (Serbian translation), Mikro knjiga, Belgrade, 2011			
No. of active teaching hours	Lectures: 30	Practice: 30	
Teaching methods Theoretical lectures, practical exercises, students' independent work, consultation with students			
Examination (maximum number of points 100)			
Exam prerequisites	50 points	Final exam	50 points
Student's participation during lectures		Oral exam	50
practical exercises			
projects			
tests	50		

Study program : Master of information technologies			
Course title: INTRODUCTION TO DATA SCIENCE			
Teacher(s): Nenad Filipovic, Vladimir M. Milovanovic			
Course status: Elective			
Number of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective: The goal of the course is the introduction to all major aspects of data science, learning how to use software tools, data management, data presentation and data analysis. Within the course, students will be introduced to best practice from the field of industry and research.			
Course learning outcomes: Students should acquire skills in data management techniques. They should learn to choose adequate methods for presenting data, as well as use the basic methods of machine learning and statistics. Students should be skilled to prepare adequate reports, to recognize potential security, personal and ethical problems when processing data. They should learn to choose the right license for work and software			
Course content <i>Lectures</i> The course offers an introductory overview of the topics which are relevant data science. Data processing – Acquisition. Storage. Cleaning. Summing up. Visualization. Analysis - Prediction. Clasterization. Statistical conclusion. Business and social aspects – Privacy.Security. Ethics. Licenses. Intellectual property. <i>Practice</i> Python и R libraries. Use of auxiliary tools for versioning (Github) and repetitions (Jupyter). Use of public repositoria - ArXiv, Zenodo.			
Literature 1. W. Hadley, G. Grolemund, R for statistical data processing, Mikro knjiga, 2017 2. S. E. Buttrey, ,L. R. Whitaker, A Data Scientist's Guide to Acquiring, Cleaning, and Managing Data in R, John Wiley & Sons, 2017. 3. G. Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly Media, 2009. 4. H. Wickham, Elegant Graphics for Data Analysis, Springer, 2015.			
No. of active teaching hours		Lectures: 30	Practice: 15+30
Teaching methods Lectures, exercises and independent work of students.			
Examination (maximum number of points 100)			
Exam prerequisites	70 points	Final exam	30 points
Student's participation during lectures		Oral exam	30
practical exercises			
projects			
tests	50		
seminars	20		

Study program: Master of information technologies			
Course title: ARTIFICIAL INTELLIGENCE			
Teacher (s): Tatjana Stojanović International lecturer: Zoran Bosnić			
Course status: Elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective: Increasing the knowledge of methods and techniques of artificial intelligence. Building capacity of students to solve demanding real and research problems using artificial intelligence methods.			
Course learning outcomes: Students have competences to apply artificial intelligence methods in order to solve specific real problems in various fields. Students have competences to use methods and techniques of artificial intelligence in research activities, both those performed on projects within other master study courses, and those related to the elaboration of a master's thesis. Students have competences to judge critically, from the scientific aspect, the opportunities and limitations of artificial intelligence.			
Course contents: <i>Lectures</i> Problem-solving and searching. Advanced heuristic searching methods. Searching in real time. Problems related to satisfying the limitations. Reasoning in problems related to satisfying the limitations. Planning. Classic planning techniques. Planning by searching forwards and backward. Heuristic planning. Planning and acting of agents in a real environment. Probability judgment. Presentation of uncertain knowledge. Bayes networks. Markov models. Learning. Example-based learning. Probability models. Kernel-based methods. Clustering methods. Learning through intensification. Group learning. Selection and validation of models. <i>Practice</i> Implementation of artificial intelligence methods covered by lectures in Python programming language.			
Literature 1. Stuart Russell, Peter Norvig, Veštačka inteligencija, savremeni pristup (Artificial intelligence, modern approach), CET, Belgrade 2011. 2. George Luger, Artificial intelligence – Structures and Strategies for Complex Problem Solving, Fifth Edition, Addison-Wesely, 2005. 3. Tom Mitchell, Machine Learning. New York: Mc Graw-Hill, 1997. 4. Patrick Henry Winston, Artificial Intelligence (3rd Edition), Pearson, 1992.			
No. of active teaching hours		Lectures: 30	Practice: 15+30
Teaching methods Problem-oriented lectures, practice, independent student work, consultations. Combination of traditional teaching and e-learning with appropriate literature. The practice is realized as laboratory exercises in computer classrooms, where students independently or with the assistants help solve real problems from the field of artificial intelligence.			
Examination (maximum number of points 100)			
Exam prerequisites	70 points	Final exam	30 points
Student's participation during lectures	4	oral exam	30
practical exercises			
seminar(s)	20		
midterm(s)	20+26		
seminar(s)	20		

Study program : Master of Information Technologies		
Course title: MACHINE LEARNING		
Teacher (s): Tijana Geroski		
Lecturer from abroad: Themis Exarchos		
Course status: Elective		
No. of ECTS: 6		
Prerequisites: enrolled in an adequate semester		
Course objective: Enabling students to understand the concepts and practical application of supervised machine learning in the field of regression and classification.		
Course learning outcomes: Mastering the course material allows a student to: • Understand key concepts of machine learning (theoretical assumptions, mathematical basics, advantages, and disadvantages of algorithms of supervised and unsupervised machine learning). • Distinguish basic approaches to machine learning. • Apply the procedure for selection and evaluation of optimal models for the given problem. • Effectively apply the fundamental regression algorithms and classification to the problems of medium complexity.		
Course contents: <i>Lectures</i> Basic concepts of machine learning. Areas of application. Types of machine learning. Supervised learning. Setting up a supervised learning problem. Model. Minimizing the errors of a model. Pre-adapting and subadapting. Cross-checking. Functions of loss. Regularization. The balance between the systematical deviation and variance. Models based on trees. Decision trees training. Decision trees pruning. Presentation of decision trees in the form of rules. Methods of nearest neighbors. Separating boundaries. Curse of dimensionality. Linear models for regression and classification. Linear regression. Multiple linear regression. Logistic regression. Multinomial logistic regression. Artificial neural networks. Perceptron. Gradient Descent. Artificial neural networks with propagation in advance. Activation functions. Probability models. Naive Bayesian Classifier. Methods based on core functions. Support vector methods. The maximum margin problem. Joint training. AdaBoost. Random Forest. Evaluation and selection of models. Confusion matrix. Sensitivity and specificity. ROC curve. Surface below the ROC curve (AUC). <i>Practice</i> Application of software tools and implementation of solutions in the R environment and Python programming language. Work on exercises involves the application of acquired knowledge to solve specific tasks in the field of supervised machine learning.		
Literature 1. Tom Mitchell, <i>Machine Learning</i>. New York: Mc Graw-Hill, 1997. 2. Ethem Alpaydın, <i>Introduction to Machine Learning</i>, Third Edition, The MIT Press Cambridge, Massachusetts, London, England, 2014. 3. John D. Kelleher, Brian Mac Namee, Aoife D’Arcy, <i>Fundamentals of machine learning for predictive data analytics, Algorithms, Worked Examples, and Case Studies</i>, The MIT Press Cambridge, Massachusetts, London, England, 2015. 4. Kevin P. Murphy, <i>Machine Learning: A Probabilistic Perspective</i>, The MIT Press Cambridge, Massachusetts, London, England, 2012. 5. Stuart Russel, Peter Norwig, <i>Veštačka inteligencija, savremeni pristup, prevod trećeg izdanja</i>, RAF Računarski fakultet, Beograd/ CET Computer Equipment and Trade, Beograd / Portalibris, Beograd, 2011.		
No. of active teaching hours:	Lectures: 30	Practice: 15+30
Teaching methods Lectures: lectures and discussions using multimedia content; case studies.		

Practice: practical work with e-learning tools, project work; The assistant provides all the help needed to students. Interactive participation of students, which includes analysis of cases from practice, preparation of project assignments from the curriculum content.

Examination (maximum number of points 100)

Exam prerequisites	70 points	Final exam	30 points
Student's participation during lectures		written exam	20
practical exercises		oral exam	10
projects			
Midterm exam(s)	20+20		
seminar(s)	30		

Study program: Master of Information Technology			
Course title: NATURAL LANGUAGE PROCESSING			
Teacher (s): Tatjana Stojanovic			
Lecturer from abroad: Marko Robnik Šikonja			
Course status: elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective Introducing students with modern statistical techniques of natural language processing and their practical use.			
Course learning outcomes The student understands the approaches to syntax and semantics in natural language processing, knows the techniques of machine translation and knows how to apply standard open source tools in natural language processing.			
Course contents: <i>Lectures</i> Introduction to natural language processing. Organizations and types of dictionaries and corps. Models and classifications of the language. Segmentation of text, word recognition and sentence recognition. Bayes' approaches to solving ambiguity and correcting errors. Implementation of hidden Markov chains and application in POS tagging. Neural networks and neural language models. Application of recurrent neural networks. Syntax and probability parsing, parsing contextually free grammars. Shallow parsing and final automats. Classification of texts based on semantics and sentiment. Methods and tools in speech recognition. Challenges in machine translation. <i>Practice</i> Joint conception and elaboration of topic and content of projects. Reference to the concept, resources, and literature. Monitoring and discussion of solutions and results during project work and its documentation.			
Literature 1. Stuart Russell, Peter Norvig, Вештачка интелигенција – Савремени приступ, СЕТ, Београд, 2011 2. D. Jurafsky, J. H. Martin, Speech and Language Processing, Prentice Hall, 2008. 3. C. D. Manning, P. Raghavan, H. Schütze, An Introduction to Information Retrieval, Cambridge University Press, 2008. S. Bird, E. Klein, E. Loper. Natural language processing with Python. O'Reilly Media, Inc., 2009.			
No. of active teaching hours:		Lectures: 30	Practice: 15+15
Teaching methods The classes use classical teaching methods. In practical learning the given principles are exercised and the areas of application are considered. Specific problems are solved independently or by team work.			
Examination (maximum number of points 100)			
Exam prerequisites	70 points	Final exam	30 points
student's participation during lectures		oral exam	30
colloquiums	30		
seminars	40		

Study program: Master of Information Technology			
Course title: BIOINFORMATICS			
Teacher (s): Nenad Filipovic, Velibor Isailovic			
Lecturer from abroad: Dimitrios Fotiadis, Themis Exarchos			
Course status: elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective Students will be introduced with concepts and techniques of bioinformatics. Sequencing DNA, RNA and work with protein structures.			
Course learning outcomes Upon completion of the course, students will be trained to work with sequences of DNA and RNA, three-dimensional protein structures, and individual protein sequences. Students will acquire knowledge necessary for further scientific and research work in the field of bioinformatics.			
Course contents: <i>Lectures</i> Bioinformatics - from laboratory to application. Machine learning in bioinformatics. Use of nucleotide sequence databases. Use of databases of proteins and specialized sequences. Working with a unique DNA sequence. Working with a single protein sequence. Search for similarity in the database sequence. Comparison of two sequences. Alignment of multiple sequences. Editing of the alignment. Working with three-dimensional protein structures. Working with RNA. Construction of phylogenetic trees. <i>Practice</i> Exercises are performed in a computer classroom. Creating a project with a practical and concrete problem.			
Literature 1. M. Rocha and P. G. Ferreira: Bioinformatics Algorithms: Design and Implementation in Python, First Edition, Academic Press, 2018) (ISBN 978-0128125205) 2. P. M. Selzer, R. J. Marhöfer, O. Koch: Applied Bioinformatics: An Introduction, Second Edition, Springer, 2018. (ISBN 978-3319682990) 3. L. Baker: Bioinformatics: Tools and Techniques, CALLISTO REFERENCE, 2018. (ISBN 978-1641160032) 4. R. Elder: Building Bioinformatics Solutions, Createspace Independent Publishing Platform, 2017. (ISBN 978-1975792152) 5. C. Malkoff: Bioinformatics, Proteomics and Genomics, CALLISTO REFERENCE, 2017. (ISBN 978-1632398048)			
No. of active teaching hours		Lectures: 30	Practice: 30
Teaching methods Lectures, auditory exercises and students' independent work.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
student's participation during lectures	5	oral exam	30
practice	15		
projects	50		

Study program: Master in Information Technologies			
Course title: ELECTRONIC COMMERCE			
Teacher in charge: Zoran S. Kalinić			
Status of the course: Elective			
ECTS: 6			
Prerequisites: Enrolled in appropriate semester			
Course objective The objective of the course is to introduce students to modern theoretical and practical aspects of electronic commerce (e-commerce), as well as to the e-commerce architecture, usage of modern technological solutions, methods, techniques and tools in e-commerce implementation, the most important business models of e-commerce and their characteristics, payment systems used in e-commerce, the basics of digital marketing, legal aspects and perspectives of further development of e-commerce.			
Learning outcomes of the course - Knowledge and understanding of basic concepts, technologies and models of electronic commerce, - Practical knowledge and skills on methods, techniques and software tools for the development of e-commerce systems and applications			
Course content <i>Theoretical part - lectures</i> Concepts and principles of e-commerce. The most important e-commerce business models (B2B, B2C, C2C). Mobile commerce. Payment systems in e-commerce. Social networks in e-commerce. E-commerce infrastructure. Development and application of new technologies in traditional retail chains. E-commerce globalization. Strategy and implementation of e-commerce. E-commerce management. E-commerce development tools. The importance and methods of e-commerce marketing. The basics of digital marketing. Legal and ethical issues related to e-commerce. Security, privacy and consumer rights issues in e-commerce. Perspectives of further development of e-commerce. <i>Practical part - exercises</i> An analysis of contemporary e-commerce models. Practical exercises on e-commerce systems and applications computer lab. Case studies - examples of e-commerce. Project - creating an e-store using an open source Content Management System (CMS).			
Literature 1. Bjelic, P., Global electronic commerce (in Serbian), Faculty of Economics, University of Belgrade, 2012 2. Koncar, J., Electronic Commerce (in Serbian), Faculty of Economics, University of Novi Sad, 2008. 3. Electronic Commerce, additional teaching materials in electronic form. <i>Additional literature</i> 4. Laudon, K., Traver, C., E-commerce 2017, 13th edition, Pearson Education Limited, 2017. 5. Turban, E., King, D., Lee, J., Liang, T-P., Turban, D., Electronic Commerce 2018 - A Managerial and Social Networks Perspective, 9th edition, Springer, 2018			
Number of active teaching hours		Lectures: 30	Practice: 30
Teaching methods Lectures, case studies, discussion, practical work and tasks in computer lab, project.			
Examination methods (maximum 100 points)			
Exam prerequisites	75 points	Final exam	25 points
Student's activity during lectures		Oral exam	25
Practical classes/tests			
Project	25		
Colloquiums	50		
Seminars/homework			

Study Program: Master of Information Technology			
Name of the Course: IT PROJECT MANAGEMENT			
Teacher/Teachers: Nenad D. Stefanović			
Teacher from the industry: Srdjan Atanasijević			
Course status: Elective			
ECTS No: 6			
Condition: Enrolled in an appropriate semester			
Aim of the course Introducing students with basic concepts, methods, techniques and tools for successful IT project management.			
Course outcome Students will acquire all the necessary theoretical and practical knowledge in project management, with emphasis on specific methods and techniques for managing IT projects. After the completion of the course, students have the necessary knowledge and skills for successful project management, team participation, IT services management, and the practical application of methods and software tools. Acquired knowledge can be used on a wide range of projects, as well as on taking official international exams from mentioned areas.			
Contents of the course <i>Theoretical lessons</i> Basics of project management; project management methods (PMBOK, Prince, etc.); project life cycle (initiation, planning, execution, monitoring and control and closing); project scope management; project integration; project time planning; project cost management; project quality management; project human resources management; risk management; project communication management; procurement management; quality management; stakeholder management; software project management (RUP, MSF, agile methods); Scrum method for managing IT projects; IT management in the ITIL framework (strategy, design, transition, operations and improvement); techniques and methods for unifying the development of software and IT operations and the continuous delivery of software (DevOps). <i>Practical lessons</i> Working in the software package MS Project and Project Server in a cloud: creating and working with files; working with tasks; working with resources; assigning tasks to resources; working with views; tuning of the timetable, project monitoring and project management; reporting on and sharing information. Project Server Administration and project portfolio management. Kanban Project Management Systems (Planner, Trello, etc.). Group work - preparation of a complete IT project plan in the MS Project software package and preparation of supporting documentation. Visits to partner companies from the IT sector.			
Literature 1. N. Stefanovic, Project Management, internal script. 2. PMI, A Guide to the Project Management Body of Knowledge, 6th edition, 2017. 3. Cynthia Snyder, Cynthia Snyder Dionisio, Microsoft Project 2016 for Dummies, Wiley, 2016. 4. Agrawal and a group of authors, Software Project Management, University Press, 2011.			
Number of active classes		Theoretical lessons: 30	Practical lessons: 30
Teaching performance methods Lectures and exercises in the room (computer classroom) equipped with a video bim, computers and internet access. A combination of classic teaching with e-learning accompanied by relevant literature. Problem-oriented teaching, practical lessons, independent student work - homework assignments and project assignments. Usage of the state-of-the-art web services (Office 365) in teaching, communication, team work, application development, and collaboration. Conducting live consultations, as well as through video conferences.			
Knowledge assessment (maximum number of points 100)			
Pre-exam obligations		50 points	Final exam
Activities during lectures			Oral exam
Practical teaching			Project assignment and defense
			50

Projects			
Colloquium(s)	50		

Study programme: Master of information technologies			
Course title: INTERNET OF THINGS			
Teacher (s): Vladimir M. Cvjetković International lecturer: Dimitrios Fotiadis			
Course status: Elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective: Presenting and explaining IoT field as a modern concept of networking and unnoticeable integration of various sensors and actuators in the everyday physical environment in order to collect measurable data from sensors and interact with physical surrounding through actuators, using omnipresent Internet infrastructure. Introducing various hardware and software architectures that allow the implementation of IoT systems, specifications, design and implementation of IoT systems and, encouraging creative and unique projects.			
Course learning outcome: Understanding the essence and fundamentals of IoT, operability with technologies, software tools and hardware for implementation of IoT systems; acquired qualifications for independent specification, design, and implementation of IoT system.			
Course contents: <i>Lectures</i> Development of IoT concept, technologies for IoT, IoT hardware (Single Board Computers – SBC), GPIO (General Purpose Input Output) electric measurements, sensors and measurements of non-electric parameters, connecting analogue and digital sensors, connecting actuators, features for connecting actuators, network connections, features for network connections, NodeJS, Web express, Linux SBC, IoT systems based on Arduino SBC family and Raspberry Pi RPI, specification, design and implementation of IoT systems. <i>Practice</i> Electric measurements, sensors and measurement of non-electric parameters, connecting analogue and digital sensors, connecting actuators, features for connecting actuators, network connections, features for network connections, NodeJS, Web express, Linux SBC, IoT systems based on Arduino SBC family and Raspberry Pi RPI, specification, design and implementation of IoT systems.			
Literature 1. Dogan Ibrahim, Internet stvari (Internet of Things), Agency Eho, 2016, ISBN: 9788680134055 2. Warwick A. Smith, C programiranje za Arduino (C programming for Arduino), Agency Eho, 2017, ISBN: 9788680134086 3. Bert Van Dam, Arduino Uno, Agency Eho, 2017, ISBN: 9788680134079 4. M. Švaljek, Arduino Succinctly, Syncfusion Inc., 2501 Aerial Center Parkway Suite 200 Morrisville, NC 27560 USA, 2015. 5. http://www.syncfusion.com/ 6. https://www.arduino.cc/ 7. https://www.tinkercad.com/circuits 8. http://saperel.com/ 9. http://www.ed.rs/ed/tekstovi/principi/opste.htm			
No. of active teaching hours:		Lectures: 30	Practice: 30
Teaching methods Lectures, exercises, laboratory exercises, consultations, seminars.			
Examination (maximum number of points 100)			
Exam prerequisites	70 points	Final exam	30 points
Student’s participation during lectures		Oral exam	
practical exercises		Written exam	30
project(s)			
midterm(s)	40		
seminar(s)	30		

Study Program: Master of Information Technology			
Name of the course: BIG DATA PROCESSING			
Teacher/Teachers: Ana M. Kaplarević-Mališić			
Teacher from abroad: Dimitrios Fotiadis			
Course status: Elective			
ECTS No: 6			
Condition: Enrolled in an appropriate semester			
Aim of the course			
Getting acquainted with the basics of storing, processing and analyzing large amounts of data using solid mathematical basis and up-to-date software tools.			
Course outcome			
The student knows and understands the mathematical base, standards and technologies that deal with the storage, processment and analysis of mass data. He is able to independently create a decision support application that uses a large amount of data as an input.			
Content of the course			
<i>Theoretical lessons</i>			
Mathematical basics. Relation to classic parallel programming of shared and distributed memory. Scientific and business applications that involve processing of large amounts of data. The concept of MapReduce, its advantages and limitations. Scaling in NoSQL databases such as MongoDB, Cassandra and Neo4j. Optimization and heuristics over a large amount of data. Cluster computing by using Apache Hadoop, Apache Spark and Hive. Advanced application of Apache Spark using MLib and SparkSQL libraries. Striming applications using message lines, as well as Apache Kafka. Concepts of virtualization and containerization.			
<i>Practical lessons</i>			
Creating illustrative applications using current Big Data technologies. Independent development and creation of cluster applications by using basic RDD access in Spark, as well as calling routines from libraries. Scripting by using Python and R programming languages. Measuring and optimizing performance of MapReduce applications. Streaming applications by using Message Queuing and Apache Kafka frames. Creating a scaling plan. Cluster Administration, Containerization, Docker and Kubernetes.			
Literature			
1. Chodorow, Kristina, MongoDB: The Definitive Guide: Powerful and Scalable Data Storage, O'Reilly Media, Inc., 2013. 2. White, Tom, Hadoop: The definitive guide, O'Reilly Media, Inc., 2012. 3. Spark, Apache, Apache Spark: Lightning-fast cluster computing. URL http://spark.apache.org (2016).			
Number of active classes		Theoretical lessons: 30	Practical lessons: 15+15
Teaching performance methods			
In teaching/learning of subjects methods of active teaching/learning are applied. Apart from ex-catedra teaching of lessons and laboratory exercises, interactive methods of learning in classroom are applied, as well as individual and team independent activities of students outside of the classroom (in a computer center, library, home). Interactive learning is applied in the form of independent individual work, cooperative and collaborative learning, problem-based learning, team work, and development of group or team projects (seminars).			
Knowledge assessment (maximum number of points 100)			
Pre-exam obligations	70 points	Final exam	30 points
Activities during lectures		Oral exam	30
Practical teaching	4		
Projects			
Colloquium(s)	18+18		
Seminar(s)	30		
Note:			
For the performance of lectures on the course a Hadoop/HPC кластер of 6 knots is available: 1 x Fujitsu PRIMERGY RX2540 M1 , 2 Intel(R) Xeon(R) CPU E5-2620 v3 @ 2.40GHz, 32 GB, 8 TB			

5 x HP ProLiant DL165 G7, 2 X AMD Opteron(TM) Processor 6272, 16 GB, 300GB
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Course title: 3D COMPUTER GRAPHICS			
Teacher (s): Boban Stojanović			
Lecturer from industry: Adrian Djura			
Course status: elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective Acquiring basic knowledge in the field of three-dimensional computer graphics.			
Course learning outcomes Students gained basic skills in raster and vector graphics. They are able to independently develop applications with three-dimensional graphics using appropriate software tools, applying the principles of computer graphics.			
Course contents: <i>Lectures</i> Computer graphics and geometry as computer disciplines. Structure of input / output devices. Graphic hardware. Raster graphics. Ray-tracing algorithms. Mathematical apparatus (trigonometry, analytic geometry and linear algebra). Coordinate systems. Graphics in space. Basic facilities in space. Transformations in space. Linear transformations (scaling, shear, rotation, reflection). Composition and decomposition of transformations. Translation and affine transformations. Inverse transformations. Transformation of coordinate systems. Views. Display types (wire structure, shading, hidden lines). Transformation of the view. Transformations of camera, projection and viewport transformations. Orthographic projection. Perspective. Graphic tube. Clipping. Z-buffer algorithm. Precision. Data Structures. Representation of points, polygons and bodies. Graph scene. Spatial data structures. <i>Practice</i> Draw basic objects with attributes (dashed lines, line thickness). An incremental algorithm for drawing circles and ellipses. Polygons, filling the inside of the polygon and polygon orientation. Wired poliedra model. Polygonal mesh network. Development of spatial models. Transformation of the model and view. Partial transformations of scene elements. Animated display. Usage of the Unity 3D Development Platform.			
Literature 1. Драган Цветковић. Рачунарска графика, CET Београд, 2006. 2. P. Shirley, S. Marschner. Fundamentals of Computer Graphics, CRC Press, 2009. 3. J. Kessenich, G. Sellers, D. Shreiner. OpenGL Programming Guide, Pearson Education, 2013. (www.opengl-redbook.com) 4. https://unity.com			
No. of active teaching hours:		Lectures: 30	Practice: 30
Teaching methods Problem-oriented teaching, student preparation of seminars, homework assignments, practical training.			
Examination (maximum number of points 100)			
Exam prerequisites	70 points	Final exam	30 points
student's participation during lectures		oral exam	30
colloquiums	50		
seminars	20		

Study program: Master of Information Technology			
Course title: PROGRAMMING OF MOBILE APPLICATIONS			
Teacher (s): Nenad Grujović, Vukašin Slavković			
Course status: elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective Acquiring general knowledge and special skills for understanding the concepts of mobile computing. Gaining technologies and tools for developing software solutions for mobile devices and systems.			
Course learning outcomes Knowledge of technologies for programming mobile applications. The student is competent to understand the concepts of mobile computing and to develop software solutions for mobile computing systems.			
Course contents: <i>Lectures</i> Overview of mobile computing. Hardware of mobile devices. Communication protocols for mobile devices. Programming languages and operating systems for mobile devices. User interface in mobile devices. Multimedia in mobile devices. Graphics. Network services. Location based services. Working with databases. Security in mobile devices. <i>Practice</i> Exercises are performed in a computer classroom. Creating a project with a practical and concrete problem.			
Literature 1. Schwarz R., Steele J., Nelson D.: Android 4 Израда апликација помоћу пакета Android SDK, Микро књига, 2014, ISBN 978-8675553908 2. Taniar D.: Mobile Computing: Concepts, Methodologies, Tools, and Applications, Information Science Reference 2009, ISBN 978-1605660547 3. Kamal D.: Mobile Computing, 2th edition, Oxford University Press, 2012, ISBN 978-0198068914 4. Rogers R., Lombardo J., Mednieks Z., Meike G.: Android Application Development, 5. Shroff Publishers & Distributors Pvt Ltd 2010, ISBN 978-8184047332			
No. of active teaching hours:		Lectures: 30	Practice: 30
Teaching methods Lectures, laboratory exercises, homework assignments, projects			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
student’s participation during lectures	5	written exam	30
practical exercises	30		
colloquiums	35		

Study program: Master of Information Technologies		
Course title: SOFTWARE ENGINEERING		
Teacher (s): Boban S. Stojanović		
Lecturer from industry: Vladan Atanasijević		
Course status: Obligatory		
No. of ECTS: 6		
Prerequisites: enrolled in an adequate semester		
Course objective Упознавање са методама и техникама за развој софтвера у свим фазама животног циклуса.		
Course learning outcomes Knowledge gained by students after mastering the program: Knowledge, understanding and use of methods and techniques in individual phases of software development. The skills that students acquired after mastering the program: Efficient use of tools that are applied at certain stages of software development. Systematicity (the ability to apply certain methods and techniques in software engineering necessarily and adequately), precision (clear and unequivocal presentation of facts), iterativity (the need to apply feedback between specific phases in order to improve solution and coexistence), incrementality (new versions of projects and solutions are better than previous ones), documentation (understanding that without successful documentation, successful development of information systems is not possible).		
Course contents: <i>Lectures</i> Introduction to Software Engineering. Analysis and synthesis. Techniques, tools, procedures, paradigms. Quality. Participants in the process. System approach. Engineering approach. The development team. Modeling process and life cycle. Process, life cycle, process structure. Phases of development. Process models (waterfall, waterfall with prototype, V model, prototype model, incremental and iterative phase development, spiral model). Agile development methods (extreme programming, Scrum, ...). Recording requests. The importance of the requests. Performing of the requests. Types of requests. Conflict resolution. Notations (entity-relationship diagrams, sequence diagrams, final automata, data flow diagrams, case - usage diagrams). Prototyping. Documenting of requests (specification of software requirements). System designing. Conceptual and technical design. Modularity. Architectural styles (layers, microservices, ...). Characteristics of a good design. User experience. Object-oriented design. Characteristics (identity, abstraction, classification, encapsulation, inheritance, polymorphism, persistence). Cases of use. Presentation of classes (class diagrams). Diagrams of the sequence of cooperation, states, activities, ...). Documentation of software design. Testing of the program. Errors and cancellations. Types of errors. Organization of testing. Test teams. Unit testing. Integration testing. Test planning. Automated testing tools. <i>Practice</i> Installation of the work environment. Getting acquainted with collaborative tools. Getting acquainted with code versioning tools. Team work on the development of a software solution for a given problem. Documenting software requirements. Documentation of software design. Presentation of the solution.		
Literature 1. L. Pfleeger, J.M. Atlee, Софтверско инжењерство, теорија и пракса, CET, Београд, 2006.		
No. of active teaching hours:	Lectures: 30	Practice: 15+30
Teaching methods Theoretical instruction is carried out in the form of interactive lectures, during which the teacher exhibits the contents of the subject using electronic presentations and traditional methods. Students actively participate in teaching through discussions on various variants of problem solving and their consequences on the quality of		

the software solution in terms of meeting the functional, project and process requirements, as well as the process of delivering and maintaining the software.

Practical classes are carried out in the form of laboratory exercises in computer classrooms, where students in teams continuously work on the realization of the project for development of the given software. From week to week students with researchers analyze the current development, the consequences of the selected solutions and define the goals of further development.

In addition to classical teaching in lectures and exercises, students have the opportunity to consult with teachers and researchers in relation to problems in mastering the materials.

Examination (maximum number of points 100)

Exam prerequisites	70 points	Final exam	30 points
student's participation during lectures		oral exam	30
practical exercises	50		
seminars	20		

Study program: Master of information technologies			
Course name: ENGLISH LANGUAGE IN INFORMATION TECHNOLOGIES			
Teacher(s): Neda Vidanovic Miletic			
Course status: Obligatory			
No. of ECTS: 6			
Prerequisites: /			
Course objective: The overall objective of the course is further improvement and work on productive and receptive language skills. The specific objectives of the course include mastering more complex forms of the general academic register, as well as the English for specific purposes (ESP) in this field. Acquisition of professional terminology, training of students to use professional literature, as well as mastering the academic register in writing and speech.			
Course learning outcomes: Students are trained for written and spoken professional communication, independent use of professional literature in English, as well as further training in the field of information technology. Through the preparation of seminar papers, they mastered professional terminology and novelties in using familiar words and expressions in a specific register.			
Course contents: <i>Theory</i> Lectures are based on interactive communicative approach. Materials are analysed related to information and communication technologies, software development, human-computer interaction, artificial intelligence, etc. <i>Practice</i> <i>Analysis of specific grammar units. Seminar papers writing related to the topic of information and communication technologies. Oral discussions to the topics from proffesion and academic lives of students and their interests and plans. Team work and participation in mini-debates and argumentation.</i>			
Literature: Eric H. Glendinning, John McEwan: <i>Oxford English for Information Technology</i> , 2 nd edition, Oxford University Press, 2011. David Hill: <i>English for Information Technology 2</i> (Vocational English Series), Pearson Education, 2012. Michael McCarthy and Felicity O'Dell: <i>Academic Vocabulary in Use</i> , 2 nd edition, Cambridge University Press, 2016. Martin Hewings: <i>Advanced Grammar in Use</i> , Cambridge University Press, 2002. <i>Oxford English-Serbian Student's Dictionary</i> , Oxford University Press, 2015. <i>Dictionary of Information Technology</i> , 3rd edition, Peter Collin Pub Ltd, 2002.			
Number of active teaching classes:	Lectures: 2	Practice: 2	
Teaching methods Mixed interactive method through lectures, practice and consultations – text analysis, oral presentation, conversation and discussion, video presentations, seminars			
Examination (maximum number of points 100)			
Exam prerequisites	50 points	Final exam	50 points
Student's participation during lectures	10	Written exam	40
Practical exercises		Oral exam	10
Colloquiums	30		

seminars	10		
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Study Program: Master of Information Technology			
Name of the Course: DEEP LEARNING			
Teacher/Teachers: Branko Arsić			
Lecturer from the economy: Miloš Radović			
Course status: Elective			
ECTS No: 6			
Condition: Enrolled in an appropriate semester			
Aim of the course Training students to understand the paradigm of deep learning as a field of machine learning, based on presenting data on a high degree of abstraction. The course introduces students to the key elements of classic neural networks, structural techniques of scientific calculations, regularization techniques, and learning algorithms, and considers models such as: convolutional, recurrent and generic rival neural networks. Deep-learning methods are being studied in important areas of artificial intelligence such as: forecasting, computer vision, natural language processing, speech and sound signal understanding. The course implies development of applications in modern software frames for deep learning (Tensorflow, Keras, R, Python).			
Course outcome The mastered material will enable the student: to substantially understand the benefits of deep learning in relation to alternative approaches to machine learning; to master the techniques of learning the depth models; to explain the areas of application of discriminatory and generic depth models; to appropriately apply models for supervised, semi-supervised and unsupervised learning; to apply methods and techniques of deep learning to understanding images, text, and speech; to evaluate quality metrics of depth models; to design and shape depth models in high-level languages.			
Content of the course <i>Theoretical lessons</i> Building elements of deep learning. Linear algebra (Special types of matrices and vectors, tensors, eigenvalues, norms, PCAs ...). Probability and information theory (distribution laws, Bayes rules...). Elements of numerical calculations (stabilization of functions in terms of errors - overflow, underflow, gradient optimization methods, optimization with constraints ...). Mechanical learning elements (learning algorithms, overfitting, underfitting, hyperparameters and validation sets, maximum reliability method, supervised and supervised learning, stochastic gradient descent ...). Architecture of deep neural networks (multilayer architectures of process units, backpropagation algorithm). Regularization of depth networks (L1, L2, dropout, data set, noise, multitask learning ...). Optimization in training deep networks (challenges - vanishing / exploding gradient, strategies of initialization parameters, adaptive learning algorithms ...). Convolutional networks (convolution, pooling, parameter sharing, convolution functions, structured outputs, efficient convolution algorithms ...). Sequential models (recurrent and recursive networks, LSTM, GRU). Generic models (Bolcman machines, auto-encoders, GANN ...). Practical methodology and application of depth models (performance metrics, selection of the appropriate model, hyperparametric selection strategies, debugging, large-scale deep learning, CUDA, computer vision, speech recognition, natural language processing, other applications). <i>Practical lessons</i> Application of software frames for deep learning (Tensorflow, Keras, R, Python). Work on exercises involves the application of acquired knowledge to solve specific current problems in different areas of deep learning.			
Literature 1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep learning, MIT Press, 2017. 2. Michael Nielsen, Neural Networks and Deep Learning, Determination press, 2015. 3. Stuart Russel, Peter Norwig, Artificial intelligence, contemporary approach, translation of the third edition, RAF School of Computing, Belgrade/ CET Computer Equepment and Trade, Belgrade / Portalibris, Belgrade, 2011.			
Number of active classes		Theoretical lessons: 30	Practical lessons: 15+15
Teaching performance methods Problem-oriented teaching, practical lessons and exercises with software support, independent student work and consultation.			
Knowledge assessment (maximum number of points 100)			
Pre-exam obligations		70 points	Final exam 30 points

Activities during lectures		Oral exam	10
Practical teaching	20	Written exam	20
Projects			
Colloquium(s)	20		
Seminar(s)	30		

Study program : Master of information technologies			
Course title: BIOLOGICALLY INSPIRED COMPUTING			
Teacher(s): Filipovic D. Nenad, Isailovic M. Velibor			
Course status: Elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective: Introducing students with concepts and techniques of biological computing, selected examples of the application of evolutionary computing and genetic algorithms.			
Course learning outcomes: Upon completion of the course students will be able to solve problems of biologically inspired computing using the approach of evolutionary computing and genetic algorithms.			
Course contents: <i>Lectures</i> Evolutionary algorithm. Genetic algorithms. Evolutionary strategies. Neural networks. Hybridization with other techniques, math algorithms. Schemes for classification, search and optimization based on biological computing. Coevolution, interactive evolution. <i>Practice</i> Exercises are performed in a computer classroom. Creating a project with a practical and concrete problem.			
Literature 1. A.E. Eiben and J.E. Smith: Introduction to Evolutionary Computing, Second Edition, Springer, 2015. (ISBN 978-3-662-44873-1) 2. S. Haykin: Neural networks and learning machines, Third Edition, Pearson, 2008. (ISBN 978-0-13-147139-9) 3. A. Brabazon: Natural computing algorithms, Springer, 2015. (ISBN 9783662436318)			
No. of active teaching hours		Lectures: 30	Practice: 30
Teaching methods Lectures, auditory exercises and independent work of students.			
Examination (maximum number of points 100)			
Prerequisites	Points	Final exam	Points
Student’s participation during lectures	5	Oral exam	30
Practice	15		
Projects	50		

Study program : Master of information technologies			
Course title: DECISION SUPPORT SYSTEMS			
Teacher(s): Filipovic D. Nenad, Rankovic M. Vesna			
Teacher from abroad: Themis Exarchos			
Course status: Elective			
Number of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective The goal of the course is the introduction to concepts, theoretical bases and possibilities of decision support systems. Students should acquire skills to independently apply the acquired knowledge in resolving actual problems.			
Course learning outcomes Students should acquire skills to model and resolve actual problems of optimal decision making in the conditions of uncertainty and unpredictability.			
Course content <i>Lectures</i> Basic concepts of decision support systems. Decision making theory. The problem of rationality in decision making. Decision making factors. Decision making phases. Types of decision making systems. The structure of decision making systems. Research and analysis of data for the support of decision making. Decisions made on K-nearest neighbors rules. Reasoning in the conditions of uncertainty. Bayes decision rule. Bayes networks and training. Belief networks. Neural networks. Fuzzy logic. Method of support vectors. Classifiers and classification. Stable and unstable predictors. Class imbalance problem. Data pre-processing. Outlier detection and prediction of missing data. Designing tools for decision support: data acquisition, knowledge recording and modelling, system validation. Examples of decision support systems. <i>Practice</i> Practical exercises are conducted in a computer classroom. Work on the project with a concrete practical problem.			
Literature 1. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006. 2. M. R. Berthold, D. Hand, Intelligent Data Analysis, Springer, 2007. 3. M. G. M. Hunink, P. P. Glasziou, J. E. Siegel, J. C. Weeks, J. S. Pliskin, A. S. Elstein, M. C. Weinstein, Decision Making in Health and Medicine: Integrating Evidence and Values, Cambridge University Press, 2001.			
No. of active teaching hours		Lectures: 30	Practice: 30
Teaching methods Lectures, exercises, encouraging independent work			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	Points
Students' participation during lectures	5	Oral exam	30
test(s)	40		
seminar(s)	25		

Study program : Master of information technologies			
Course title: INTELLIGENT INFORMATION SYSTEMS			
Teacher(s): Nenad D. Stefanovic, Vladimir J. Rankovic			
Course status: Elective			
Number of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective Introduction to and learning about the concepts, methods, techniques and tools of business intelligence (BI) Data Science and Big Data Analytics.			
Course learning outcomes Acquired knowledge in the field of the analysis of business systems, data integration (extracting, transforming, cleaning and reading), data dimensional modelling, data warehouse design, OLAP (On Line Analytical Processing), Data Mining, management of enterprise performance and reporting. Acquired knowledge after the completion of the program: Methods, techniques and tools of business intelligence, t.i. of Data Science, Designing intelligent information systems in various fields. Acquired skills after the completion of the program: Practical application of theoretical knowledge and efficient application of tools for the realization of Data Warehouse, Big Data и Data Mining systems and the skills to interpret results. Acquired attitudes after the completion of the program: Understanding the significance of intelligent information systems in decision making and management.			
Course content <i>Theory</i> Basics of business intelligence systems; Analysis and modelling of business systems for the realization of BI projects; Data Warehouse and OLAP; Dimensional modelling (cubes, dimensions, facts, hierarchies, KPI, denormalization); Enhancing the performance of BI systems (tuning, partition, etc.); Languages for examination (MDX, DAX, R, Python, etc.); Real Time BI and monitoring of business activities (Business Activity Monitoring – BAM); Data Mining (Machine Learning) – algorithms, methods of DM model development, demonstration on concrete examples; Performance Management – PM - Key Performance Indicators – KPI, Balanced Scorecard, software for PM; Reporting (report creating, dashboards, mashups, итд.); BI portals; BI modules of leading software packages (SAP BW, Oracle Enterprise Business Intelligence or Microsoft Dynamics BI); Big Data analytics (Hadoop, Spark, Pig, Mahout, Hive, HDInsight, Data Lake, Data Factory, etc.); Stream Analytics; Cloud Analytics; Intelligent services and digital assistants for analytics and decision making. <i>Practice</i> Introduction to the examples of the realization of intelligent information systems. Design and development of intelligent information systems using adequate software products and data sets. Work in cloud analytics environment (platform, services and tools). Excel and PowerBI service for reporting and visualization. Open code BI systems and tools.			
Literature 1. Nenad Stefanovic, Uvod u poslovnu inteligenciju (Introduction to business intelligence - internal textbook). 2. Brian Larson, Delivering Business Intelligence with Microsoft SQL Server 2016 4th Edition, McGraw-Hill, 2016. 3. Adam Jorgensen et al. Microsoft Big Data Solutions, Wiley, 2014.			
No. of active teaching hours		Lectures: 30	Practice: 0+30
Teaching methods Lectures and practical exercises in a computer classroom equipped with video beam and computers with Internet access. Combination of classical lectures and e-learning with related literature. Problem-oriented teaching, practical exercises, independent work of students, homework and project assignments. Application of the latest web service (Office 365) in lectures, communication, team work, application design and cooperation. Consultation with students in person and online.			
Examination (maximum number of points 100)			
Exam prerequisites		50 points	Final exam 50 points

Student participation during lectures		oral exam	20
practical exercises		Written exam	30
projects			
project assignments	50		

Study program: Master of information technologies			
Course title: WEB MINING			
Teacher (s): Blagojević Marija			
Course status: Elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective: Within this course, students are expected to learn about the specificities of the analysis of web documents and unstructured data. Additionally, they need to learn more about specific opportunities in the application of web mining technologies.			
Course learning outcomes: Students need to gain knowledge in theory and practice in the area of documents contents analysis, classification, and clustering of web documents. Additionally, they need to learn basic techniques and tools for the analysis of the web structure and web approach.			
Course contents: <i>Lectures</i> Introduction to web mining. Specifics of the web documents. Techniques for analysis of web documents contents. Identification of documents topic and ranking the terms in the document. Classification and clustering of documents. Web structure analysis, ranking the documents by their significance. Techniques for improving the website rating. Analysis of web approach. Identification of behavioral patterns of website users. Web visualization. Social networks statistics. <i>Practice</i> Introduction to basic tools for web mining and their application. Tools for document classification. Structure of log files and tools for log analysis.			
Literature 1. Bing Liu: Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer, Heidelberg; New York, 2011 2. Soumen Chakrabarti, Mining the Web: Discovering Knowledge from Hypertext Data, Morgan Kaufmann, 2002			
No. of active teaching hours:		Lectures: 30	Practice: 30
Teaching methods Lectures: lectures and discussions with the use of multimedia contents; case studies. Practice: practical work with tools for e-learning, work on projects; assistants will provide all necessary help to students.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
Student's participation during lectures		written exam	
practical exercises		oral exam	30
midterm(s)	30		
seminar(s)	40		
Examination methods can vary. The table only gives the preview of some options (written exams, oral exams, project presentation, seminars, etc.)			
*maximum length 2 pages of A4 format			

Study program : Master of Information Technologies			
Course title: IMAGE PROCESSING			
Teacher (s): Filipović D. Nenad, Jovičić R. Gordana			
Course status: Elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective: The objective of the course is to introduce students to the basics of computer graphics such as processing of visual signals, edge detection and line separation, text processing, representation of scene characteristics, motion, stereovision and various methods for image processing. The goal is also to enable students to independently do a complex project from computer graphics.			
Course learning outcomes: After mastering the program and passing the exam in Image Processing, candidates will be able to engage in research and scientific work from this new field. They will be capable of processing visual signals, using methods for the image processing, and forming a three-dimensional image in computed tomography, as well as using Fuzzy Logic in image processing. Candidates will be able to apply this knowledge in the software industry in the field of educational software development, film animations, advertising spots, military industry, automotive industry, biomedical industry, etc.			
Course contents: <i>Lectures</i> Visual signals processing. Edge detection and line separation. Analysis by parts. Texture. Presentation of the characteristic of the scene. Motion. Stereovision. Shape determination methods. X-ray image processing method. Method for the formation and analysis of images in computed tomography. Methods for analyzing the image obtained by ultrasound. Method for processing a thermionic image. Methods for the formation of a 3D image in computed tomography. Image fusion. Fuzzy logic in image processing. Change shape recognition. <i>Practice</i> Students will be trained for basic research in the subject area within the framework of the study research work.			
Literature 1. R. Szeliski: Computer Vision: Algorithms and Applications, Springer, 2010. (ISBN 978-1848829343) 2. E.R. Davis: Computer and Machine Vision: Theory, Algorithms, Practicalities, Academic Press, 2012. (ISBN 978-0123869081)			
No. of active teaching hours:		Lectures: 30	Practice: 30
Teaching methods Lectures, auditory exercises, independent work.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
Student’s participation during lectures	5	oral exam	30
practical exercises	65		

Study program: Master of Information Technology			
Course title: MULTIMEDIA DATA ANALYSIS			
Teacher (s): Vladimir Mladenović			
Course status: elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective The main objective of the course is that students acquire theoretical and practical knowledge in the field of analysis of multimedia data content including speech analysis, image and video material analysis and for the purpose of their application in security systems.			
Course learning outcomes Students will be introduced to the main characteristics of speech as a signal and techniques for speech analysis. He will also acquire knowledge in the field of image analysis including segmentation as a basis for classifying images, color classification and spectral parameters of images and video material.			
Course contents: <i>Lectures</i> Problems of analyzing unstructured data. Speech as a signal, its parameters and elements that can be used for classification. Estimation of stress level based on speech analysis. Image as a two-dimensional signal. Filter and transformation of an image as the basis of the analysis. Classification of images based on colors, objects, etc. Image quality assessment. Characteristics of video material and its analysis. Video material segmentation and tracking. Video quality assessment. Image and video material protection - Watermarking. Compressive sensing. Greedy algorithms. <i>Practice</i> Realization of basic algorithms for voice and image analysis in MATLAB, MATHEMATICA WOLFRAM and PYTHON environment. Projects in the field of analysis of speech, images and video materials.			
Literature 1. Ajay Divakaran, Multimedia Content Analysis: Theory and Applications, Спрингер, 2009. 2. Mark T. Maybury, Multimedia Information Extraction: Advances in Video, Audio, and Imagery Analysis for Search, Data Mining, Surveillance and Authoring, Wiley-IEEE Computer Society, 2012 3. Authors: Zhang, Yushu, Xiang, Yong, Zhang, Leo Yu, Secure Compressive Sensing in Multimedia Data, Cloud Computing and IoT Springer, ©2019 4. Achim Zielesny, From Curve Fitting to Machine Learning, An Illustrative Guide to Scientific Data Analysis and Computational Intelligence, Springer, 2016			
No. of active teaching hours		Lectures: 30	Practice: 30
Teaching methods Lectures: lectures and discussions using multimedial content; case studies. Exercises: practice using e-learning tools, project work; The researcher provides all the help students need.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
student’s participation during lectures		written exam	
practice		oral exam	40
colloquiums			
seminars	60		

Study program: Master of information technologies		
Course title: SOFTWARE QUALITY MANAGEMENT		
Teacher(s): Marija Blagojević		
Course status: Elective		
Number of ECTS: 6		
Prerequisites: enrolled in an adequate semester		
Course objective Introduction to models and characteristics of standardized requirements for the level of security and the level of software quality management		
Course learning outcomes Understanding and learning the procedures of the quality management of software products motivating students to use the examples of the current testing standards. In domain of practical lessons and software testing, the learning outcomes are related to: 1) explaining different components of usability testing; 2) explaining the procedure of test conducting, accepting and evaluating; 3) choosing adequate tools and techniques and providing good testing environment; 4) designing the "stress test" that will be focused on critical issues that may affect the system performance; 5) analyzing the results of the test acceptance to determine whether the product meets required criteria; 6) summing up and analyzing the data obtained from testing and providing recommendations for follow up activities.		
Course content <i>Theory</i> Topics: 1) Standardized terminology for software development and system documentation (quality control - QC, quality assurance - QA, total quality management - TQM), [1]*, [2] – concepts and vocabulary. 2) Model and concept of software quality (the examples of current and revoked standards, [3]), value and costs of quality assurance and quality management. 3) Ethics and culture of software engineering (SI), [4]. 4) Obligations imposed by the requirements of the standards for software development (examples from the processes of software and system life cycle), [5], [6], risk management [7]. 5) Model and characteristics of product quality (QP) – software product standardized in the field of SI: - Part 1: Quality model, [8]; - Part 2: External metrics, [9]; - Part 3: Internal metrics, [10]; - Part 4: Quality in the application of metrics, [11]. 6) Evaluation of the process for software quality standardized in the field of IT through several aspects, [5]: - Part 2: Conducting evaluation, [12]; - Part 3: Instructions for conducting evaluation, [13]; - Part 4: Instructions for implementing improvements of the process and determining the process capabilities, [14]; - Part 5: An example of the model of process evaluation [15]; - Part 6: An example of the model of the evaluation of the system's life cycle process, [16]; - Part 7: Evaluation of the organization's level of development, [17]. 7) Guidelines for documenting the application systems based on computers, [18]. 8) The process of preparing the software documentation for users, [19]*.		
<i>Practice</i> Topics: Requirements of the standards for software quality (influential factors, interdependence, software integrity levels). Error levels (error, fault, failure, mistake). Software quality management techniques (static, dynamic, people-oriented, analytical, testing). Evaluation of a software product (statistical, trend analysis and predictions). The application of CASE tools and the standards for software testing.		
Literature 1. ISS – Institut za standardizaciju Srbije (Institute for Standardization of Serbia): http://www.iss.rs/standard/advance_search.php 2. SRPS ISO/IEC 90003:2017 Softverski inženjering – Smernice za primenu ISO 9001:2008 na računarski softver (Software engineering – Guidelines for the application of ISO 9001:2008 to computer software) 3. Ž. Micić: IT u integrisanim sistemima, Odlukom Naučno-nastavnog veća Tehničkog fakulteta, broj VIII-1232/14 od 13. juna 2007, COBISS.SR-ID 146094860, ISBN 978-86-901809-6-7, Tehnički fakultet Čačak, 2008 (IT in integrated systems, Decision of the Scientific and academic council of the Technical Faculty no. VIII-1232/14 of June 13, 2007 COBISS.SR-ID 146094860, ISBN 978-86-901809-6-7, Technical Faculty in Čačak, 2008) 4. Ž. Micić and others: Razvoj znanja i standarda za kvalitet sofvera (Development of knowledge and standards for software quality), Scientific journal "Menadzment totalnim kvalitetom" ("Total quality management"), YU ISSN 0354-9771, No. 2, Vol. 27, p. 119-122, XXVI JUSK conference, Belgrade, October 12-15, 1999		
No. of active teaching hours	Lectures: 30	Practiceaba: 30
Teaching methods		

Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
Student's participation during lectures	10	written exam	20
practical exercises	20	oral exam	10
tests	20		
seminars	20		
Examination methods may vary, those given in the table are some of the options: (written exam, oral exam, project presentation, seminars, etc.			
* Given references refer to the additional literature from the stated web address of IIS –SRPS ISO/IEC standards (marked ***): [1]- ***2382-20:1997, [2]- ***15504-1:2011, [3]- SRPS ISO 9000-3:1993, [4]-***15288:2012, [5]***12207:2012, [6]- ***TR 15271:2007, [7]- ***16085:2010, [8]- ***9126-1:2011 + 25000, [9]- ***TR 9126-2:2010 + 25000, [10]- ***TR 91263:2010, [11]- ***TR 9126-4:2010, [12]- ***15504-2:2009, [13]- ***15504-3:2009, [14]- ***15504-4:2009, [15]- ***155045:2009, [16]- ***TR 15504-6:2009, [17]- ***TR 15504-7:2009, [18]- SRPS ISO 6592:1997, [19]- ***15910:2010			

Study program : Master of information technologies
Course title: DATAFLOW COMPUTERS AND THEIR APPLICATION
Teacher (s): Filipović D. Nenad
Lecturer from industry: Milutinović M. Veljko
Course status: Elective
No. of ECTS: 6
Prerequisites: enrolled in an adequate semester
Course objective: The goal of the course is the introduction to contemporary architectures of DataFlow computers and acquiring of necessary knowledge of DataFlow computers for independent research, solution modelling and application of these computers. DataFlow computers can reach the acceleration 10 to 100 times faster compared to ControlFlow computers, even a larger acceleration is possible under certain conditions, while the consumption of electric energy is 10 times less and 10 times less physical volume allowing for a greater flexibility and precision in processing certain issues. In addition, the goal of this course is to teach students to use creative techniques in this domain, as well as the techniques necessary for the management of complex projects in the field covered by this course.
Course learning outcomes: Students are expected to develop skills to understand and independently design contemporary systems based on DataFlow computers using program models that Intel announced for its chip processor to be brought on market by the end of 2020. In addition, students are expected to develop skills to program DataFlow computers at higher abstraction levels, as well as to compare various paradigms per parameters, such as speed, consumption of electric energy, the transistor count in a single chip and flexibility in the treatment of algorithms.
Course contents: <i>Lectures</i> The course analyzes the development of super computers (Feynman and Neumann paradigm), defines DataFlow SuperComputing paradigm, describes its advantages and introduces new DataFlow program model using Maxeler computer as an example. The course covers all the phases of the system development based on DataFlow paradigm: program compilation, operating system, methods for algorithm acceleration, methods for decreasing energy consumption, synergy with IoT и WSN, t.i with systolic fields and ASIC components. DataFlow computers are presented through a comparative analysis with ControlFlow computers. Particular attention is paid to contributions of 4 Nobel Prize winners (Feynman, Prigogine, Kahneman, Hunt), which can make the cumulation process much more effective under adequate conditions. In addition, the focus is placed on the issues related to efficacy and effectiveness in domain of research and development. <i>Practice</i> Practical exercises include the analysis of tools for the development of programs using DataFlow computers, before all by introducing students to MaxIDE program environment. During practical exercises students are introduced to a number of examples for the application of DataFlow computers in the following fields: algorithmic mathematics, image processing, engineering study, tensor account (which can be applied in genomics, financial analyses, simulations in natural sciences, security, etc.). The course includes 4 homework assignments (algorithmic mathematics, image processing, engineering study and tensor account). Study research includes an opportunity for the cooperation related to DataFlow book series published by Springer and Elsevier (on the list of SCI indexed publications), as well as a possibility of the participation in creative scientific research projects.
Literature 1. ELSEVIER: Stojanovic, S., Bojic, D., Bojovic, M., Valero, M., Milutinovic, V., "An overview of selected hybrid and reconfigurable architectures," Elsevier 2. ELSEVIER: Korolija, N., Popovic, J., Cvetanovic, M., and Bojovic, M., "Dataflow-Based Parallelization of Control-Flow Algorithms," Advances in Computers 3. ACM: Trobec, R. Vasiljevic, R., Tomasevic, M., Milutinovic, V., et al, "Interconnection Networks for PetaComputing," ACM Computing Surveys, November 2016. 4. ACM: Flynn, M., Mencer, O., Milutinovic, V., at al, "Moving from PetaFlops to PetaData," Communications of the ACM, May 2013. 5. IEEE: Milutinovic, V., "The HoneyComb Architecture," Proceedings of the IEEE, 1989.

6. IEEE: Milutinovic, V. et al, "Splitting Spatial and Temporal Localities for Entropy Minimization" Tutorial of the IEEE ISCA, 1995.
7. SPRINGER: Kotlar, M., Milutinovic, V., "The Tensor Calculus Operations for the Data Flow Paradigm," Springer, 2019
8. SPRINGER: Milutinovic, V., and Kotlar, M., editors, "Exploring DataFlow Paradigm," Springer 2019
9. SPRINGER: Milutinovic, V., Kotlar, M., et al, "DataFlow SuperComputing Essentials," Springer, 2017
10. SPRINGER: Milutinovic, V., et al, "Guide to DataFlow SuperComputing," Springer, 2015, 2016, 2017, 2018 (textbooks)
11. IET: Jovanovic, Z. and Milutinovic, V., "FPGA accelerator for floating-point matrix multiplication," IET Computers & Digital Techniques, Vol. 6, 2012 pp. 249-256.
12. ELSEVIER: Milutinovic, V., editor, Advances in Computers: "DataFlow," Elsevier, 2015, 2016, 2017, 2018, 2019, 2020 (SCI Book).

No. of active teaching hours:

Lectures: 30

Practice: 30

Teaching methods

Lectures, exercises, projects, demonstrations.

Examination (maximum number of points 100)

Exam prerequisites	points	Final exam	Points
Student's participation during lectures		written exam	20
practical exercises		oral exam	20
seminar(s)	60		

Study program : Master of Information Technologies		
Course title: CLOUD COMPUTING		
Teacher (s): Miloš Ivanović		
Lecturer from abroad: Zlatan Car		
Course status: Elective		
No. of ECTS: 6		
Prerequisites: enrolled in an adequate semester		
Course objective: The aim of the course is to provide detailed knowledge and understanding of cloud computing and all levels of service orientation (SaaS), provide knowledge of infrastructure, platforms, and applications in the form of services, learn about design patterns, architectural models and best practices.		
Course learning outcomes: Students will be able to develop infrastructure for the operation of public, hybrid and private types of infrastructure, to design and implement PaaS service architecture, design and implement PaaS applications, understand the specifics of architecture and infrastructure in Cloud. Students will be trained to develop SaaS applications on the most important PaaS / IaaS platforms.		
Course contents: <i>Lectures</i> Developing applications for the server side. Definition of cloud computing, purpose, role and significance, goals. Challenges: Infrastructure management, cloud application architecture, data storage, security, other aspects. Characteristics: elasticity and scalability, access in the sense of services, monitoring, resource sharing (association), etc. Service models: IaaS (Infrastructure-as-a-Service), PaaS (Platform-as-a-Service), SaaS (Software-as-a-Service). <i>Detailed overview of the IaaS:</i> • Overview of concepts, architectural perspectives • Private, public and hybrid type of service. • Introduction to and comparison of the most important IaaS technologies <i>Detailed overview of the PaaS:</i> • Overview of concepts, architectural perspectives • Changes in development models: data stability: distributed file system, unstructured storage, NoSQL database, SQL database in the cloud; Business level: Web services, REST services. • Understanding and comparison of the major PaaS technologies for Java EE: Azure, Google App Engine, etc.. <i>Detailed overview of the SaaS:</i> • Overview of concepts, architectural perspectives • Access models, concepts of development <i>Implementation models</i> • Private, public, hybrid cloud, management, SLA and QoS <i>Practice</i> • Installation, setup and configuration • Cloud applications development • Hybrid cloud configuration Getting to know the most important public clouds: Amazon, Google App Engine, Azure, OpenStack, etc.		
Literature 1. G. Reese, Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, O'Reilly Media, 2009. 2. M. Armbrust et al., Above the Clouds: A Berkeley View of Cloud Computing, UC Berkley, 2009 3. J. Varia, Cloud Architectures, Amazon Web Services White Paper.		
No. of active teaching hours:	Lectures: 30	Practice: 15+30
Teaching methods		

Lectures are performed using the "ex-cathedra" method for presenting teaching content. Problem-oriented and practical teaching.

A part of the auditory exercises is realized using the method of "ex-cathedra". The rest of the exercises are realized using the "case" method with interactive student participation and include practical work with the most important public clouds.

Examination (maximum number of points 100)

Exam prerequisites	70 points	Final exam	30 points
Student's participation during lectures		Oral exam	30
practical exercises	4		
projects			
Midterm exam (s)	23+23		
seminar(s)	20		

Note:

A server for virtualization of the following features is available for teaching on the subject: HP ProLiant DL360 Gen9, 2 x Intel(R) Xeon(R) CPU E5-2620 v4 @ 2.10GHz, 64 GB, 2TB

Study program : Master of Information Technologies			
Course title: COMPUTER SYSTEMS PROTECTION			
Teacher (s): Marjan D. Milošević			
Lecturer from industry: Srđan Atanasijević			
Course status: Elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective: Working with the basic concepts of computer system protection. Introducing students with new security threats and risks, as well as techniques for protecting computer systems on specific examples. Increasing the level of awareness about possible threats and attacks primarily in the Internet environment, as well as expanding knowledge on new tools for detecting vulnerabilities of existing systems, modeling threats and applying preventive protection. Getting acquainted with the current European Data Privacy Standards.			
Course learning outcomes: Students will be able to perform modeling of threats in modern information and communication systems, to apply specialized software for detecting and eliminating attacks, independently define perimeter protection methods, analyze malicious software, and implement security measures at different stages of software development.			
Course contents: <i>Lectures</i> Introduction to computer systems protection. Security threats and risks. Analysis of attacker methodology. Access control mechanisms. Threat modeling methodologies. Models of protection. Physical protection. Hardware protection. Cryptographic methods of protection. Digital signature and digital certificates. Computer networks protection. Application protection. Internet-stuff security. Malware Analysis. <i>Practice</i> Application of social engineering methods. Risk Management Methods. Phishing methods. Examples of virus and antivirus software and malware analysis software. Examples of cryptography application. Examples of digital signature applications and steganography. Authentication methods. Application of PKI. Application of firewalls, Pentesting.			
Literature 1. Д. Плескоњић, Н. Мачек, Б.Ђорђевоћ, М.Царић, Сигурност рачунарских система и мрежа, Микро књига. Београд, 2007. 2. J.Farshaw, Напади на мрежне протоколе, хакерски водич за хватање мрежног саобраћаја, анализу и искоришћавање рањивости мреже, Микрокњига, Београд, 2018 3. G. Najera-Gutierrez, J.A. Ansari, Kali Linux тестирање непробојности веба, треће издање, Компјутер библиотека, Чачак, 2018. 4. Authorized lectures available on the e-learning website (http://eucenje.ftn.kg.ac.rs)			
No. of active teaching hours:		Lectures: 30	Practice: 30
Teaching methods Methods of popular lectures, case studies, discussion, practical work, individual computer work, project work.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
Student’s participation during lectures	5	Written exam	30
practical exercises	5	Oral exam	20
Midterm exam(s)			
seminar(s)	40		
Evaluation of knowledge may be differ. The following table lists only some options: (written exams, oral exam, project presentation, seminars, etc.).			
* maximum length of 2 A4 pages			

Study program: Master of information technologies			
Course title: HUMAN COMPUTER INTERACTION			
Teacher(s): Djordje Damnjanović			
Teacher from the industry: Tatjana Atanasijević			
Course status: Elective			
ECTS No: 6			
Condition: Enrolled in an appropriate semester			
Aim of the course The subject examines the concept of human-computer interaction from both sides of the user interface, including human factors, performance analysis, learning processes, usability studies and interaction styles. The Course also addresses the process of user interface development with an emphasis on user-centered design and interface evaluation methodology.			
Course outcome By the end of the course, the student understands the importance of human factors, cognitive processes, environment and user training and successfully applies these concepts in the development, implementation and analysis the performances of user interface.			
Contents of the course <i>Theoretical lessons</i> Concepts of interaction and interface. Evolution of computer interfaces. Problems of interaction between humans and computers. Understanding the users: cognitive principles and cognitive ergonomics. Types and examples of user interfaces. Graphic user interfaces. Perceptual user interfaces. Attention-based user interfaces. Web-oriented user interfaces. Intelligent user interfaces and adaptation to user needs. Methodology of user interface development. The importance of good design and understanding user models. Task-oriented user modeling. Organization of graphical interface display. Menu and window systems. Feedback and user support. Usability concept. Evaluation of usability of user interfaces. Handwriting recognition. Computer vision. Comprehensive computing. Virtual reality. Software tools for user interface development. <i>Practical lessons</i> - Group analysis and discussion of individual topics, selected articles, and seminar papers. - Solving assigned tasks and problems, both independently and under the teacher supervision.			
Literature 1. Ж. Обреновић, Интеракција човека и рачунара, Факултет организанионих наука, Београд, 2004. 2. J. Shnajderman, C. Plaisant, Dizajniranje korisničkog interfejsa, CET, Beograd, 2005. 3. A. Sears, J.A. Jacko (Eds.), The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications, 3rd edition, CRC Press, 2012. 4. Дебевц, М, Милошевић, Д, Увод у интеракцију човек-рачунар, универзитетски уџбеник, Технички факултет Чачак, ISBN 978-86-7776-111-0, 2010.			
Number of active classes		Theoretical lessons: 30	Practical lessons: 30
Teaching performance methods A combination of classical teaching methods with the use of an e-learning tools, with the specified literature; Homework and project assignments with the use of the tools above.			
Knowledge assessment (maximum number of points 100)			
Pre-exam obligations	70 points	Final exam	30 points
Student’s participation during lectures	10	Written exam	
practical exercises	30	Oral exam	30
midterm(s)	30		
seminar(s)			

Study program : Master of information technologies			
Course title: VIRTUAL REALITY SYSTEMS			
Teacher(s): Filipovic D. Nenad, Isailovic M. Velibor			
Course status: Elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective: Training students to design and implement a virtual/augmentative reality system.			
Course learning outcomes: Upon completion of the course, students will be able to use acquired knowledge and skills to develop a virtual/augmentative reality system with practical experience with a variety of VR (virtual reality) devices.			
Course contents: <i>Lectures</i> Milgram's real-virtual continuum and metrics of virtuality/augmentativity. VR system elements, VR devices - immersive and nonimmersive classes, 3D audio, 3D video and tactile devices, tracking techniques of body, head, limb and eye, VR / AR interactivity, VR programming techniques on examples (for example, using OpenGL). Examples of VR systems, augmentative reality systems, basic AR architecture systems, AR systems examples. <i>Practices</i> Exercises are performed in a computer classroom. On the exercises, using a programmatic (eg using OpenGL) or modern authoring system students develop simple VR/AR scenes with non/semi/immersive devices. Creating a project with a practical and concrete problem.			
Literature 1. R. Szeliski: Computer Vision: Algorithms and Applications, Springer, 2010. (ISBN 978-1848829343) 2. E.R. Davis: Computer and Machine Vision: Theory, Algorithms, Practicalities, Academic Press, 2012. (ISBN 978-0123869081)			
No. of active teaching hours		Lectures: 30	Practices: 30
Teaching methods Lectures, auditory exercises and independent work of students.			
Examination (maximum number of points 100)			
Exam prerequisites	Points	Final exam	Points
Student’s participation during lectures	5	Oral exam	30
Practical exercises	15		
Projects	50		

Study program: Master of information technologies			
Course title: USER INTERFACE DESIGN			
Teacher (s): Ana M. Kaplarević-Mališić			
Lecturer from industry: Tatjana Atanasijević			
Course status: Elective			
No. of ECTS: 6			
Prerequisites: enrolled in an adequate semester			
Course objective: The course introduces the concepts of interaction between a man and a computer and design of user interface, as well as the assessment methods and techniques that can be used during the whole life cycle of computer interactive systems. It explains the principle and processes for documenting and implementing different development phases, including requests analysis, users needs analysis, information architecture, development of prototypes, modeling and production.			
Course learning outcomes: At the end of the course, students are expected to understand the significance of human factor, cognitive processes, context analysis, users' needs and demands, their transformation into specifications and prototypes, and to successfully implement them during the development, implementation and analysis of user interface performances.			
Course contents: <i>Lectures</i> Concepts of user interface design in the product life cycle. Standards, principles, most influential factors. Concepts of interaction and interface. Understanding and conceptualization of interaction design. Cognitive aspects, social interaction, emotional interaction. Interfaces – command, graphic, multimedia, virtual reality, web, mobile telephones, electronics and appliances, speech, touch, movement, gestures, haptics, augmented reality. Methodology and activities of user interface design. Information architecture. Interaction design. Scalability engineering. The visual design of the user interface. Engineering of prototype design. Methodology and process of user interface design in agile software development. The phase of empathy/scalability research – definition of demands and validation of problems. The phase of definition / information architecture – problem examination. The phase of interactive design (Idea-Prototype-Test) / interaction design, prototyping and visual design – solution specification. The phase of programing and releasing into production process / engineering of user interface – solution validation. The phase of valuation / analysis of scalability – solution scalability. <i>Practice</i> - Group analysis and discussion about certain topics, selected articles and seminars. - Solving assigned tasks and problems, both independently and under the supervision of teachers.			
Literature 1. R. Hartson, P. S. Pyla, <i>The UX Book: Process and guidelines for ensuring a quality user experience</i> , Elsevier (2012) 2. B. Shneiderman, C. Plaisant, M. Cohen, S. Jacobs, N. Elmqvist, N. Diakopoulos, <i>Designing the user interface: strategies for effective human-computer interaction</i> , Pearson (2016) 3. B. Shneiderman, C. Plaisant, M. Cohen, S. Jacobs, N. Elmqvist, N. Diakopoulos, <i>Designing the user interface: strategies for effective human-computer interaction</i> , Pearson (2016) 4. J. Gothelf, <i>Lean UX: Applying lean principles to improve user experience</i> , O'Reilly Media, Inc. (2013) 5. R. Unger, C. Chandler, <i>A Project Guide to UX Design: For user experience designers in the field or in the making</i> , New Riders (2012)			
No. of active teaching hours:	Lectures: 30	Practice: 30	
Teaching methods Problem-oriented lectures, practice, independent work of students, consultations.			
Examination (maximum number of points 100)			
Exam prerequisites	70 points	Final exam	30 points
Student's participation during lectures	10	oral exam	30
practical exercises			
project(s)	30		
mid-term(s)			
seminar(s)	30		

Study program: Master of information technologies			
Course title: INTERNSHIP			
Teacher (s):			
Course status: Mandatory			
No. of ECTS: 5			
Prerequisites: enrolled in an adequate semester			
Course objective: Introducing to students the terms and methods of work in business organizations and institutions dealing with computing and information technologies. Students need to learn about the global organization and functioning models of organizations, place and role of computer centers, tasks and their successful solving, as well as to take part in problem solving.			
Course learning outcomes: The students have the capacity to engage themselves efficiently and successfully in activities within the scope of work that hosting organizations perform, to improve the level of practical knowledge, to build capacities to handle new conditions and to improve their communication level.			
Course contents: <i>Within 45 working hours the students:</i> - will be introduced to: • Organization, tasks, and ways of an institution's functioning • Organization and ways of computer centers' functioning • Information flows, their creation and management • Hardware and software platform in use • Built information system, current tasks, and activities; - receive specific tasks they need to perform on their own.			
Literature			
No. of active teaching hours	Lectures: 0	Practice: 0	
Teaching methods The internship is realized in the business, scientific and educational institutions, through individual work. A mentor from hosting organization staff is assigned to each student. Studying the process and activities through insight to documentation and practical work on certain tasks. At the end of the internship period, a mentor from the hosting organization assesses the internship which is one of the elements of the total internship assessment. After the internship, students submit the seminar on their tasks and activities and give a presentation about them.			
Examination (maximum number of points 100)			
Exam prerequisites	60 points	Final exam	40 points
Student's participation during lectures		oral exam	40
practical exercises			
projects			
seminar(s)	60		

Study program: Master of information technologies			
Course title: STUDY RESEARCH WORK			
Teacher (s): All teachers of the study programme			
Course status: Obligatory			
No. of ECTS: 10			
Prerequisites: enrolled in an final semester of basic academic studies			
Course objective: To introduce students to the rules, procedures and processes of independent and comprehensive research work, as well as writing professional / scientific texts.			
Course learning outcomes: The student is trained in the application of principles and theoretical basics, practical knowledge acquired during the studies, and for the use of both written literature and content that can be found on the Internet, thus being able to independently improve their knowledge.			
Course contents: <i>Study Research</i> The content of the course is determined by the mentor for each candidate separately, and is made by the candidate's independent work on the topic he has selected from the list of available topics for the Final Paper. This work is continuously monitored by the mentor. The student should also research, for the preparation of the Final Paper, the basic results of the narrow areas on which the Final Paper is based. The student should master the style of writing and be able to use literature independently, including the reviewed texts (scientific works and books).			
Literature Literature is determined by the mentor, depending on the subject of the Final Paper.			
No. of active teaching hours:		Lectures:: 0	Practice: 10
Teaching methods The mentor introduces a student with the subject of the Final Paper and recommends the literature. The student works independently in consultation with the mentor. If necessary, the student can also consult with other teachers, who deal with issues related to the topic of work itself.			
Examination (maximum number of points 100)			
Exam prerequisites	70 points	Final exam	30 points
student's participation during lectures		oral exam	30
practical exercises	70		

Study program : Master of information technologies			
Course title: FINAL WORK			
Teacher(s): All teachers from the study program			
Course status: Obligatory			
No. of ECTS: 15			
Prerequisites: Passed all exams from graduate academic studies			
Course objective: The goal of the final work is to demonstrate the ability of the student to independently process a topic in the field of informatics. The student also needs to demonstrate that he can use available software and literature (including literature from the Internet), to accurately and precisely write the work, to know how to quote the literature, and clearly explain his work.			
Course learning outcomes: The student showed his independence in processing the subject and precision in preparation of the text. The student also showed that he can make an electronic presentation of his work, that he can orally present the most important parts of his work in a good way, and that he can respect the given time.			
Course contents: Final work - thesis represents the student’s independent work made in a written form, with instructions and consultations with the subject teacher. The student chooses the topic for the preparation of the thesis in the field of scientific-professional and professional-applicative subjects.			
Literature: Depending on the selected topic.			
No. of active teaching hours		Lectures:	Practices:
Teaching methods The student submits at least three copies of completed work to the subject teacher and one copy to the Faculty library. The student also delivers his work to the Faculty library in an electronic form. The Commission for Defense of Final Work is formed by the Council of the Institute of Mathematics and Informatics at the proposal of the subject teacher. The date and time of the public defense of work is published on the bulletin board of the Faculty at least five working days before the scheduled date of the defense, and the candidate's assessment of this exam is communicated to the candidate immediately after the completed defense, with an appropriate explanation.			
Examination (maximum number of points 100)			
Exam prerequisites	Points	Final exam	Points
Student’s participation during lectures		Oral exam	
Practical exercises			
Projects			