ALFA BK UNIVERSITY

Faculty of Mathematics and Computer Sciences
(ALFABK-FMCS)

STUDY PROGRAMME

Computer Science

UNDERGRADUATE ACADEMIC STUDIES

Course:	**Mathematical analysis 1**
Course id: 19.OR001	
Number of ECTS: 6	
Teacher:	**Danijela Karaklić; Zorica Savanović**
Course status:	Mandatory

Precondition courses: None

Educational goal

Getting to know and mastering the basic concepts from the differential and integral calculus of functions of one real variable.

Educational outcomes (acquired knowledge):

Upon completion of the course, the student has a basic knowledge of the functions of one real variable and the differential and integral calculus. He is able to follow courses in professional fields in which the concepts and techniques he has mastered are applied and to identify problems to which he can apply the acquired knowledge.

Course content/structure

Theoretical classes: Arrays. Convergence criteria. The notion of a real function of one variable. Limit value of the function. Continuity of function. Properties of functions continuous on a segment. The first derivative of the function. Differential function and application. Higher order differentials. Basic theorems of differential calculus. Taylor's formula. The notion of extremum. Necessary and sufficient conditions for the extreme.

Convexity of curve and bend point. Curve asymptotes. A definite integral. Indefinite integral. Relationship of definite and indefinite integral. Shift and partial integration methods. Integration of rational and some classes of irrational functions. Integral calculus applications. Uncharacteristic integrals. Numeric rows. Degree rows.

Practical teaching: Tasks from the stated theoretical areas.

Literature

1. D. Adnađević, Z. Kadelburg: Mathematical Analysis 1, Faculty of Mathematics, Belgrade 2008.
2. S. Dajović: Mathematics 1 and 2, FON, Belgrade 2007.
3. Đ. Jovanov, R. Lazović, D. Đorić: Mathematics 1, Collection of tasks, FON, Belgrade 2007.
4. R. Stankovic, N. Deretic, M. Nikolcevic: Mathematics - basics of theory with examples. Blace: Business School of Vocational Studies, 2013.
5. R. Stanković, N. Deretić: Practicum in mathematics, Belgrade Business School, Belgrade 2008.

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods.

Frontal, group

Knowledge evaluation (maximum 100 points)

Pre-examination obligations: Colloquium exam: 50 Lecture attendance: 5 Exercise attendance: 5	Final exam:40

Course:	**Mathematical logic and algebra**
Course id. 19.OC0001	
Number of ECTS: 6	
Teacher:	**Ivan Pavkov**
Course status:	**Mandatory**

Precondition courses: None

Educational goal

Acquisition of general and professional knowledge in mathematical logic and algebra.

Educational outcomes (acquired knowledge):

Upon completion of the course, the student has basic knowledge of mathematical logic and algebra and is able to attend courses in professional fields in which those concepts and techniques are applied and to identify problems to acquired knowledge can be applied.

Course content/structure

The notion of a set and basic operations with sets. Powerset. Cartesian product. The notion of relation. Equivalence relations. Order relations. A set of natural numbers. Mathematical induction. The concept of function. Injection, sirjection and bijection. Basic set identities. Countability (countability of a set of integers, set of rational numbers) and uncountableness (uncountableness of a set of real numbers). Cantor-Bernstein theorem. The axiom of choice and its equivalents.

Proposition calculus. The notion of sentence. Basic operations of propositional logic. Propositional formulas. Propositional algebra. Normal forms - CNF, DNF. Valuation of propositional logic. Tautology. Proving set identities using tautologies.

First-order predicate calculus. First order language. Terms and formulas. Free and bounded variables. Value of terms and formulas. Valid formulas, examples and methods of prooving (board method, scolemization, resolution method etc.).

The concept of algebraic structure. Basic algebraic structures. Homomorphisms; subalgebras and generating sets; direct products. Congruences. Semigroup, group, ring, field. Degree of an element in a group, Lagrangian theorem, order of an element. Cyclic groups. Euler group and Euler theorem. Isomorphism theorem for groups and applications.
Polynomials over finite and infinite fields.

Literature

1. Vojvodić, G. (1992). *Algebra,* Novi sad: Institute of Mathematics, Faculty of Science
2. Vojvodić, G. (1998). *Lectures in mathematical logic and algebra*: University in Novi Sad
3. Prešić S. (1983), *Elements of Mathematical Logic,* Institute for Textbooks and Teaching Aids, Belgrade
4. Mijailović Ž., Petrović Ž. (2007), *Mathematical Logic,* Faculty of Mathematics, Belgrade.
5. Kalajdžić G. (1998), *Algebra*, Faculty of Mathematics, Belgrade
6. Mijailović Ž. (1998), *Algebra*, Milgor, Belgrade
7. Božović N., Mijailović Ž. (1990), *Introduction to group theory*, Scientific book, Belgrade
8. Perić V. (1980), *Algebra*, Svjetlost, Sarajevo

Number of active teaching classes (weekly)	Lectures: 2	Practical classes: 2

Teaching methods

Classes are conducted frontally in a group

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 50 Activity: 10 Lecture attendance: Exercise attendance:	Written exam: 20 Oral exam: 20

Course:	**Introduction to Computer Science**
Course id.	
Number of ECTS: 6	
Teacher:	**Boban Vesin**
Course status:	**Mandatory**

Precondition courses: None

Educational goal

Preparing students to:
- Adopt basic concepts of computer technology such as: bit, byte, register, memory, multiplexer, software, hardware, coding, switching function, combinational and sequential logic, data buses, addresses and control signals, central processing unit and computer systems architecture;
- They study the laws of Boolean algebra and Demorgan's rules, specifics of arithmetic operations in the binary system, ways of realization and optimization of switching functions;
- Learn to solve practical problems in the implementation and optimization of switching functions, and understand the architecture of computer systems

Educational outcomes (acquired knowledge):

It is expected that students after passing the exam can:
- Analyse, optimize and implement switching functions;
- Uses basic logical functions for realization of complex logical and arithmetic functions;
- Uses standard logic for the realization of computer system components
- Compare the obtained realizations with standard solutions;
- Describe the basic components of computer systems;
- Distinguish details and analyse the basic architectures of computer systems.

Course content/structure

Theoretical classes

Introduction. Number systems. Number system conversion. Numbers with a moving decimal point. Codes in computer systems. Basic arithmetic operations in binary number system. Incomplete complement. Complete complement. Boolean and switching algebra. De Morgan's theorem. Basic logical operations. Combinational logic. Minimization of switching functions. Realization of arithmetic functions. Semi-adder and complete adder. Sequential logic. Memories. Computer systems architecture. Central processing unit, CPU. Microprocessor and microcontroller architecture. Coupling of microprocessors with computer system components.

Practical classes, Exercises

Electronics Workbeanch: a tool for realizing switching functions. Realization of DeMorgan's patterns and rules. Realization of minimized logic functions by logic circuits. Realization of minimization obtained by Carnoux maps: product sum or product sum. Realization of a 7-segment decoder for a decimal counter. Basic serial and parallel port signals.

Literature

1. Lazić, B., Osnovi računarske tehnike, Akademska misao, Beograd, 2006.
2. Maxfield, C., An unconventional guide to electronics fundam., compon., and processes, Elsevier, 2003.

Number of active teaching classes (weekly)	Lectures: 2	Practical classes: 2

Teaching methods

Classes are conducted frontally in a group, experimental

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 40	Written exam:
Activity: 10	Oral exam: 30
Lecture attendance:	
Exercise, laboratory: 20	

Course:	**Sociology**
Course id.	
Number of ECTS: 6	
Teacher:	**Aleksandar B. Prnjat**
Course status:	Mandatory, first year, first semester

Precondition courses: None

Educational goal

Introduction to the theoretical and methodological assumptions of the study of society. Analysis of key sociological theories. Analysis of social grouping and forms of social sacredness. Analysis of contemporary social conflicts.

Educational outcomes (acquired knowledge):

Acquiring basic knowledge about society, social phenomena and processes.

Course content/structure:

Theoretical classes:

Subject and scientific method of sociology as a science. Society and the individual. Social structure. Social dynamics and social change. Social interaction and everyday life. Social grouping. Biosocial social groups. Pre-ethnic and ethnic global groups. Social stratification. Modern organizations. Work and economic life. Political grouping. Forms of social consciousness.

Practical classes:

Exercises, Other forms of teaching, Study research work. Getting to know modern forms of social conflicts.

Literature

- Gidens, E. (2003). „Sociologija“, Ekonomski fakultet, Beograd

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods

Lectures, exercises, seminar papers, colloquia and discussions.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 25 Activity: 15 Lecture attendance: Practical work: 15 Seminar paper: 15	Written exam: Oral exam: 30

Course:	**English language 1**
Course id.	
Number of ECTS: 5	
Teacher:	**Aferdita Crnisanin**
Course status:	**Compulsory, first year, first semester**

Precondition courses: None

Educational goal

Introduction to the basic areas of business English. Systematic building of adequate vocabulary and completion of knowledge of grammar basics with even practice of basic skills (reading, writing, listening & speaking). Enabling students to use professional literature in English, for proper communication in all basic areas of English business language

Educational outcomes (acquired knowledge):

Students are able to use spoken and written English in simpler, everyday situations.

Course content/structure

Theoretical classes

Course content English 1 is English for academic and professional purposes in the field of informatics. Knowledge of general English at the intermediate level is assumed and professional English is processed. The main goals of teaching are methodical processing of modern professional texts and the adoption and expansion of knowledge about IT terminology, introducing students to the specific structures of the language of science and technology, as well as the systematization of relevant grammar. The most common skills are reading, understanding original English, speaking, and translating. At the end of the course, students should be able to present / understand basic topics related to their profession.

Practical classes: Exercises, Other forms of teaching, Study research work

Use of article, noun, adjectives, pronouns, auxiliary verbs (be, do, have), modal verbs. Use and construction of verb tenses (Present Simple, Present Continuous, Present Perfect, Past Simple, Future forms). Questionable and negative sentence form. Vocabulary related to everyday topics: dating, family, free time, work, food and drink, naming and description of everyday objects, description of people and places and the like.

Literature

- (2004): Oxford Oxford Dictionary of Business Oxford, University Press
- Mitic, G. (2005): "Reading Texts, Short English Grammar Book," FON, Belgrade
- Prnjat, Z. & Petkovic, V .. (2006): "English Language 1", FTB University "BK", Belgrade
- Murphy, R. (2007): “English Grammar in Use”. Third Edition. CUP
- "Business English Reader 1" (collection of professional texts adapted to the curriculum in electronic edition)
- monolingual and bilingual dictionaries

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods

Classes are realized with the help of modern technology and are supported by a series of practical examples with the aim that students master the subject as well as possible. Workshops for the exchange of ideas and knowledge through group discussion are also applied. Mentoring and team work are used in the preparation of seminar papers on the agreed topic.

Knowledge evaluation (maximum 100 points)

Pre-exam obligations	Points	final exam	*Points*
activity during the lecture	10	*written exam*	20
practical teaching	10	*oral exam*	20
colloquia	30		
seminars	10		

Course:	**Mathematical analysis 2**
Course id. 19.OI0003	
Number of ECTS: 6	
Teacher:	**Danijela Karaklić**
Course status:	**Mandatory, first year, second semester**

Precondition courses: Mathematical analysis 1

Educational goal

Introduction and mastering of basic concepts from differential and integral calculus of functions of several variables, differential equations and functions of complex variables.

Educational outcomes (acquired knowledge):

Upon completion of the course, the student has basic knowledge of differential and integral calculus of functions of several variables, differential equations and functions of complex variables. The student is able to follow courses in professional fields in which the concepts and techniques that the student has mastered are applied, and to recognize problems and to apply the acquired knowledge.

Course content/structure

Theoretical classes

The notion of a function of several variables. Limit value and continuity. Partial derivatives. Total differential. Differentiability. Elements of field theory. Differential in a given direction and gradient. Taylor's formula. Necessary and sufficient conditions for an unconditional extreme. Necessary and sufficient conditions for the conditional extremum.

Double and triple integral. Change of variables in double and triple integral.

The concept of differential equation (DE). First order DE solving methods. Linear DEs of the second order. Higher order linear DEs. DE systems. The notion of the first integral. Linear DE systems. Fundamental matrix. Matrix exponent. Stability. The term partial DE.

Functions of a complex variable. Cauchy-Riemann conditions. Analytical functions. Integral. Cauchy's theorem and Cauchy's formulas. Residue.

Laplace transform. Inverse Laplace transform. Application of Laplace transform.

The basic problem of the variational calculus. Euler's equation.

Practical classes

Tasks from the stated theoretical areas.

Literature

D. Adnađević, Z. Kadelburg: Matematička analiza 2, Matematički fakultet, Beograd 2008.

Perišić, D., Pilipović, S., Stojanović, M. (1997). Funkcije više promenljivih - diferencijalni i integralni račun. Novi Sad: Univerzitet u Novom Sadu, Prirodno-matematički fakultet

Nikolić-Despotović, D., Budinčević, M. (1998). Zbirka rešenih zadataka iz kompleksne analize. Novi Sad: Univerzitet u Novom Sadu, Prirodno-matematički fakultet

Čomić, I. (1990). Matematička analiza 1 - Diferencijalni račun funkcija više promenljivih i elementi diferencijalne geometrije. Beograd: Naučna knjiga

S. Dajović: Matematika 2, FON, Beograd 2007.

V. Vujčić, S. Dajović: Matematika 3, FON, Beograd 2006.

E. Pap, I. Štajner-Papuga, Analiza II za informatičare, Univerzitet u Novom Sadu, Prirodno-matematički fakultet, 2005

Number of active teaching classes (weekly)	Lectures: 2	Practical classes: 2

Teaching methods

Classes are conducted frontally in a group

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 50 Activity: 10 Lecture attendance: Exercise attendance:	Written exam: 20 Oral exam: 20

Course:	**Computer organization and architecture**
Course id.	
Number of ECTS: 6	
Teacher:	**Dejan V. Đukić, Goran S. Keković**
Course status:	Mandatory, first year, second semester

Precondition courses: Introduction to computer science

Educational goal

The aim of the course is to present the computer, and especially its process unit, as a technical system, to analyse its internal structure and to present the basic concepts of computer architecture, as well as to explain the concept of a set of commands and write software for modern computer systems. In addition, the aim of the course is to present the structure of modern computer systems, to give an introduction to the hierarchical organization of memory and to explain the concepts of cache and virtual memory, to explain the interrupt mechanism, its significance, use and writing software, to present communication mechanisms. with peripheral units, to introduce the basic concepts of parallel and flow execution of instructions, multiprocessor systems and computer communications.

Educational outcomes (acquired knowledge):

Upon successful completion of the course, the student will be able to:
- logically designs simple digital devices, and explains their work
- analyses the constituent components of computers and computer processors, evaluates their role and significance
- analyses protocols and time diagrams in inter-component communication
- analyses a set of computer processor commands and uses it to write simple programs.
- explain the operation of cache memory and virtual memory
- uses the program interrupt mechanism, analyses the capabilities of the processor from the point of view of interrupts and to write simple programs for processing interrupts
- analyses the mechanisms of communication of the processor with peripheral units
- describes the mechanisms of parallel and flow execution of commands, and presents the basic types of multiprocessor systems
- uses synchronization mechanisms in writing programs for communication and data transmission

Course content/structure:

Theoretical classes:

Introduction to digital systems, logic circuits, combinatorial and sequential logic. The concept of a virtual machine - levels. Computer structure. Processor architecture. A set of programmatically available registers. Instruction formats. Ways of addressing. A set of instructions. Transmission instructions. Arithmetic instructions. Logical instructions. Movement and rotation instructions. Jump instructions. Other instructions. Interruption mechanism. Sources of interruption. Interrupt processing and return from the interrupt routine. Interrupt priority and interrupt masking. Masking of all masking interruptions - interruption prohibition. Interruption nesting. Processor operation organization. Instruction flow diagram. Processor operations and synchronous operation. Processor structure and microoperation. Wired realization of the control unit. Firmware implementation of the control unit. Highway organization. Arbitration methods (centralized and distributed arbitration). Bus synchronization (asynchronous and synchronous control). Hierarchical organization. High performance system buses. Organization of inputs / outputs. Basic techniques. Controllers. in / and devices. Programmed in / i with readiness bit test. Programmed in / and using the interrupt mechanism. Direct access controllers (DMA). I / O with a DMA controller. Memory transfer - memory. Peripheral controller with DMA access. Direct peripheral control. Output multiplexing. Control of seven-segment displays. Keyboard control. Connecting D / A and A / D controllers. Basic concepts of computer communications. Memory. Basic concepts and divisions. Overlap access to memory modules. Cache memory. Associative mapping. Direct mapping. Set of associative memory. Virtual memory.

Practical classes:

Computational exercises. Laboratory exercises. Demonstration exercises. Electronics, switches, simple processor model, practical experiments with standard logic circuits, simulation software. Design of individual components, work in machine language, work on assembler.

Literature

- Arhitektura i organizacija računarskih sistema, Negovan Stamenković, Besjeda 2019. ISBN 978-

99938-1-380-4
- Arhitektura računara–ekukacioni računarski sismeti, priručnik za simulaciju sa zadacima, Đorđević J, Nikolić V, Radivojević Z, akademske misli, Beograd 2004. godine.
- Tomašević V., Osnovi arhitekture i organizacije računara, Univerzitet Singidunum, 2019, p. 243.
- Hennessy J., Patterson D., Computer Architecture: A Quantitative Approach 6th Edition, Elsevier, 2019, p.857.
- Đorđević J., Arhitektura računara: edukacioni računarski sistem, Akademska misao, 2018, p. 330.

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods

Lectures and exercises use frontal, group and laboratory-experimental teaching methods with the use of modern technology.

Knowledge evaluation (maximum 100 points)	
Pre-examination obligations: Colloquium exam (2): 60 (30+30) Activity: 10 Lecture attendance: Exercise attendance:	Final exam: 30

Course:	**Linear algebra**
Course id. 19.OC0004	
Number of ECTS: 6	

Teacher:	**Ivan Pavkov**
Course status:	**Mandatory**

Precondition courses: Mathematical logic and algebra

Educational goal

Acquisition of general and professional knowledge of linear algebra.

Educational outcomes (acquired knowledge):

Upon completion of the course, the student has basic knowledge of linear algebra and is able to attend courses in professional fields in which those concepts and techniques are applied. Moreover, students are capable to identify problems that can be solved using the acquired knowledge.

Course content/structure

Vectors of ordered n-tuples in real and complex space. Norm, distance and angle. Vector space. Vector subspace, intersection and sum of vector spaces. Linear independence of vectors. Linear envelope. Direct product of vector spaces. Linear mappings. Base and dimension of vector space. Coordinates.

Matrices. Matrix operations. Types of matrices. Matrices of linear mapping. Equivalent and similar matrices. Rank of a matrix. Determinant, definition and properties. Bine-Cauchy's theorem. Calculation of the determinant. Inverse matrix.

Systems of linear equations. A set of solutions and its structure. Gaussian procedure. Kronecker-Capelli theorem. Kramer's theorem.

Eigenvalues and eigenvectors. Polynomials of matrices and linear operators, minimal and characteristic polynomials. Cayley-Hamilton theorem. Bilinear and square forms. Matrices of triangular and diagonal type. Diagonalization. Classification of real symmetric forms. Jordan matrix.

Euclidean vector spaces. Scalar product, norm, distance, angle. Cauchy-Schwartz inequality. Orthogonality, orthonormal base. Gram-Schmidt procedure of orthogonalization, orthogonal projection, distance between vector subspaces. Orthogonal matrices. Mixed and vector product in Euclidean vector space. Orthogonal operators, canonical bases and matrices.

Literature

1. Kalajdžić G. (2007), Linear algebra, 5th edition, Faculty of Mathematics, Belgrade
2. Stojaković Z., Herceg D. (1992), *Linear algebra and analytical geometry,* Novi Sad: University of Novi Sad, Institute of Mathematics
3. Lipkovski A. (2007), *Linear algebra and analytical geometry*, 2nd edition, Institute for Textbooks and Teaching Aids, Belgrade.
4. Herceg D., Stojaković Z. (1989), *Numerical methods of linear algebra-book of exercises,* Belgrade: Construction book

Number of active teaching classes (weekly)	Lectures: 2	Practical classes: 2

Teaching methods

Classes are conducted frontally in a group

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 50 Activity: 10 Lecture attendance: Exercise attendance:	Written exam: 20 Oral exam: 20

Course:	**Fundamentals of programming**
Course id: 19.OI0002	
Number of ECTS: 6	
Teacher:	**Goran Keković, assistant Vladimir Mikić**
Course Status:	Mandatory, the first year, the first semester

Precondition courses: None

Educational goal

The course aims are to give a broad insight into the field of programming languages and learning about the process of software development with special emphasis on procedural programming languages, with the use of basic data structures and algorithms, basic search and sorting.

Educational outcomes (acquired knowledge)

The student is trained to apply top-down methods for designing algorithms. Also, the student is trained to create algorithmic solutions in the form of computer programs as well as to design, encode and test software solutions, including knowledge of techniques and methods for finding and correcting errors.

Course content/structure

Lectures

Introduction to the field of programming languages. Brief overview and comparison of basic program paradigms. Activities in the process of software development and maintenance. The concept of algorithm and its role in the problem-solving process. Basic concepts from low-level programming, machine-oriented languages. High-level procedural programming languages. Fundamentals of syntax and semantics of high-level programming languages. The concept of variable, data type, operator and expression. Basic primitive and structured types. Commands. Basic control structures. Pointing mechanism and dynamic memory allocation. Structural decomposition and modularization. Subroutines. Recursion. File concept. Input / output operations. Illustration of procedural programming concepts in a specific procedural language with parallel and comparative elaboration of alternative implementation of basic concepts in other procedural languages

Exercises

Students independently solve tasks on the computer, going step by step through all phases of program development, from the phase of analysis of the obtained task, selection of the appropriate algorithm, implementation of the selected algorithm, to program entry in the selected environment and appropriate program testing. The topics of the tasks are harmonized with the lectures and exercises from the subject.

Literature

1. L. Kraus, *Programming language C with solved tasks*, Akademska misao, Belgrade, 2008.
2. B. Keringhan, D. Ritche, *Programming Language C*, Contemporary Administration, Belgrade, 1989,
3. D. Urošević, *Algorithms in the programming language C* , Mikroknjiga, Belgrade, 2006.

Number of active teaching classes (weekly)				Other classes
Lectures: 2	Exercises: 3	Other forms of teaching	Study research	

Teaching methods

Classical teaching methods with the use of modern technology in lectures and exercises.

Knowledge evaluation (maximum 100 points)			
Pre obligations	points	**Final exam**	points
Lecture attendance	10	Oral part of the exam	30
Laboratory exercise attendance	20		
Colloquia	30		
Seminars	10		

Course:	**Algorithms and data structures 1**
Course id:	
Number of ECTS: 7	
Teacher:	**Kopanja S. Lazar**
Course Status:	mandatory, first year, second semester

Precondition courses: Mathematical logic and algebra

Educational goal

Acquiring basic knowledge of fundamental concepts of data structures and algorithms used in applications and programming.

Educational outcomes (acquired knowledge)

Ability to apply the acquired knowledge in solving problems, as well as the ability to identify, formulate and solve problems of practical importance.

Course content/structure

Theory classes

1. Introduction
2. Basic data types
3. Static and dynamic data structures
4. Arrays - types and operations
5. Representation of arrays in memory
6. Array optimizations
7. Lists- singly, doubly and circular linked lists - definition and operations
8. Queues - definition, implementation and basic operations
9. Stacks - definition, implementation and basic operations
10. Trees - definition, implementation and types of trees
11. Binary trees - definition, memory representation, basic operations
12. Definition of the algorithm
13. Presentation of algorithms
14. Sorting. Sorting methods
15. Searching algorithms. Sequential and binary search

Practical classes follow the content of the lecture

Literature

Tomašević Milo, Strukture podataka, Akademska misao, 2011.
Živković Miodrag, Algoritmi, Matematički fakulte Beograd , 2000.
Dejan Živković, Uvod u algoritme i strukture podataka, Univerzitet Singidunum, Beograd, 2010.

Number of active teaching classes (weekly)				Other classes
Lectures: 2	Exercises: 2	Other forms of teaching	Study research	

Teaching methods

Lectures, auditory exercises and laboratory exercises

Knowledge evaluation (maximum 100 points)

Pre obligations	points	**Final exam**	points
Lecture attendance	10	Oral part of the exam	20
Laboratory exercise attendance		Written exam	20
Colloquia	40		
Seminars			

Course:	**Introduction to Numerical Mathematics**
Course id: 19.OI0004	
Number of ECTS: 6	
Teacher:	**Miroslava Mihajlov Carević**
Course status:	Mandatory

Precondition courses: None

Educational goal

Acquisition of general and professional knowledge from numerical algorithms.

Educational outcomes (acquired knowledge):

Upon completion of the course, the student has basic knowledge of numerical algorithms. He is able to follow courses in professional fields in which the concepts and techniques he has mastered are applied and to identify problems to which he can apply the acquired knowledge. He is able to solve practical tasks from the exposed area using the Matlab software package. Can evaluate the reliability of the obtained results.

Course content/structure

Theoretical classes: Numerical mathematics, role in mathematical modelling. Sources and types of errors. Direct and iterative methods for solving systems of linear equations. Interpolation polynomials. Interpolation error. Numerical differentiation and integration. Numerical methods for solving systems of linear equations, finding the inverse matrix and determinant values. Methods for finding eigenvalues and eigenvectors of quadratic regular matrices. Methods for solving nonlinear equations and systems of nonlinear equations.

Methods for solving differential equations.

Application of the mentioned methods using the Matlab software package.

Practical classes: Tasks from the stated theoretical areas.

Literature

1) B. Jovanović, D. Radunović: Numerical Analysis, Faculty of Mathematics, Belgrade 2003.
2) D. Radunović: Numerical Methods, Academic Thought, 2004.
3) D. Radunović, A. Samardžić, F. Marić: Numerical methods - a collection of problems through C, Matlab and Fortran, Academic Thought, 2005.
4) D. Herceg, N. Krejic: Numerical analysis - a collection of tasks, University of Novi Sad, Novi Sad, 1998.

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods. Frontal, group

Knowledge evaluation (maximum 100 points)	
Pre-examination obligations: Colloquium exam: 50 Lecture attendance: 5 Exercise attendance: 5	**Final exam:40**

Course:	**Operation research**
Course id:	
Number of ECTS: 6	
Teacher:	**Marija Paunović, Danijela Karaklić**
Course status:	**Mandatory, second year, third semester**

Precondition courses: None

Educational goal

Adoption of methods of mathematical modelling of real problems and mastering methods for finding their optimal solutions.

Educational outcomes (acquired knowledge)

Upon completion of the course, students are trained to independently create a mathematical model of a real problem, as well as to solve it in terms of finding optimal solution with the use of appropriate software.

Course content/structure

Theoretical classes

Subject and goal of operational research. History.

Mathematical modelling of problems, methods of model formation. Simulation modelling.

Queues, inventory management.

Optimization and mathematical modelling.

Linear programming-graphic and simplex method. Transport problem.

Nonlinear programming. Dynamic programming.

Matrix games, upper and lower value of the game, saddle point. Determining the optimal strategy of the player, the concept of pure and mixed strategy.

Decision analysis, selection of the optimal decision by the max-min criterion of cost-effectiveness, the criterion of maximum probability and the Bayesian criterion.

Practical classes

Tasks from the stated theoretical areas.

Literature:

Petrić J., Šarenac L., Kojić Z., Operaciona istraživanja 1, Naučna knjiga, Beograd, 1992.
Petrić J., Šarenac L., Kojić Z., Operaciona istraživanja 2, Naučna knjiga, Beograd, 1992.
S. Krčevinac, M. Čengalović, V, Kovačević-Vujčić, M. Martić, M. Vujošević, Operaciona istraživanja 1, NEWPRESS, Smederevo, 2012.

Number of active teaching classes (weekly)	Lectures: 2	Practical classes: 2

Teaching methods

Classes are conducted frontally in a group

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 50 Activity: 10 Lecture attendance: Exercise attendance:	Written exam: 20 Oral exam: 20

Course:	**Introduction to object oriented programming**
Course id:	
Number of ECTS: 6	
Teacher:	**Goran Keković**
Course status:	**Mandatory, second year, third semester**

Precondition courses: Introduction to programming

Educational goal

The course continues with an Introduction to programming and expanding the topic by which it represents the whole. Introduction to the basic concepts and paradigms of object oriented programming: encapsulation, inheritance, polymorphism and generic programming in C ++ and Java.

Educational outcomes (acquired knowledge):

The student is able to independently write simpler programs in C ++ and Java, applying the basic concepts and paradigms of object - oriented programming. The student is prepared to follow other subjects that have elements of object-oriented programming in their content.

Course content/structure

Theoretical classes

Working with pointers in the programming language C. Pointer arithmetic. Pointers and functions. Pointers and fields. Dynamic memory reservation. Command line arguments. Structures. Definition. Structures and pointers.

Basic concepts and paradigms of object-oriented programming in C ++ and Java programming languages. Encapsulation: classes and objects. Construction of buildings. Class and object members. Operators and operator overlap. Simple data structures: arrays, matrices, single-linked lists, stack and row. Inheritance and polymorphism. Templates in the C ++ programming language. Generic classes in the Java programming language. Exception handling.

Practical classes

Students independently solve complex tasks on the computer, going step by step through all phases of program development, from the phase of analysis of the obtained task, selection of the appropriate algorithm, implementation of the selected algorithm, to program entry in the selected environment and appropriate program testing. The topics of the tasks are harmonized with the lectures and exercises from the subject.

Литература:

1. L. Kraus, Programski jezik C sa rešenim zadacima, Akademska misao, Beograd, 2008.
2. B. Keringhan, D. Ritche, Programski jezik C, Savremena administracija, Beograd, 1989,
3. D, Urošević, Algoritmi u programskom jeziku C“, Mikroknjiga, Beograd, 2006.
4. Brus Ekel, Mislite na Javi, prevod 4. izdanja, Mikro knjiga
5. Herbert Šilt, Java J2SE 5: Kompletan priručnik, Mikro knjiga, 2007.
6. Stenli B. Lipman, Osnove jezika C++, Cet, 2000.

Number of active teaching classes (weekly)	Lectures: 2	Practical classes: 2

Teaching methods

Lectures and exercises use frontal, group methods as well as laboratory-experimental teaching methods with the use of modern technology.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 30 Activity: 10 Practical classes: 20 Seminar paper: 10	Written exam: Oral exam: 30

Course:	**English language 2**
Course id.	
Number of ECTS: 5	
Teacher:	**Aferdita Crnisanin**
Course status:	**Compulsory, second year, third semester**

Precondition courses: English language 1

Educational goal

The aim of the course is to provide students with sufficient prior knowledge for independent work in the profession and for further training in a global context.

Educational outcomes (acquired knowledge):

Students are able to use spoken and written English in simpler, everyday situations.

Course content/structure

Theoretical classes

Course content English 2 is English for academic and professional purposes in the field of informatics. Knowledge of general English at the intermediate level is assumed and professional English is processed. The main goals of teaching are methodical processing of modern professional texts and the adoption and expansion of knowledge about IT terminology, introducing students to the specific structures of the language of science and technology, as well as the systematization of relevant grammar. The most common skills are reading, understanding original English, speaking, and translating. At the end of the course, students should be able to present / understand basic topics related to their profession.

Practical classes: Exercises, Other forms of teaching, Study research work
Analysis of texts from the processed areas.

Literature

• (2004): Oxford Oxford Dictionary of Business Oxford, University Press
• Mitic, G. (2005): "Reading Texts, Short English Grammar Book," FON, Belgrade
• Prnjat, Z. & Petkovic, V .. (2006): "English Language 1", FTB University "BK", Belgrade
• Murphy, R. (2007): “English Grammar in Use”. Third Edition. CUP
• "Business English Reader 1" (collection of professional texts adapted to the curriculum in electronic edition)
monolingual and bilingual dictionaries

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods

Classes are realized with the help of modern technology and are supported by a series of practical examples with the aim that students master the subject as well as possible. Workshops for the exchange of ideas and knowledge through group discussion are also applied. Mentoring and team work are used in the preparation of seminar papers on the agreed topic.

Knowledge evaluation (maximum 100 points)

Pre-exam obligations	Points	final exam	*Points*
activity during the lecture	10	*written exam*	20
practical teaching	10	*oral exam*	20
colloquia	30		
seminars	10		

Course:	**Psychology**
Course id.	
Number of ECTS: 7	
Teacher:	
Course status:	Elective

Precondition courses: None

Educational goal: Students should be introduced to basic psychological concepts in general psychology. Students should acquire knowledge about the origin, structure and nature of psychic life. Students should be introduced to the basic methodological principles and approaches of the psychological research. Enabling students to apply general psychological knowledge in direct professional practice.

Educational outcomes (acquired knowledge): Students are introduced to the basic psychological concepts of general psychology. Acquired knowledge about the origin, structure and nature of psychic life. Students are able to apply general psychological knowledge in direct professional practice.

Course content/structure

Lectures: Subject, tasks and branches of psychology; methods and techniques of psychological research; organic bases of psychic life; personality development factors; mental processes (cognitive, affective, conative) and psychological traits; individual personality: development, structure and types.

Practical classes: Application of certain methods and techniques; instructions for writing seminar papers; analysis of articles from scientific journals; analysis of exercise results; seminar paper writing; seminar paper defense.

Literature

Primary:

1. Rot, Nikola. Opšta psihologija, (11-26, 26-45, 55-62). Beograd: Zavod za udžbenike i nastavna sredstva, 2004.
2. Hrnjica, S. Opšta psihologija sa psihologijom ličnosti, (11-65, 130-150, 221-274, 277-323). Beograd: Naučna knjiga Nova, 2005.

Additional:

3. Hok, R. R. Četrdeset znanstvenih studija koje su promijenile psihologiju, (odabrana poglavlja). Naklada Slap, Jastrebarsko. 2004.

Number of active teaching classes	Lectures 2	Practical classes 3

Teaching methods: Academic speaking, problem solving presentation, research methods, workshop work in small groups, discussion on a previously given topic, asking questions after lectures or assigned reading. Consultations are performed individually.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	Final exam	Points
Lecture attendance	10	Written part of the exam	-
Practical classes	20	Oral part of the exam	30
Colloquium exam	40		
Seminar paper	-		

Course:	**Algorithms and data structures 2**
Course id.:	
Number of ECTS: 7	
Teacher:	**Kopanja S. Lazar**
Course Status:	**mandatory, second year, forth semester**

Precondition courses: Algorithms and data structures 1

Educational goal

Acquiring advanced knowledge of sophisticated concepts of data structures and algorithms used in applications and programming.

Educational outcome (acquired knowledge)

Ability to apply the acquired knowledge in solving complex problems, as well as application of algorithms in solving problems of practical importance.

Course content/structure

Theory classes

1. The basics of data structure, arrays, and rows, summary
2. Methods of solving complex algorithms
3. Algorithm complexity analysis
4. Backtracking, greedy algorithms, dynamic programming, geometric algorithms
5. Lists
6. Stacks and Queues with complex operations
7. Trees, specific examples and balanced trees
8. Graphs - definition, representation.
9. Graph search algorithms. Search of a directed graph.
10. Algorithms for determining reachability of a vertex within a graph.
11. Weighted graphs. Dijkstra, Floyd, Kruskal's and Prim's algorithm.

Practical classes follow the content of the lecture

Literature

1. Tomašević Milo, Strukture podataka, Akademska misao, 2011.
2. Živković Miodrag, Algoritmi, Matematički fakulte Beograd , 2000.
3. Dejan Živković, Uvod u algoritme i strukture podataka, Univerzitet Singidunum, Beograd, 2010.
4. Drozdek A., *Data Structures and Algorithms in C++*, 4th edition. Cengage Learning,Boston MA, 2012.,

Number of active teaching classes:				Other classes
Lectures: 3	Exercises: 2	Other forms of teaching	Study research	

Teaching methods

Lectures, auditory exercises and laboratory exercises.

Knowledge evaluation (maximum 100 points)

Pre obligations	points	**Final exam**	points
Lecture attendance	10	Oral part of the exam	20
Laboratory exercise attendance		Written exam	20
Colloquia	50		
Seminars			

Course:	**Object-Oriented Programming**
Course id.: 19.OI0013	
Number of ECTS: 5	
Teacher:	**Goran Keković, assistant Miloš Ilić**
Course Status:	**Mandatory, the second year, the fourth semester**

Precondition courses: no

Educational goal

Understanding and mastering the principles of object-oriented programming, such as abstraction, encapsulation, inheritance and polymorphism. Understanding the concepts of exceptions and templates, as well as the basic concepts of competitive and event-driven programming. Acquiring the skill of object-oriented programming in C ++. Using the standard template library (STL). Getting to know the Java language.

Educational outcomes (acquired knowledge)

Upon successful completion of the course, students will be able to:
- interpret and apply the paradigm of object-oriented programming;
- demonstrate the principles of object-oriented programming in C ++;
- solve practical problems in C ++;
- use the standard template library (STL).
- develops object-oriented multithreaded applications with a graphical user interface in Java.

Course content/structure

Lectures

An overview of OO programming concepts in C ++. Classes and objects. Constructors and destructors. Static members. Friends. Nested and local classes. Operator overlap. Derivation and inheritance. Polymorphism and dynamic binding. Abstract classes. Multiple inheritance. Exceptions. Template functions and classes. Standard Template Library (STL). Input and output flows. An overview of Java programming concepts.

Exercises

Auditory practises, laboratory demonstration and laboratory control exercises. Home works.

Literature

1. L. Kraus, *Programming language C ++ with solved tasks*, Akademska misao, Belgrade, 2011.
2. D. Milicev, Lj. Лазаревић,.. Marušić, *Object Oriented Programming in C ++*, Script with Practicum, Mikro knjiga, Belgrade, 2001.
3. M. Stanković, *Programming Languages*, Faculty of Electronics in Niš, Edition: basic textbooks, 2000.
4. Martin Fowler, Kendall Scott: *UML Distilled: A Brief Guide to the Standard Object Modeling Language*, Second Edition. August 1999. Addison-Wesley Professional, ISBN: 020165783X
5. Kraus, L., *Solved problems in the Java programming language*, 3rd edition, Academic Thought, Belgrade, 2012,

Number of active teaching classes (weekly): 4				Other classes
Lectures: 2	Exercises: 2	Other forms of teaching	Study research	

Teaching methods

Classical teaching methods with the use of modern technology in lectures and exercises.

Knowledge evaluation (maximum 100 points)

Pre obligations	points	**Final exam**	points
Exercise attendance	20	Oral part of the exam	30
Lecture attendance	10		
Colloquia	30		
Seminars	10		

Course:	**Signals and systems**
Course id.	
Number of ECTS: 8	
Teacher:	Dejan V. Đukić
Course status:	Elective, second year, fourth semester

Precondition courses: None

Educational goal

Introduction to the basics of systems theory, using a general systems approach, including modeling methods and computer simulation algorithms in the state space of (non) linear discrete and continuous dynamical systems with distributed and concentrated parameters.

Educational outcomes (acquired knowledge):

Ability to apply methodology and system analysis of business processes.

Course content/structure:

Theoretical classes:

Classification and basic properties of signals and systems. Concept of general system theory, system state vector, input and output vectors. Discretization of analog signals and models of the selection process. Fourier, Laplace and z-transform. Connection of transformation relations of analog and discrete signals. Methods and algorithms of mathematical modeling. Time and frequency analysis of the system. System management and estimation conditions. System stability, polynomial and frequency criteria. Computer simulation, system responses to typical input signals, multivariable analysis in state space. Analog-to-digital and digital-to-analog signal conversion. Software solutions.

Practical classes:

Exercises, Other forms of teaching, Study research work. Team work in solving tasks from individual thematic units, introduction to the optimization of linear continuous and discrete control systems.

Literature

- Petrović T., Rakić A., (2006): Signali i sistemi, Deksin, Beograd
- Padulo L., Arbib M.A., (1974): System Theory, A Unified State-Space Approach to Discrete and Continuous Systems, Philadelphia, Saunders.

Number of active teaching classes	Lectures: 3	Practical classes: 3

Teaching methods

In addition to lectures and computational exercises, in the classroom, using the formed simulation models of various physical processes, the time and frequency characteristics of the analysed system and signal are considered.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 30 Activity: 10 Lecture attendance: Practical work: 20:	Written exam: 40 Oral exam:

Course: **Course id: 19.OI0021** **Number of ECTS: 8**	**Multimedia systems**
Teacher:	**Nenad Gligorić**
Course status:	Elective

Precondition courses: None

Educational goal is to provide knowledge about principles, technology, devices, that are being used in development of multimedia projects. The goal is to familiarize with processes and software for processing and compression of multimedia signal. Implementation of standards for data transmission and multimedia signal.

Educational outcomes (acquired knowledge):
The students completing the Multimedia system design course will be capable to use software for signal processing, development of multimedia content in form of web pages, DVD, video tutorials and understanding communication techniques that are being used for transmission and distribution of the multimedia signal.

Course content/structure
Theoretical lectures
Introduction to multimedia. Multimedia hardware technologies. Platforms. Interfaces. Devices for memory and storage. Input devices. Output devices. Architecture of multimedia systems. Multimedia devices for processing of video and audio signals. Format of text, graphic, sound, and motion picture.
Communication in multimedia technology. Multimedia software and tools. Use of tools: Adobe Photoshop, Adobe Premier, Adobe After Effects. Synchronization of image and sound. Methods for processing and compression of multimedia signals. JPEG compression. H261, H263, H264, MPEG1, MPEG2 and MPEG4 standards. Distribution of multimedia signal. Transmission of multimedia signal over the Internet. Projection of multimedia systems.

Laboratory exercises
- Input of audio/video material in different formats to computer.
- Sound software. Sound recording, environmental sound. Sound editing.
- Work with image processing software
- Image editing.
- Correction of recorded video material and application of special effects.
- Unifying software for sound and picture.
- Combination of motion graphic video live audio/ video material.
- Combination of live image with 3D.
- Development of multimedia interactive projects.

Literature
1. Ze-Nian Li, Mark Drew, Jiangchuan Liu, *Fundamentals of Multimedia*, Prentice-Hall, 2014.
2. R. M. Perea, *Internet Multimedia Communications Using SIP*, Elsevier, Inc., 2008.
3. M. Petrović, I. Petrović, Priručnik za laboratorijske vežbe, Viser, Beograd, 2010.

Number of active teaching classes	Lectures: 3	Practical classes: 3

Teaching methods
Lectures and laboratory practice are based on frontal, group methods, as well as using laboratory-experimental methods facilitating information communication technologies.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	**Final exam: 30**
Activity:10; Exercise attendance: 20; Colloquium exam: 30; Seminary: 10	

Course:	**Computer modeling of the system**
Course id.	
Number of ECTS: 8	
Teacher:	Boban D. Vesin
Course status:	Elective, second year, fourth semester

Precondition courses: None

Educational goal

Education of students in modelling and analysis of systems using computer resources.

Educational outcomes (acquired knowledge):

At the end of the course, the student is able to independently model and analyse systems of diverse physical characteristics using computers.

Course content/structure:

Theoretical classes:

Brief introduction to Matlab and analysis of basic signal and system properties. Data structures, variables, operators and basic functions, vectors and matrices. Graphical representation of discrete and analog signals. Matlab programs - scripts. Time signal transformations. Basic system features. Basics Matlab - Simulink. Connecting S with Simulink.

Practical classes:

Exercises, Other forms of teaching, Study research work. The exercises are a group analysis and discussion of individual topics in the modelling of heterogeneous physical processes. Permanent solution of assigned tasks and problems, independently, and under the supervision of teachers.

Literature

- Petrović T., Rakić A., Signali i sistemi, Deksin, 2005.
- Arnos G., MATLAB, An introduction with applications, John Wiley, 2004.
- Stephen L., Dynamical systems with applications using MATLAB, Birkhauser, 2004.

Number of active teaching classes	Lectures: 3	Practical classes: 3

Teaching methods

The lectures present the theoretical part of the material, followed by examples that illustrate the application of theory to solving problems. Exercises include assignments from lecture materials. Parts of the material that can be combined into logical wholes can be taken during the semester through the colloquium.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 25 Activity: 10 Seminar paper: 15 Practical work:: 20	Written exam: Oral exam: 30

Course:	**Pedagogy**
Course id.	
Number of ECTS: 8	
Teacher:	**Gordana P. Budimir-Ninković**
Course status:	Mandatory

Precondition courses: None

Educational goal: The aim of the course is that students master the basics of pedagogical science, pedagogical concepts and laws and to enable them to use pedagogical sources independently and critically and understand the phenomenon of upbringing and education. Enabling students to learn independently, infer and think critically, as well as to correctly observe and explain the pedagogical phenomena. Developing interest in the study of pedagogical content and research on pedagogical phenomena. Developing love for the vocation of the educator. Gaining a positive professional attitude towards pupils in the process of educational work in primary and secondary schools.

Educational outcomes (acquired knowledge): General pedagogical culture of a teacher; the ability to achieve the best and the most successful educational work with primary and secondary school pupils by applying the acquired practical knowledge, skills and abilities. Students are able to analyse and improve their own pedagogical competence in working with students and parents. They are able to design, implement and evaluate the cooperation of the school with the environment and the cooperation of teachers with parents.

Course content/structure

The concept and subject of pedagogy. Education as the broadest pedagogical concept and process. The importance of education and upbringing. Education and society: moral crisis, education and culture, education for tolerance and multiculturalism, education and work, education and socio-emotional development, educational and individual development, education and children's rights, education and maturity, education and civilisational heritage, education and ecology. The relation between upbringing and education. Personality development factors. Historical overview of the development of education and pedagogy. The most famous pedagogues and their works. System of pedagogical disciplines. The relation between pedagogy and other sciences. The aim and tasks of education. Versatile personality development. Intellectual education. Aesthetic education. Psychical education. Work education. Moral education. Principles of education and upbringing. General methods and means of upbringing and education. Upbringing system. Basic factors of the education and upbringing system. Education system. Personality and profession of the educator. Education in free time. Lifelong learning.

Literature

1. Budimir-Ninković, Gordana. Pedagogija. Kragujevac: Fakultet pedagoških, 2016.
2. Budimir-Ninković, Gordana. Pedagogoška hrestomatija. Kragujevac: Fakultet pedagoških nauka, 2015.
Additional:
3. Budimir-Ninković, Gordana. Pedagoški Praktikum. Kragujevac: Pedagoški fakultet, 2009.
4. Komenski, Jan Amos.Materinska škola, Beograd: Prosveta, 1946.
5. Lok, Džon. Misli o vaspitanju. Beograd: Kultura, 1950.
6. Grej, Džon.Deca su iz raja. Beograd: Esotherija, Moć knjige, 2001.
7. Vaspitanje za demokratiju. Zbornik radova. Urednik S. Joksimović. Beograd: Institut za pedagoška istraživanja, 2005.

Number of active teaching classes	Lectures 3	Practical classes 3

Teaching methods: Lectures, practical classes, discussion with students, the analysis of seminar papers and testing the knowledge acquired during classes. Consultations.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	**Points**	**Final exam**	**Points**
Lecture attendance	10	Written part of the exam	
Practical classes	-	Oral part of the exam	30
Colloquium exam	50		
Seminar paper	10		

Course:	**Combinatorics and graph theory**
Course id.	
Number of ECTS: 6	
Teacher:	Ivan D. Pavkov
Course status:	Mandatory, third year, fifth semester

Precondition courses: Mathematical logic and algebra

Educational goal

Acquiring basic knowledge of combinatorics and graph theory.

Educational outcomes (acquired knowledge):

Upon completion of the course, the student should have basic knowledge of graph theory and algorithms and be able to apply them in problems in practice. He is able to follow courses in professional fields in which the concepts and techniques he has mastered are applied and to identify problems to which he can apply the acquired knowledge.

Course content/structure:

Theoretical classes:

Counting. Permutations of sets. Combinations of sets. Binomial formula. Permutations and combinations of multisets. Polynomial formula. On and off formula. Dirichlet principle. Breaking numbers into additions. Number of circulations. Stirling numbers of the second and first kind. White numbers. Generator functions. Differential equations. Fibonacci numbers. Concept, parts and types of graphs. Isomorphism of graphs. Walks, chains, roads, cycles. Connectivity. Planar graphs. Euler's and Hamilton's graphs. The commercial traveller problem. The shortest path problem. Dijkstra and the Floyd-Worschel algorithm. Trees. Kruskalov and Primov algorithm. Representation of graphs by matrices. Colouring graphs. Chromatic number. Applications of graph theory in computing.

Practical classes:

Tasks from the stated theoretical areas.

Literature

- Mladenović, P. (1992). Kombinatorika. Beograd: Društvo matematičara Srbije
- D. Veljan, Kombinatorika s teorijom grafova, Školska knjiga, Zagreb 1989.
- J. A. Anderson, Diskretna matematika sa kombinatorikom, Računarski fakultet, Beograd, 2005.
- V. Petrović, Teorija grafova, Novi Sad, 1998.

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods

frontal, group

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 50 Activity: 10 Lecture attendance: Exercise attendance:	Written exam: 20 Oral exam: 20

Course:	**Operating Systems**
Course id: 19.OI0016	
Number of ECTS: 6	
Teacher:	**Goran Keković**
Course Status:	**Mandatory, the third year, the fifth semester**

Precondition courses: None

Educational goal

The course is an introductory course in system software. Introduction to operating systems. Principles of operating systems. Deepening theoretical knowledge of Linux and Windows, operating systems. Training to use the Linux + network operating system.

Educational outcomes (acquired knowledge)

At the end of the course, students are expected to successfully master the basic concepts of operating systems, and fully master data protection techniques.

Course content/structure

Lectures

The role and tasks of operating systems. Development, structure and overview of operating systems. Hardware basics for performing operating system functions. Functioning of a typical operating system. Programs, program tasks, processes and threads within a computer system. Mutual exclusion of threads. Operating system kernel. Communication between threads, synchronization mechanisms. Ways to assign processors to threads. Communication between processes. Respect for time limits. Hierarchy of memory space. Memory management. File management. Input / output control. Operating system interfaces. Examples of operating systems: UNIX / Linux, Windows.

Practical classes: Exercises, Other forms of teaching, Study research work

Verification of concepts introduced in lectures on specific systems in use today, primarily Windows and Linux. Installation, administration and maintenance.

Literature

1. Đorđević B. (2005), *Operating Systems*, Mikro knjiga, Belgrade,
2. Archer Harris J. (2001), *Operating Systems*, McGraw-Hill, USA,

Number of active teaching classes (weekly): 4				Other classes
Lectures: 2	Exercises: 2	Other forms of teaching	Study research	

Teaching methods

The lectures use classical teaching methods with the use of modern information technology. The principles of operating systems are explained. Illustrative examples are analysed in the exercises using classical teaching methods. Computers solve problems by creating tasks in an appropriate environment.

Knowledge evaluation (maximum 100 points)

Pre obligations	points	**Final exam**	points
Lecture attendance	10	Oral part of the exam	40
Laboratory exercise attendance	15		
Colloquia	20		
Seminars	15		

Course:	**Databases 1**
Course id:	
Number of ECTS: 6	
Teacher:	**Vesin D. Boban**
Course Status:	**Mandatory, the third year, the fifth semester**

Precondition courses: None

Educational goal

The aim of the course is understanding and adopting the basic concepts and techniques of relational databases.

Educational outcome (acquired knowledge)

Upon completion of the course, students acquired the basic concepts and techniques of data modelling. They are able to:
- represent simpler databases by creating relational connections between entities
- convert entity relationship diagrams (ER diagrams) into the relational schema model in standard normal form
- interactively use the SQL language

Course content/structure

Theory classes

Database systems: history and motivation; components. Database management systems; functions; database architecture and data organization; data independence. Data modelling: conceptual models; entity-relationship data model. Relational data model; relational algebra and relational calculus. Database query languages; review; SQL. Designing relational databases; functional and ambiguous dependency; normal forms.

Practical classes: Practicing the basic principles of relational algebra and relational calculus. Practicing database representation by creating relationships between entities. Mastering basic SQL techniques by writing and performing queries on a given database.

Literature

Pavlović Lažetić, G.(1999), „Osnove relacionih baza podataka“, Matematički fakultet u Beogradu
Ulman, J & Widom,J. (2008), "A First Course in Database Systems", Prentice Hall (3rd edition)
Silberschatz, A., Korth, H.F. & Sudarshan, S.(2002), "Database system concepts", McGraw-Hill (4th edition)
Date, C.J. (2004). "An introduction to database systems", Addison-Wesley (8th edition).

Number of active teaching classes (weekly): 4				Other classes
Lectures: 2	Exercises: 2	Other forms of teaching	Study research	

Teaching methods

Classical teaching methods with the use of a projector are used in the lectures. The presented principles and analysing typical problems are practiced in the exercises. During the practical classes, students apply the learned techniques.

Knowledge evaluation (maximum 100 points)

Pre obligations	points	**Final exam**	points
Lecture attendance and activity	10	Written exam	20
Exercise attendance and project		Oral exam	20
Colloquium exam	50		
Seminary			

Course:	**English language 3**
Course id.	
Number of ECTS: 5	
Teacher:	**Aferdita Crnisanin**
Course status:	**Compulsory, fourth year, fifth semester**

Precondition courses: English language 2

Educational goal

Students are introduced to the basic concepts from the narrower field of profession in English, where the main goal is to provide students with knowledge of the professional language for quality monitoring of information literature in English. Since, in order to achieve that goal, it is equally necessary to know the vocabulary, i.e. the contents of the English language itself, as well as the language structures, have a significant place in grammar.

Educational outcomes (acquired knowledge):

The student understands texts and has the ability to present professional content with special emphasis on communication skills. The student can use professional literature and express his ideas as well as new knowledge in English in written and oral communication

Course content/structure

Theoretical classes

English language lingua franca of the information age. Means of communication and communication globalization, mass media. Electronic computer: historical development of computers and their application. Types of computers, main parts of computers, computer management. Computer education in English-speaking countries. Dynamics of information language development. Internet. Use of English on the Internet, abbreviations and acronyms. Rules of conduct on the Internet, computer crime. Expressing mathematical concepts in English.

Practical classes: Exercises, Other forms of teaching, Study research work

The exercises practice the comparative pronunciation of internationalism in the field of information systems in English and Serbian. Practicing with verbs and verb tenses in active and passive. Also in the exercises, students prepare teaching materials that are successively published on the course website.

Literature

(2004): Oxford Oxford Dictionary of Business Oxford, University Press

Mitic, G. (2005): "Reading Texts, Short English Grammar Book," FON, Belgrade

Prnjat, Z. & Petkovic, V .. (2006): "English Language 1", FTB University "BK", Belgrade

Murphy, R. (2007): “English Grammar in Use”. Third Edition. CUP

"Business English Reader 1" (collection of professional texts adapted to the curriculum in electronic edition)

Thomson, A.J., Martinet, A.V. (2003). A Practical English Grammar, Oxford University Press

monolingual and bilingual dictionaries

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods

Communicative and grammatical-translation method in combination.

Knowledge evaluation (maximum 100 points)

Pre-exam obligations	Points	final exam	*Points*
activity during the lecture	10	*written exam*	
practical teaching	15	*oral exam*	40
colloquia	20		
seminars	15		

Course:	**Fundamentals of geometry**
Course id: 19.OI0037	
Number of ECTS: 7	
Teacher:	**Miroslava Mihajlov Carević**
Course status:	Elective

Precondition courses: None

Educational goal: Introduction to basic concepts from the basics of geometry and analytical geometry, as well as training students for abstract thinking.

Educational outcomes (acquired knowledge): Upon completion of the course, the student has basic knowledge of the basics of geometry and analytical geometry and is able to follow courses in professional fields in which mathematical models are created and solved. The student is able to perform analytical formulas of geometric objects and examine their mutual position and to apply this knowledge to mathematical modelling of specific problems, as well as to geometrically interpret the obtained results.

Course content/structure

Theoretical classes: A brief overview of the history of geometry, the development of the idea of axiomatic grounding. Axiomatic introduction of geometry. Absolute geometry - axioms of incidence, arrangement, congruence and continuity (Dedekind's axiom). Axiom of parallelism (Euclid's fifth postulate). Hilbert's axiom system. Transformations of coincidence and similarity. Relation of congruence of geometric figures, congruence of lengths, congruence of angles, congruence of triangles. Isometric transformations in the plane, axial and central symmetry, translation. Classification of isometric transformations. Historical development of the idea of hyperbolic geometry. Lobachevsky's axiom, non-Euclidean (hyperbolic) geometry. Parallelism and hyperparallelism.

Introduction to analytical geometry. Distance of two points. The division is longer in the given size. Equation forms equal. The distance of a point from a plane. The mutual position of the two planes and the angle between them. The equation of the line in space, the vector, parametric and canonical form of the line equation. A straight line equation that passes through two points. The distance of a point from a line. The distance of two lines in space. The angle between two lines. The mutual relationship is straight and equal.

Practical teaching: Tasks from the stated theoretical areas.

Literature

1. M. Prvanović, Basics of geometry, Construction book, Belgrade, 1987.
2. V. Petrović, P. Tošić, A collection of problems from the basics of geometry, PMF, Novi Sad, 1985.
3. Z. Stojakovic, D. Herceg: Linear Algebra and Analytical Geometry, UNS, Novi Sad, 1992.
4. H. Blažić, N. Bokan, Z. Lučić, Z. Rakić: Analytical Geometry, Faculty of Mathematics, Belgrade, 2003.

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods : Frontal, group

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	**Final exam:40**
Colloquium exam: 50 Lecture attendance: 5 Exercise attendance:5	

Course:	**Software project management**
Course id: 19.OI0038	
Number of ECTS: 7	
Teacher:	**Nenad Gligorić**
Course status:	Elective

Precondition courses: None

Educational goal is to provide skills and knowledge in project management in scope of software development of information systems. Student will be introduced with basic principles in scope of project management. Project approach and application in the business processes. Basic conditions of successful management of project with special focus on importance of the project domain definition, planning, project management, and resources.

Educational outcomes (acquired knowledge):
The students will be capable to work on the projects, and they will be introduced with most common problems and existing solutions for management of different types of the projects. The focus is on the teamwork and execution of processes using empirical methods.

Course content/structure
Theoretical lectures
Introduction to projects. Meaning and importance of project management. Historical approach to development of the project management topic. Important factor of successful and unsuccessful project execution. Project lifecycle. Project organisation. Project manager. Decision support software for project management. Project documentation. Project evaluation. MS Project 2010.

Practical course:
Laboratory practice includes definition of the scope of the problems that will be analysed, facts and theoretical approach to be identified, using interactive approach. Students will be familiarized with standard information solutions for project management. Sections given during the lectures will be followed by the assignment to be executed in scope of the project on practical course. Students can choose the topic and develop the project in a team. The final outcome is submission of the project proposal to active tenders and call for funding.

Literature
-Main
- Kerzner, H. (2003): „*Project Management a system approach to planning*“, scheduling and controlling, John Wiley
- Jovanović, P., : „Upravljanje projektima“, FON, Beograd

-Supplementary
Gray, C.F., Larson, E.W.,: “*Project management*”, McGraw Hill, Boston

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods
Lectures and laboratory practice are based on frontal, group methods, as well as using laboratory-experimental methods facilitating information communication technologies.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations: Activity:10; Colloquium exam: 50;	**Final exam: 20** **Written exam: 20;**

Course:	**Microcontroller systems**
Course id.	
Number of ECTS: 5	
Teacher:	Đukić V. Dejan, Goran S. Kekoović
Course status:	Mandatory, third year, sixth semester

Precondition courses: None

Educational goal

The aim of the course is to introduce and train students to understand the working principles of microprocessors and microcontrollers. In addition, the aim of the course is to enable students to understand the function of the accompanying peripherals as well as the beginning of the connection with the microprocessors of the MCS-51 family.

Educational outcomes (acquired knowledge):

After taking the course, students will be able to independently design simple hardware modules based on modern microcontrollers compatible with the MCS-51 family.

Course content/structure:

Theoretical classes:

Microprocessor history. Microprocessor structure. Microprocessor performance. Microcomputers. Architecture of microcomputer systems. Classifications. Constructive characteristics. Scope. Microcontrollers. Overview of families of modern microcontrollers. Microcontrollers with improved performance. Embedded systems. Components of microcontroller systems. MCS-51 family of microcontrollers. Architecture. External data memory. Write and read data from external memory. Time diagrams. Coupling with other components of the microcontroller system. Higher programming languages for microcontrollers. C51 compiler. A51 assembler. BL51 linker. OHS51 object-hex converter.

Practical classes:

Computational exercises. Laboratory exercises. Demonstration exercises.

Literature

- Milivojević, Z., Mikrokontroleri - Arhitektura 8051, Punta, Niš, 2005.
- Karakanov, Z., Christensen, K., Embedded Systems Design with 8051 Microcontrollers, Marcel Dekker, New York, 1999.

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods

Lectures and exercises use frontal, group methods, as well as laboratory-experimental teaching methods with the use of modern technology.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 30 Activity: 10 Seminar paper: 10: Practical work: 20:	Written exam: Oral exam: 30

Course:	**Databases 2**
Course id:	
Number of ECTS: 6	
Teacher:	**Vesin D. Boban**
Course Status:	**mandatory, third year, sixth semester**

Precondition courses: Databases 1

Educational goal

The aim of the course is understanding and adopting advanced database concepts and techniques, as well as to master application query languages and transaction programming. Realizing the importance of physical organization of data in the database is also the goal of the course.

Educational outcome (acquired knowledge)

Upon completion of the course, students has mastered database modelling and programming techniques. Students are trained for:
- actively using the SQL query language
- programming simpler databases
- understanding the database management system
- following modern trends in the field of databases

Course content/structure

Therory classes

Combining database language and procedural programming language SQL/C; SQL/PHP.
Fourth generation environment. Transaction management: transactions, failure and recovery, concurrency control. Client-server database systems. Physical database design: file structure; indexed files, hash files, variable-length record files. Database efficiency and settings.
Practical classes: Mastering advanced SQL techniques by querying. Insert query languages into procedural languages (SQL/C). Practicing the principles of transaction management. Students are given a practical task consisting of independently designing an ER data model and translating it into a relational model.

Literature

Pavlović Lažetić, G.(1999), „Osnove relacionih baza podataka“, Matematički fakultet u Beogradu
Lazarević, B., Marjanović, Z., Aničić N., Babarogić, S. (2006): „Baze podataka“, Fakultet organizacionih nauka u Beogradu
Ulman, J & Widom,J. (2008), "A First Course in Database Systems", Prentice Hall (3rd edition)
Silberschatz, A., Korth, H.F. & Sudarshan, S.(2002), "Database system concepts", McGraw-Hill (4th ed.)
Date, C.J. (2004). "An introduction to database systems", Addison-Wesley (8th edition)

Number of active teaching classes (weekly): 4				Other classes
Lectures: 2	Exercises: 2	Other forms of teaching	Study research	

Teaching methods

Classical teaching methods with the use of a projector are used in the lectures. The presented principles and analyzing typical problems are practiced in the exercises. During the practical classes, students apply the learned techniques.

Knowledge evaluation (maximum 100 points)

Pre obligations	points	**Final exam**	points
Lecture attendance and activity	10	Written exam	20
Exercise attendance and project		Oral exam	20
Colloquium exam	50		
Seminary			

Course: **Course id: 19.OC0013** **Number of ECTS: 5**	**Programming languages and paradigms**
Teacher:	**Nenad Gligorić**
Course status:	Mandatory

Precondition courses: Programming 2, Introduction to object-oriented programming

Educational goal is to introduce basic characteristics of different programming styles, with a focus on the programming languages that are most representative for specific programming paradigms. Learning of basic principles of programming languages and different paradigms: C, C++, Prolog, Lisp, JavaScript.

Educational outcomes (acquired knowledge):
The students will be familiar with general and specific properties of different programming language paradigms, and to distinct which programming language belongs to a certain programming paradigm. Focus will be on object-oriented paradigm, procedural paradigm, logical paradigm, functional and script paradigms.

Course content/structure
Theoretical lecture
Review of the development of software paradigm. Basic characteristic of most used software paradigms: procedural, object, logical, functional, concurrent and script. Comparison of the programming paradigms. Functionalities, optimization of programming languages and representatives of different paradigms.
Laboratory practice
Practice od general principles of programming languages through different programming paradigm. Problem solving of a problem using different programming languages C (procedural paradigm), C++(object-oriented paradigm), Prolog (logical paradigm) и JavaScript (script paradigm). Selection of the most suitable programming paradigm for solvation of different problem types.

Literature

1. Tucker, A., Noonan, R. (2001): „Programming Languages: Principles and Paradigms“, McGraw-Hill Science
2. Sebesta, R., (2006): „Concepts of programming languages“, Addison Wesley (7th edition)
3. S. Barry Cooper, Benedikt Löwe, and Andrea Sorbi: New Computational Paradigms: Changing Conceptions of What is Computable, Springer Verlag, 2007.

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods
Lectures and laboratory practice are based on frontal, group methods, as well as using laboratory-experimental methods facilitating information communication technologies.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	**Final exam: 20**
Activity:10; Colloquium exam: 40; Seminary: 10;	**Written exam: 20;**

Course:	**Mobile computing**
Course id.	
Number of ECTS: 8	
Teacher:	Boris S. Damnjanović
Course status:	Elective, third year, sixth semester

Precondition courses: Object oriented programming

Educational goal

The primary goal of this course is to introduce students to the basic principles of mobile application development, with a focus on the Android platform. The secondary goal of this course is to gain experience and practical skills in the development and implementation of applications for Android mobile phones through work on practical projects. Among other things, another goal of the course is for students to acquire the necessary skills to conduct research activities in this dynamic area by exploiting existing environments and simulators, such as the Android Studio software package.

Educational outcomes (acquired knowledge):

The general competencies that students will acquire are analysis, synthesis and prediction of solutions and consequences, mastering research methods, procedures and processes, as well as applying knowledge in practice. The professional outcome of this course includes the following components: understanding the hardware and software platform of mobile devices; understanding the basic concepts of mobile application development - what are the basic characteristics, benefits and challenges, as well as understanding limitations such as limited battery life and the need to save energy; training for independent application of basic concepts of mobile applications and understanding of trade-offs in energy use and execution efficiency, in order to implement mobile applications that are robust, usable and efficient; training for independent application development for Android phones.

Course content/structure:

Theoretical classes:

The role of mobile application development in the software industry. Features of mobile devices. An overview of hardware platforms and operating systems. Development environments and programming languages for mobile devices. Mobile application architecture. User interface development. Activity as a basic component of the Android application. Explicit and implicit intentions, fragments, application data storage (SQLite database, Shared Preferences). AsyncTask and Internet connection. Use an external API to retrieve data. Applications based on Content Provider and Broadcast Receiver components. Services for background work, work with sensors and application localization.

Practical classes:

Practical classes follow theoretical classes and are realized in computer classrooms. During the practical classes, students will gain insight into setting up the development environment, setting up emulators, as well as developing mobile applications for Android phones and the practical application of the principles adopted during the theoretical classes.

Literature

- R. Kamal:Mobile Computing, Oxford University Press, 2008.
- Jevtovic Milojko, Velickovic Zoran: Komunicacioni protokoli prepletenih slojeva, Akademska misao 2012
- James Tolbot, Justin Molean: Programiranje android aplikacija, CET 2014
- D. Griffiths, Head First Android Development, 2nd Edition, 2017, p. 928.
- G. Nudelman, Android Design Patterns: Interaction Design Solutions for Developers, Wiley, 2013, p. 459.
- E. Burnette, Hello, Android, Introducing Google's Mobile Development Platform, 4th Edition, Pragmatic· Programmers, 2015, p. 251.

Number of active teaching classes	Lectures: 3	Practical classes: 3

Teaching methods

Teaching is performed using ICT, where in addition to classical teaching methods, modern presentation and demonstration tools and techniques are used, using an interactive method of working with students. Lectures and exercises are performed using didactic and educational content in electronic and digital form (which includes recorded lectures and mentoring exercises) on various video presentation media.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations: Colloquium exam: 20 Activity: 10 Project: 40 Exercise attendance:	Final exam: Written exam: Oral exam: 30

Course:	**Informatics teaching methodology**
Course id.	
Number of ECTS: 8	
Teacher:	Lazar Kopanja
Course status:	Elective, third year, sixth semester

Precondition courses: None

Educational goal

Training for pedagogical work in the field of informatics and introduction to software packages that are processed and used in school.

Educational outcomes (acquired knowledge):

Students will be able to independently teach computer science in primary and secondary schools.

Course content/structure:

Theoretical classes:

Preparation of classes. The structure of time. Time planning. Board planning. Teaching aids planning. Planning the required software. Planning the necessary data. Sequence of actions. Exposure speed. Tests and evaluation. Work with different ages. Didactics of IT contents. Operating system. Internet. Standard software packages: Word processing. Worksheets. Presentations. Database. Drawing. Computer center maintenance. Procurement of equipment. Equipment maintenance. Local area network. Software maintenance. Selected topics. Manual skills required. Independent student projects. Computer-assisted education in various fields. Educational software. Distance learning.

Practical classes:

Exercises, Other forms of teaching, Study research work, Preparation of necessary resources. Presentation of materials. Tests and evaluation. Discussions. Student work control. Practical practice of classes in school according to the contents of theoretical classes.

Literature

- N, Denić, Beleške sa predavanja u vidu skripte sa PowerPoint prezentacijama.
- Branković, D., Mandić, D.(2003): Metodika informatičkog obrazovanja. Beograd: Mediagraf, Banja Luka: Filozofski fakultet u Banjoj Luci.
- Mandić, P. i Mandić, D.(1997): Obrazovna informaciona tehnologija Učiteljski fakultet Beograd, Jagodina i Užice

Number of active teaching classes	Lectures: 3	Practical classes: 3

Teaching methods

The lectures use classical teaching methods with the use of modern technology. Illustrative examples are analysed in the exercises using classical teaching methods. Theoretical classes, theoretical and practical exercises, practical work in school.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations: Colloquium exam: Activity: 10 Seminar work: 30: Work in school: 30:	Final exam: Written exam: Oral exam: 30

Course:	**Probability and statistics**
Course id.	
Number of ECTS: 6	
Teacher:	Dragiša Žunić
Course status:	Mandatory, third year, sixth semester

Precondition courses: Mathematical Analysis 1, Combinatorics and Graph Theory

Educational goal

Acquiring basic knowledge of probability theory and training for the application of that knowledge in solving problems from practice. Introduction to the basic methods of descriptive and analytical statistics and training for the application of these methods in solving problems in practice. Knowledge of probability theory is the basis for understanding the methods and models of statistical analysis

Educational outcomes (acquired knowledge):

At the end of the course, the successful student is expected to fully master the basic concepts and applications of probability and statistics. He is able to apply statistical tests and simulation methods to study real phenomena. Special emphasis is placed on understanding descriptive statistics and statistical inference.

Course content/structure:

Theoretical classes:

Probability theory-space of elementary events. Definition of probability and basic properties. Conditional probability and independence of events. The formula of total probability. Bayesian formula. Random events, traits. Operations and relations with random events. One-dimensional random variables of discrete type. One-dimensional random variables of continuous type, parameters of a random variable. Discrete distribution models. Continuous distribution models. Boundary value theorems in probability. Two-dimensional random variables of discrete type. Two-dimensional random variables of continuous type. Marginal distributions. Conditional distributions. Regression analysis. Statistical inference, population, sample. Descriptive statistics, statistical features. Frequency distribution, graphical display of frequency distribution. Landmark parameters, indices. Statistics and their distributions. Evaluation theory, evaluation selection criteria. Confidence intervals. Hypothesis testing. Parametric tests. Nonparametric tests. Regression models. Methods of analysis of variance. Statistical packages (SPSS). Individual indices. Weighted and unweighted group indices. Time series analysis - moving average method. Autoregressive models.

Practical classes:

Tasks in the above areas.

Literature

- Stojković, M. (2001). Statistika. Subotica: Ekonomski fakultet Subotica
- Stojković, H. M. (2002) Primena statistike - zbirka primera. Subotica
- Vuković, N. (2006): „Osnove verovatnoće“, FON, Beograd,
- Vuković, N (2007): „Statističko zaključivanje“, FON, Beograd
- Stojanović, V: „Statistika i verovatnoća – za nženjere“FIM, Beograd, 2012.

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods

The lectures use classical teaching methods with the use of modern technology. The principles of descriptive and analytical statistics are explained. Illustrative examples are analysed in the exercises using classical teaching methods. Computers solve problems by creating tasks in an appropriate environment.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 50 Activity: 10 Lecture attendance: Exercise attendance:	Written exam: 20 Oral exam: 20

Course:	**Artificial intelligence 1**
Course id.	
Number of ECTS: 7	
Teacher:	Dejan Đukić
Course status:	Mandatory, fourth year, seventh semester

Precondition courses: Programming 2, Introduction to Object Oriented Programming, Combinatorics and Graph Theory

Educational goal

Introduction to the basic concepts and algorithms of artificial intelligence, including their theoretical foundations, analysis and practical applications. Students will have the opportunity to understand and apply basic algorithms of supervised and unsupervised learning with examples of good practice and tips for applying these algorithms.

Educational outcomes (acquired knowledge):

Students will be able to identify problems that are solved by artificial intelligence algorithms. They are able to interpret and analyse different types of algorithms, implement them in the appropriate programming language and evaluate their performances. They will learn to combine algorithms and create a data flow, from data pretreatment procedures to evaluate the approaches used. They will gain the necessary experience to overcome problems during the application of algorithms (accuracy, computer requirements, over-adjustment, regularization).

Course content/structure:

Theoretical classes:

Introduction and basic concepts. Components of artificial intelligence systems and basic types of learning. Different types of machine learning problems. Basic concepts: goal function, overadjustment, regularization, performance evaluation, dimensionality problem, validation procedures, bias / variance compromise. Supervised learning (Bayesian learning theory, quadratic classifiers, parametric and nonparametric estimation of probability density (maximum likelihood and Bayesian estimation, KDE, kNN), linear and logistic regression, linear discriminant functions, neural networks, carrier vector method). Unsupervised learning (k-means, hierarchical clustering), dimensionality reduction: PCA and LDA.

Practical classes:

Computational exercises. Research project. Study research work.

Literature

- Crnojević, V, Prepoznavanje oblika za inženjere, Fakultet tehničkih nauka, Novi Sad, 2014.Bishop, C.M, Pattern Recognition and Machine Learning, Springer, New York, 2006.
- Richard O. Duda, Peter E.Hart, David G. Stork, Pattern Classification, 2nd Edition, Wiley, 2001.
- Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

Number of active teaching classes	Lectures: 2	Practical classes: 3

Teaching methods

Lectures, computer exercises, seminar work, consultations, active learning, learning through project and research, workshops.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: Activity: 10 Project: 30: Seminar work: 20:	Written exam: 40 Oral exam:

Course:	**Cyber security**
Course id.	
Number of ECTS: 7	
Teacher:	Milena V. Radenković, Milan G. Đorđević
Course status:	Mandatory, fourth year, seventh semester

Precondition courses: None

Educational goal

The aim of the course is to study the existing security problems of computer systems, such as and techniques and approaches that enable better protection of these systems and prevention of attacks.

Educational outcomes (acquired knowledge):

Mastering all aspects of security and protection of computer systems and networks.

Course content/structure:

The course covers the following areas: Introduction to Computer Systems Security, Security hardware, Software security, Network security, Mobile wireless network security, Web security, Privacy, Anonymity, Principles of cryptography.

Literature

- Computer Security . Dieter Gollmann, 2nd edition (Amazon)
- Security Engineering . Ross Anderson (Available online)

Number of active teaching classes	Lectures: 3	Practical classes: 2

Teaching methods

Lectures, tutorials, colloquia, consultations, tests, homework and written exams

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 30 Activity: 10 Seminar paper: 20: Exercise attendance:	Written exam: 20 Oral exam: 20

Course:	**English language 4**
Course id.	
Number of ECTS: 5	
Teacher:	**Aferdita Crnisanin**
Course status:	**Compulsory, fourth year, seventh semester**

Precondition courses: English language 2

Educational goal

The aim of the course is to acquaint students with the concepts from the narrower field of profession in English, where the main goal is to provide students with knowledge of professional language necessary for quality monitoring of information literature in English.

Educational outcomes (acquired knowledge):

The student is trained to write abstracts and abstracts and presentations in English.

Course content/structure

Theoretical classes

Structure, organization and data processing. Information systems. Information networks, data transmission and information. Data transmission systems. Kinds of. Programming and programming languages. Types of programs. Operating systems. Basics of written and oral communication. Basics of business correspondence. E-commerce. Application of modern technology in business communication. Review of grammatical structures: indefinite verb forms and their translation. Review of grammatical structures: noun and prepositional sets. An overview of grammatical structures: conjunctions and their role in a sentence. Types of complex sentences. Review of grammatical structures: types of dependent sentences. Participle in dependent sentences.

Practical classes: Exercises, Other forms of teaching, Study research work

Writing a summary and abstract, e-mail, presentation. Using the Internet CDs and dictionaries for this purpose.

Literature

• (2004): Oxford Oxford Dictionary of Business Oxford, University Press
• Mitic, G. (2005): "Reading Texts, Short English Grammar Book," FON, Belgrade
• Prnjat, Z. & Petkovic, V .. (2006): "English Language 1", FTB University "BK", Belgrade
• Murphy, R. (2007): “English Grammar in Use”. Third Edition. CUP
• "Business English Reader 2" (collection of professional texts adapted to the curriculum in electronic edition)
• monolingual and bilingual dictionaries

Number of active teaching classes	Lectures: 2	Practical classes: 2

Teaching methods

Communicative and grammatical-translation method in combination.

Knowledge evaluation (maximum 100 points)

Pre-exam obligations	Points	final exam	*Points*
activity during the lecture	10	*written exam*	
practical teaching	10	*oral exam*	40
colloquia	30		
seminars	10		

Course:	**Signal processing**
Course id.	
Number of ECTS: 8	
Teacher:	Dejan Đukić
Course status:	Elective, fourth year, seventh semester

Precondition courses: None

Educational goal

Introduction to the theoretical foundations and practical aspects necessary for the design of digital filters and training students to use appropriate hardware and software tools.

Educational outcomes (acquired knowledge):

Ability of the student to select an adequate circuit structure in order to meet the specifications of appropriate systems for digital signal processing, as well as the ability to implement an algorithm for digital signal processing in software or hardware.

Course content/structure:

Analysis of discrete signals and systems in the time and frequency domain. Fourier transform. Z transformation. Digital processing of continuous signals. Discrete Fourier transform (DFT). Fast Fourier Transform (FFT). Transmission functions and frequency responses. Digital filters of infinite impulse response (IIR). Digital filters of finite impulse response (FIR). Realization of digital filters. Discrete Random Signals DSP Processor Basics. Assembler, higher programming languages. Digital signal processing with different selection frequencies. Digital filter banks (QMF banks, multi-stage filter banks). Application of digital signal processing (spectral analysis of sinusoidal, non-stationary and random signals, music signal processing, digital music signal synthesis, signal compression, transmultiplexers, discrete multitone digital data transmission, converters with oversampling). Discrete Hilbert transformer. Adaptive filters (equalization of telecommunication channels, echo cancellation). Analysis and processing of DSP systems using Matlab software.

Literature

- Lj. Milić, Z. Dobrosavljević, Uvod u digitalnu obradu signala, Akademska misao, 2004.
- Antoniou, Digital signal processing –signals, systems and filters, McGrawHill, 2006.
- 3. Vidosav Stojanović, Diskretne mreže i procesiranje signala:, Univerzitet u Nišu, Elektronski fakultet 2004.

Number of active teaching classes	Lectures: 3	Practical classes: 3

Teaching methods

Lectures and exercises use frontal, group methods, as well as laboratory-experimental teaching methods with the use of modern technology.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 30 Activity: 10 Seminar paper: 20: Exercise attendance:	Written exam: 20 Oral exam: 20

Course: **Course id: 19.ORNMAT** **Number of ECTS: 8**	**Mathematics teaching methodology**
Teacher:	Miroslava Mihajlov Carević
Course status:	Elective

Precondition courses: None

Educational goal

Acquiring knowledge in the field of mathematics teaching methodology and training students for their application.

Educational outcomes (acquired knowledge):

Enabling students to apply modern methodological principles, techniques of educational technology in the preparation and teaching of mathematics.

Course content/structure

Theoretical classes: Mathematics is a scientific discipline and a school subject. Mathematics teaching methodology.

Psychological, pedagogical and logical bases of mathematics teaching. Forms of thinking in the process of teaching mathematics. Mathematical concepts and methods of their introduction into teaching mathematics. Induction and deduction. An analogy. Teaching methods in mathematics teaching. The role and place of the task in the teaching of mathematics, their choice depending on the goals of teaching and the methodology of solving tasks. Catalogue of Heuristic Rules Field. Teaching programming method. Problem-based learning, differentiation and individualization. Classes and types of classes in mathematics teaching. Forms of work. Monitoring and evaluation of students' work and results in mathematics teaching. Planning in mathematics teaching. Motivation and encouragement for learning mathematics.

Practical classes: Exercises

Written preparation of classes, demonstration of classes and hospices in primary and secondary school classes, analysis of the teaching process and teaching.

Literature

1. Zech, F.: Grundkurs Mathematik didaktik – Theoretiche und praktis – che Anleitungen fur das Lehren und Lernen von Mathematik, Beltz Verlag – Weinheim und Basel, Berlin, 1999.
2. Marjanović, M.: Methodology of Mathematics I, Faculty of Teacher Education, Belgrade, 1996.
3. Marjanović, M.: Methodology of Mathematics II, Faculty of Teacher Education, Belgrade, 1996.

Number of active teaching classes	Lectures: 3	Practical classes: 3

Teaching methods

The lectures use classical teaching methods with the use of modern technology. Illustrative examples are analysed in the exercises using classical teaching methods. Theoretical classes, theoretical and practical exercises, practical work in school. Analysis of written preparations for classes and demonstration of classes. Analysis of classes held in primary and secondary schools.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations: Activity during the lecture: 10 Seminary work: 30 Lecture at school: 30	**Oral exam: 30**

<table>
<tr><td colspan="2">Course:</td><td colspan="3" rowspan="3">Professional Practice (Internship)</td></tr>
<tr><td colspan="2">Course id:</td></tr>
<tr><td colspan="2">Number of ECTS: 3</td></tr>
<tr><td colspan="2">Teacher:</td><td colspan="3">All of the teachers</td></tr>
<tr><td colspan="2">Course status:</td><td colspan="3">Mandatory, fourth year, seventh semester</td></tr>
<tr><td colspan="5">Precondition courses: None</td></tr>
<tr><td colspan="5">Educational goal
The aim of professional practice is to enable students to encounter specific problems in the field of computer science in actual situations, as well as to master certain practical knowledge related to that field.</td></tr>
<tr><td colspan="5">Educational outcomes (acquired knowledge):
Upon completion of the internship, students will be able to understand the way to approach specific tasks and problems in the field of computing in real-life circumstances. Students will also have the opportunity to apply the knowledge and skills acquired in these studies in the practice</td></tr>
<tr><td colspan="5">Course content/structure
The internship lasts a month and is realized in cooperation with other scientific and economic organizations that have a developed IT sector (primarily software companies). The student has the opportunity to choose the institution/company in which he/she will have professional practice, or in which he/she will apply the already acquired knowledge in practice. Employed students can also do an internship within the organization in which they are employed.
Before starting the internship, the student agrees with the selected teacher, as a supervisor, on specific tasks to be performed during the internship. The student is obliged to keep records of their activities, and upon completion of the internship, to bring a certificate of completed internship, as well as to submit an appropriate report (Professional Practice Portfolio with completed assignments and appropriate documentation).</td></tr>
<tr><td colspan="5">Literature
4. Zech, F.: Grundkurs Mathematik didaktik – Theoretiche und praktis – che Anleitungen fur das Lehren und Lernen von Mathematik, Beltz Verlag – Weinheim und Basel, Berlin, 1999.
5. Marjanović, M.: Methodology of Mathematics I, Faculty of Teacher Education, Belgrade, 1996.
6. Marjanović, M.: Methodology of Mathematics II, Faculty of Teacher Education, Belgrade, 1996.</td></tr>
<tr><td>Number of active teaching classes</td><td>Lectures:</td><td>Practical classes:</td><td colspan="2">Other forms of classes: 6x15=90</td></tr>
<tr><td colspan="5">Teaching methods
Professional practice in a selected organization. The internship supervisor reviews the Professional Practice Portfolio and evaluates the student's knowledge through the defense of the practical work. The final output document is a record with a proposal of assessment and special observations and recommendations for the candidate in terms of support for career advancement.</td></tr>
<tr><td colspan="5">Knowledge evaluation (maximum 100 points)</td></tr>
<tr><td colspan="2">Pre-examination obligations:
Professional practice in a selected institution/organization 30
Professional Practice Portfolio 40</td><td colspan="3">Written exam -
Oral exam: Presentation of completed tasks and oral defence of practical work 30</td></tr>
</table>

Course:	**Computer networks**
Course id.	
Number of ECTS: 6	
Teacher:	**Aleksandar Zakić**
Course status:	Mandatory, fourth year, eighth semester

Precondition courses: None

Educational goal

Acquiring general and specific knowledge of the theory and principles of functioning of computer networks, as well as introducing students to computer network applications.

Educational outcomes (acquired knowledge):

Upon completion of the course, the student has basic knowledge of computer networks, knows the basic principles, maintenance and principles of operation and is able to work on computer networks based on mastered principles and applications.

Course content/structure:

Introduction to the work program, assessment methods and exams. Computer-basic concepts. Layered architecture, OSI model, TCP / IP model. General terms related to computer communication. Client-server model. Connecting two computers, direct connection, modem connection. Connecting multiple computers, bus, star, tree and ring topologies. Local area networks. City networks. Broadband networks. Media access methods. Addressing. Protocols. Switching networks. Routing algorithms. Traffic congestion control algorithms. Computer networks and the Internet. Internet services. Network devices. IP addressing. Routing. BGP and adaptive routing. MPLS architecture. Protocols. Point-to-point and point-to-multipoint communication. Error detection and correction. Multiple approach techniques. QoS. Virtual private networks (L2, L3 and hybrid). Ethernet Metro. Optical networks. GMPLS. Networks with sensors. Triple play / IPTV.

Literature

Z. M. Urošević (2004), Uvod u računarske telekomunikacije i mreže, Tehnički fakultet, Čačak.

M. Stojčev (2005), Računarske mreže i prenos podataka, Elektronski fakultet, Niš.

R. Kurose, K. Ros, S. Košćal, R. Janković (2005), Umrežavanje računara, SET Beograd.

A. S. Tanenbaum (2003), Computer Networks, 4th ed. Prentice Hall PTR.

K. M. Sivalingham, S. Subramaniam (2005), Emerging Optical Network Technologies-Architectures, Protocols and Performance, Springer.

L. L. Peterson, B. S. Davie (2012), Computer Networks: A Systems Approach, 5th ed., Elsevier.

Number of active teaching classes	Lectures: 3	Practical classes: 2

Teaching methods

Lectures and exercises use frontal, group methods, as well as laboratory-experimental teaching methods with the use of modern technology.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 30 Activity: 10 Seminar paper: 20: Exercise attendance:	Written exam: 20 Oral exam: 20

Course: **Course id: 19.OI0020** **Number of ECTS: 8**	**Web programming**	
Teacher:	**Nenad Gligorić**	
Course status:	Mandatory	
Precondition courses: Programming 2, Introduction to object-oriented programming, Databases 2		
Educational goal is to provide knowledge about principles and methods for web programming, and technology for projecting and testing of dynamic web pages.		
Educational outcomes (acquired knowledge): The students will be capable of developing functional web applications, presentations and state of the art structured web sites, as well as to test and promote the web pages.		
Course content/structure Introduction to theory of web design. Rules. Concepts. Briefing and planning. Domains. Information about domains. Structure of the website. Website navigation. Principles of effective navigation. Accessibility. Web design problems. Technologies of web design and programming languages: HTML, Javascript, DHTML, CGI, PHP, Java Servlets, JSP, form styles, formatting, positioning, standards. Testing of web applications. Website promotion. Submitting website to search engines. Updating presentations.		
Literature [1] J. N. Robbins (2008), *Naučite Web dizajn – vodič kroz (X)HTML, CSS i Web grafiku*, Mikroknjiga, Beograd, 2008. [2]. J. Niederst (2001), *Learning Web Design: A Beginner's Guide to HTML, Graphics, and Beyond*, O'Reilly. [3] P.J. Lynch, S. Horton (2002), *Web Style Guide: Basic Design Principles for Creating Web Sites*, 2nd Edition, Univ Press.		
Number of active teaching classes	Lectures: 2	Practical classes: 2
Teaching methods Lectures and laboratory practice are based on frontal, group methods, as well as using laboratory-experimental methods facilitating information communication technologies.		
Knowledge evaluation (maximum 100 points)		
Pre-examination obligations: Activity:10; Colloquium exam: 30; Seminary: 20;	**Written exam: 20;** **Final exam: 20**	

Course:	**Artificial intelligence 2**
Course id:	
Number of ECTS: 7	
Teacher:	
Course status:	Elective, fourth year, eighth semester

Precondition courses: Probability and Statistics, Artificial Intelligence 1

Educational goal

The course introduces students to advanced topics in the field of artificial intelligence, with special emphasis on the theoretical foundations of advanced techniques and tools for implementation. Topics related to specific modern techniques of supervised, unsupervised and semi-supervised learning are covered.

Educational outcomes (acquired knowledge):

Students will learn to interpret and connect various advanced algorithms and approaches to artificial intelligence. Scientists provide data, identify and select the most appropriate approaches, regularization techniques, as well as monitor the training process and adjust regularization parameters. Students will master the use of a number of software tools and machine learning algorithms.

Course content/structure

Neural networks: introduction, architectures and training procedures, evaluation and application. Group learning: bagging and boosting. Clustering-advanced algorithms, mixture-based models and the expectation maximization algorithm (EM). Genetic algorithms. Semi-supervised algorithms. Hidden Markov models. Probabilistic graphic models (inference, belief propagation, practical application).
Practical teaching
Computational exercises. Research project. Study research.

Literature

1. Goodfellow, I, Bengio, Y, Courville, A, Deep Learning, MIT Press, Cambridge, 2017.
2. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
3. Bishop, C M, Pattern Recognition and Machine Learning, Springer, New York, 2006.
4. Hastie, T, Tibshirani, R, Friedman, J, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, New York 2009.
5. Khanna, T, Foundations of Neural Networks, Addison-Wesley, Massachusetts, 1990.

Number of active teaching classes	Lectures: 3	Practical classes: 3

Teaching methods

Lectures, computer exercises, seminar work, consultations, active learning, learning through project and research, workshops.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations: Activity:10; Project: 40; Seminar paper: 10;	**Final exam** **Written exam: 40;**

Course:	**Computer graphics**
Course id.	

Number of ECTS: 7	
Teacher:	Milena V. Radenković
Course status:	Mandatory, fourth year, eighth semester

Precondition courses: None

Educational goal

The aim of the course is to master the theoretical and mathematical foundations of computer graphics, as well as the use of certain software applications in computer graphics.

Educational outcomes (acquired knowledge):

Students will be trained to use software tools in computer graphics as well as to work in graphic and design studies. They will also be able to follow technological advances in the field of computer graphics.

Course content/structure:

Theoretical classes:

Introduction to computer graphics. Basic concepts. Vector and raster graphics. Colour models. Hardware components for graphic input and output. Graphical user interfaces (GUI). The place and role of models in computer graphics. Light sources. Camera model. Working with cameras. Coordinate systems in computer graphics. Geometric interpretation of two-dimensional graphic transformations (translation, rotation, scaling, reflection, distortion). Transformations from the global coordinate system to the coordinate system of the plane of observation. Two-dimensional truncation (point truncation, line truncation, polygon truncation). Three-dimensional truncation. 2D and 3D graphics. 2D to 3D image conversion and vice versa. Work with different graphic formats and software applications.

Practical classes:

Follows theoretical classes (work with vector and bitmap graphics, making flyers, posters, business cards, stickers, cover pages, prepress, work with software for 2D to 3D image conversion).

Literature

- J.Foley, A. Van Dam, S. Feiner, J. Hughes, Computer Graphics, Principles and Practice, Addison, Wesley, 1997.
- Starčević i ostali; Računarska grafika - praktikum za laboratorijske vežbe, VISER, Beograd 2009.
- Shalini Govil-Pai-Principles of Computer Graphics, Theory and Practice using OpenGL and Maya, Springer 2004.
- Watt, A., 3D Computer Graphics (3rd edition), Addison-Wesley, 2000.

Number of active teaching classes	Lectures: 3	Practical classes: 3

Teaching methods

Knowledge evaluation (maximum 100 points)

Pre-examination obligations:	Final exam:
Colloquium exam: 40 Activity: 10 Seminar work: 10: Exercise attendance:	Written exam: 40 Oral exam:

Course:	**Computer vision**
Cours id.:	
Number of ECTS: 6	
Teacher:	**Kopanja S. Lazar**
Course Status:	mandatory, fuorth year, eighth semester

Precondition courses: Mathematical analysis 2, Probability and statistics

Educational goal

The aim of the course is to provide a broad foundation in the field of computer image processing and analysis; to present technical solutions for obtaining digital images, to expose mathematical transformations and filtering of two-dimensional signals, algebraic, statistical methods, logical and morphological methods and methods of image analysis; to present some solutions in the domains of coding and summarizing visual information, modelling objects and the environment, object recognizing and drawing conclusions from static and dynamic images.

Educational outcome (acquired knowledge)

Upon successful completion of the course, students will be able to:
- make a decision on the conditions for recording digital images of the required quality
- apply mathematical transformations to two-dimensional functions
- apply algebraic, statistical and morphological methods to images to extract important components or details
- design and program algorithms for automatic drawing of conclusions from particular classes of static and dynamic images

Course content/structure

Theory classes

Introduction to optics and optical sensors for digital image acquisition, discretization and quantization; application of Fourier transform to two-dimensional functions; a review of some important integral transformations applied to image processing; application of algebraic transformations; application of statistical methods for the purpose of analysis and image processing; morphological analysis of images; separation of components from images, image segmentation; image compression; drawing conclusions from static and dynamic images.

Practical classes

Computational exercises. Laboratory exercises. Development project.

Literature

1. R. Szeliski, Computer Vision: Computer Vision: Algorithms and Applications, 2010.
2. A. Zisserman and R. Hartley, Multiple View Geometry in Computer Vision, Cambridge University Press, 2003.
3. Computer Vision: A Modern Approach: David A. Forsyth, Jean Ponce, Pearson Education, Limited, 2011
4. Acketa, D. (1986). Odabrana poglavlja teorije prepoznavanja oblika sa primenama. Novi Sad: Univerzitet u Novom Sadu, Prirodno-matematički fakultet

Number of active teaching classes:				Other classes
Lectures: 2	Exercises: 3	Other forms of teaching	Study research	

Teaching methods

Lectures and exercises use frontal and group method, as well as laboratory-experimental teaching method with the use of modern technology. The seminary paper is performed in the form of a development project, which is performed in groups and publicly defended.

Knowledge evaluation (maximum 100 points)

Pre obligations	points	**Final exam**	points
Lecture attendance	10	Oral part of the exam	20
Laboratory exercise attendance		Written exam	20
Colloquia	20		
Seminars	30		

Course:	**Final Thesis Subject**	
Course id:		
Number of ECTS: 2		
Teacher:	**Supervisor**	
Course status:	Mandatory, fourth year, eighth semester	
Precondition courses: 210 ECTS credits		
Educational goal Preparation of students for independent research work on the final paper. With the help of a supervisor, the student observes, presents the methodology and solves a specific current problem with research methods, with the application of theoretical and applied knowledge acquired during the studies.		
Educational outcomes (acquired knowledge): By the end of the course, the student is introduced to the basic methods of scientific and professional work in the field of computer science and informatics. The student is able to use the acquired knowledge, to study and research topics in this scientific field.		
Course content/structure Science and scientific work. Problem and scientific problem. Hypothesis and hypothesis verification. Scientific observation and scientific experiment. General methodology of scientific calculation. Classification of research. Experimental research. Code of ethics for scientific research. The concept of authorship and intellectual property. Classification of scientific work. Citation. Review. Oral presentation. Presentation assistance. Writing professional and scientific paper.		
Literature 1. Zoran Popović: Kako napisati i publikovati naučno delo, Akademska misao, Beograd, 1999.		
Number of active teaching classes (weekly)	Lectures:	Practical classes: 6
Teaching methods Frontal, group, individual and practical method.		
Knowledge evaluation (maximum 100 points)		
Pre-examination obligations: Seminary: 30	**Oral part of the exam: 70**	

Course:	**Final Thesis**
Course id:	
Number of ECTS: 4	
Teacher:	**Supervisor and Committee**
Course status:	**Mandatory,** fourth year, eighth semester

Precondition courses: Submission and defence of the Final thesis is possible upon passing all exams students had during the undergraduate academic studies.

The Aims of the Final Thesis:

The aim of the Final thesis is for the student to show the ability to engage in professional (or scientific) research, apply adequate methods of data collection and processing, as well as the ability to independently write professional or scientific papers, present professional problems and represent certain professional ideas.

Educational outcomes (acquired knowledge):

By preparing and defending the Final thesis, students are able to solve real applicable problems, as well as to consider and analyse theoretical solutions. This includes developed critical thinking, the ability to analyse problems, synthesize solutions, and predict the consequences of the selected solution, using scientific methods and procedures. Especially important is the ability to adopt relevant innovations in the profession, their connection with the acquired knowledge, application in practice and clear transmission to the professional and general public.

Course content/structure

The Supervisor of the Final thesis assigns a topic from the area covered by the curriculum, which the candidate can successfully process within three months, based on the acquired knowledge, study of the relevant literature, practical or experimental work..

Literature

Relevant literature in the field of research, which is directly related to the topic of the Final thesis.

Number of active teaching classes (weekly)	Lectures:	Practical classes:

Methods of execution:

The student can write the Final thesis from all professional subjects passed with the lowest grade 8. The Rulebook on writing the Final thesis at undergraduate or master academic (master) studies at Alfa BK University in Belgrade stipulates the procedure for applying for, writing and defending the Final thesis.

Knowledge evaluation

The Committee (consisting of the supervisor and two members) gives a single grade for the Final Thesis and its defence.