University of Kragujevac

Faculty of Engineering

COURSE CATALOG

UNDERGRADUATE ACADEMIC STUDIES

ELECTRICAL ENGINEERING & COMPUTER SCIENCE

No.	ID	Course title	Specific scientific or artistic field	Sem.	L	E	LE	RW	Other	ESPB
1.	OE1-ADM	Algebra and Discrete Mathematics	Applied mathematics	I	3	2				6
2.	OE1-IM	Engineering mechanics	Applied mechanics	I	3	2				6
3.	OE1-OET	Fundamentals of electrical engineering	Electrical engineering and computer science	I	3	3				6
4.	OE1-OP	Fundamentals of computer programming	Electrical engineering and computer science	I	3	3				6
5.	OE1-PRA	Practicum in computer tools	Electrical engineering and computer science	I	1	1	1			3
6.	OE1-EJ	English language	English language in engineering	I	2	1				3
7.	OE2-A1	Analysis 1	Applied mathematics	II	3	3				6
8.	OE2-PF	Applied physics	Applied physics	II	3	2				6
9.	OE2-ORT	Fundamentals of Computer Engineering	Electrical engineering and computer science	II	3	2	1			6
10.	OE2-PJ	Programming languages	Applied informatics in engineering	II	3	1	1			6
11.	OE2-POE	Practicum in fundamentals of electrical engineering	Electrical engineering and computer science	II	1	1	1			3
12.	OE2-OPME	Fundamentals of entrepreneurship management and economics	Engineering management	II	2	1				3
13.	OE3-A2	Analysis 2	Mathematics, Applied mathematics	III	3	3				6
14.	OE3-TEH	Electrical circuit theory	Electrical engineering and computer science	III	3	2				6
15.	OE3-ORS	Fundamentals of Computer Systems	Electrical engineering and computer science	III	3	2	1			6
16.	OE3-ASP	Algorithms and data structures	Software engineering, Applied informatics in engineering	III	3	1	1			6
17.	OE3-OOP	Object-oriented programming	Applied informatics in engineering	III	3	1	1			6
18.	OE4-IS	Engineering statistics	Mathematics, Applied mathematics	IV	2	2				6
19.	OE4-OE	Fundamentals of electronics	Electrical engineering and computer science	IV	3	2	1			6
20.	OE4-AOR	Computer Architecture and Organization	Electrical engineering and computer science	IV	3	2				6
21.	OE4-SIS	Signals and systems	Control enginnering and mechatronics, Electrical engineering and computer science	IV	2	3				6
22.	OE4-OS	Operating systems	Electrical engineering and computer science	IV	3	2	1			6
23.	OE5-DE	Digital electronics	Electrical engineering and computer science	V	3	2	1			6
24.	OE5-DOS	Digital signal processing	Electrical engineering and computer science	V	3	2				6
25.	OE5-MPS	Microprocessor systems	Electrical engineering and computer science	V	3	2	1			6
26.	OE5-RM	Computer networks	Electrical engineering and computer science	V	3	2	1			6
27.	OE5-OTK	Fundamentals of telecommunications	Electrical engineering and computer science	V	3	2				6
28.	OE5-SAU	Automatic control systems	Electrical engineering and computer science	V	3	2				6

No.	ID	Course title	Specific scientific or artistic field	Sem.	L	E	LE	RW	Other	ESPB
29.	OE6-BP	Databases	Applied informatics in engineering, Electrical engineering and computer science	VI	3	1	1			6
30.	OE6-VI	Artificial intelligence	Applied informatics in engineering, Electrical engineering and computer science	VI	3	1	1			6
31.	OE6-SI	Software engineering	Applied informatics in engineering, Software engineering	VI	3	1	1			6
32.	OE7-SP	Analog electronics†	Electrical engineering and computer science	VII	3	2				6
33.	OEE-AE	Fundamentals of machine learning‡	Electrical engineering and computer science	VII	3	2				6
34.	OEE-OMU	Electromagnetic compatibility	Electrical engineering and computer science	VII	3	2				6
35.	OEE-EMK	Digital image processing	Electrical engineering and computer science	VII	3	2				6
36.	OEE-DOS	Audio signal processing	Electrical engineering and computer science	VII	3	2				6
37.	OEE-OAS	Analog electrical filters	Electrical engineering and computer science	VII	3	2				6
38.	OEE-AEF	Human-computer interaction	Electrical engineering and computer science	VII	3	2				6
39.	OEE-IČR	Internet of things	Electrical engineering and computer science	VII	3	2				6
40.	OEE-IS	Designing of VLSI systems	Electrical engineering and computer science	VII	3	2				6
41.	OEE-PVS	Applied deep learning†	Electrical engineering and computer science	VI/VIII	3	2				6
42.	OEE-PDU	Digital systems design‡	Electrical engineering and computer science	VI/VIII	3	2				6
43.	OEE-PDS	Electromagnetics	Electrical engineering and computer science	VI/VIII	3	2				6
44.	OEE-EM	Digital signal processing systems	Electrical engineering and computer science	VI/VIII	3	2				6
45.	OEE-SDOS	Virtual instruments†	Electrical engineering and computer science	VI/VIII	3	2				6
46.	OEE-VI	Functional hardware verification‡	Electrical engineering and computer science	VI/VIII	3	2				6
47.	OEE-FVH	Real-time systems Programming	Electrical engineering and computer science	VI/VIII	3	2				6
48.	OEE-PRV	Cryptography and blockchain technologies	Electrical engineering and computer science	VI/VIII	3	2				6
49.	OEE-CBT	Optoelectronics	Electrical engineering and computer science	VI/VIII	3	2				6
50.	OEE-OPT	Fundamentals of physical electronics	Electrical engineering and computer science	VI/VIII	3	2				6
51.	OEE-OFE	Expert systems	Applied informatics in engineering	VII	3	2				6
52.	OES-ES	Design of internet applications	Applied informatics in engineering, Electrical engineering and computer science	VII	3	2				6
53.	OES-PIA	Design of mobile applications	Примењена информатика у инжењерству, Електротехника и рачунарство	VII	3	2				6

No.	ID	Course title	Specific scientific or artistic field	Sem.	L	E	LE	RW	Other	ESPB
54.	OES-PMA	Software design	Appled informatics in engineering	VII	3	2				6
55.	OES-PS	Concurrent and distributed programming	Electrical engineering and computer science	VII	3	2				6
56.	OES-KDP	Software-defined networks	Electrical engineering and computer science	VII	3	2				6
57.	OES-SDM	Computer vision	Applied informatics in engineering	VII	3	2				6
58.	OES-KV	Decision-making systems in medicine	Applied informatics in engineering	VII	3	2				6
59.	OES-SOM	Parallel computer systems	Applied computer science, Electrical engineering and computer science	VII	3	2				6
60.	OES-PRS	Design of informational systems	Applied informatics in engineering, Electrical engineering and computer science	VII	3	2				6
61.	OES-PIS	E-business	Information engineering	VII	3	2				6
62.	OES-EP	Bioengineering and bioinformatics	Bioengineering	VI/VIII	3	2				6
63.	OES-BIB	Computer graphics	Applied informatics in engineering	VI/VIII	3	2				6
64.	OES-RG	Software testing	Applied informatics in engineering	VI/VIII	3	2				6
65.	OES-TS	Software project management	Industrial engineering	VI/VIII	3	2				6
66.	OES-USP	Compiler construction	Electrical engineering and computer science	VI/VIII	3	2				6
67.	OES-PP	Advanced software architectures	Electrical engineering and computer science	VI/VIII	3	2				6
68.	OES-NSA	Cybercrimes and information security	Electrical engineering and computer science	VI/VIII	3	2				6
69.	OES-VKIB	NoSQL databases	Electrical engineering and computer science	VI/VIII	3	2				6
70.	OES-NBP	Functional programming‡	Electrical engineering and computer science	VI/VIII	3	2				6
71.	OES-FP	Fundamentals of industrial automatization	Industrial engineering	VII	3	1	1			6
72.	OEO-OIA	Design of Electronic Appliances	Production engineering, Electrical engineering and computer science	VII	3	1	1			6
73.	OEO-PEU	Finite elements 1	Applied mechanics	VII	3	1	1			6
74.	OEO-KE1	Electrotechnical materials	Production engineering	VII	3	2				6
75.	OEO-ETM	Smart materials	Production engineering	VII	3	2				6
76.	OEO-PM	Internship		VII			6			4
77.	OEO-RMU	Computer-aided measuremet and control	Control Systems and Mechatronics	VIII	3	1	1			6
78.	OEO-IS	Engineering software	Energetics and Process Techniques	VIII	3	1	1			
79.	OEO-KPI	Computer-aided engineering	Applied mechanics, Applied informatics in engineering	VIII	3	1	1			6
80.	OEO-MIP	Inovation management and entrepreneurship	Engineering management	VIII	3	1	1			6
81.	OEO-MIS	Modeling and simulations	Applied mechanics, Applied informatics in engineerin	VIII	3	1	1			6
82.	OEO-IIS	Information system engineering	Information engineering	VIII	3	1	1			6

No.	ID	Course title	Specific scientific or artistic field	Sem.	L	E	LE	RW	Other	ESPB
83.	OE8-DIR	Diploma Thesis Research Work		VIII				3		3
84.	OE8-DIO	Diploma Thesis Preparation and Defense		VIII			3			5

† will be performed in odd years

‡ will be performed in even years

UNDERGRADUATE ACADEMIC STUDIES - ELECTRICAL ENGINEERING and COMPUTER SCIENCE

FIRST YEAR								SECOND YEAR								THIRD YEAR								FOURTH YEAR							
I					II			III					IV			V					VI			VII					VIII		
1. AG **Algebra and discrete mathematics** 6 ECTS					7. AG **Analysis 1** 6 ECTS			13. AG **Analysis 2** 6 ECTS					18. TM **Engineering Statistics** 6 ECTS			23. SP **Digital Electronics** 6 ECTS					28. PA **Databases** 6 ECTS			33. PA **Module Elective Course 1** 6 ECTS					38. PA **Module Elective Course 5** 6 ECTS		
3	2	0	0		3	3	0	0		3	3	0	0		2	2	0	0		3	2	1	0		3	1	1	0		3	2	0	0		3	2	0	0
2. AG **Engineering Mechanics** 6 ECTS					8. AG **Applied Physics** 6 ECTS			14. TM **Electrical Circuit Theory** 6 ECTS					19. SP **Fundamentals of Electronics** 6 ECTS			24. SP **Digital Signal Processing** 6 ECTS					29. SP **Artificial Intelligence** 6 ECTS			34. PA **Module Elective Course 2** 6 ECTS					39 PA **Module Elective Course 6** 6 ECTS		
3	2	0	0		3	2	0	0		3	2	0	0		3	2	1	0		3	2	0	0		3	1	1	0		3	2	0	0		3	2	0	0
3. TM **Fundamentals of Electrical Engineering** 6 ECTS					9. TM **Fundamentals of Computer Engineering** 6 ECTS			15. SP **Fundamentals of Computing Systems** 6 ECTS					20. SP **Computer Architecture and Organization** 6 ECTS			25. SP **Microprocessor Systems** 6 ECTS					30. SP **Software Engineering** 6 ECTS			35. PA **Module Elective Course 3** 6 ECTS					40. PA **Module Elective Course 7** 6 ECTS		
3	3	0	0		3	2	1	0		3	2	1	0		3	2	0	0		3	2	1	0		3	1	1	0		3	2	0	0		3	2	0	0
4. TM **Fundamentals of Computer Programming** 6 ECTS					10. TM **Programming Languages** 6 ECTS			16. TM **Algorithms and Data Structures** 6 ECTS					21. SP **Signals and Systems** 6 ECTS			26. SP **Computer Networks** 6 ECTS					31. PA **Elective Course ECE-spring** 6 ECTS			36. PA **Module Elective Course 4** 6 ECTS					41. PA **Module Elective Course 8** 6 ECTS		
3	3	0	0		3	1	1	0		3	1	1	0		3	2	0	0		3	2	1	0		3	2	0	0		3	2	0	0		3	2	0	0
5. PA **Practicum in Computer Tools** 3 ECTS					11. PA **Practicum in Fundamentals of Electrical Engineering** 6 ECTS			17. SP **Object-Oriented Programming** 6 ECTS					22. SP **Operating Systems** 6 ECTS			27. SP **Elective Course** 6 ECTS					32. PA **Elective Course SE-spring** 6 ECTS			37. PA **Internship** 4 ECTS					42. PA **Diploma Thesis Research Work** 3 ECTS		
1	1	1	0		1	1	1	0		3	1	1	0		3	2	1	0		3	2	0	0		3	2	0	0							0	0	0	5
6. AG **Serbian Language** 3 ECTS					12. AG **Entrepreneurial Management Fundamentals and Economics** 3 ECTS																												43. PA **Diploma Thesis Preparation and Defense** 5 ECTS		
2	1	0	0		2	1	0	0																															
L	AE	LE	RW		L	AE	LE	RW		L	AE	LE	RW		L	AE	LE	RW		L	AE	LE	RW		L	AE	LE	RW		L	AE	LE	RW		L	AE	LE	RW
Total classes per week																																								
15	12	1	0		15	10	3	0		15	9	3	0		14	10	2	0		15	10	3	0		15	7	3	0		12	8	0	0		12	8	0	5
15		25			15		24			15		24			14		25			15		22			15		20			12		20			12		5	
15					15					14					15					15					12					12					0			
Total ECTS																																							
30 ECTS					30 ECTS					30 ECTS					30 ECTS					30 ECTS					30 ECTS					28 ECTS					32 ECTS			

Abbreviations:

L - lectures

AE - auditory exercises

LE - laboratory exercises

RW - research work

Subject Type:

AG - academic/general-education

TM - theoretical/methodological

SP - scientific/professional

PA - professional/applicative

Study programme:	Electrical Engineering and Computer Science
Course title:	Algebra and Discrete Mathematics
Instructor/Instructors:	Milica Milivojević Danas, Marija Stanić, Nenad Stojanović, Tatjana Tomović Mladenović
Subject status:	compulsory
ECTS:	6
Condition:	

Course objective

Introducing students to the basic concepts and facts of algebra and discrete mathematics necessary for studying electrical engineering and computer science.

Course outcome

Students are prepared for successful completion of advanced-level mathematical courses by equally emphasizing theoretical thinking and practical applications.

Course contents

Lectures

Relations, functions and operations.
Propositional calculus. Propositional formulas. Tautologies. Application of tautologies in reasoning. Methods for proving tautologies.
The first order calculus. The first order formulas. Interpretation of predicate formulas. Valid formulas.
Combinatorics. Permutations. Variations. Combinations. Compositions. Partitions. The Principle of Inclusion and Exclusion.
Graphs. An undirected graph. A directed graph. Digraph. Node degree. Subgraph. Partial graph. Connection of graphs. Regular graph. Complete graph. Contour. Tree. Isomorphism of graphs. The complement of a graph.
Universal algebra. Groupoid. Semigroup. A quasi-group. A group. Ring. Field. Polynomials and rational functions. Ring of polynomial. Division of polynomials. Bezu's theorem. Horner's scheme. Viet's formula. The greatest common divisor of polynomials. Euclid's algorithm. Derivative polynomial. Properties of zeros of real polynomials. Rational functions. Real rational functions. Simple rational functions. Representation of a rational function as a sum of polynomials and rational functions.
Linear algebra. Vector space. Linear dependence and independence of vectors. A vector subspace. Standard spaces. The basis and dimension of a vector space. Matrices. Submatrices. Matrix operations. Determinants. Properties of determinants. Adjoint matrix. Inversion matrix. Rank matrix. Equivalent matrices. Systems of linear algebraic equations. Kramer's formulas. Gauss method. Kronecker - Capelli's theorem. Linear operator. Eigenvalues and eigenvectors of a linear operator. Eigenvalues and eigenvectors of a square matrix. Eigenpolynomial of a square matrix. Similarity matrices. Matrix representation of the linear operator. Eigenpolynomial of a linear operator. Diagonalization of linear operator and square matrix. The minimum polynomial of a square matrix. Jordan matrices. Unitary spaces. Orthogonal and collinear vectors. Isomorphism of vector spaces. Vector spaces Rn and Cn. Euclidean space En. The angle between the vectors in En. Cartesian rectangular coordinate system in the plane and in space. Vector geometry in R3. Scalar product in R3. Vector product in R3. Mixed product in R3. Equations of the plane in R3. Equations of lines in R3. Second-order surfaces in R3.

Exercises

Corresponding tasks from the mentioned areas of theoretical teaching.

Literature

1. I. Lacković, M. Merkle, D. Cvetković, i drugi, Matematika I - algebra, Akademska misao, 2014
2. Gojko Kalajdžić, Algebra, Zavod za udžbenike, Beograd, 2011.
3. S. Lipschutz, M. Lipson, Schaum’s Outline of Theory and Problems of Linear Algebra, 3rd edition, The McGraw−Hill Companies, 2004.
4. S. Lipschutz, M. Lipson, Schaum’s Outline of Theory and Problems of Discrete Mathematics, 3rd edition, The McGraw−Hill Companies, 2007.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures and exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	70	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Engineering mechanics
Instructor/Instructors:	Nenad Grujović, Jovičić Gordana, Gordana Bogdanović, Vladimir Dunić, Dragan Rakić, Vladimir P. Milovanović
Subject status:	compulsory
ECTS:	6
Condition:	none

Course objective

Students are learning basic concepts of statics, basic physical laws of kinematics, dynamics, mechanical waves and oscillatory motion and their application to solving examples encountered in technical practice.

Course outcome

Knowing how to define and solve engineering problems based on knowledge of mechanics.

Course contents

Lectures

Types of mechanics, basic concepts of statics, connections and reactions of connections, general system of forces and couplings, reduction of the system of forces to a point, equilibrium conditions of the general system of forces and couplings.
Kinematics of a particle position vector, coordinate systems, velocity of a particle, vector of velocity and acceleration in Cartesian, polar, cylindrical and natural coordinate systems, radius of curvature of the path, tangential and normal acceleration, circular motion.
Particle dynamics: basic laws of dynamics, differential equations of motion of a material particle, rectilinear motion of a point under the influence of force, curvilinear motion of a particle, projectile motion.
Complex motion of a particle: definition of complex motion of a point, speed and acceleration of a point in complex motion, Coriolis theorem.
Laws of the dynamics of a material particle: rate of change of momentum,(linear momentum, the impulse of a force), rate of change of angular momentum (angular momentum), work-energy theorem (the work of a force, conservative forces, kinetic energy), Some special cases of movement of a material particle: motion under the influence of a central force, Kepler's laws, Newton's law of gravitation, motion of a particle under the influence of the force of gravity, satellite orbits and trajectories), forced motion of a material particle, D'Alembert's principle for a material particle.
Kinematics of a rigid body: number of degrees of freedom, types of motion of a rigid body, translation, fixed-axis rotation of a body, angular velocity and angular acceleration, plane motion of rigid body, decomposition of plane motion, velocities and accelerations of points.
Dynamics of the material system: center of mass of the system, distribution of masses and moments of inertia of masses. Steiner's theorem, the law of motion of the center of mass of a material system. Law on rate of change and conservation of linear momentum of the material system. The law of rate of change and conservation of angular momentum. Kinetic energy of a material system (Koenig's theorem), Kinetic energy for translational, plane motion and fixed axis rotation of a rigid body. Work-energy theorem for material system. Cconservation of mechanical energy. Some special cases of body motion: translational motion, fixed axis rotation, dynamic reactions in bearings, differential equation of fixed axis body rotation, physical pendulum, plane motion of a body. Impact mechanics: effect of impact forces on a material particle, ball impact in stationary surface, central collision of two spheres, effect of impact force on a fixed axis body rotating, center of impact. Motion of a body of variable mass. The equations of Meshcherski and Tsiolkovsky. Number of degrees of freedom of motion, generalized coordinates and generalized forces. The virtual displacements principle. General equation of statics and dynamics. Lagrangian equations of the second kind.
Oscillations with one degree of freedom: free oscillations without and with damping, forced oscillations without and with damping.
Waves. The basics. Wave propagation through the rod (longitudinal). Wave propagation speed.

Exercises

Solving selected problems.

Literature

1. Hibbeler, R.C., Engineering Mechanics Dynamics, Prentice Hall., 2012
2. J. L. Meriam, L. G. Kraige, Engineering Mechanics: Dynamics, Wiley, 2018
3. M. Kojić, M. Mićunović, Kinematika, Naučna knjiga, Beograd 1988.
4. M. Kojić, Dinamika, Naučna knjiga, Beograd 1975.
5. M. Kojić, Milan Mićunović, Teorija oscilacija, Naučna knjiga, Beograd

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2
Teaching methods Lectures and auditory exercises				
Knowledge assessment (maximum number of points 100)				
Pre-exam obligations	points		**Final exam**	points
colloquiums	60		oral exam	40

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of Electrical Engineering
Instructor/Instructors:	Jasna Radulović, Mina Vasković Jovanović, Marijana Gavrilović Božović
Subject status:	compulsory
ECTS:	6
Condition:	none

Course objective

Introduction to basic concepts, equations, and methods of analysis of electrostatic fields, current fields, stationary magnetic fields and electromagnetic induction. Introduction to concepts, methods of analysis, and theorems of electric circuits with direct and alternating currents.

Course outcome

The course aims to enable students to analyze practical problems in electrostatic and electromagnetic fields, as well as to master methods for efficient solution of complex linear electric circuits with direct and periodic currents.

Course contents

Lectures

Electrostatics. Coulomb's law. Electric field. Gauss's law. Electrostatic induction. Capacitors. Dielectrics in electrostatic fields.
Direct currents. Electric current. Electric circuits. Kirchhoff's first and second laws. Methods for solving electric networks. Electric networks with capacitors.
Electromagnetism. Constant magnetic field. Electromagnetic force. Biot-Savart law. Ampere's law. Law of conservation of magnetic flux. Magnetic field in material medium. Magnetic circuits. Variable electromagnetic field. Faraday's law. Inductance. Energy.
Alternating currents. Phasor and complex representation of alternating quantities. RLC circuit. Methods for solving alternating current electric networks. Three-phase systems. Transient regimes.

Exercises

Practical classes involve solving practical electrical circuits manually or with the help of software tools, as well as working on assignments and practical examples related to theoretical classes.

Literature

1. A. Đorđević: Osnovi elektrotehnike, 1. deo, Elektrostatika, Akademska misao, Beograd, 2007.
2. A. Đorđević: Osnovi elektrotehnike, 2. deo, Stalne struje, Akademska misao, Beograd, 2013.
3. A. Đorđević: Osnovi elektrotehnike, 3. deo, Elektromagnetizam, Akademska misao, Beograd, 2013.
4. A. Đorđević: Osnovi elektrotehnike, 4. deo, Kola promenljivih struja, Akademska misao, Beograd, 2013.
5. J. Radulović: Elektrotehnika sa elektronikom, Mašinski fakultet u Kragujevcu, Kragujevac, 2011.
6. Giorgio Rizzoni, James Kearns, Fundamentals of Electrical Enginnering, Second edition, McGraw Hill, 2022.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	3

Teaching methods

Theoretical lectures, exercises, and independent student work.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	20
midterm exam(s)	60	oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of Computer Programming
Instructor/Instructors:	Vladimir M. Milovanović
Subject status:	compulsory
ECTS:	6
Condition:	none

Course objective

Mastering the knowledge and skills necessary for writing and testing shorter computer programs in a high-level programming language, as well as for independently solving simpler algorithmic and computational tasks using a computer. Understanding and applying the fundamental concept of abstraction.

Course outcome

Training for independent analysis of the problem setting and performance of functional requirements, as well as the design of appropriate low-complexity algorithms and their implementation in the program code within the development environment, as well as correction of the program code with testing and debugging.

Course contents

Lectures

The idea of abstraction and allowing the programmer to think about the solution to a concrete problem rather than the low-level operations dictated by the computer hardware. Functions. Control. Higher-order functions. Recursion. Sequences. Strings. Arrays. Tuples. Sets. Dictionaries. Classes. Objects. Inheritance. Lists. Trees. Abstraction with functions and data. Exceptions. Input and output. Files. Regular expressions. Libraries.

Exercises

Practical teaching is conducted as part of auditory exercises in the computer classroom. For each topic, a set of examples and tasks with solutions is processed, with a demonstration on the computer and independent work of students on modifying and testing the program.

Literature

1. Vladimir M. Milovanović, Komponovanje računarskih programa, FIN, Kragujevac, 2021.
2. Miloš Kovačević, Osnove programiranja u Python-u, Akademska misao, Beograd 2017.
3. John V. Guttag, Introduction to Computation and Programming Using Python, 3rd edition, MIT Press, 2021
4. Harold Abelson, Gerald Jay Sussman, Martin Henz, Tobias Wrigstad, Julie Sussman, Structure and Interpretation of Computer Programs, JavaScript Edition (SICP JS), MIT Press, 2022
5. Guido van Rossum et al., Python 3 Documentation: Language/Library Reference and Tutorial, Python Software Foundation, http://docs.python.org

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	3

Teaching methods

Lectures and auditory exercises in the computer classroom.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	30	written exam	30
homework(s) and seminar(s)	10	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Practicum in Computer Tools
Instructor/Instructors:	Vladimir M. Milovanović, Marijana Gavrilović Božović, Ivan Krstić
Subject status:	compulsory
ECTS:	3
Condition:	none

Course objective

To enable students to independently use software packages in everyday engineering practice. All considered and processed computer tools are free software.

Course outcome

Students will be able to use GNU/Linux operating systems at the elementary level as well as (distributed) systems for source code management and version control, to correctly arrange and edit text and insert equations and images into it, to draw electrical schematics, to draw diagrams function and visualize data, to use free software packages for numerical and symbolic calculations.

Course contents

Lectures

Software, licenses, proprietary and free software. Operating systems. GNU/Linux operating systems. Graphical user environments. Installing the operating system. Installing the program. Work in a graphical user environment. Command line. Text editors. Scripts and automation. Source code management. Git. Text processing and typesetting. LaTeX. Graphic formats, vector and raster graphics. Drawing electrical circuit schematics. Plotting of function diagrams. Programs for numerical calculations. Programs for symbolic computation.

Exercises

Teaching in a laboratory or computer classroom in the form of a workshop.

Literature

1. William Shotts, The Linux Command Line: A Complete Introduction, 2nd edition, No Starch Press, 2019.
2. Scott Chacon, Ben Straub, Pro Git, second edition, Apress 2014., http://git-scm.com/book/en
3. Wikibook Contributors, "LaTeX", http://en.wikibooks.org/wiki/LaTeX
4. Massimo Redaelli, Stefan Lindner, Stefan Erhardt, Romano Giannetti, CircuiTikZ manual, Package Documentation www.ctan.org/pkg/circuitikz
5. John Eaton, David Bateman, Søren Hauberg, Rik Wehbring, GNU Octave, http://docs.octave.org
6. SymPy Development Team, SymPy Documentation, http://docs.sympy.org

Hours per week of active teaching	**Lectures:** 1	**Exercises:**	2

Teaching methods

Presentations, video lessons and hands-on teaching in the computer classroom.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical classes and projects	10	written exam	30
midterm exam(s)	30		
homework(s) and seminar(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	English language
Instructor/Instructors:	Sandra Stefanović, Neda Vidanović Miletić
Subject status:	compulsory
ECTS:	3
Condition:	none

Course objective

The objective of this course is for students to acquire professional vocabulary, master grammar units and express themselves independently in an oral and written form.

Course outcome

To enable students to use foreign professional literature (in English), as well as to present the results of their work and research in English for specific purposes.

Course contents

Lectures

Analysis of a certain number of texts related to the field of study. Introduction to specific structures of the technical vocabulary. Vocabulary expansion with technical terms. Usage of professional literature and dictionaries. Analysis of the selected topics: history of software, software engineering, software paradigms, artificial intelligence, electronics and electrical engineering, drones, bitcoins, robotics, engineering of the future, industry 4.0.

Exercises

Revision of grammatical structures.

Literature

1. Sandra Stefanovic (2022). English for Engineers, Faculty of Engineering, Kragujevac, ISBN 978-86-6335-097-7
2. John C. Rigdon (2016). Dictionary of Computer and Internet Terms, Published by: Eastern Digital Resources
3. Douglas Downing, Michael Covington, Melody Covington (2020). Dictionary of Computer and Internet Terms, ISBN 978-1438008783
4. Darko Kovačević (2021). English Language for Electrical Engineers 1, Faculty of Electrical Engineering, Univesity of East Sarajevo, Akademska misao Beograd, ISBN: 978-86-7466-905-1

Hours per week of active teaching	**Lectures:**	2	**Exercises:** 1

Teaching methods

Classical frontal teaching combined with group and individual approach with the use of modern teaching resources. Knowledge testing will be conducted via tests and seminar papers.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	10	written exam	30
midterm exam(s)	30	oral exam	
homework(s) and seminar(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Analysis 1
Instructor/Instructors:	Milica Milivojević Danas, Marija Stanić, Nenad Stojanović, Tatjana Tomović Mladenović
Subject status:	compulsory
ECTS:	6
Condition:	no

Course objective

Introducing students to the basic concepts and facts of mathematical analysis necessary for studying electrical engineering and computer science.

Course outcome

Students are prepared for successful completion of advanced-level mathematical courses by equally emphasizing theoretical thinking and practical applications.

Course contents

Lectures

The cardinal number of the set.
Real and complex numbers. Order in the set of real numbers. Some inequalities. Complex numbers. Elementary functions.
Sequences and sets of real numbers. Sequences limit value. Properties of convergent sequences. Infinite limit values. Two theorems about sequences. Monotonic sequences. Subsequences and stacking points of sequences. The Cauchy criterion of sequences convergence. Open, closed and compact sets of real numbers.
Functions: Limit value and continuity. Limit value of functions. The relation between the limit value of sequences and functions. Continuity of function. Continuous functions on compact sets. Even continuity. Speed of convergence and infinitesimal size.
Differential calculus. Definition of derivative and differential and their geometric and mechanical meaning. Basic rules for calculating derivatives and differentials. Theorems about the mean value in differential calculus. Derivatives and differentials of higher orders. Lopital's rules. Taylor's formula. Examining functions using the differential calculus method.
Integrals. Area calculation problem and definition of integral. Primitive function and indefinite integral. Basic methods of integration. Integration of rational functions. Integration of some irrational functions. Integral sums and the definite integral. The connection between the definite and the indefinite integral. Properties of the definite integral. Applications of the definite integral. Improper integral.
Number series. Series with non-negative terms. Series with terms of arbitrary sign and alternate rows. Functional series. Introduction. Uniform convergence of series of functions. Uniform convergence of series.
Differential equations. Basic terms. The Cauchy problem and the existence of a solution. Differential equations of the first order. An equation that separates the variables. Homogeneous differential equation. Linear differential equation. Bernoulli's differential equation. Lagrange's, Clair's and Riccati's differential equation. Total differential equation. Some second-order differential equations. Higher-order differential equations that can be reduced in order. Higher order linear differential equations.
Orthogonal polynomials. Classical orthogonal polynomials.

Exercises

Corresponding tasks from the specified areas of theoretical teaching.

Literature

1. Milan Merkle, Matematička analiza - teorija, primeri, zadaci, Računarski fakultet, 2006.
2. Milan Merkle, Matematička analiza -teorija i hiljadu zadataka, Akademska misao 2018.
3. Erwin Kreyszig, Advanced Engineering Mathematics, JOHN WILEY & SONS, INC., ISBN 978-0-470-45836-5
4. Michael Oberguggenberger, Alexander Ostermann, Analysis for Computer Scientists - Foundations, Methods, and Algorithms, Springer London Dordrecht Heidelberg New York, 2011.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	3

Teaching methods

Lectures, exercises, consultations

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	
midterm exam(s)	70	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Applied Physics
Instructor/Instructors:	Slobodan Savić, Novak Nikolić, Marijana Gavrilović Božović
Subject status:	compulsory
ECTS:	6
Condition:	none

Course objective

Mastering physical concepts related to optics, atomic and semiconductor physics, fluid mechanics, and thermodynamics through familiarization with the principles of operation of optical, electronic, thermal, and hydrodynamic devices used in sensors, information transmission, lighting and image formation, measurements, energy sources, and conversion. Positioning physics in modern technology.

Course outcome

Understanding the nature of light and its role in the implementation of sensors and information transmission systems. Mastering the fundamentals of 20th-century physics through the application of semiconductor devices and atomic radiation. Acquiring engineering skills in calculations of heat and work exchanged during changes of state in different materials (ideal and real fluids). Understanding and analyzing reversible and irreversible cyclic processes, the principles of operation of heat engines and pumps, gas and steam turbine plants, and refrigeration systems.

Course contents

Lectures

Laws of wave and geometrical optics; illumination; optical fibers, cameras. Elements of modern physics; atomic and nuclear structure; pn junction; lamps, lasers, LEDs; solar cells, image sensors; radioactive sensors. Fluid statics and dynamics; viscosity; sensors; thermodynamic system; state variables; ideal and real gas; first and second laws of thermodynamics; polytropic changes of ideal gases; reversible and irreversible changes of state; reversible and irreversible cyclic processes.

Exercises

General problem-solving techniques implemented through computational exercises aimed at enabling students to identify the basic elements of problems, utilize them to formulate and solve physical-mathematical models, efficiently verify solutions, and eliminate errors.

Literature

1. P. Marinković, P. Mihailović, Odabrana poglavlja fizike, Optika i toplota, Akademska misao, 2017.
2. K. Nikolić, P. Marinković, J. Cvetić: Fizika zbirka rešenih zadataka, DN Centar, Beograd 2014.
3. Obrović, B., Savić, S.: Zbirka rešenih zadataka iz Mehanike fluida - osnovni kurs, Mašinski fakultet, Kragujevac, 2011.
4. Bojić, M., Termodinamika, Mašinski fakultet u Kragujevcu, Kragujevac, 2011.
5. Nikolić, N., Nikolić, D., Termodinamika: zbirka rešenih zadataka, Fakultet inženjerskih nauka Univerziteta u Kragujevcu, Kragujevac, 2020.
6. Çengel, Y. A., Boles, M. A., Thermodynamics: An Engineering Approach, 5th edition, McGraw-Hill College, Boston, USA, 2006.
7. Borgnakke, C, Sonntag, R. E., Fundamentals of Thermodynamics, 8th edition, John Wiley & Sons, Inc., New Jersey, USA, 2012.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Theoretical lectures, exercises, and independent student work.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	60	written exam	20
Homework assignments and seminars		oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of Computer Engineering
Instructor/Instructors:	Mina Vasković Jovanović, Ivan Krstić
Subject status:	compulsory
ECTS:	6
Condition:	None

Course objective

To familiarize students with Boolean algebra, switch functions, switching networks, logical and memory elements, and combinational and sequential modules.

Course outcome

Upon completion of the course, students will be able to: understand the structure of switching networks, perform analysis and synthesis of combinational and sequential networks, and use combinational and sequential modules.

Course contents

Lectures

Number systems and codes. Number representation in computer systems. Boolean algebra. Switching functions. Minimization of switching functions. Functions and structure of switching networks. Logical elements. Memory elements. Structure, analysis, and synthesis of combinational and sequential switching networks. Standard combinational modules. Standard sequential modules.

Exercises

Examples of switching function minimization, analysis and synthesis of combinational and sequential networks. Designing flip-flops. Analysis of networks with standard combinational modules (multiplexer, demultiplexer, priority encoder, decoder, incrementer, decrementer, comparator, adder, and subtractor). Designing registers, counters, and memory of a specific capacity. Simulation of modules using a visual simulator: multiplexer, demultiplexer, decoder, encoder, shifter, incrementer, decrementer, serial carry adder, carry lookahead adder, arithmetic unit, logic unit, arithmetic-logic unit, comparator, register, and counter. Designing a network using the mentioned modules.

Literature

1. Đorđević J., Radivojević Z., Punt M., Protić J., Stanisavljević Ž.: Osnovi računarske tehnike, Akademska misao, Beograd, 2017, ISBN 978-86-7466-669-2
2. Đorđević J., Radivojević Z., Drašković D., Stanisavljević Ž., Punt M., Milenković K.: Osnovi računarske tehnike - Prekidačke mreže - Zbirka rešenih zadataka, Akademska misao, Beograd, 2016, ISBN 978-86-7466-587-9
3. Introduction to Computer Science, ITL Education Solutions Limited, Dorling Kindersley, India, 2011, ISBN 9788131760307
4. Elahi, A., Computer Systems: Digital Design, Fundamentals of Computer Architecture and ARM Assembly Language. Switzerland, Springer International Publishing, 2022, ISBN 9783030934484

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	3

Teaching methods

Lectures, computational exercises, and laboratory exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	20	written exam	30
midterm exam(s)	50	oral exam	

Study programme:	Electrical Engineering and Computer Science
Course title:	Programming Languages
Instructor/Instructors:	Nenad Grujović, Velibor Isailović
Subject status:	compulsory
ECTS:	6
Condition:	no condition

Course objective

Familiarization with modern programming languages. Programming with connection to databases in an Internet environment. Training to work in teams on designing and programming real software projects.

Course outcome

Development of standard and advanced procedural console applications using the C programming language, object-oriented software using the C++ programming language, and installation and configuration of the necessary components for the development and implementation of applications in the Internet environment using databases.

Course contents

Basic terms. Procedural programming - Programming language C. Object-oriented programming (OOP) - Programming language C++. Programming in the Internet environment. WEB servers. WEB programming. Programming for databases. Latest trends and development environments: NET, QT, IoT.

Literature

1. Hensen A.: Programiranje na jeziku C, Mikroknjiga, Beograd, 1995.
2. Milićev D.: Objektno orijentisano programiranje na jeziku C++, Mikroknjiga, Beograd, 1995
3. Bjarne Stroustrup, The C++ Programming Language, 4th Edition 4th Edition, Addison-Wesley Professional, May 9, 2013, ISBN 978-0275967307

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Teaching is in the form of lectures and exercises in the computer classroom. The teaching material is available in electronic form on the LMS system. Tests are taken through the automatic system testing within the LMS.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	
midterm exam(s)	40	oral exam	30
homework(s) and seminar(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Practicum in fundamentals of electrical engineering
Instructor/Instructors:	Jasna Radulović, Mina Vasković Jovanović, Marijana Gavrilović Božović
Subject status:	compulsory
ECTS:	3
Condition:	none

Course objective

Introduction to basic concepts, equations, and methods of analysis of electrostatic fields, current fields, stationary magnetic fields and electromagnetic induction. Introduction to concepts, methods of analysis, and theorems of electric circuits with direct and alternating currents.

Course outcome

The course aims to enable students to analyze practical problems in electrostatic and electromagnetic fields, as well as to master methods for efficient solution of complex linear electric circuits with direct and periodic currents.

Course contents

Lectures

Electrostatics. Coulomb's law. Electric field. Gauss's law. Electrostatic induction. Capacitors. Dielectrics in electrostatic fields.
Direct currents. Electric current. Electric circuits. Kirchhoff's first and second laws. Methods for solving electric networks. Electric networks with capacitors.
Electromagnetism. Constant magnetic field. Electromagnetic force. Biot-Savart law. Ampere's law. Law of conservation of magnetic flux. Magnetic field in material medium. Magnetic circuits. Variable electromagnetic field. Faraday's law. Inductance. Energy.
Alternating currents. Phasor and complex representation of alternating quantities. RLC circuit. Methods for solving alternating current electric networks. Three-phase systems. Transient regimes.

Exercises

Practical classes involve solving practical electrical circuits manually or with the help of software tools, as well as working on assignments and practical examples related to theoretical classes.

Literature

1. A. Đorđević: Osnovi elektrotehnike, 1. deo, Elektrostatika, Akademska misao, Beograd, 2007.
2. A. Đorđević: Osnovi elektrotehnike, 2. deo, Stalne struje, Akademska misao, Beograd, 2013.
3. A. Đorđević: Osnovi elektrotehnike, 3. deo, Elektromagnetizam, Akademska misao, Beograd, 2013.
4. A. Đorđević: Osnovi elektrotehnike, 4. deo, Kola promenljivih struja, Akademska misao, Beograd, 2013.
5. J. Radulović: Elektrotehnika sa elektronikom, Mašinski fakultet u Kragujevcu, Kragujevac, 2011.
6. Giorgio Rizzoni, James Kearns, Fundamentals of Electrical Enginnering, Second edition, McGraw Hill, 2022.

Hours per week of active teaching	**Lectures:** 1	**Exercises:** 2

Teaching methods

Theoretical lectures, exercises, and independent student work.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical training	60	written exam	40

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of entrepreneurship management and economy
Instructor/Instructors:	Aleksandar Aleksić, Snežana Nestić
Subject status:	compulsory
ECTS:	3
Condition:	

Course objective

The objective of the course is to provide an understanding of the basic concepts of management and economics, as well as the acquisition of basic entrepreneurial knowledge and skills - necessary for initiating an entrepreneurial spirit and creating the basis for lifelong education in the field of entrepreneurship.

Course outcome

The student should develop and/or improve basic entrepreneurial skills - with special emphasis on the elements of initiative, creativity, innovation, the ability to analyze and evaluate ideas, the ability to work in a team, and communication skills. The student should understand the basic concepts of macro and microeconomics, the basic elements and techniques of management, leadership, entrepreneurship, the differences between leaders, entrepreneurs, and managers, and the basic stages of the development of an entrepreneurial venture - from idea to realization.

Course contents

Lectures

Basics of entrepreneurship. Creativity and innovation. Entrepreneurial opportunity. Preparing a business plan. Financing of an entrepreneurial venture. Basic elements and techniques in management. Leadership. Motivation. Teams and corporate culture. Corporate social responsibility and business ethics. Basic economic terms and principles. Basic principles of the market economy. Supply, demand, and price formation. Production and costs. National income. Economic growth. Labor force and labor market.

Exercises

Exercises is executed as auditory exercises, with preparation and defending of the team's project (the development and presentation of the business idea).

Literature

1. Levi Jakšić M., Marinković S., Petković J., Rakićević J., Jovanović M., Tehnološko preduzetništvo, Fakultet organizacionih nauka, Univerzitet u Beogradu, Beograd, 2018.
2. Babić M., Ninković R., Preduzetništvo, teorija proces i praksa, Mašinski fakultet u Kragujevcu i Unija poslodavaca Srbije, 2007.
3. Aleksić, A. Nestić, S., Savković, M., Mijović, N. Komatina, N. Cvetić, T., Osnovi preduzetničkog menadžmenta i ekonomije – Praktikum, Fakultet inženjerskih nauka, Univerzitet u Kragujevcu, 2021.
4. Mankju G. Principi ekonomije, 3 izdanje, Ekonomski fakultet Beograd, 2008.
5. Van den Ende, Jan. Innovation Management. Bloomsbury Publishing, 2021.

Hours per week of active teaching	**Lectures:**	2	**Exercises:**	1	

Teaching methods

Teaching is comprised of lecturing and auditory exercises. A method of teaching is foreseen to place students in the position of active participants in the acquisition and creative use of knowledge. This includes: lectures with the use of multimedia tools, guest lecturers from the ranks of successful entrepreneurs (especially former students of the faculty), group activities of students, and the use of Internet resources. Fulfillment of all student obligations is executed through lecturing and auditory exercises with the consultation of teachers and associates.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	10	written exam	30
midterm exam(s)	30	oral exam	
projects	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Analysis 2
Instructor/Instructors:	Milica Milivojević Danas, Marija Stanić, Nenad Stojanović, Tatjana Tomović Mladenović
Subject status:	compulsory
ECTS:	6
Condition:	/

Course objective

Introducing students to the basic concepts and facts of mathematical analysis necessary for studying electrical engineering and computer science.

Course outcome

Students are prepared for successful completion of advanced-level mathematical courses by equally emphasizing theoretical thinking and practical applications.

Course contents

Lectures

Real functions of several independent variables. Metric spaces. Limit and continuity. Differential calculus of functions of several variables. Partial derivatives. Rules of differentiation, differentiability of composite functions. Mean value theorem. Higher order partial derivatives. Taylor formula. Local extrema. Conditional extrema.

Multiple integrals. Jordan measure. n-integral. Darboux sums. Properties of n-integral. Double integrals, triple integrals. Change of variables. Application of integrals.

Line and surface integrals. Line integrals of the first and second kind: definition, properties, calculation. Independence of path, Green's theorem. Surface integrals of the first and second kind: definition, properties, calculation. Stokes' formula, Gauss-Ostrogradsky formula.

Field theory. Vector function, derivative of vector function, scalar field, directional derivative, gradient, vector field, divergence, rotor, classification of vector fields.

Complex analysis. Complex numbers. Properties of the complex plane. Complex functions. Properties of complex functions. Taylor and Laurent series. Definition and types of isolated singularities. Residue. Application of residue for integral calculation.

Systems of differential equations. Normal systems of differential equations. Laplace transformation.

Introduction to numerical analysis. Theory of errors. Interpolation of functions. Numerical differentiation. Numerical integration (Newton-Cotes formulas, Gaussian quadrature formulas). Numerical methods for solving nonlinear equations and systems (Newton's method, secant method, interval halving method, Newton-Kantorovich method). Numerical methods of linear algebra (factorization methods, Jacobi method, Gauss-Seidel method).

Exercises

Corresponding tasks from the mentioned areas of theoretical teaching.

Literature

1. Milan Merkle, Matematička analiza - teorija, primeri, zadaci, Računarski fakultet, 2006.
2. Milan Merkle, Matematička analiza -teorija i hiljadu zadataka, Akademska misao 2018.
3. Erwin Kreyszig, Advanced Engineering Mathematics, JOHN WILEY & SONS, INC., ISBN 978-0-470-45836-5
4. Michael Oberguggenberger, Alexander Ostermann, Analysis for Computer Scientists - Foundations, Methods, and Algorithms, Springer London Dordrecht Heidelberg New York, 2011.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	3

Teaching methods

Lectures, exercises, consultations

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	70	oral exam	30

Study Programme:	Electrical Engineering and Computer Science
Course title:	Electrical circuit theory
Instructor/Instructors:	Jasna Radulović, Marijana Gavrilović Božović, Ivan Krstić
Subject status:	compulsory
ECTS:	6
Condition:	none

Course objective

Presenting fundamental knowledge of the theory of electrical circuits from the perspective of electrical engineering professionals and researchers. Building the basic understanding of analog signal processing using electrical circuits.

Course outcome

Understanding the basic concepts and gaining insights into the physical processes described by electrical circuits and their corresponding mathematical models. Recognizing, formulating, and modeling problems, and finding engineering solutions based on the theory of electrical circuits in various fields of electrical engineering.

Course contents

Lectures

Electric elements, circuits, and networks. Application of matrices and graphs in circuit analysis. Basic elements of an electrical circuit. Elements with multiple ports. Complex periodic steady-state response. Natural frequencies of circuits, resonance, and anti-resonance. Analysis of electrical circuits in transient regime in the time domain using differential equations and classical solving methods. Laplace transform. Inverse Laplace transform. Analysis of electrical circuits using Laplace transform. Analysis of circuits with distributed parameters. Transmission lines. Polyphase systems. Three-phase electrical circuits. Computer-aided analysis of electrical circuits.

Exercises

Exercises and practical examples related to theoretical instruction. Solving practical electrical circuits manually or using software tools (circuit analysis tools: LTSpice; numerical modeling tools: Octave, Scilab, Maxima). Laboratory exercises related to theoretical instruction.

Literature

1. B. Rejlin, Theory of Electrical Circuits I, Circuit Analysis in the Time Domain, 7th edition, Akademska misao, 2009
2. B. Rejlin, Theory of Electrical Circuits II, Circuit Analysis in the Frequency Domain, 5th edition, Akademska misao, 2009.
3. Miodrag Gmitrović, Radmila Petković, Theory of Electrical Circuits - Problem Collection, 2nd edition, University of Niš, Faculty of Electronic Engineering, 1999.
4. M. Potrebić, D. Tošić, Collection of Exam Problems in Theory of Electrical Circuits, Akademska misao, 2012.
5. Nilsson, J.W., Reidel, S.A., Electric Circuits, Prentice Hall, 2001.
6. Anant Agarwal, Jeffrey Lang, Foundations of Analog and Digital Electronic Circuits, Elsevier, 2005.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Theoretical lectures, exercises, and independent student work.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	60	written exam	20
Homework assignments and seminars		oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of Computer Systems
Instructor/Instructors:	Mina Vasković Jovanović, Milan Čabarkapa
Subject status:	compulsory
ECTS:	6
Condition:	None

Course objective

Acquisition of basic engineering knowledge about processor architecture and organization, and familiarization with the procedures for designing digital systems.

Course outcome

Acquired basic knowledge about the architecture of digital computers: representation of data and instructions in a computer, microoperations, structure of the main memory, processor, and control unit. Introduction to the stack model, processor functions, and interrupt structures.

Course contents

Lectures

Design of digital systems. Unit structure and interconnection. Computer structure. Memory. Processor. Input/output system. Bus. Program model. Data types. Instruction formats. Addressing modes. Instruction set. Interrupts. Organization. ALU - direct connections. Control unit - hardwired/microprogrammed implementation.

Exercises

Solving tasks and practical examples related to the theoretical teaching.

Literature

1. Đorđević J., Radivojević Z., Punt M., Protić J., Stanisavljević Ž.: Fundamentals of Computer Engineering, Akademska misao, Belgrade, 2017, ISBN 978-86-7466-669-2
2. Đorđević J., Radivojević Z., Punt M., Protić J., Milicev D., Milenković A., Nikolić B.: Fundamentals of Computer Engineering: Device Design - Collection of Solved Problems, Akademska misao, Belgrade, 2017, ISBN 978-86-7466-689-0
3. Elahi, A., Computer Systems: Digital Design, Fundamentals of Computer Architecture and ARM Assembly Language. Switzerland, Springer International Publishing, 2022, ISBN 9783030934484

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	3

Teaching methods

Lectures, computational exercises, and laboratory exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	20	written exam	30
midterm exam(s)	50	oral exam	

Study programme:	Mechanical Engineering, Electrical Engineering and Computer Science
Course title:	Algorithms and Data Structures
Instructor/Instructors:	Nenad Filipović, Velibor Isailović
Subject status:	compulsory
ECTS:	6
Condition:	Basics of programming, Mathematical analysis

Course objective

The goal of the course is to familiarize students with the basics of algorithms and data structures in such a way that they can independently solve mathematical and physical problems in any programming language.

Course outcome

After mastering the program and passing the exam in the Algorithms and Data Structures course, candidates will be able to independently solve complex algorithmic tasks in the field of programming as well as interpret software source codes developed in a standard way. They will also be able to successfully follow subjects from the field of informatics, which are naturally linked to the work of algorithms and the organization of data structures.

Course contents

Lectures

Basic terms in algorithms and data structures. Complexity of algorithms, loops, recursion. Memory principles. Data structures, classes, structures, class inheritance. Sorting. Searching. Binary trees, balanced trees. Linear data structures. Algorithms with graphs, Ford, Dijkstra. Data coding, data compression. Numerical algorithms. Parsers. String matching, lexical and syntactic analysis. Random process generators. Algorithms in computer graphics, OpenGL.

Exercises

Corresponding tasks from the mentioned areas of theoretical teaching.

Literature

1. Filipović, N., Algoritmi i strukture podataka, Mašinski fakultet Kragujevac, 2010.
2. Urošević, D.,Algoritmi u programskom jeziku C, Mikroknjiga, Beograd,1996.
3. Filipović, N., Programski jezik C, Tehnički fakultet Čačak, 2003.
4. Bowman, Charles F. Algorithms and data structures: an approach in C. Saunders College Publishing, 1994.
5. Salaria, R. S. Data Structures & Algorithms Using C++. Khanna Publishing House, 2004.

Hours per week of active teaching	**Lectures:**	3	**Exercises:** 2

Teaching methods

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	10	written exam	60
homework(s) and seminar(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Object Oriented Programming
Instructor/Instructors:	Nenad Grujović, Velibor Isailović
Subject status:	compulsory
ECTS:	6
Condition:	no condition

Course objective

Understanding and mastering of the basic principles of object-oriented programming, such as abstraction, encapsulation, inheritance and polymorphism. Understanding the concepts of exception throwing and handling. Understanding the concept of generic classes, interfaces and methods. Acquiring the skill of object-oriented programming in the Java language.

Course outcome

Upon successful completion of the course, students will be able to:
- interpret and apply the paradigm of object-oriented programming in the Java language;
- demonstrate the principles of object-oriented programming in the Java language;
- solve practical problems in the Java language;

Course contents

Lectures

An overview of object oriented programming concepts in the Java language. Classes, interfaces, packages. Constructors. Static members. Nested data types. Local and anonymous classes. Lambda expressions. Abstract classes. Class inheritance and interface implementation. Polymorphism, static and dynamic binding. Exceptions. Generic classes, interfaces and methods. Collections. Graphical user interfaces. Threads and concurent programming.

Exercises

Practical exercises, laboratory demonstrative exercises, laboratory control exercises. Homework.

Literature

1. Schildt H.: Java JDK9: Kompletan priručnik, prevod 10. izdanja, Mikro knjiga, Beograd, 2018, ISBN: 978-86-7555-428-8
2. Schildt H.: Java: The Complete Reference, Tenth Edition, McGraw-Hill, October 2017,ISBN: 9781259589348

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises and laboratory exercises on the computer.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	35	oral exam	30
homework(s) and seminar(s)	35		

Study programme:	Electrical Engineering and Computer Science
Course title:	Engineering statistics
Instructor/Instructors:	Danijela Tadić, Dobrivoje Ćatić
Subject status:	compulsory
ECTS:	6
Condition:	none

Course objective

Course objective is the understanding of the concept of processing data obtained from evidence or by measurement using statistical methods.

Course outcome

The student should know modelling of uncertainties using probability theory. The student should know how to determine confidence intervals and test hypotheses for statistical parameters calculated on a given set of data. In the case when it is not possible to determine statistical parameters on a given set of data, the student should know how to test the dependence of variables using non-parametric hypotheses. The student should be able to analytically describe the dependence of two or more variables as well as to test their strength using regression and correlation analysis.

Course contents

Lectures

Combinatorics. Basic consideration of probability theory (definitions of probability, conditional probability, total probability theorem, Bayes formula). Discrete random variable (binomial distribution, Poisson distribution). Continuous random variable (normal distribution, unit normal distribution, multidimensional random variables, laws of large numbers, Central Limit Theorem). The samples (the term of population, term of sample, frequency distribution, measures of concentration and measures of dispersion). The confidence intervals for basic and derived statistical parameters for large and small samples. Parametric hypothesis testing for basic and derived statistical parameters for large and small samples. Testing of non-parametric hypotheses. Regression and correlation analysis.

Exercises

Computational exercises

Literature

1. D. Tadić (2020), Statistika, primena u inženjerstvu i menadžmentu. Fakultet inženjerskih nauka.
2. M. Merkle (2020), Verovatnoća i statistika za inženjere i studente tehnike, Akademska misao.
3. SONG, T. T., Fundamentals of Probability and Statistics for Engineers, State University of New York at Buffalo, Buffalo, New York, USA, John Wiley & Sons, Ltd, 2004, ISBN: 978-0-470-86815-7.
4. MASON, Robert, LIND, Douglas, MARCHAL, William, Statistical Techniques in Business and Economics, McGraw-Hill Companies, Inc. for manufacture and export, 1999, ISBN 0-07-303935-7.

Hours per week of active teaching	**Lectures:** 2	**Exercises:**	2

Teaching methods

The theoretical part is performed using a presentation and on the table. The exercises are carried out in the computer classroom on the blackboard and using Excel (Data Analysis).

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	30
midterm exam(s)	50	oral exam	
homework and seminars	15		

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of Electronics
Instructor/Instructors:	Vladimir M. Milovanović, Marijana Gavrilović Božović
Subject status:	compulsory
ECTS:	6
Condition:	Fundamentals of Electrical Engineering

Course objective

Introduction to semiconductor physics and familiarization with the principles of operation of semiconductor devices, as well as models, primarily diodes and MOS field-effect transistors. Enabling students to independently analyze, design and implement simple analog and digital circuits in discrete and integrated technology, and to independently perform stimulation and measurements in the laboratory using an oscilloscope.

Course outcome

Students trained to independently analyze, design and implement simple analog and digital electronic circuits, as well as to perform the necessary measurements in the laboratory. Students prepared for further education and listening of more advanced courses in the field of analog and digital electronics.

Course contents

Lectures

Fundamentals of semiconductor physics. PN junction. Diode. MOS field effect transistor. Bipolar and junction field-effect transistor. Basic amplifier couplings and single-stage amplifiers. Inverter. Implementation and realization of basic combinational logic circuits at the transistor level. Current mirrors and active loads. Differential amplifiers. Multistage amplifiers (cascade and cascode). Operational amplifier. Circuits with operational amplifiers. Schmitt trigger and comparators. Bistable, monostable and astable circuits. Multivibrators and generators of linear time bases.

Exercises

Examples of analysis and synthesis of basic and complex electronic circuits.

Literature

1. Slavoljub Marjanović, Elektronika 1 - komponente i kola, Akademska misao, Beograd, 2004.
2. Vančo Litovski, Osnovi elektronike: teorija, rešeni zadaci i ispitna pitanja, Akademska misao, 2006.
3. Radivoje Đurić, Osnovi elektronike: zbirka rešenih problema, 3. izdanje, Akademska misao, 2017.
4. Anant Agarwal, Jeffrey Lang, Foundations of Analog and Digital Electronic Circuits, Elsevier, 2005
5. R. Jacob Baker, CMOS: Circuit Design, Layout, and Simulation, 4th edition, Wiley-IEEE Press, 2019.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and auditory exercises in the classroom, as well as laboratory exercises in the laboratory.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical teaching (lab. exercises)	10	written exam	30
midterm exam(s)	30	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Computer architecture and organization
Instructor/Instructors:	Zoran Babović
Subject status:	compulsory
ECTS:	6
Condition:	None

Course objective

Introduction to architecture of RISC and CISC microporocessors, system bus, input/output system, and memory system.

Course outcome

Upon completion of the course, students will be able to understand the architecture and organization of processors,
buses, input/output system and memory system, as well as to use the literature for further studies in this field.

Course contents

Lectures

RISC and CISC processor architecture. Programming model. Data types. Instruction formats. Addressing modes. Instruction set architecture. Interrupt mechanism. System bus. Bus arbitration. Buses with atomic and split cycles. Multiple system buses. Input/output systems. Peripherals and peripheral controllers. Input/output programming. Interrupt handling - vectored and polled approach. Memory systems. Cache memory, associative, set-associative, and direct mapping. Main memory update techniques in cache memory, write-back, write-through, block fetching techniques including write-allocate, and write-no-allocate. Virtual memory with page organization.TLB unit.

Exercises

CISC and RISC processor architecture. Programming model. Data types. Instruction formats. Addressing modes. Instruction set architectures. Interrupt mechanism. Interrupt priorities. System bus. System bus cycles. Input/output. Peripherals and peripheral controllers. Programming the data block transfer from input/output. Interrupt handling - vectored and polled approach. Cache memory. Virtual memory

Literature

1. Jovan Đorđević, "Arhitektura računara", Skripta, Elektrotehnički fakultet u Beogradu
2. Jovan Đorđević, "Arhitektura računara - Edukacioni računarski sistem", Akademska misao, 2018.
3. A. Tanenbaum, Arhitektura i organizacija računara, Mikro knjiga, Beograd, 2007.
4. D. A. Patterson, J. L. Hennessy,"Computer Organization and Design: The Hardware/Software Interface," 5th Edition, Morgan Kaufmann, 2013.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Realization of teaching according to the model of interactive teaching with the use of practical work methods.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	40
midterm exam(s)	40	oral exam	
homework(s) and seminar(s)	15		

Study programme:	Electrical Engineering and Computer Science
Course title:	Signals and systems
Instructor/Instructors:	Milan Matijevic
Subject status:	compulsory
ECTS:	6
Condition:	-

Course objective

Introducing students to the fundamentals of modeling continuous and discrete systems, as well as characterizing continuous and discrete signals. Understanding the basic tools for signal and system analysis in the time, frequency, and complex domains.

Course outcome

After completing this course, students will have the basic skills to classify and analyze measured experimental data, perform basic experiments on systems, and apply basic tools for signal processing (such as Fourier series, Fourier transformation, Laplace transformation, Z transformation).

Course contents

Lectures

Theoretical lectures cover the classification of signals and systems, system properties, Fourier series of signals, Fourier transformation, Bode diagrams, Laplace transformation of signals, transfer function, stability and causality of continuous and discrete LTI systems, Z transformation of signals, theorem on the sampling of continuous signals, discrete transfer function, modeling, analysis, and synthesis of LTI systems.

Exercises

In practical exercises, students are required to complete tasks with the assistance of a teaching assistant and independently using the MATLAB software package.

Literature

1. Oppenheim A., Willsky A.: Signals and Systems, 2nd ed. Prentice Hall, 1996, ISBN 978-0138147570
2. Phillips C., Paar J., Riskih R.: Signals, Systems, and Transforms, Prentice Hall, 2003, ISBN 978-0131989238
3. http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-003-signals-and-systemsfall-2011

Hours per week of active teaching	**Lectures:** 2	**Exercises:**	3

Teaching methods

Lectures, auditory exercises and laboratory exercises on the computer.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	0	written exam	
midterm exam(s)	40	oral exam	40
Lab projects	20		

Study programme:	Electrical Engineering and Computer Science
Course title:	Operating Systems
Instructor/Instructors:	Milan Čabarkapa
Subject status:	compulsory
ECTS:	6
Condition:	/

Course objective

To familiarize students with the purpose and functions of operating systems, as well as the fundamental principles of their operation, design, and implementation.

Course outcome

After completing the course, the student will acquire fundamental knowledge of concepts, algorithms, principles, problems, and solutions related to operating systems in general, without being specific to any particular operating system. Students will be able to understand and use existing systems, as well as independently design and implement their own specialized systems.

Course contents

Lectures

Process management. Processes and threads. Synchronization and communication between processes. Memory management. Address binding. Memory sharing. Organization and allocation of memory. Virtual memory. Input/output subsystem. System I/O services. I/O subsystem. File systems. File system interface. File system implementation.

Exercises

Exercises follow lectures.

Literature

1. Milan Čabarkapa, Bogdan Milićević „Materijali za učenje na Moodle platformi za predmet Operativni sistemi“, Fakultet inženjerskih nauka, Univerzitet u Kragujevcu, 2023.
2. Milićev, D.: Osnovi operativnih sistema, Mikro knjiga, 2020, ISBN 978-86-7555-446-2
3. Đorđević B., Pleskonjić D., Maček N.: Operativni sistemi, Mikro knjiga, Beograd, 2005, ISBN 86-7555-274-2
4. Silberschatz A., Galvin P. B., Gagne G., Operating System Concepts, John Wiley & Sons, 10th ed., 2018.
5. Tanenbaum A. S., Modern Operating Systems, Prentice Hall, 3rd ed., 2007.

Hours per week of active teaching	**Lectures:** 3	**Exercises:** 3

Teaching methods

Lectures and tutorial exercises, computer laboratory exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	20
midterm exam(s)	30	oral exam	20
projects	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Digital electronics
Instructor/Instructors:	Vladimir M. Milovanović
Subject status:	compulsory
ECTS:	6
Condition:	Fundamentals of Computer Engineering and Computing Systems

Course objective

Introduction to the theoretical foundations of digital electronics, as well as to the basic digital electronic circuits from the aspect of use and the aspect of design. Enabling students to use standard analysis methods and synthesis methodologies of elementary and more complex digital electronic circuits and systems.

Course outcome

Students trained to independently analyze, design and implement elementary and more complex combinational and sequential digital electronic circuits, as well as to use the necessary software tools for designing digital circuits. Students prepared for further education and advanced courses in the field of digital electronics and design of digital integrated circuits and systems.

Course contents

Lectures

Impulse and digital signals. CMOS process technology. Metrics. Static and dynamic characteristics of logic circuits. Static CMOS logic circuits. Logical effort. Connections, wires and interconnections. Transmission gate and dynamic logic circuits. Latches and flip-flops. Sequential logic circuits. Analysis and synthesis of sequential networks and finite-state machines. Timing. Arithmetic circuits. Adders, multipliers, dividers. Arithmetic-logical units. Nonvolotile and volotile memories. Dynamic and static memories with random access (DRAM and SRAM). Energy and power dissipation. Hardware description languages. Programmable logic components (Field-Programmable Gate Array - FPGA).

Exercises

Laboratory exercises and project development, as well as ASIC and/or FPGA implementation of digital electronic circuits and systems of medium complexity.

Literature

1. Dejan Živković i Miodrag Popović, Impulsna i digitalna elektronika, Akademska misao, 2004.
2. Jan Rabaey, Anantha Chandrakasan, Borivoje Nikolić, Digital Integrated Circuits, 2nd edition, Pearson, 2002.
3. David Hodges, Resve Saleh, Horace Jackson, Analysis and Design of Digital Integrated Circuits, 3rd edition, McGraw-Hill, 2003.
4. Neil Weste, David Harris, CMOS VLSI Design: A Circuits and Systems Perspective, 4th edition, Pearson, 2010.
5. David Harris, Sarah Harris, Digital Design and Computer Architecture, 2nd edition, Morgan Kaufmann, 2012.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2+1

Teaching methods

Lectures and auditory exercises in the classroom, as well as laboratory exercises in the laboratory.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical teaching (lab exercises)	10	written exam	30
midterm exam(s)	30	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Digital signal processing
Instructor/Instructors:	Ivan Krstić
Subject status:	compulsory
ECTS:	6
Condition:	none

Course objective

To train students to analyze and design algorithms for digital signal processing. To train students to choose adequate structure of a circuit in order to satisfy specifications of typical systems for digital signal processing. To train students to implement digital signal processing algorithms in software or hardware.

Course outcome

After this course students are able to understand and apply Discrete Fourier transform and digital filtering methods.

Course contents

Lectures

Discrete Fourier transform (DFT) and efficient computation of DFT. Spectral analysis of signals. Design of systems with infinite impulse response. Design of systems with finite impulse response. Structures for realization of discrete systems with finite and infinite impulse response. The influence of finite wordlength to system characteristics.

Exercises

Spectral analysis of signals and filter design using MATLAB (MATLAB clone). Implementation of digital filters.

Literature

1. M. Popović, Digitalna obrada signala, Akademska misao, Beograd, 2003.
2. M. Sečujski, N. Jakovljević, V. Delić, Digitalna obrada signala, Fakultet tehničkih nauka u Novom Sadu, Novi Sad, 2019.
3. M. Sečujski, V. Delić, N. Jakovljević, Zbirka zadataka iz digitalne obrade signala, Fakultet tehničkih nauka u Novom Sadu, Novi Sad, 2014.
4. V.K. Ingle, J.G. Proakis, Digital Signal Processing Using MATLAB: A Problem Solving Companion, 4th ed., Cengage Learning, 2017.
5. A.V. Oppenheim, R.W. Schafer, Discrete-Time Signal Processing, 3rd ed., Prentice-Hall, 2009.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures with computer demonstrations. Exercises in computer laboratory.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical lessons	20	written exam	20
midterm exam(s)	40	oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Microprocessor systems
Instructor/Instructors:	Zoran Babović
Subject status:	compulsory
ECTS:	6
Condition:	None

Course objective

Introduction to advanced capabilities of modern microprocessors and mastering design and programming of microprocessor systems and microcontrollers.

Course outcome

Upon completion of this course, students will be able to: a) design the necessary hardware for the assigned problem, b) program the necessary software for a given hardware design and problem description, c) independently investigate the documentation of new components up to the level required for using such components in the system

Course contents

Lectures

Introduction to advanced concepts of modern microprocessors. Introduction to architecture and application of the CISC microprocessor Intel 8086, and the organization of the computer system based on that processor. Connecting 8086 to the system, the external controller interrupts, and to peripheral controllers. Pipeline organization of RISC processors. ARM processor architecture. Introduction to the architecture and application of the ARM Cortex microcontrollers M3 and M4 and the most common peripherals. Input-output parallel port. External interrupt controller. Timers including output compare mode, PWM, and input capture mode. Analog signals. Serial communication via USART, I2C, SPI. An introduction to contemporary design issues microprocessor systems.

Exercises

Development of new fully functional systems (including hardware and software) based on 8086 microprocessors and ARM Cortex M3 and M4 microcontrollers.

Literature

1. M. Prokin, Računarska elektronika, Akademska misao, Beograd, 2006.
2. Yifeng Zhu, "Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C", 3rd Edition, E-Man Press LLC, 2017.
3. Yu-Cheng Liu, Glenn A. Gibson, Microcomputer Systems: The 8086/8088 Family Architecture Programming and Design, Prentice Hall, 1986.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	3

Teaching methods

Theoretical teaching, exercises, consultations.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	30
midterm exam(s)	30	oral exam	
projects	20		
homework(s) and seminar(s)	15		

Study programme:	Electrical Engineering and Computer Science
Course title:	Computer Networks
Instructor/Instructors:	Marijana Gavrilović Božović, Milan Čabarkapa
Subject status:	compulsory
ECTS:	6
Condition:	none

Course objective

Introducing students to the fundamental concepts of modern computer networks and communication protocols.

Course outcome

The course provides a broad overview of computer networks in general, based on communication protocols at various levels. By mastering the knowledge from this course, students gain a clear understanding of how computer networks function, from the physical to the application level.

Course contents

Lectures

Reference model; LAN technologies - Ethernet ; switches, STP, RSTP, VLAN; WAN - HDLC, PPP, Frame Relay; Network layer - addressing, routing principles,, ARP, ICMP; Routing protocols - Distant Vector, RIP; Link State, OSPF, redistribution; Transport layer - TCP, UDP; auxilliary protocols - RARP, BOOTP, DHCP, NAT; application layer - DNS; IPv6 - auto-configuration, transition from IPv4 to IPv6.

Exercises

Solving different tasks and problems in auditory exercises. Problem solving in network simulator in laboratory exercises.

Literature

1. Wendell Odom, CCENT/CCNA ICND1, official exam certification guide, Cisco Press, 2008
2. James F. Currose, Keith W. Ross, Computer Networking A Top-Down Approach, Eight edition, Pearson, 2020.
3. Slavko Gajin, Principi konfigurisanja računarskih mreža, Akademska misao, 2018.
4. A. Tanenbaum, N. Feamster, D. Wetherall, Computer Networks, Sixth edition, Pearson, 2021.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	3

Teaching methods

Lectures, auditory exercises, laboratory exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical training	40	oral exam	30
midterm exam	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of telecommunications
Instructor/Instructors:	Milan Čabarkapa, Mina Vasković Jovanović
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

Introducing students to the fundamental principles of information theory (statistical and error-correcting coding) and digital transmission of information.

Course outcome

Students are familiar with the fundamental topics in the field of information theory, analog and digital telecommunications, principles of transmitting analog and digital signals in the baseband and passband frequency range, as well as principles of optimal signal detection.

Course contents

Lectures

Information Theory:
-How can the amount of information emitted by a source be measured?
-How can information be more efficiently represented by a sequence of zeros and ones?
-How can manipulation of binary symbols ensure that information is not damaged during transmission?
-What is the maximum amount of information that can be transmitted through a physical medium in a unit of time?
Telecommunication Signals - signals emitted by a source and signals transmitted through a channel:
-In what form do natural information occur that needs to be transmitted?
-How to describe signals in the time and frequency domains?
-What should be the medium for transmission to prevent signal damage?
-How to measure the level of signal damage during transmission?
-Can any signal be represented as a sequence of zeros and ones, and vice versa?
Transmission of Digital Signals:
-How to represent a sequence of zeros and ones as an electrical signal with minimal damage to binary symbols during transmission?
-How to adapt signal transmission to radio channels and cable transmission?
-How to transmit multiple different signals through a single medium?

Exercises

Exercises follow lectures.

Literature

1. P. Ivaniš, V. Blagojević „ Uvod u digitalne telekomunikacije“, Akademska Misao, 1. izdanje, Beograd, 2020, ISBN: 978-86-7466-853-5.
2. P. Ivaniš, V. Blagojević, S. Brkić „Materijali za predavanje i vežbe za predmet Osnovi telekomunikacija za smerove RTI i SI“, Elektrotehnički fakultet, Univerzitet u Beogradu.
3. Dukić M.L., Marković G. i Vujić S.: Principi telekomunikacija – Zbornik rešenih problema, Akademska misao, 2009, Beograd
4. Glover . A., Grant M.: Digital Communications, Prentice Hall, 2004, London
5. Proakis G., Salehi M.: Communication Systems Engineering, Prentice Hall, London, 2002

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	30
midterm exam(s)	50	oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Automatic Control Systems
Instructor/Instructors:	Mina Vasković Jovanović
Subject status:	elective
ECTS:	6
Condition:	Signals and Systems

Course objective

The objective of the subject is to acquaint students with the basic elements of systems, basic techniques for the analysis of continuous and discrete systems, as well as basic methods for designing conventional and certain classes of unconventional controllers.

Course outcome

Students are familiar with the basic elements of control systems, system structure, and control laws. They are capable of performing modeling of simpler systems, analyzing transient and steady-state regimes, discretizing continuous transfer functions, analyzing models in the state space, examining stability of continuous and discrete systems, and designing various compensators.

Course contents

Lectures

Characterization of systems in transient and steady-state regimes, Discretization of continuous systems, State-space models and feedback closure, Observer design, Stability of continuous and discrete systems, Analysis and compensation of systems using frequency analysis, Tuning of PID controllers.

Exercises

Solving tasks and practical examples related to the theoretical teaching.

Literature

1. Đurović Ž., Kovačević B., Sistemi automatskog upravljanja, Akademska misao, Beograd, 2006., ISBN 86-7466-263-3
2. Đurović Ž., Kovačević B., Diskretni signali i sistemi, Akademska misao, Beograd, 2004., ISBN 86-7466-263-3
3. Ogata K.: Modern Control Engineering, Prentice Hall, 2010, ISBN 978-0-13-713337-6

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures and computational exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	30
midterm exam(s)	50	oral exam	20

Study programme:	Electrical Engineering and Computer Science, Mechanical Engineering
Course title:	Databases
Instructor/Instructors:	Erić D. Milan, Grujović A. Nenad, Đorđević M. Aleksandar
Subject status:	compulsory
ECTS:	6
Condition:	/

Course objective

Acquiring and mastering basic knowledge about the logical and physical framework of databases, database management systems, database design and communication between applications and the database.

Course outcome

Students will be able to independently design, create and maintain databases.

Course contents

Lectures

Covers the following topics: Introductory considerations (Classical data processing and its shortcomings; Definition and basic concepts of databases). Basic concepts (Information, data, entity, attribute, domain, logical record, file, file sets, databases, data banks, automatic data processing, informational system). Data models (Conceptual modeling, structures and constraints, hierarchical, network and relational model, E-R data model, object-oriented data model). Types of databases (Database management systems). Relational databases (Relational algebra, relational calculus, design of relational databases, concept of data normalization, translation of E-R model to relational model, types of relations). Software support (Tools for designing informational systems and SUBP (CASE tools, definition, division and elements)). Basic elements of the query language SQL (definition of the structure concept, operations - queries, updating databases, views, restrictions; Commands for defining data, commands for manipulating data and commands of control functions). Designing relational databases (Notion of data normalization, dependency theory, normal forms). Basics of analytical (multidimensional) databases (Data warehouses; Transactional and analytical processing; Data mining and knowledge discovery). Concurrent access to databases (Transaction execution management and database recovery). Security of databases (Protection of databases from unauthorized use).

Exercises

Practical teaching consists of exercises and independent work. The student achieves independent work through a project assignment. The project assignment, as well as the necessary instructions, is related to the design of the logical data model and the physical model of the databases of the real system.

Literature

1. Lazarević B.: Database, FON Beograd, Beograd 2003.
2. R. Elmasri, S. Navathe, Fundamentals of Database Systems, Addison-Wesley, Boston, 2003.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, lab exercises, students' independent research and solving problems based on the assigned tasks (consultations in the preparation of the project assignment and independent work of students through learning and the preparation of the project assignment).

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	55
midterm exam(s)	25	oral exam	
projects	15		

Study programme:	Electrical Engineering and Computer Science
Course title:	Artificial intelligence
Instructor/Instructors:	Vesna Ranković, Tijana Geroski
Subject status:	compulsory
ECTS:	6
Condition:	/

Course objective

IStudents are introduced to the basic concepts of artificial intelligence. Experience is gained in the field of knowledge representation, reasoning methods, fuzzy systems, neural networks, metaheuristic optimization methods, as well as modeling, design and testing of various artificial intelligence systems. Fields of application in technology, medicine, economics, finance, pharmacy, video games and other areas are investigated. During the exercises, using appropriate programs, examples from different fields of application of artificial intelligence will be processed.

Course outcome

Students will master the basic principles of artificial intelligence system design.

Course contents

Lectures

Basics of artificial intelligence: mathematical logic, knowledge and reasoning. Expert systems: knowledge representation, reasoning methods. Designing expert systems. Neural networks. Neuron and neuron model. Architecture and learning of artificial neural networks. Single layer perceptron. Algorithms for learning a single layer perceptron. Multilayer perceptron. Backpropagation error algorithm. RBF neural network. Recurrent neural networks. Hopfield and Ellman neural network. Metaheuristic optimization methods. Genetic algorithms. The structure of the basic genetic algorithm. Uninformed and informed search. Breadth-depth search, hillclimb search, best-first search, branch-and-bound search. Algorithm A*. Strategy games and artificial intelligence. Minimax algorithm, Alpha – Beta clipping. Uncertainty modeling. Fuzzy set theory and approximate reasoning. Examples of phased system applications. Hybrid systems of artificial intelligence. Probabilistic reasoning. Bayesian networks. Naive Bayesian classifier.

Exercises

Exercises are performed in the computer classroom. Various software tools and libraries are used to develop artificial intelligence systems.

Literature

1. Predrag Janičić, Mladen Nikolić: Veštačka inteligencija, Matematički fakultet, 2023 http://poincare.matf.bg.ac.rs/~janicic//books/VI_A4.pdf
2. Vesna Ranković, Inteligentno upravljanje, Mašinski fakultet, Kragujevac, 2008
3. Russell and P. Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition, Prentice Hall, 2010.
4. A.V. Ameet Machine learning and artificial intelligence. (2020): 978-3.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and computer classroom exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	40	oral exam	30
projects	20		
homework(s) and seminar(s)	10		

Study programme:	Mechanical Engineering, Electrical Engineering and Computer Science
Course title:	Software engineering
Instructor/Instructors:	Nenad Filipović, Velibor Isailović
Subject status:	compulsory
ECTS:	6
Condition:	none

Course objective

Fundamentals of programming, Mathematical analysis, Programming languages, Algorithms and data structures

Course outcome

After completing the program and passing the software engineering exam, candidates will be able to independently participate in larger teams for professional software development. They will be able to develop software documentation, estimate the price of software, perform structural and object-oriented analysis in the UML language, perform specification and verification of software, as well as successfully maintain software projects.

Course contents

Lectures

Introduction to Software Engineering. Quality criteria for software products. Software process models. Basic principles and development of software documentation. Analysis phase. Software cost estimate. Functional rules. Data-driven rules. Structural analysis, Principles of scenarios. Object-oriented analysis. Software specification and verification. Software design. Structural design. Object-oriented design. Application of software. Testing systems. Functional testing. Software metrics. Software maintenance. Reverse engineering, Quality and standardization. Ergonomics, Management projects.

Exercises

Development of a complex software project in teams.

Literature

1. Veljović, A., UML Osnove objektnog modeliranja, Kompjuter biblioteka Čačak, 2005.
2. Filipović, N., Objektno-orjentisano programiranje, skripta, Tehnički fakultet Čačak, 2001, Čačak.
3. Rumbaugh, J., Booch, G., & Jacobson, I. The unified modeling language user guide. Addison-wesley. 1999.
4. Dathan, B., Ramnath, S., Dathan, B., & Ramnath, S. The Unified Modelling Language. Object-Oriented Analysis, Design and Implementation: An Integrated Approach, 427-453. 2015.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises, laboratory exercises, independent work.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lecture	5	written exam	
practical teaching	65	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Analog electronics
Instructor/Instructors:	Vladimir M. Milovanović
Subject status:	elective
ECTS:	6
Condition:	Fundamentals of Electronics

Course objective

Familiarity with the principle of operation of a negative feedback amplifier in the small signal regime, both at low and high frequencies, taking into account all parasitic capacitive effects and noise. Enabling students to independently analyze, design and implement linear and non-linear lumped analog electronic circuits, and to independently perform measurements on analog electronic circuits, as well as to independently solve more complex problems in the field of analog electronics.

Course outcome

Students trained to independently analyze, design and implement linear and non-linear lumped analog electronic circuits in the entire frequency range. Students prepared to independently perform the necessary measurements on analog electronic circuits.

Course contents

Lectures

Feedback and loop gain. Amplification and input and output resistance within the feedback loop. Model of MOS field-effect transistor at high frequencies. Frequency characteristics. Broadband amplifiers. Noise. Power amplifiers. Rectifiers and filters. Voltage regulators and stabilizers. Oscillators and frequency synthesizers.

Exercises

Examples of analysis and synthesis of fundamental amplifier circuits at low and high frequencies. Demonstration of the application of analog circuits in the synthesis of more complex electronic systems.

Literature

1. Slavoljub Marjanović, Elektronika linearnih kola i sistema, Akademska misao, Beograd, 2002.
2. Radivoje Đurić, Zbirka zadataka iz analogne elektronike, Grafos International, Pančevo, 2004.
3. P. Gray, P. Hurst, S. Lewis, R. Meyer, Analysis and Design of Analog Integrated Circuits, 5th, Wiley, 2009.
4. Behzad Razavi, Design of Analog CMOS Integrated Circuit, 2nd edition, McGraw-Hill, 2017.
5. A. Sedra, K. Smith, T. Carusone, V. Gaudet, Microelectronic Circuits, 8th edition, Oxford University Press, 2019.
6. Phillip E. Allen, Douglas R. Holberg, CMOS Analog Circuit Design, 3rd edition, Oxford University Press, 2011.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and auditory exercises on the blackboard, as well as an independent research work on homework problem sets and projects with advices from the instructor.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical teaching and project(s)	10	oral exam	30
midterm exam(s)	30		
homework(s) and seminar(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of Machine Learning
Instructor/Instructors:	Vladimir M. Milovanović
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Understanding the fundamental theoretical concepts of machine learning and statistical pattern recognition, as well as familiarization with slightly more advanced methods through practical examples of application. An overview of machine learning techniques in the services and solutions of the world's leading companies encountered on the Internet and in everyday computer work with a prospect on technologies that will be introduced in the near future.

Course outcome

Mastering the necessary knowledge and skills for designing systems based on machine learning, as well as the ability to apply modern techniques of statistical pattern recognition in solving specific engineering tasks and problems, as well as recognizing them during a plain user encounter with them.

Course contents

Lectures

Introduction. Basic terms. Supervised learning. Linear regression of one and more variables. Non-linear regression. Classification. Logistic regression. Regularization. Naïve Bayes classifiers. Gaussian discriminant analysis. Generalized linear models. Kernels. Support vector machines. Decision trees. Ensembles. Random forest. Perceptron. Fundamentals of artificial neural networks. A trade-off between bias and variance. Vapnik–Chervonenkis (VC) theory. Unsupervised learning. The method of k-means. Principal component analysis. Independent component analysis. Anomaly detection. Recommender systems. Markov decision processes. Reinforcement learning. An overview of the presented methods that are used in everyday work.

Exercises

A brief review of linear algebra and numerical analysis. Examples of the application of machine learning in the control of robots, autonomous vehicles, bioinformatics, speech recognition and text translation, as well as in deep analysis and processing of Internet and mobile data. Software tools, libraries and frameworks for machine learning based on the Python programming language.

Literature

1. Predrag Janičić, Mladen Nikolić, "Veštačka inteligencija", Matematički fakultet u Beogradu, 2021.
2. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer-Verlag, 2006.
3. T. Hastie, R. Tibshirani, J. Friedman, "The Elements of Statistical Learning", 2nd edition, Springer, 2016.
4. S. Shalev-Shwartz, S. Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.
5. R. Duda, P. Hart, D. Stork, "Pattern Classification", 2nd edition, Wiley-Interscience, 2000.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures, exercises, consultation and independent research work under the advisor/instructor guidance.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical teaching and seminar(s)	10	oral exam	30
midterm exam(s)	30		
homework(s) and project(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Electromagnetic Compatibility
Instructor/Instructors:	Jasna Radulović
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Introduction to Electromagnetic Compatibility (EMC) problems encountered in practice. Engineering solutions to these problems. Introduction to EMC testing.

Course outcome

Enabling for computer simulation of circuits and devices regarding EMC. Mastery of circuit and device design methods that ensure compliance with EMC conditions.

Course contents

Lectures

Electromagnetic environment and compatibility. Natural and artificial sources of interference. Conducted interference. Radiated interference. Compromising electromagnetic radiation. Electromagnetic susceptibility. Signal integrity. Design methods. Grounding and shielding. Parasitic resonances. Filtering. Cables, connectors, and components.

Exercises

Computer simulations of circuits and devices in terms of EMC.

Literature

1. Surutka, J., Elektromagnetika, Građevinska knjiga, Beograd, 1971.
2. A. R. Đorđević, Elektromagnetika, Akademska misao, Beograd, 2012.
3. A. Đorđević, D. Olćan, Ispitivanje elektromagnetske kompatibilnosti, Akademska misao, Beograd, 2012.
4. T. Williams, EMC for Product Designers, Newness, Oxford, UK, 2007.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and computer simulations.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	30
practical teaching	50	oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Digital image processing
Instructor/Instructors:	Marijana Gavrilović Božović
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Introducing students to the basic components of systems and concepts of digital image processing.

Course outcome

Enabling students to use established methods of digital image processing and independently create and develop algorithms for digital image processing.

Course contents

Lectures

Transformation of multi-channel grayscale images, Histogram modification, Noise elimination, Two-dimensional Fourier transformation applied to an image, Edge sharpening and detection, Generalized image segmentation, Morphological processing, Representation of objects through attributes, Shape recognition.

Exercises

Examples of image processing: document content analysis, microscopic image analysis, quality control in industry, motion control. Independent development of programs for quality enhancement, image filtering, and segmentation, object extraction in images, and their specification.

Literature

1. R. C. Gonzalez, R. E. Woods: "Digital Image Processing",Fourth Edition, Prentice Hall, 2018.
2. R. C. Gonzalez, R. E. Woods, S. L. Eddins: "Digital Image Processing using MATLAB", Second Edition, Prentice Hall, 2009.
3. M. Popović, Digitalna obrada slike, Akademska misao, 2006.
4. Vladimir Ostojić, Tatjana Lončar-Turukalo " Praktikum za računarske vežbe iz digitalne obrade slike", Novi Sad, Fakultet tehničkih nauka, 2017.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, auditory and laboratory exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical training	40	oral exam	30
midterm exam	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Audio signal processing
Instructor/Instructors:	Ivan Krstić
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Acquiring knowledge about audio signals, particularly speech and music. Understanding the characteristics of individual audio signals, knowledge of tools for analysis and processing.

Course outcome

Students gain the necessary level of knowledge about speech and music signals. Based on this, they are able to engage in the analysis and processing, compression, coding, and transmission of audio signals.

Course contents

Lectures

Time-frequency analysis of audio signals. Sound perception. Music coding techniques based on perceptual coding. Speech production. Speech signal coding techniques based on source coding. Algorithms for noise removal from speech signals. Digital audio effects. Electronic musical instruments.

Exercises

Use of software tools (Praat, Matlab, Sox) and programming languages (Python, Faust, ChucK).

Literature

1. S. Jovičić, Govorna komunikacija: fiziologija, psihoakustika i percepcija, Nauka Beograd, 1999.
2. Gold B., Morgan N.: Speech and Audio Signal Proc. - Proc. And Perception of Speech and Music, Wiley, 2000.
3. U. Zolzer, Digital Audio Signal Processing, 2nd ed., Wiley, 2008.
4. J.O. Smith, Physical audio signal processing for virtual musical instruments and audio effects, http://www.dsprelated.com/dspbooks/pasp/

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Theoretical lectures, exercises, projects.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical lessons	60	written exam	20
		oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Analog electrical filters
Instructor/Instructors:	Ivan Krstić
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Introduce the fundamental concepts of the analog electric filter design and the underlying filter design theory. Provide the theoretical background for all filter design stages. Introduce practical techniques for filter implementation, fabrication and laboratory measurements.

Course outcome

Understand the mathematical techniques that are used in analog electric filter design. Design filters that meet a given set of specifications and perform a basic sensitivity analysis of a filter. Be able to use CAD tools to verify the filters designed, account for real world implementation effects, and optimize the filter design.

Course contents

Lectures

Review of concepts and algorithms in modern electric circuit theory relevant to the design of analog electric filters. Fundamentals of electric circuit synthesis. Symbolic and numeric software tools for filter design. Analog electric filter design stages. Modeling and simulation. Implementation technologies and fabrication. Measurements on the laboratory prototype and documentation.

Exercises

Complete analog electric filter design: simulation, implementation (fabrication), measurements, documentation and presentation.

Literature

1. V. V. Petrović, D. V. Tošić, A. R. Djordjević, Microwave Passive Circuits, University of Belgrade – School of Electrical Engineering, 2010.
2. M. D. Lutovac, D. V. Tošić, B. L. Evans, Filter Design for Signal Processing using MATLAB and Mathematica, Prentice Hall, 2001. (Original title)
3. L. Wanhammar, Analog Filters Using MATLAB, Springer, 2009. (Original title)
4. H. G. Dimopoulos, Analog Electronic Filters: Theory, Design and Synthesis, Springer, 2012. (Original title)

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, problem-solving classes, computer simulations, practical work in the laboratory.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
projects	50	written exam	40
		oral exam	10

Study programme:	Electrical Engineering and Computer Science
Course title:	Human-computer interaction
Instructor/Instructors:	Milan Čabarkapa
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

Introducing students to the design and implementation of primary human-computer interaction principles.

Course outcome

The acquired knowledge and skills form the basis for the development of high-quality technical solutions of the highest possible utility in student's future professional engineering practice.

Course contents

Lectures

Development of user-oriented interaction with their active participation. Levels of human-computer interaction. Necessary knowledge from cognitive psychology, known heuristics, and MVC/MVP/MVVM architectures. Collection, interpretation, and analysis of requirements. Understanding of the user, task, and context of use. HCI notations. Classes of HCI prototypes and their evolution into the final solution. Tools for developing different types of interfaces. Design and spaces: GUI, web, mobile, embedded, ubiquitous. Representation and visualization. Interactive devices. Utility of interfaces. Evaluation of utility.

Exercises

Exercises follow lectures.

Literature

1. D. Ivetić, Interakcija čovek računar, Fakultet tehničkih nauka, Univerzitet u Novom Sadu, 2012
2. M. Jovanović, A. Jevremović, Interakcija čovek-računar, Univerzitet Singidunum, Beograd, 2020.
3. B. Shneiderman, C.Plaisant, Dizajniranje korisničkog interfejsa, CET, 2005 (prevod na srpski).
4. A. Dix, J. Finlay, G. Abowd, R Beale, Human-Computer Interaction, Pearson Education, 2004.
5. Sharp, H., Rogers, Y., Preece, J. (2015). Interaction Design: beyond human-computer interaction. New York: John Wiley & Sons, Inc., 4th ed.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and tutorial exercises

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	20
midterm exam(s)	30	oral exam	20
homework(s) and seminar(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Internet of Things
Instructor/Instructors:	Milan Čabarkapa, Jasna Radulović
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

Introduction to the fourth industrial revolution, structures, and concepts of basic & derived areas of the Internet of Things (IoT) and new communication and computing technologies. Familiarization with the principles of operation and design of smart devices, technologies for their networking, concepts and hierarchical structures, application development, cyber security issues, and principles of hierarchical data processing in the field of IoT.

Course outcome

Students will aquire following skills: the conceptualization of sets of smart devices and their networking, implementation of platforms, protocols, and intelligent environments, and working on the development of solutions for different areas of application of the Internet of Things (IoT).

Course contents

Lectures

Principles, concepts, and architecture of IoT connected structures. Smart devices and networking technologies. Application and communication protocols of IoT. Principles of designing IoT networks. Techniques for hierarchical processing and analysis of data within IoT networks. Cyber threats and security aspects in IoT networks. Standardization of IoT networks.

Exercises

Exercises folllow lectures

Literature

1. Dr Mladen Koprivica, Dr Goran Marković, Materijal sa predmeta IoT Mreže, Elektrotehnički fakultet, Univerzitet u Beogradu, 2022.
2. M.Tanasković, Internet stvari, Univerzitet Singidunum, 2020.
3. O. Hersent, D. Boswarthick, and O. Elloumi, The Internet of Things: Key Applications and Protocols, John Wiley & Sons Ltd., 2011.
4. O. Hersent, D. Boswarthick, and O. Elloumi, The Internet of Things: Key Applications and Protocols, John Wiley & Sons Ltd., 2011.
5. O. Vermesan, P. Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems

Hours per week of active teaching	**Lectures:**	**Exercises:**

Teaching methods

Lectures and auditing exercises

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	20
midterm exam(s)	30	oral exam	20
projects	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Designing of VLSI systems
Instructor/Instructors:	Zoran Babović
Subject status:	elective
ECTS:	6
Condition:	None

Course objective

Introduction of students to the principles of designing computer VLSI systems. Introduction to hardware description languages.

Course outcome

Students will be able to independently design computer VLSI systems.

Course contents

Lectures

Designing computer VLSI systems involving the use of hardware description languages like VHDL and Verilog. The principles of designing a RISC processor are demonstrated through the process of designing a RISC-V processor including various phases of design and the decision-making process. Pre-fabrication and post-fabrication testing of components.

Exercises

A number of solved assignments will be given, including examples such as the design of processor resources and interconnects. The assignments also involve designing, simulating, and synthesizing a small yet functional processor using FPGA technology.

Literature

1. V. Milutinonovic, Surviving the design of a 200MHz microprocessor, IEEE Computer Society Press, USA, 1997.
2. M. Petrovic, A. Smiljanic, " Programiranje Alterninih FPGA čipova, " Akademska misao, Beograd, 2008.
3. D. M. Harris, S. L. Hariss, “Digital Design and Computer Architecture, 2nd edition,” Morgan Kaufmann, 2013
4. N. H.E. Weste, D. M. Harris, “CMOS VLSI Desing - A Circuits and Systems Perspective, 4th edition, Addison-Wesley, 2011.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Theory teaching, excersises, projects, and consultation.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	30	written exam	30
projects	40	oral exam	

Study programme:	Electrical Engineering and Computer Science
Course title:	Applied Deep Learning
Instructor/Instructors:	Vladimir M. Milovanović
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Understanding the fundamental theoretical concepts of deep learning and artificial neural networks, as well as familiarization with slightly more advanced methods through practical application examples. An overview of deep learning techniques in services and solutions of the world's leading companies that are encountered on the Internet and everyday work on the computer with prospect on technologies that will be introduced in the near future.

Course outcome

Mastering the necessary knowledge and skills for designing systems based on artificial neural networks, as well as the ability to apply modern deep learning techniques in solving specific engineering tasks and problems, as well as recognizing them during a plain simple user encounter with them.

Course contents

Lectures

Introduction. Basic terms. Artificial neural networks. Multilayer perceptron and fully connected networks. Shallow neural networks. Deep neural networks. Hyperparameters. Regularization. Optimization algorithms. Convolutional neural networks. Object detection. Image segmentation. Neural style transfer. Computer vision. Recurrent neural networks. Language models. Natural language processing. Sequence models. Transformers. Generative-adversarial networks. Spiking neural networks. Deep reinforcement learning.

Exercises

Examples of the application of deep learning in facial recognition, style transfer, autonomous vehicles, bioinformatics, speech recognition and machine text translation, as well as in deep analysis and processing of Internet and mobile data. Examples of popular models and neural networks. Software tools, libraries and frameworks for deep learning based on the Python programming language.

Literature

1. A. Zhang, Z. Lipton, M. Li, A. Smola, "Dive into Deep Learning", arXiv preprint arXiv:2106.11342, 2021
2. R. Sutton, A. Barto, "Reinforcement Learning: An Introduction", 2nd edition, Bradford Books, 2018.
3. I. Goodfellow, Y. Bengio, A. Courville, "Deep Learning", The MIT Press, 2016.
4. Eugene Charniak, "Introduction to Deep Learning", The MIT Press, 2019.
5. François Chollet, "Deep Learning with Python", 2nd edition, Manning, 2021.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, exercises, consultation and independent research work under the advisor/instructor guidance.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical teaching and seminar(s)	10	oral exam	30
midterm exam(s)	30		
homework(s) and project(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Digital systems design
Instructor/Instructors:	Vladimir M. Milovanović
Subject status:	elective
ECTS:	6
Condition:	Digital electronics

Course objective

Familiarization and introducing the students to the project flow methodology, design phases and more advanced techniques for designing complex digital electronic circuits and systems. Detailed introduction to the "front-end" and "back-end" design phases, as well as the modular design of digital VLSI systems. Enabling students to use standard industrial and free software tools and packages, as well as mastering methods for analysis, synthesis and design of complex digital systems.

Course outcome

Students familiar with the standard design flow in the design of complex digital systems, and know the "front end" and "back end" design phases, as well as the methodology and basic and more advanced techniques of designing digital integrated circuits and systems. Students are trained for independent design and both ASIC realization as well as FPGA implementation of medium complexity VLSI systems.

Course contents

Lectures

Fundamentals of functional programming. Hardware description and hardware design languages. Chisel. Logic and high-level synthesis. System-on-a-chip design. Methodology of digital hardware generators and IP blocks. General purpose processors and RISC-V processor cores. Dedicated accelerators. Buses and integration of IP blocks. Digital macros and memory compilers. Clock signal distribution and generation. Synchronizers and synchronization techniques. Pipeline(d) and parallel processing. Design of low-power integrated circuits. Clock gating and power gating. Trade-off between delay/performance and energey/power consumption. Dynamic power and frequency scaling.

Exercises

Design flow. Digital "front-end" and "back-end" parts of the design flow. Tcl (Tool Command Language) programming language. An example of design and implementation of high-complexity digital VLSI system on FPGA development boards/kits/platforms and/or ASIC realization until the generation of GDSII file ready to be sent for fabrication/manufacturing.

Literature

1. Dejan Živković, Miodrag Popović, "Impulsna i digitalna elektronika", Akademska misao, 2004.
2. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", 2nd edition, Pearson, 2010.
3. Sarah Harris, David Harris, "Digital Design and Computer Architecture", RISC-V Edition, Morgan Kaufmann, 2021.
4. Pong P. Chu, "RTL Hardware Design Using VHDL", Wiley, 2006.
5. Erik Brunvand, "Digital VLSI Chip Design with Cadence and Synopsys CAD Tools", Pearson, 2010.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures through presentations and slides, whereas as part of practical classes, students are introduced to tools for designing, and both ASIC and FPGA implementation of digital systems, while exercises in the laboratory are used for independent research work of students under the advisor/instructor guidance.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical teaching and seminar(s)	10	oral exam	30
midterm exam(s)	30		
homework(s) and project(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Electromagnetics
Instructor/Instructors:	Jasna Radulović
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

The aim is to introduce the basics of engineering electromagnetics in line with the needs of mobile and satellite communication systems, RF and microwave engineering, radar systems, fast digital communications, wireless systems, optical telecommunications, optoelectronics, nanotechnology, bioengineering, plasma physics, semiconductor physics, electric power machines and systems, and electromagnetic compatibility.

Course outcome

The student's ability to recognize, formulate, and solve basic engineering problems that require knowledge of electromagnetics and to understand the operating principles of typical devices and systems based on electromagnetics principles.

Course contents

Differential and integral equations, boundary conditions, and theorems related to electrostatics, steady currents, steady magnetic fields, and time-varying electromagnetic fields. It also covers Maxwell's equations, retarded potentials, uniform plane electromagnetic waves, reflection and refraction, guided electromagnetic waves, waveguides, electromagnetic radiation, antennas, and electromagnetic compatibility.

Literature

1. Surutka, J., Elektromagnetika, Građevinska knjiga, Beograd, 1971.
2. A. R. Đorđević, Elektromagnetika, Akademska misao, Beograd, 2012.
3. B. Notaroš, V. Petrović, M. Ilić, A. Đorđević, B. Kolundžija, M. Dragović, Zbirka ispitnih pitanja i zadataka iz elektromagnetike, Akademska misao, Beograd, 2008.
4. Garg, R., Analytical and Computational Methods in Electromagnetics, Artech House, 2008.

Hours per week of active teaching	**Lectures:**	3	**Exercises:** 2

Teaching methods

Lectures, exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	70	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Digital signal processing systems
Instructor/Instructors:	Ivan Krstić, Marijana Gavrilović Božović
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

In this course students should familiarize with the basic architectures, tools for software and hardware design, and implementations of signal processing systems with digital signal processors or programmable FPGA chips.

Course outcome

After this course students should be able to design signal processing systems using digital signal processors or programmable FPGA chips.

Course contents

Lectures

Architecture of integrated digital signal processors. Tools for software and hardware design. Realization of filtering and DFT algorithms on digital signal processor. Hardware realization of signal processing algorithms on FPGA chips. Multirate signal processing systems and their application.

Exercises

Use of design tools for digital signal processors. Use of design tools for FPGA chips.

Literature

1. M. Popović, Digitalna obrada signala, Akademska misao, Beograd, 2003.
2. M. Temerinac, S. Berber, Ž. Lukač, Osnovi algoritma i struktura DSP 1, Fakultet tehničkih nauka u Novom Sadu, 2014.
3. U. Meyer-Baese, Digital Signal Processing Using Field Programmable Gate Arrays, 4th ed., Springer Verlag, 2014.
4. S.A. Khan, Digital Design of Signal Processing Systems: A Practical Approach, John Wiley & Sons, 2011.
5. T.B. Welch, C.H.G. Wright, M.G. Morrow, Real-Time Digital Signal Processing from MATLAB to C with the TMS320C6x DSPs, 3rd ed., CRC Press, 2017.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, laboratory work, design projects.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical lessons	60	written exam	20
		oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Virtual instruments
Instructor/Instructors:	Ivan Krstić, Marijana Gavrilović Božović
Subject status:	elective
ECTS:	6
Condition:	N/A

Course objective

Acquiring basic knowledge in the field of computer application in the implementation of measurement and control systems using the concept of virtual instrumentation. Familiarization with the implementation of virtual instruments and their hardware and software architecture. Acquiring knowledge about the implementation of measuring devices using the concept of virtual instrumentation. Mastery of students in modern technologies and trends in the field of signal measurement and analysis. Acquiring knowledge in the basics of designing computer-based measuring systems.

Course outcome

Ability to understand the operation of computers in the implementation of measurement and control systems and the principles of virtual instrumentation. Ability to understand the principles of operation of measuring devices and the implementation of programs in the LabVIEW software package. Ability to implement measurement, acquisition, and data processing using virtual instrumentation and LabVIEW programs. Capability to implement simple measurement and acquisition systems.

Course contents

Introduction to virtual instrumentation. Characteristics of virtual instruments. Characteristics of software and hardware for virtual instrumentation. Instrument connection and control. Concept of virtual instrumentation distribution. Implementation of remote measurements. Virtual laboratories. LabVIEW software package. Creating a virtual instrument (VI). Running the program and debugging. Creating VIs and subVIs. Loops and structures. Event-driven programming. Data grouping using strings, arrays, and clusters. Local and global variables. Graphs and charts. Working with files. Formulas and equations. Real-time operation, continuous data analysis. Signal measurement and acquisition. Measurement converters and adapters. Categories of measurement signal sources. Signal scaling. Signal measurement and acquisition devices, types, and features. Signal measurement and analysis using LabVIEW software package. Internet capabilities in LabVIEW programming. Implementation of measurements via the Internet.

Literature

1. J. Tomić, M. Milovanović, Virtualna instrumentacija primenom LabVIEW programa, Fakultet tehničkih nauka u Novom Sadu, Novi Sad, 2012.
2. J. Tomić, M. Kušljević, Merenje i analiza signala primenom LabVIEW programa, Fakultet tehničkih nauka u Novom Sadu, Novi Sad, 2016.
3. A. Milovanović, Virtuelna instrumentacija, Tehnički fakultet u Čačku, Čačak, 2010.
4. C.L. Clark, LabVIEW Digital Signal Processing and Digital Communications, McGraw-Hill, 2010.
5. R. Bitter, T. Mohiuddin, M. Nawrocki, LabVIEW Advanced Programming Techniques, Taylor & Francis, 2007.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, exercises, project assignments, and consultations.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical lessons	50	written exam	30
		oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Functional hardware verification
Instructor/Instructors:	Ivan Krstić
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Acquisition of knowledge in the field of basic methods and tools for conducting functional verification of digital electronic systems. Familiarization with the basic characteristics of hardware verification languages.

Course outcome

Ability to create a verification plan based on the functional specification of the design, development of a verification environment using a verification language, verification of a complex digital system using the developed verification environment.

Course contents

Importance of verification. Functional verification. Process of functional verification. Verification plan. Verification environment. Basic components of the verification environment. Measurement of verification plan coverage. Code coverage. Functional coverage. Verification based on coverage measurement. Hardware functional verification languages "e" and System Verilog. Industrial tools for hardware functional verification.

Literature

1. S. Dautović, V. Vranjković, Računarske vežbe iz predmeta Formalne metode projektovanja i verifikacije hardvera, Fakultet tehničkih nauka u Novom Sadu, Novi Sad, 2014.
2. A. Meyer, Principles of Functional Verification, Newnes, 2003.
3. C. Spear, G. Tumbush, SystemVerilog for Verification, Springer Verlag, 2012.
4. A. Piziali, Functional Verification Coverage Measurement and Analysis, Springer Verlag, 2004.
5. S. Palnitkar, Design Verification with e, Prentice Hall, 2003.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, computer exercises, individual projects, consultations.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
projects	60	written exam	40

Study programme:	Electrical Engineering and Computer Science
Course title:	Real-Time Systems Programming
Instructor/Instructors:	Mina Vasković Jovanović
Subject status:	elective
ECTS:	6
Condition:	None

Course objective

Introducing students to the basic characteristics of real-time systems, architecture of real-time operating systems, scheduling theory, multitasking concept, and principles of real-time system design and development. Enabling students to analyze, design, and implement real-time systems based on microcontrollers.

Course outcome

Enabling students to independently design and implement parts and complete embedded systems.

Course contents

Lectures

Introduction to real-time systems, architecture of real-time operating systems, standard objects and services of the operating system, basic concepts of communication and synchronization of independent program threads. Development of embedded real-time applications through the use of operating system objects and services.

Exercises

Overview of the library of program functions of the selected real-time operating system. Analysis and development of multi-threaded program code, debugging code within an integrated development environment.

Literature

1. Milićev D., Furlan B.: Programiranje u realnom vremenu – skripta sa praktikumom i rešenim zadacima, Elektrotehnički fakultet u Beogradu, 2011., ISBN 978-86-7225-046-6
2. Saranovac L., Popović I., Namenski računarski sistemi, Akademska misao, Beograd, 2017., ISBN 978-86-7466-703-3
3. Qing L., Yao C.: Real-Time Concepts for Embedded Systems, CMP Books, 2003, ISBN 978-1578201242
4. Laplante P.: Real-Time Systems Design And Analysis, A John Wiley & Sons, Inc., Publication, 2004, ISBN 978-0471228554
5. Marwedel P.: Embedded System Design, Springer International Publishing, 2018, ISBN 978-3-319-56043-4

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures and classroom exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	20	written exam	30
midterm exam(s)	30	oral exam	20

Study programme:	Electrical Engineering and Computer Science
Course title:	Criptography and blockchain technologies
Instructor/Instructors:	Milan Čabarkapa, Jasna Radulović
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

Introducing students to security policies, attacks, vulnerabilities, and encryption. Understanding the basics of cryptography and security protocols. Familiarizing with the basic and general principles for implementing, maintaining, and improving information security management. Introduction to blockchain technology based on cryptographic principles and its applications.

Course outcome

Understanding of basic and advanced cryptographic algorithms and techniques. Familiarity with blockchain methodologies based on cryptographic principles. Successful completion of the course also implies the ability to understand the potential and future directions of blockchain technology, as well as its implications for those who develop, manage, and adopt it.

Course contents

Lectures

Availability, authentication, authorization, confidentiality, integrity, and access control; Applied cryptography and cryptographic algorithms. Transposition, substitution, sequential cipher algorithms, block cipher algorithms. Asymmetric encryption. Networking. Consensus mechanisms. Coins and tokens. Smart contracts. Distributed applications (dApps). Decentralized autonomous organizations (DAOs). Practical implementations in specific areas of human activities.

Exercises

Exercises follow lectures.

Literature

1. Pleskonjić D., Maček N., Đorđević B., Carić M.: Sigurnost računarskih sistema i mreža, Mikro knjiga, Beograd, 2007, ISBN 978-8675553052
2. Pleskonjić D., Maček N., Đorđević B., Carić M.: Sigurnost računarskih sistema i mreža, Mikro knjiga, Beograd, 2007, ISBN 978-8675553052
3. Dr Milan Čabarkapa, Materijali na Moodle platformi za predmet Kriptografija, Fakultet inženjerskih nauka, Univerzitet u Kragujevcu, 2023..
4. Chris Burniske, Jack Tatar, Cryptoassets, October 2017, Publisher: McGraw-Hill, ISBN: 9781260026689
5. E. Golden Julie, Noor Zaman Jhanjhi, J. Jesu Vedha Nayahi, Blockchain Technology: Fundamentals, Applications, and Case Studies (Internet of Everything (IoE)), CRC Press, 2020.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	20
midterm exam(s)	40	oral exam	20
homework(s) and seminar(s)	20		

Study programme:	Electrical Engineering and Computer Science
Course title:	Optoelectronics
Instructor/Instructors:	Marijana Gavrilović Božović
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Explanation of physical phenomena resulting from the interaction of light with matter and the description of possible ways to utilize them. Understanding the operation of basic optoelectronic devices. Demonstration of basic optoelectronic phenomena through examples and enabling students to use optoelectronic devices correctly.

Course outcome

After completing the course, students will be able to explain the principles of operation of different types of instruments that incorporate optical and optoelectronic components at their core. They will also be able to identify the potential advantages and disadvantages of proposed systems based on their intended applications. Students will be capable of independently simulating the optical part of a system using dedicated software and providing proposals for suitable accompanying electronic circuits tailored to specific applications.

Course contents

Lectures

Introduction to optoelectronics, EM spectrum and measurements in optoelectronics, radiometry and photometry, geometric optics, matrix analysis of light propagation in optical systems, wave optics (Fresnel equations, diffraction, interference and polarization of light, diffraction grating, polarizers, analyzers), optical waveguides and optical fibers, types of optical fibers, attenuation and dispersion in optical fibers. Optical detectors (photomultipliers, pyroelectric and thermoelectric detectors, photoresistors, photodiodes, phototransistors). Solar cells. Introduction to laser technology (stimulated emission and light amplification, optical amplifiers and resonators), types of lasers. Semiconductor light sources (LEDs and LD diodes). Technologies for image display and recording. Applied optoelectronics.

Exercises

Numerical examples related to the chapters covered in theoretical lectures.

Literature

1. Philip C. D. Hobbs: Building Electro-Optical Systems: Making it All Work, 2nd Edition, John Wiley & Sons Inc., 2009.
2. Eugen Hecht and Alfred Zajac: "Optics", 5-nd Ed. Addison-Wesley Publishing Company, 2004.
3. J.Dakin, R. Brown, Handbook of optoelectronics, Second Edition, Concepts, Devices and Techniques, Volume 1, CRC Press, Taylor and Francis group, 2018
4. Jovana Gojanović, Petar Matavulj, Zbirka zadataka iz optoelektronike - prostiranje svetlosti, Akademska misao, 2020.
5. Milatović D: Optoelekttronika, Svetlost, Sarajevo, 1987.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and auditory exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam	70	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of physical electronics
Instructor/Instructors:	Marijana Gavrilović Božović
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Introduction to the Basics of Electronic Band Structure Theory in Semiconductors. Building upon this foundation, students acquire knowledge in the field of semiconductor electronic and optoelectronic components, such as diodes, transistors, lasers, LEDs, photodetectors, and solar cells.

Course outcome

Mastering the principles of operation of modern semiconductor electronic and optoelectronic devices, which serve as a foundation for further exploration and understanding of fields such as analog and digital electronics, optical telecommunications, quantum mechanics, statistical physics, quantum electronics, micro and nanoelectronics, and spintronics.

Course contents

Lectures

Kronig-Penney model. Intrinsic and extrinsic semiconductors, carrier concentration, carrier transport in semiconductors, drift-diffusion model, non-homogeneous semiconductor. PN junction, transitional regimes in diodes. Metal-semiconductor junction, MOS structure, heterostructure devices. Semiconductor optoelectronic components, lasers, LEDs, photodetectors, solar cells. JFETs, MOSFETs, and bipolar transistors.

Exercises

Numerical examples related to the chapters covered in theoretical lectures.

Literature

1. Dejan Gvozdić: "Osnove fizičke elektronike", Akademska Misao, 2017.
2. Beng G. Streetman and Sanjay Banerjee: Solid State Electronic Devices , Prentice Hall, 2000.
3. I.A.S.Sedra, K.C. Smith: Microelectronic Circuits, Oxford University Press, 1998.
4. J.Wilson, J.Hawkes: Optoelectronics - an introduction, Prentice Hall, 1998.
5. Jasna Crnjanski, Dejan Gvozdić: Zbirka zadataka iz Osnova fizičke elektronike, Akademska misao, 2021

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures and auditory exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam	70	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Expert systems
Instructor/Instructors:	Vesna Ranković, Tijana Geroski
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Introducing students to the basic concepts and techniques of expert systems. During the course, students will study the most popular implementation models of these types of applications.

Course outcome

Ability of students to understand the technology of expert systems, its basic characteristics and possibilities of application.

Course contents

Lectures

Introduction. Basic principles and applications of expert systems (ES). Characteristics of ES. Typical problems. ES performance. Architecture of expert systems. Expert systems and conventional software systems. Presentation of knowledge in ES. Knowledge presentation techniques. Rules, semantic networks and frameworks in ES. Representation of uncertainty. Inference mechanisms. Types of reasoning. Search role. Inference efficiency. Rule-based inference. Forward chaining. Backward chaining. Frame-based reasoning. Inference with uncertainty. Case-based reasoning. Knowledge engineering. ES development process. ES development tools. Knowledge gathering techniques. Fuzzy logic and expert systems.

Exercises

Exercises are performed in the computer classroom. Various software tools and libraries are used to develop expert systems.

Literature

1. Bojić D., Gligorić M., Nikolić B.: Zbirka zadataka iz Ekspertskih sistema, Akademska misao, Beograd, 2009, ISBN 978-86-7466-362-2
2. Vesna Ranković, Inteligentno upravljanje, Mašinski fakultet, Kragujevac, 2008
3. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach. 3rd Edition, Prentice Hall, 2010.
4. Gupta, I., and Garima N. Artificial Intelligence and Expert Systems. Mercury Learning and Information, 2020.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Realization of lectures according to the model of interactive teaching with the use of practical work methods.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	40	written exam	
projects	20	oral exam	30
homework and seminars	10		

Study programme:	Electrical Engineering and Computer Science
Course title:	Design of internet applications
Instructor/Instructors:	Miladin Ž. Stefanovic, Aleksandar M. Đorđević
Subject status:	elective
ECTS:	6
Condition:	No

Course objective

The objective of the course is an introduction to the basics of programming Internet applications. The goal is to present advanced techniques, programming languages, tools, environments, and databases, as well as methods and techniques for designing and developing Internet applications

Course outcome

Students will be able to design and develop complex multi-layered Internet applications using the most effective methods and technologies. Mastery of tools and programming languages for client-side Internet application programming. Mastery of tools and programming languages (server-side script) for Internet application development. Mastery of designing and developing software solutions in the Internet environment based on various databases. Understanding and solving specific problems and issues in the Internet environment (sessions and data persistence), as well as security and safety concerns of developed applications.

Course contents

Lectures

Within the subject, the student is expected to master the basic elements of client-side scripting languages (HTML and CSS). The student should also acquire skills in developing Internet-web applications (using client and server-side scripting languages) through the following topics: Basics of PHP and JavaScript programming languages (Programming language basics, Classes and objects, Forms, Accessing databases, MySQL, SQLite databases, Sessions, cookies, and data persistence, Regular expressions, Files, Ajax and JQuery), as well as security and safety issues related to developed applications.

Exercises

Within the subject, the student is expected to master the basic elements of client-side scripting languages (HTML and CSS). The student should also acquire skills in developing Internet-web applications (using client and server-side scripting languages) through the following topics: Basics of PHP and JavaScript programming languages (Programming language basics, Classes and objects, Forms, Accessing databases, MySQL, SQLite databases, Sessions, cookies, and data persistence, Regular expressions, Files, Ajax and JQuery), as well as security and safety issues related to developed applications.

Literature

1. Ђорђевић, А., Пушкарић, Х., Стефановић, М. (2019).: Пројектовање и развој Web апликација за електронско пословање, ISBN 978-86-6335-063-2
2. Грујовић Н., Миливојевић Н.: Електронско пословање и менаџмент односа са корисницима, скрипта, 2008
3. Пантовић В., Динић С., Старчевић Д.: Савремено пословање и интернет технологије, Енергопројект, 2002, ISBN 86-83723-01-1
4. Turban E., King D.: Introduction to E-Commerce, Prentice Hall - Pearson Education, 2003. ISBN 978-0130094056
5. Dyché J.: CRM Handbook, Addison Wesley, 2001. ISBN 978-0201730623

Hours per week of active teaching	**Lectures:**	2	**Exercises:**	2

Teaching methods

Lectures, exercises, seminar papers, consultations, practical work (programming). Quizzes: Basics of PHP and Website Development. A student can take the final exam if they score at least 35 points in the pre-exam obligations.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	30

projects	40	oral exam	
homework(s) and seminar(s)	25		

Study programme:	Electrical Engineering and Computer Science
Course title:	Design of mobile applications
Instructor/Instructors:	Nenad Grujović, Vukašin Slavković
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Acquisition of general knowledge and special skills for understanding mobile computing concepts. Mastering technologies and tools for developing software solutions for mobile devices and systems.

Course outcome

Knowledge of mobile application programming technologies. The student is competent to understand the concepts of mobile computing and to develop software solutions for mobile computing systems.

Course contents

Mobile Computing Overview. Communication Protocols for Mobile Devices. Programming Languages and Operating Systems for Cross-Platform Mobile Application Development (Android, iOS). User Interface in Mobile Devices. Multimedia in Mobile Devices. Animations in Mobile Applications. Working with Local and Internet Databases. Working with Maps and Payment Services in Mobile Applications.

Literature

1. Schwarz R., Steele J., Nelson D.: Android 4 Izrada aplikacija pomoću paketa Android SDK, Mikro knjiga, 2014, ISBN 978-8675553908
2. Taniar D.: Mobile Computing: Concepts, Methodologies, Tools, and Applications, Information Science Reference 2009, ISBN 978-1605660547
3. Kamal D.: Mobile Computing, 2th edition, Oxford University Press, 2012, ISBN 978-0198068914
4. Rogers R., Lombardo J., Mednieks Z., Meike G.: Android Application Development, Shroff Publishers & Distributors Pvt Ltd 2010, ISBN 978-8184047332
5. N. Grujovic, V. Slavkovic - material on moodle portal

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, laboratory exercises, homework, projects

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	30
midterm exam(s)	30	oral exam	
projects	35		

Study programme:	Electrical Engineering and Computer Science
Course title:	Software Design
Instructor/Instructors:	Nenad Filipović, Velibor Isailović
Subject status:	elective
ECTS:	6
Condition:	no condition

Course objective

Understanding and mastering the concepts of software modeling and design using the UML language and design patterns. Application of the UML language through 14 types of diagrams, as well as the most commonly used building design patterns, structural design patterns and behavioral design patterns. Understanding of multi-layer and service-oriented software architectures. Understanding the concept of object relational mapping in databases.

Course outcome

The student knows the concepts of software modeling and design using complex software architectures. The student is able to model complex software systems using the standard language UML 2. When designing software, the student is able to recognize the requirements for application and to apply adequate design patterns from the catalog of design patterns.

Course contents

Lectures

Overview of modeling concepts and the UML language. Structural diagrams of: classes, components, objects, deployments, packages, compositions and profiles. Behavior diagrams: sequence diagrams, use case diagrams, activity diagrams, interaction overview diagrams, state machine diagrams, communication diagrams, timing diagrams. Concepts and classification of design patterns. Building, structural and behavioral patterns. Object and class design patterns. Multi-layered and service-oriented software architectures. Object relational mapping of databases.

Exercises

Practical exercises, laboratory demonstrative exercises, laboratory control exercises. Homework.

Literature

1. Gama, E., Helm, R., Johnson, R., Vlissides, J., Готова решења, CET, Београд, 2002., ISBN: 86-7991-153-4
2. Gamma Erich, Helm Richard, Johnson Ralph, Vlissides John, Design Patterns: Elements of Reusable Object-Oriented Software, 1st Edition, Addison-Wesley Professional, 1994., ISBN 0-201-63361-2
3. Gabriel Baptista, Francesco Abbruzzese, C#9 i .NET 5 arhitektura softvera, prevod 2. izdanja, Kompjuter biblioteka - Beograd, 2021, ISBN 9788673105635

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises and laboratory exercises on the computer

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	35	oral exam	30
projects	35		

Study programme:	Electrical Engineering and Computer Science
Course title:	Concurrent and distributed programming
Instructor/Instructors:	Zoran Babović
Subject status:	elective
ECTS:	6
Condition:	None

Course objective

Introduction to the characteristics of concurrent and distributed systems, synchronization of threads and processes, and principles of distributed application development. Introduction to the concepts of fault-tolerant systems in a distributed environment.

Course outcome

Students will be able to independently design and implement concurrent and distributed applications.

Course contents

Lectures

Basic concepts and definitions, threads, concurrent and parallel execution. Critical section, and mutual exclusion. Locking, Bakery Algorithm. Instructions with atomic operations such as TestAndSet (TAS) and CompareAndSwap (CAS). Semaphores, conditional queues, monitors, and barriers. Lock-free programming and transactional memory. Process communication through message passing. Network programming using TCP and UDP sockets. Server sockets, thread per connection approach, and reactive pattern. Remote Procedure Calls (RPC) including gRPC and Java RMI. Object marshaling and demarshaling, message formats including JSON and Protocol Buffers. Logical time and order of events. Synchronization of physical clocks using NTP and PTP protocols. P2P systems and consistent hashing. Consistency, linearization, and eventual consistency. Fault-tolerant systems, replication, quorum, leaders, and followers. Paxos and Raft consensus protocols. Distributed transactions, 2PC protocols, and Saga. Distributed processing in a cluster using Apache Hadoop and Apache Spark.

Exercises

Implementation of concurrent applications, producer-consumer problems, client-server communication via sockets, RPC in Java programming language. Implementation of distributed applications using tools such as ZooKeeper. Implementation of distributed processing through Apache Spark platforms.

Literature

1. Stevan Milinković, „Konkurentno i distribuirani sistemi“, CET 2019.
2. Z. Radivojević, I. Ikodinović, Z. Jovanović, Konkurentno i distribuirano programiranje, Akademska misao, 2008.
3. B. Goetz, et al., “Java Concurrency in Practice”, Addison-Wesley, 2006.
4. G. Coulouris, et al., "Distributed systems - Concepts and Design", 5th Edition, Addison Wesley, 2012.

Hours per week of active teaching	**Lectures:3**	**Exercises:**	2

Teaching methods

Theory teaching and exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	40
midterm exam(s)	30	oral exam	
projects	25		

Study programme:	Electrical Engineering and Computer Science
Course title:	Software-defined networks
Instructor/Instructors:	Milan Čabarkapa, Marijana Gavrilović Božović
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

Introducing students to modern intelligent network architectures and environments based on the concept of Software-Defined Networking (SDN)

Course outcome

Students will aquire engineering work skills with advanced networking concepts that form the fundamentals of the fourth and fifth industrial revolution.

Course contents

Lectures

SDN architectures. Logical centralization of intelligence. Programmability. Management function in SDN. Dynamic software implementation. Abstraction. Separation of user application from other network elements. SDN/NFV concept. Virtualization within SDN. Implementation of orchestration and virtualization. OpenFlow. ONAP-based orchestration. Cisco NSO-based orchestration. Intent-based networking. YANG models.

Exercises

Exercises follow lectures.

Literature

1. Božidar Radenković, Marijana Despotović-Zrakić, Zorica Bogdanović, Dušan Barać, Aleksandra Labus, Živko Bojović, Internet inteligentnih uređaja – Prvi udžbenik na srpskom jeziku iz oblasti Internet of things, Fakultet organizacionih nauka, 2017., ISBN:978-86-7680-304-0
2. Dr Mladen Koprivica, Dr Goran Marković, Materijal sa predmeta IoT Mreže, Elektrotehnički fakultet, Univerzitet u Beogradu, 2022.
3. M.Tanasković, Internet stvari, Univerzitet Singidunum, 2020.
4. Paul Goransson, Chuck Black, Timothy Culver, Software Defined Networks A Comprehensive Approach 2nd Edition, 2016
5. D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, and J. Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, 2017.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and auditing exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	20
midterm exam(s)	30	oral exam	20
homework(s) and seminar(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Computer vision
Instructor/Instructors:	Tijana Geroski
Subject status:	elective
ECTS:	6
Condition:	

Course objective

The aim of the course is to familiarize students with the modern directions of development of computer and machine vision. Overview of goals and methods for image formation, image analysis and processing, and computer vision. Characteristics of perspective image formation. Basic image analysis: theoretical signal methods, filtering, image enhancement, image reconstruction, segmentation, classification, representation. Basic computer vision: multiscale representation, edge detection and other distinctive features. Stereo and multi-camera systems. Object recognition, morphology.

Course outcome

After completing the course, students will be able to identify basic concepts, terminology, models and methods in computer vision and image processing, systematically develop and analyze a number of basic methods of computer vision - tracking and recognition of objects in images and video sequences and image filtering, image enhancement, segmentation, classification, etc. Students will be familiar with the possibilities of application in surveillance systems, modern systems for tracking people and objects, medicine, television, professional photography, etc.

Course contents

Lectures

Basic principles of image formation, colors, basic image operations for improving and extracting information from digital images , filters and image pyramids, local features, panoramic photo stacking, perspective projections, stereo vision , recognition of objects in the image, face recognition , search of large databases picture etc. Gray level transformations, filtering techniques and feature detection such as corners, edges and regions (segmentation). Methods for deriving three-dimensional information about the external world from visual information, using cues such as texture, shading, stereo, and motion. Methods for object recognition.

Exercises

the Python programming language software tool to create an application of the described methods. Work on the exercises implies the application of acquired knowledge in order to develop computer vision algorithms. Implementation of algorithms: Image classification/recognition. Object detection. 3D computer vision. Introduction to 3D Data.

Literature

1. Milosavljević Aleksandar, Računarski vid. ISBN: 978-86-6125-244-0, 2021
2. Szeliski, Richard. Computer vision: algorithms and applications. Springer Nature, 2022.
3. Forsyth, David A., and Jean Ponce. Computer vision: a modern approach. prentice hall professional technical reference, 2002.
4. Stockman, George, and Linda G. Shapiro. Computer vision. Prentice Hall PTR, 2001.
5. Gonzalez, Rafael C. Digital image processing. Pearson education india, 2009.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

3 hours of lectures per week + 2 hours of exercises per week on the computers + independent work on the computer for mastering the material from the lectures and exercises, doing homework and preparing for the exam
Practical teaching takes place in computer classrooms, where students solve real problems in the field of Python programming language independently or with the help of assistants.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
colloquiums	40	oral exam	30
seminary	20		

homework(s) and seminar(s)	10		

Study programme:	Electrical Engineering and Computer Science
Course title:	Decision-making systems in medicine
Instructor/Instructors:	Tijana Geroski
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Introduction of students to the concepts, theoretical foundations and possibilities of the decision-making system in medicine. Students should master basic shape recognition techniques in the medical domain: hypothesis testing, parametric classification, non-parametric classification, clustering , as well as decision-making techniques based on neural networks and fuzzy logic. Enabling students to independently apply acquired knowledge in solving real problems.

Course outcome

Students are trained to model and solve real problems of optimal decision-making in conditions of uncertainty and uncertainty. Students acquire skills to generate or collect quality training sets, to apply some of the appropriate techniques for hypothesis testing, to design parametric or non-parametric classifiers, to design a data clustering system, to apply neural networks in decision-making, to construct a fuzzy expert system.

Course contents

Lectures

Basic concepts of decision support systems. Decision making theory. Evaluation of the decision-making system. The problem of rationality in decision-making. Decision factors. Stages of decision-making. Types of decision systems. The structure of the decision-making system. Research and data analysis to support decision-making. Decision-making based on K nearest neighbors rules. Reasoning under uncertainty: Bayesian decision making, Bayesian networks and training. Belief networks. Neural networks. Fuzzy logic. Method of support vectors. Classifiers and classification. Outlier detection and missing data prediction. Construction of decision support tools in medicine: data acquisition, recording and modeling of knowledge, system validation. Examples of decision systems in medicine.

Exercises

Exercises are performed in the computer classroom. Development of a project with a practical and concrete problem - application of multiple algorithms such as decision trees, neural networks, k nearest neighbors, Bayesian network, random forest method of support vectors, etc., to the presented medical problem and discussion of the obtained results. Comparison of results obtained by different methods, critical highlighting of advantages and disadvantages of applied algorithms.

Literature

1. Tanjga, R, Tanjga M. Teorija odlučivanja, Visoka škola za ekonomiju i informatiku, Prijedor, 2014.
2. Barro, Senén, and Roque Marín. Fuzzy logic in medicine, 2002.
3. Dybowski, Richard, and Vanya Gant, eds. Clinical applications of artificial neural networks. Vol. 200, no. 1. New York: Cambridge University Press, 2001.
4. Hunink, MG Myriam, Milton C. Weinstein, Eve Wittenberg, Michael F. Drummond, Joseph S. Pliskin, John B. Wong, and Paul P. Glasziou. Decision making in health and medicine: integrating evidence and values. Cambridge university press, 2014.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises, laboratory exercises, independent work.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical teaching	20	written exam	
homework	20	oral exam	30
seminary work	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Parallel Computer Systems
Instructor/Instructors:	Miloš R. Ivanović
Subject status:	elective
ECTS:	6
Condition:	None

Course objective

Acquaintance and understanding of basic terms related to parallel computer systems and programming models. Getting to know the architecture of parallel systems, models of distributed and shared memory, with special reference to the performance analysis of the implemented algorithms.

Course outcome

The student understands the concepts and has the skill of concrete implementation of basic algorithms in the environment of MPI and CUDA standards using the C programming language. The student acquired the ability to analyze and improve the performance of the obtained parallel implementations.

Course contents

Lectures

Motivation and history. The evolution of the supercomputing. Modern parallel computers. The search for competitiveness. Programming models of parallel computers. Architectures and network topologies. Processor arrays. Multiprocessors. Clusters. Flynn's taxonomy. Parallel algorithm design. The task-channel model. Foster's Design Methodology. Finite difference method. The extreme value of the sequence. Problem of n bodies. I/O operations. Programming using the MPI standard. Individual and collective communications. Performance analysis. Amdahl's law and the Amdahl effect. Gustavson-Barsis law. Karp-Flat metric. Isoefficiency metric. Graphics processors and CUDA principles. Mapping and reduction principles.

Exercises

MPI standard. Individual and collective communications in MPI. Blocking and non-blocking communications. Analysis and measurement of performance on different parallel architectures and with different number of processors. Methods of problem decomposition. Functional and domain decomposition. Sieve of Eratosthenes, Floyd's Algorithm. Problems in number theory. Sorting. Parallelization of linear algebra operations. Finite difference methods. Monte-Carlo methods. CUDA programming. Apache Spark.

Literature

1. Michael J. Quinn, Parallel programming in C with MPI and OpenMP, McGraw. Hill, 2003.
2. Ivanović, Miloš. Paralelno programiranje, Prirodno-matematički fakultet Kragujevac, 2016.
3. Cheng, John, Max Grossman, and Ty McKercher. Professional CUDA C programming. John Wiley & Sons, 2014.
4. Penchikala, Srini. Big data processing with apache spark. Lulu. Com, 2018.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises, laboratory exercises, homework

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	50
midterm exam(s)	45	oral exam	

Study programme:	Electrical Engineering and Computer Science
Course title:	Design of informational systems
Instructor/Instructors:	Erić D. Milan, Đorđević M. Aleksandar
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Acquiring and mastering basic knowledge about informational systems, methodological approaches to analysis, design and implementation of informational systems for modern development. Explain in details the role of computer hardware, software, databases, computer networks and human resources in the mentioned approaches.

Course outcome

Students will be trained both for independent and team development of informational systems with the use of modern concepts of modeling and designing informational system

Course contents

Lectures

Introduction to the design of informational systems, systematical approach in the development of informational systems, the life cycle of global and informational systems, life cycle of development models of informational systems, tools for the development of informational systems, classification, types of informational systems, basic components, communication technologies, access to databases , CASE tools, internet and www environment, modern concepts of the application of informational systems.

Exercises

Practical teaching consists of exercises, independent research work and consultations during the preparation of project tasks. Independent work is achieved through a project assignment through which the student demonstrates the ability to participate in the analysis of informational system processes and data. Development of applications with a graphical user environment.

Literature

1. D.Ranđelović: Visokotehnološki kriminal, Kriminalističko-policijska akademija, Beograd, 2013
2. Erić M., Projektovanje informacionih sistema i baza podataka, TEMPUS JEP-CD-40104, skripta, Kragujevac, 2008.
3. Rainer K., Turban E., Introduction to information systems - Support and transformation of business, Data status, Belgrade, 2009.
4. Shelly, B. G, et. all, Discovering Computers, Tompson Course Technology, 2003.
5. Whitten J., Bentley J., System Analysis & Design Methods, McGraw-Hill, 2007.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Classic face-to-face teaching combined with group and individual approach with the use of current teaching tools. Knowledge will be tested through colloquiums, project assignments and a final exam.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	35
midterm exam(s)	20	oral exam	
projects	40		

Study programme:	Electrical Engineering and Computer Science
Course title:	E-bussines
Instructor/Instructors:	Miladin Ž. Stefanovic, Aleksandar M. Đorđević
Subject status:	elective
ECTS:	6
Condition:	No

Course objective

Introduction to electronic business technologies. Mastering the technology of Internet business - developing applications to support all modern aspects of electronic business. Enabling independent project design and development of e-business systems.

Course outcome

After completing the course, students are expected to be familiar with the basic technologies of electronic business, the importance and application of security in electronic business. They should be capable of analyzing market needs in the Internet environment and be independent in designing and developing software solutions for e-business.

Course contents

Lectures

Introduction to electronic business and e-commerce. System architecture for electronic business, client and server components, data management models. Security in systems: object security access, access rights management. Overview of systems, principles of system selection, future of electronic business systems. Familiarization and mastery of application development systems for electronic business in a full-stack context. Familiarization and mastery of working with frameworks for developing front-end parts of electronic business applications (JavaScript server environment Node.js and JavaScript frameworks Angular, React, Vue.js). Familiarization and mastery of working with frameworks for developing back-end parts of electronic business applications (PHP frameworks Laravel and Symfony, Python frameworks Flask and Django). Familiarization and mastery of working with NoSQL databases (JSON format and MongoDB databases). Familiarization with digital signature and certificate terminology, security standards, and protocols. Business in the Internet environment (business models, application design and development). Creating electronic business documentation.

Exercises

Setting up an online store and managing an e-commerce platform. As part of the study and research work, students will be equipped for basic research in the field, designing and developing software solutions based on open-source resources for building complex applications for electronic business.

Literature

1. Đorđević, A., Puškarić, H., Stefanović, M. (2019).: Projektovanje i razvoj Web aplikacija za elektronsko poslovanje, ISBN 978-86-6335-063-2
2. Grujović H., Milivojević N.: Elektronsko poslovanje i menadžment odnosa sa korisnicima, skripta, 2008
3. Pantović V., Dinić S., Starčević D.: Savremeno poslovanje i internet tehnologije, Energoprojekt, 2002, ISBN 86-83723-01-1
4. Turban E., King D.: Introduction to E-Commerce, Prentice Hall - Pearson Education, 2003. ISBN 978-0130094056
5. Dyché J.: CRM Handbook, Addison Wesley, 2001. ISBN 978-0201730623

Hours per week of active teaching	**Lectures:**	2	**Exercises:**	2

Teaching methods

The classes are conducted in the form of lectures and exercises in a computer classroom and the CIM Center. The teaching material is available in electronic format on the Moodle system.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
projects	20	written exam	
homework(s) and seminar(s)	50	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Bioengineering and bioinformatics
Instructor/Instructors:	Nenad Filipović
Subject status:	elective
ECTS:	6
Condition:	

Course objective

The aim of the course is to acquaint students with the possible application of bioengineering and bioinformatics in the field of cardiovascular system modeling, the coupling of the heart's work with muscle contraction, the connection of the micro and macro scale, the combination of biochemical reactions and the use of databases for searching in bioinformatics.

Course outcome

After mastering the program and passing the exam in Bioengineering and bioinformatics, candidates will be able to engage in scientific research work in this very popular and interdisciplinary field. The knowledge that candidates acquire is related to the basic concepts of cardiovascular biomechanics, circulation mechanisms, muscle contraction, the basics of bioinformatics, parallel systems and the use of bioinformatics databases in modeling and simulating coupled problems of cardiovascular systems.

Course contents

Lectures

Basic concepts of cardiovascular biomechanics. Basic principles of circulation. Forces and resistances to blood movement. Newton's laws of fluid motion. The concept of turbulence. Blood rheology. Mechanisms of circulation. Heart, electrical system. Mechanics of the heart. Heart valve function. Active contraction. Solid-fluid interactions. Experimental determination of deformations. Constitutive relations. Blood flow in the arteries. Basics of bioinformatics. Parallel systems in bioinformatics. Application of bioinformatics in medicine.

Exercises

Creation of a realistic computer model in the field of cardiovascular biomechanics.

Literature

1. Filipović N.: Osnovi bioinženjeringa, Fakultet inženjerskih nauka, Kragujevac, 2012, ISBN 978-86-86685-66-7.
2. Filipović N.: Modeliranje i simulacije kardiovaskularnih sistema, WUS Austria, CIMSI, Univerzitet u Kragujevcu, 2005.
3. Fung, C.: Biodynamics Circulation, Springer-Verlag, 1984, ISBN 978-0387908670
4. N. Filipovic, Computational Modeling in Bioengineering and Bioinformatics, Academic Press, ISBN-10: 0128195835, 2019
5. N. Filipovic, Cardiovascular and Respiratory Bioengineering, Elsevier, ISBN10 0128239565, 2022

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises, independent work

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	
practical work	65	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Computer graphics
Instructor/Instructors:	Nenad Filipović, Tijana Geroski
Subject status:	elective
ECTS:	6
Condition:	

Course objective

The goal of the course is to introduce students to the basics of computer graphics such as visual signal processing, edge detection and line extraction, texture processing, scene feature representation, movement, stereovision and various image processing methods. The goal is also for students to be able to independently complete a complex computer graphics project.

Course outcome

After completing the program and passing the computer graphics exam, candidates will be able to engage in research and scientific work in this new field. They will be able to process visual signals, use image processing methods, and form a three-dimensional image in computer tomography, as well as use fuzzy logic in image processing. Candidates will be able to apply this knowledge in the software industry in the field of educational software development, film animations, commercials, military industry, automotive industry, biomedical industry, etc.

Course contents

Lectures

Processing of visual signals. Edge detection and line extraction. Analysis by parts. Texture. Representation of a scene feature. Move. Stereovision. Methods of shape determination. Method for X-ray image processing. Method for image formation and analysis in computed tomography. Methods for analyzing images obtained by ultrasound. A method for processing a thermal imaging image. Methods of forming a three-dimensional image in computer tomography. Image fusion. Fuzzy logic in image processing. Shape recognition change.

Exercises

As part of the study research work, students will be trained for basic research in the subject area.

Literature

1. Veljović, A., UML Osnove objektnog modeliranja, Kompjuter biblioteka Čačak, 2005.
2. Filipović, N., Objektno-orjentisano programiranje, skripta, Tehnički fakultet Čačak, 2001, Čačak.
3. Rumbaugh, J., Booch, G., & Jacobson, I. The unified modeling language user guide. Addison-wesley. 1999.
4. Dathan, B., Ramnath, S., Dathan, B., & Ramnath, S. The Unified Modelling Language. Object-Oriented Analysis, Design and Implementation: An Integrated Approach, 427-453. 2015.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises, laboratory exercises, independent work.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	
practical teaching	65	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Software testing
Instructor/Instructors:	Nenad Filipović, Velibor Isailović, Tijana Geroski
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

After this course, students should understand, create and use test plan, test scenario, bug life cycle, most important methodologies and test types. Will be familiar with different levels of application testing. The participant will understand the specifics of responsive web application design and master the principles of testing such an application. Participants will understand and master the basic techniques and principles of mobile application testing ("native" and "hybrid"), as well as the basic principles and methods of application security testing.

Course outcome

1. Test terminology
2. Types of testing
3. Testing methods and techniques

Course contents

Lectures

The subject introduces the basic notions of software quality as well as its specificities in relation to other products. Quality attributes are studied as well as the standards that are applied. The student learns about software quality assurance through testing as well as prescribing and applying testing procedures. Areas of knowledge and skills are studied: Importance of software testing and quality assurance; Fundamentals of software quality; Standards for quality assurance in software development; Software quality management; Measurement in software engineering and software quality; Planning and organization of testing - Software testing techniques; Software life cycle models and application of testing techniques; Prediction of defects and software quality on the project; Reliability of software, etc.

Exercises

Application of acquired practical knowledge on selected applications where participants will have the opportunity to write test scenarios using learned techniques and methods, describing found problems ("bugs"), describing and developing a test plan for certain functionalities.

Literature

1. Dražen Drašković, Dragan Bojić, Testiranje softvera, Akademska misao, Beograd, 2019. ISBN: 978-86-7466-815-3
2. Jovan Popović, Testiranje softvera u praksi, 2019. ISBN: 978-86-7991-363-0
3. Marnie L. Hutcheson, Software Testing Fundamentals Methods and Metrics, Wiley Publishing Inc., 2003. ISBN: 0-471-43020-X
4. Bernard Homès, Fundamentals of Software Testing, John Wiley & Sons, 2013. ISBN: 978-1848213241

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises and laboratory exercises on the computer.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical teaching	35	oral exam	30
homework and seminar papers	35		

Study programme:	Electrical Engineering and Computer Science
Course title:	Software project management
Instructor/Instructors:	Ivan Mačužić
Subject status:	elective
ECTS:	6
Condition:	No

Course objective

To introduce students with the basic principles of project-based work organization. Through the presentation of the traditional and agile approach to project management, enable students to understand why exactly the agile approach is the one that has been dominantly used for software project management. Provide students with practical experience in project implementation through teamwork and an agile approach to project management.

Course outcome

Students have knowledge of concrete agile methods for project management and practical experience in working in a project team.

Course contents

Lectures

Management - features and functions. Technical and engineering management challenges and necessary skills. Project life cycle. Project management in the context of the organization. The traditional PMI approach to project management. Project management processes, Management of integration, scope, time, costs, quality, resources, communication, risk, procurement and project stakeholders. Agile approach to project management, Agile Manifesto. SCRUM, Extreme programming, LEAN approach in project management, KANBAN. Other agile project management principles. LEAN startup. Software tools for project management.

Exercises

Literature

1. Mačužić, I., Nikolić, N. Upravljanje softverskim projektima, udžbenik, Fakultet inženjerskih nauka Univerziteta u Kragujevcu, 2021, ISBN: 978-86-6335-082-3
2. Ris, E. Lean startup (prevod), MATE d.o.o., ISBN 978-86-86313-17-1
3. SCRUMstudy, A Guide to the Scrum Body of Knowledge (SBOK Guide), VMEdu Inc., 2017, ISBN 978-098992520-4

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Realization of lectures according to the model of interactive teaching with the use of practical work methods.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	10	written exam	25
midterm exam(s)	40	oral exam	5
homework(s) and seminar(s)	20		

Study programme:	Electrical Engineering and Computer Science
Course title:	Compiler Construction
Instructor/Instructors:	Mina Vasković Jovanović
Subject status:	elective
ECTS:	6
Condition:	None

Course objective

The objective of the subject is to familiarize students with the basic concepts of formal language theory, basic techniques for constructing language processors, compilers, and interpreters, and to enable students to use standard tools for constructing language processors and compilers.

Course outcome

It is expected that upon completion of the course, students will be able to demonstrate understanding, critical analysis, and application of relevant theories, models, and techniques in the field of programming compiler construction. They should be able to formally describe the syntax of a language and use standard tools to construct simpler language processors and compilers.

Course contents

Lectures

Introduction, Lexical analysis, General characteristics of microJava, Syntax analysis, Parsing concepts and techniques, Use of parser generators, Syntax-directed translation, Symbol tables, Object-oriented constructs, Execution environment, Code generation for virtual (microJava) and physical (x86) processors, Simple code generator.

Exercises

Classroom exercises that illustrate individual concepts and techniques covered in lectures. A practical project for implementing a compiler (lexical analyzer, parser, code generator for microJava) that the student develops independently.

Literature

1. A. W. Appel, Modern Compiler Implementation in Java 2nd Ed, Cambridge University Press, 2002.
2. A. Aho, M. Lam, R. Sethi, J. Ullman, Compilers/Principles, Techniques and Tools, 2nd ed, 2006.
3. D. Velašević, D. Bojić, Zbirka zadataka iz Programskih prevodilaca, Akademska misao, 2001.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, classroom exercises, laboratory exercises, independent project work.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	40	written exam	60
midterm exam(s)		oral exam	

Study programme:	Electrical Engineering and Computer Science
Course title:	Advanced software architectures
Instructor/Instructors:	Milan Čabarkapa, Mina Vasković Jovanović
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

Introducing students to the characteristics and usage of various modern software architectures, methods and principles of their use, as well as principles of development in distributed cloud/fog environments. Familiarizing with software architectures that have fault tolerance in a distributed environment.

Course outcome

Enabling students to independently design and implement software solutions in different architectures and contexts.

Course contents

Lectures

Monolithic architecture. Service-oriented architecture. Microservices architecture. Performance analysis from the perspective of these architectures (advantages and disadvantages). Hexagonal architecture. Serverless architecture. Comparison of domain-driven paradigm with event-driven paradigm. Fundamentals of DevOps paradigm. Virtualization and containerization (deployment & CI). Application integration using message systems (microservices case).

Exercises

Implementation of various types of applications in different advanced software architectures.

Literature

1. Dr Milan Čabarkapa, Materijali za izvođenje nastave iz predmeta Razvoj mobilnih servisa, Elektrotehnički fakultet, Univerzitet U Beogradu, 2020.
2. Sam Newman, „Изградња микросервиса“, OReilly, ЦЕТ 2022 (преведено на српски).
3. Chris Richardson, Microservices patterns, 2018, ISBN 9781617294549
4. E. Roman, R. P. Shriganesh, G. Brose, Mastering Enterprise JavaBeans, 3rd edition, 2005, Wiley and Sons
5. G. Coulouris, J. Dollimore, T. Kindberg, G. Blair, "Distributed systems - Concepts and Design", 5th Edition, Addison Wesley, 2012.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and computer classroom exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	30
midterm exam(s)	20	oral exam	
projects	50		

Study programme:	Electrical Engineering and Computer Science
Course title:	Cybercrime and information security
Instructor/Instructors:	Milan Čabarkapa
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

Introducing students to the basic concepts of data and system protection, as well as to security policy, attacks, and vulnerabilities. Understanding the basics of security protocols. Familiarization with the basic and general principles for the implementation, maintenance, and improvement of information security management in the system; sources of security threats, methods, techniques, procedures, and products that serve to protect data.

Course outcome

Upon passing the exam, students will:
- know the basic principles of information management;
- be familiar with possible sources of security threats;
- know methods and techniques for detecting, preventing, and neutralizing security breaches;
- be acquainted with the need for using modern technological protection tools and the methodology of their application.

Course contents

Lectures

Fundamental concepts: threats, attacks, security, and protection methods; Availability and access control; Access control and network barriers; Intrusion detection and prevention systems; Malicious software; E-commerce and Internet security; Database security; Computer network surveillance; Organizational, physical, and legal protection methods, societal aspects; Ethical hacking and penetration testing; Security standards and certification programs. Fundamentals of digital forensics.

Exercises

Security protocols; unauthorized system access; examples of free tools in the field of data protection; designing protection systems.

Literature

1. Pleskonjić D., Maček N., Đorđević B., Carić M.: Sigurnost računarskih sistema i mreža, Mikro knjiga, Beograd, 2007, ISBN 978-8675553052
2. D.Ranđelović: Visokotehnološki kriminal, Kriminalističko-policijska akademija, Beograd, 2013
3. Milosavljevic, M., Grubor G, „Digitalna forenzika računarskog sistema“, Univerzitet Singidunum, 2009.
4. William Stallings, Cryptography and Network Security, 7th edition, Pearson Education Limited 2017
5. Diogenes Y., Cybersecurity – Attack and Defense Strategies: Infrastructure security with Red Team and Blue Team tactics, Packt Publishing (January 30, 2018)

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

The teaching is conducted through lectures, exercises, and independent student work. In the lectures, students receive fundamental information. In the exercises, students acquire practical knowledge and skills for using specific tools from certain areas of data protection. Students independently complete a task that encompasses and integrates knowledge for using individual tools.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	40	oral exam	40
homework(s) and seminar(s)	20		

Study programme:	Electrical Engineering and Computer Science
Course title:	NoSQL databases
Instructor/Instructors:	Milan Čabarkapa
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

Introducing students to the principles, elements, and operation of modern non-relational databases.

Course outcome

After this course, students are capable of developing systems that use modern non-relational databases.

Course contents

Lectures

Problems of large data warehouses and scalability. Key/value data stores. Column-oriented data warehouses. Document-oriented databases. Graph-oriented databases. Operations on data. Queries over NoSQL databases. Evolution of databases. Indexing. Transaction management and data integrity. NoSQL databases and cloud computing. Map/Reduce. Performance of NoSQL databases.

Exercises

Exercises follow lectures.

Literature

1. Avramović Ž. Zoran, Marinković Dražen NoSQL baze podataka u teoriji i praksi, Аперион Б. Лука, 2015.
2. Dr Milan Čabarkapa, Materijali za izvođenje nastave iz predmeta Razvoj mobilnih servisa, Elektrotehnički fakultet, Univerzitet U Beogradu, 2020.
3. S. Tiwari Professional NoSQL, Wiley, 2011.
4. NoSQL Databases by Christof Strauch https://www.christof-strauch.de/nosqldbs.pdf
5. Bernard Marr, Data Strategy: How to Profit from a World of Big Data, Analytics and the Internet of Things Paperback – 2017

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and tutorial exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures		written exam	30
midterm exam(s)	50	oral exam	
projects	20		

Study programme:	Electrical Engineering and Computer Science
Course title:	Functional programming
Instructor/Instructors:	Vladimir M. Milovanović
Subject status:	elective
ECTS:	6
Condition:	Programming Languages and Object-Oriented Programming

Course objective

Understanding and mastering the concepts of functional programming through the Scala programming language. The specifics of the program structure in functional programming and the difference in relation to imperative programming. Familiarity with functional programming paradigms and techniques. Development of parallel functional programs.

Course outcome

Upon successful completion of the course, students will be able to: (i) understand the specifics of functional programming; (ii) write sequential or parallel functional programs in the Scala programming language; (iii) use classes from the standard Java or Scala libraries in software development.

Course contents

Lectures

An overview of the Scala programming language. Values, variables and control structures. Objects and companion objects. Classes. Functions and control abstractions. Wrapper objects. Traits as means of code reusability. Mixing Scala and Java code. Concurrent programming in the Scala programming language. Domain-Specific Languages (DSLs) based on the Scala programming language, with an emphasis on Chisel, a hardware description language (HDL) used to describe digital electronics and circuits at the register-transfer level (RTL).

Exercises

Practical exercises. Project tasks. Tasks assessment is done by means of presentation with oral defense.

Literature

1. Martin Odersky, Lex Spoon, Bill Venners, Frank Sommers, Programming in Scala, 5th edition, Artima Press, 2021.
2. Alvin Alexander, Scala Cookbook, 2nd edition, O'Reilly Media, 2021.
3. Paul Chiusano, Rúnar Bjarnason, Functional Programming in Scala, Manning, 2014.
4. Dean Wampler, Programming Scala: Scalability = Functional Programming + Objects, 3rd edition, O'Reilly Media, 2021.
5. Harold Abelson, Gerald Jay Sussman, Julie Sussman, Structure and Interpretation of Computer Programs, 2nd edition, MIT Press, 1996.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures are held with presentations. The lectures introduce concepts and explain the definition of functional programming and the Scala language. During the auditory exercises in the computer classroom, practical examples of functional programming in Scala programming language are demonstrated.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
practical teaching and seminar(s)	10	oral exam	30
midterm exam(s)	30		
homework(s) and project(s)	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Fundamentals of industrial automatizations
Instructor/Instructors:	Ivan Mačužić, Petar Todorović, Marko Đapan
Subject status:	elective
ECTS:	6
Condition:	No

Course objective

The goal of the course is to provide students with insight and basic information about current concepts, techniques and systems for industrial process automation. The subject includes an overview of the basic principles and directions of industrial automation with the definition of the main components, explanation of their function and ways of integration into functional systems that achieve the automated functioning of various industrial processes.

Course outcome

- Knowledge of the basic elements of industrial automation systems (electrical and electronic components, pneumatic components, sensors, motors, actuators, control systems, etc.), their functions and ways of integration into automation systems.
- Knowledge of the basic principles of industrial robotics, the types and ways of functioning of industrial robots, the basics of programming robotic systems.
- Machine and robotic vision systems and their integration into industrial automation systems.

Course contents

Lectures

Introduction to industrial automatization; Basic technologies of automatization and management; Industrial pneumatics and pneumatic control systems; Sensors; Electrical and electronic components of automatization systems; AC/DC and servo motors; Electric actuators; Introduction to PLC technique; Basics of PLC programming; Introduction to industrial robotics; Fundamentals of industrial robot programming; Introduction to machine and robotic vision systems and their integration into automatization systems.

Exercises

- Practical work with pneumatic didactic systems of FESTO company
- Practical work with didactic sensor systems from FESTO and SICK
- Practical work on MITSUBISHI PLC programming
- Practical work with motor drive control models
- Practical work with robots and collaborative robots from MITSUBISHI
- Practical work with SICK industrial cameras

Literature

1. Todorović P., Mačužić I., Industrijska automatizacija, Fakultet inženjerskih nauka, skripta
2. Training and educational material from FESTO, SICK, MITSUBISHI
3. Ristanović, M. Industrijska automatika, Mašinski fakultet Univerziteta u Beogradu, 2020, ISBN 978-86-6060-040-2
4. Matić, N. Uvod u industrijske PLC kontrolere,
5. Stamatios, M. Introduction to Industrial Automation, CRC Press, 2020, ISBN 978-0367571832

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, practical exercises, independent and student team work

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	10	written exam	50
midterm exam(s)	10	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Design of electrical appliencies
Instructor/Instructors:	Petar Todorović
Subject status:	elective
ECTS:	6
Condition:	no

Course objective

Combining the acquired knowledge from the study programmes that the students studied in the previous period in the field of knowledge of hardware and software in order to design elementary electronic systems that will be able to perform the previously defined goal function.

Course outcome

After completing the course, students will be able to formulate a problem, conceptualize it, choose appropriate electronics components and implement basic electronic systems/circuits (analog, digital and/or mixed signal electronics systems).

Course contents

Lectures

- Introduction to the study programme, representative examples of basic electronic systems
- Basic components of electronic systems/circuits - General view
  - passive and active electronic components,
  - operational amplifiers (general purpose, instrumentation, rail to rail, etc.),
  - microcontrollers, PFGA,
  - sensors,
  - output elements
- Basic tools used in the design of electronic circuits (EDA - Electronics Design Automation), Altuim Designer, KiCAD EDA, EasyEDA
- Drawing and reading electronic schematics
- Simulation of electronic circuits (LTspice®)
- Selection of electronic components, TH and SMD electronic components, reading and understanding electronic components data sheets
- Presentation of student works and their critical analysis
- Wisiting a company that produces electronic devices/systems
- Guest lecturer who deals with the development of electronic systems and/or works with specialized software in this field

Exercises

Description of realization of real electronic systems, Design and ordering of demo printed circuit board, Assembly of demo circuit board, Test commissioning of demo circuit board, Error analysis

Literature

1. Petar Todorović, Electronic Circuit Design (in Serbian), lecturer script 2019-2023., Available on moodle portal
2. Slobodan Petričević, Petar Atanasijević, Construction of electronic devices (in Serbian), School of Electrical Engineering, Belgrade, 2018. https://www.etf.bg.ac.rs/uploads/files/udzbenici/Konstruisanje%20Elektronskih%20Ure%C4%91aja.pdf
3. Stojan Ristić, Elecronic components (in Serbian), script, Faculty of Electronic Engineering Niš http://mikroelektronika.elfak.ni.ac.rs/files/ELEKTRONSKE%20KOMPONENTE-2011.pdf
4. Paul Horowitz, Winfield Hill, The Art of Electronics, Third Edition, ISBN 978-0-521-80926-9, Cambridge University Press, 2015.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Theoretical teaching, exercises and independent students work, which is realized through practical work and homework, visits to companies in the field covered by the course

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	10	written exam	

projects	30	oral exam	30
homework(s) and seminar(s)	30		

Study programme:	Mechanical Engineering, Electrical Engineering and Computer Science
Course title:	Finite elements
Instructor/Instructors:	Miroslav Živković, Vladimir P. Milovanović
Subject status:	compulsory/elective
ECTS:	6
Condition:	/

Course objective

Understanding the theoretical foundations of continuum linear mechanics and its application in structural analysis using the finite element method. Familiarization with the basic concept of the finite element method (FEM). Application of FEM in the analysis of real engineering problems.

Course outcome

Upon passing the Finite Elements 1 exam, students will: Have knowledge of the fundamentals of continuum linear mechanics; Understand the basics of modeling and linear analysis using the finite element method; Be able to apply their acquired knowledge in modeling and linear analysis of real engineering problems.

Course contents

Lectures

General stress state, Cauchy's formula, equilibrium equations, and the concept of stress. General state of deformation. Elastic and thermoelastic constitutive relations for isotropic and orthotropic materials. Generalized Hooke's law, flexibility matrix and elasticity matrix, 3D general case, 2D axisymmetric problems, plane strain and plane stress cases; shell, membrane, and beam. Transformation of constitutive relations. Virtual work principle in the case of general stress and deformation. Finite element method: Basic concept, interpolation functions, element matrices and structure matrices, nodal force vector. Equilibrium of the finite element system and boundary conditions. Basic 3D finite elements of lower and higher orders, elasticity matrix and stiffness matrix. Determination of deformations, stresses, and internal forces of elements. Degenerate and enhanced 3D elements. Basic, degenerate, and enhanced 2D finite elements: axially symmetric element, plane strain and plane stress states. Finite element for shells, basic theoretical formulations according to the Mindlin-Reissner plate theory. Finite element for beams, basic theoretical formulations, enhanced element, and curved rods. Dynamic analysis using the finite element method. Numerical integration and methods for solving systems of equations. Methods for integration of differential equations of structures.

Exercises

Generating finite element meshes for the relevant part, defining constraints and loads, performing analysis. Post-processing - graphical representation of obtained results and their interpretation.

Literature

1. M. Kojić, R. Slavković, M. Živković, N. Grujović: Metod konačnih elemenata I, Mašinski fakultet, Kragujevac, 1998.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

The instruction is delivered through lectures, exercises, and independent student work. During lectures, students receive fundamental information. In exercises, students acquire practical knowledge and skills in using specific tools within specific areas. Students work on independent assignments that encompass and integrate their knowledge of using various tools.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	60	oral exam	40

Study programme:	Electrical Engineering and Computer Science
Course title:	Electrotechnical materials
Instructor/Instructors:	Dragan Adamović, Nada Ratković, Dušan Arsić
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

The aim of the course is to gain the necessary knowledge important for the correct application of electrotechnical materials in practice. In this course, students will be introduced to different types of electrotechnical materials (conductors, semiconductors, superconductors, dielectrics and magnetics) and their behavior during exploitation as well as during action of external influences (load, temperature, environment, etc.). Besides, students will learn about production, impact on the environment and application of materials in various fields of electrical engineering.

Course outcome

By mastering the study program of the subject Electrotechnical materials, the student is able to solve specific problems in this field, as well as to connect the acquired knowledge in this field with other fields and apply them in practice.
Based on the acquired knowledge, students should know that for a specific task, they decide on the choice of materials according to the possibilities of their application from the aspect of physics, functionality, workability, economy and environmental protection.

Course contents

Lectures

Introduction. Structure, properties and types of materials. Metalic materials – ferrous and non-ferrous metals. Polymer materials and composite materials. Ceramics and glasses. Conductors. Semiconductors. Dielectrics (insulators). Magnetic materials. Superconductors. Modern electrotechnic materials. Material degradation. Materials selection.

Exercises

Designation and identification of materials. Testing of materials and processing of test results. Static testing of materials (testing by tension, compression, bending). Dynamic materials tests (toughness, material fatigue tests). Technological tests and non-destructive tests. Hardness determination (Brinell, Vickers, Rockwell and dynamic methods). Methods of structure characterization. Examination of some electrical properties of materials (electrical conductivity, electrical resistance, magnetism). A case study of material selection for a specific electrical device.

Literature

1. T.K. Basak, Electrical Engineering Materials, New Academic Science, 2012, ISBN 978-1-906574-43-7
2. K.M. Gupta and Nishu Gupta, Advanced Electrical and Electronics Materials – Processes and Applications, Scrivener Publishing and John Wiley & Sons, 2015, ISBN 978-1-118-99835-9
3. P. Osmokrović, Elektrotehnički materijali, Elektrotehnički fakultet, Beograd, 2003
4. P. Krčum, Materijali u elektrotehnici, Sveučilište u Splitu, Split, 2007.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, oral and laboratory exercises, seminar papers, consultations as needed.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	10	oral/written exam	30
midterm exam(s)	40		
homework and seminars	20		

Study programme:	Electrical Engineering and Computer Science
Course title:	Smart materials
Instructor/Instructors:	Fatima Zivic, Dragan Adamovic
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

Review of smart materials properties and their production methods, applications and exploitation behaviour.

Course outcome

To learn basics in smart materials field: theoretical basis related to the physical phenomena determining their function; smart material properties and material selection based on their application. To understand the role and significance of the material influence on the practical application function.

Course contents

Lectures

Theoretical basis related to the physical phenomena determining their function: electrical conductivity – semiconductors, quantum devices; polarisation effects – ferroelectric, pyroelectric and piezoelectric properties; magnetisation – ferromagnetic, paramagnetic and diamagnetic properties; optical properties – absorption, refraction and dielectric constant; phase transformation induced by large deformation; viscosity change induced by the magnetic field, magnetorheology, electro-optic effects.
Review of development, production and application of smart materials: energy harvesting materials; batteries; piezoelectric materials; magnetostrictive materials; rheological fluids; shape memory materials - shape memory alloys and shape memory polymers; thermoelectric materials; smart sensors – smart biosensors; antibacterial biomaterials; smart materials in electronics: thermal, electrochemical and electric stimulus-responsive materials, smart coatings for corrosion protection; self-cleaning coatings and their application in solar cells, display panels, smart phones; nanomaterials – semiconductor nanoparticles; nanofluids for cooling electronic components; conductive polymers – smart materials inspired by nature; 3D printing of the functional surfaces; smart structures through 3D printing – 4D printing of dielectric elastomers for soft robotic applications and low-voltage electroactive polymers; biomimetic in electronics; green and sustainable materials for batteries.

Exercises

Case studied of smart materials applications in novel IT technologies, robotics, and manufacturing, for new machines and power systems, in medicine: sensors, actuators and micro-electro-mechanical systems (MEMS). Research studies through review of scientific articles and research data analysis.

Literature

1. Surutka JV (2006) Elektromagnetika, 8. izd. Akademska misao, Beograd
2. Schwartz MM (ed) (2002) Encyclopedia of smart materials. J. Wiley, New York
3. Gaudenzi P (2009) Smart structures: physical behaviour, mathematical modelling and applications. Wiley, Chichester, UK
4. Singh J (2005) Smart electronic materials: fundamentals and applications. Cambridge University Press, Cambridge

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Teaching, audio and lab exercises

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	50	oral exam	30
projects	20		

Study programme:	Electrical Engineering and Computer Science
Course title:	Computer-Aided Measurement and Control
Instructor/Instructors:	Milan Matijevic
Subject status:	elective
ECTS:	6
Condition:	-

Course objective

The course covers practical aspects of applying modern computer technology in measurement and control systems. Theoretical concepts will be studied to the extent necessary for understanding and linking the materials from the basics of process dynamics, basic theory of measurement and control, hardware components (sensors, actuators, controllers and computers, etc.), signal processing and software implementation (PLC programming, LabView, C/C++, etc.), SCADA and DCS systems, etc.

Course outcome

The course covers fundamental knowledge of systems engineering principles, continuous and digital signals and systems, structural, functional, and other technical characteristics of measurement and control systems, principles of measuring basic physical quantities (pressure, temperature, flow, level, displacement, velocity, acceleration), methods of modeling and identification of objects and processes, selection of sensors, actuators, and controllers, tuning of industrial PID controllers, communications in measurement and control systems, principles of real-time programming, application of computer technology in measurement and control systems, architecture and characteristics of SCADA and DCS systems, principles of formal design, and techno-economic aspects of system design.

Course contents

Lectures

Theoretical classes: 1. Introductory considerations. General concept of a system and principles of systems engineering. 2. Theoretical basis of digital signals and systems. Signal analysis in dynamic systems. Sampling and reconstruction theorem for analog signals. Digital system structure. Discrete transfer function. Frequency characteristics of digital systems. 3. Stability. Closed-loop measurement and control systems. 4. Basic functional and technical characteristics of measurement and control systems. Static and dynamic characteristics of dynamic systems. Technical characteristics of devices and systems. Communications in measurement and control systems. 5. Modeling and identification. 6. Sensors. Basic principles of physical quantity measurement. 7. Sensors. Industrial applications. Data acquisition and processing. Visualization tools - LabView. 8. Actuators. 9. Control algorithms. General principles of synthesis. PID control. 10. PID controllers - design and tuning. Typical industrial control algorithms. 11. Hardware and software requirements for real-time operation. Real-time measurement and control systems. 12. Industrial controllers and automation. Sequential control. PLC programming - ladder diagrams. 13. SCADA and DCS systems. 14. Integration and implementation of control systems. Computer networks. Communication protocols in control systems. Integration with other information systems. Safety and reliability issues. 15. Principles of formal design. Technical and economic analysis.

Exercises

Practical classes: Exercises, Other forms of teaching, Study and research work.
The mentioned topics are covered through laboratory exercises.

Literature

1. Matijević M., Jakupović G., Car J.: Računarski podržano merenje i upravljanje, Mašinski fakultet u Kragujevcu, 2009
2. Karl A Astrom, Bjorn Wittenmark, Computer-Controlled Systems: Theory and Design, Third Edition (Dover Books on Electrical Engineering), ISBN: 9780486486130, 2011

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises and laboratory exercises on the computer.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	30	oral exam	40
Lab projects	30		

Study programme:	Electrical Engineering and Computer Science
Course title:	Engineering software
Instructor/Instructors:	Vladimir Vukašinović, Vanja Šušteršič
Subject status:	elective
ECTS:	6
Condition:	

Course objective

Knowledge and skills acquisition related to data gathering, processing, and presentation and solving engineering problems in software such as EXCEL, MATHCAD and GAMS.

Course outcome

Students will be familiar with various engineering software, as well as the possibilities for their application to solve different engineering problems.

Course contents

Lectures

Data processing and presentation. Data visualisation. Monte Carlo method. Defining variables, functions and mathematical expressions. Matrices and vectors. Entering and Plotting data. Programming in MathCAD. Mathematical planning and programming. Linear programming. Simplex method and duality in linear programming. Application of linear programming. Integer programming.

Exercises

Auditory exercises include working in a computer classroom and solving various engineering problems.

Literature

1. Verschuuren G.M.: Excel simulation, Holy Macro Books, Ohio, USA, 2014.
2. Duško Milinčić: MathCAD 2001 Professional, manual, 2001.
3. Vujošević M.: Linear programming (In Serbian), Faculty of Organizational Sciences, Belgrade, 2013.
4. Savitsky A.G., McKinney D.C.: GAMS tutorials for beginners, USAID, 1999.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Teaching is conducted through lectures and auditory/laboratory exercises in the computer classroom. Lectures are followed by multimedia teaching content. Students acquired knowledge is continuously checked during the semester.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	
midterm exam(s)	60	oral exam	35

Study programme:	Mechanical Engineering, Military Engineering, Electrical Engineering and Computer Science
Course title:	Computer-aided engineering
Instructor/Instructors:	Gordana Jovičić, Vladimir P. Milovanović
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

Introduction to the basic elements of numerical experimentation and acquisition of skills for conducting computer simulations of typical analyses in engineering practice using specialized software. Acquisition of necessary theoretical and practical knowledge in the field of finite element method (FEM) application in structural design, with a particular emphasis on result verification and control. Familiarization of students with optimization problems, their formulation, analytical and computational tools for solving these problems, and the application of optimization in various domains. Empowering students to optimize real systems.

Course outcome

Upon completion of the course, students will be able to: 1) Understand the significance and potential applications of computer simulations in engineering. 2) Independently conduct simple engineering computer simulations using specialized software. 3) Practically apply multiple modern software tools in the field of FEM for structural analysis during the design phase. 4) Apply algorithms in software development and utilize existing software solutions for optimizing the design and functionality of real systems.

Course contents

Lectures

Technologies of modern engineering, CAD/CAM/CAE. Overview of typical numerical methods in the field of computer-aided engineering: Interpolations (Interpolating Polynomial, Interpolating Splines - Cubic splines; Finite Difference Method; Practical aspects of interpolation); Approximations (function approximation, least squares method, Fourier series). Control of numerical errors.
• Brief presentation of the principles on which FEM is based. Indication of potential problems and specificities that can arise from different methods of modeling different types of structures. The importance of interpreting analysis results and their verification. Comparison of results obtained using different FEM software, for different mesh densities, with the possibility of comparing with analytical solutions.
• Linear optimization with constraints. Nonlinear optimization with constraints (optimality criteria, Lagrange multipliers, Karush-Kuhn-Tucker conditions, generalized reduced gradient method). Examples of practical applications (technical systems, ecological systems, business systems).

Exercises

Numerical error control; Presentation of algorithms for cubic spline interpolation; Finite difference method; Examples of analysis in Mechanical Engineering, Civil Engineering, Electrical Engineering; Optimization in engineering practice.
• Introduction to geometry of various shapes and preparation for FEM modeling, using software for pre- and post-processing FEMAP. Advanced techniques in FEM modeling.
• Computer simulations (static, dynamic analysis) for solving various types of engineering problems in practice using FEM software (PAK, NX Nastran, ANSYS, Altair software).
• Familiarization with the capabilities of optimization methods, problems of nonlinear and stochastic optimization, and computer implementation. Project in the field of nonlinear and stochastic optimization.

Literature

1. M. Kojić, R. Slavković, M. Živković, N. Grujović: Metod konačnih elemenata I, Mašinski fakultet, Kragujevac, 1998.
2. G. Jovičić, Kompjuterski podržano inženjerstvo – inženjerske simulacije, skripta u elektronskom obliku, 2010
3. D. Kovačević: MKE modeliranje u analizi konstrukcija, Građevinska knjiga, Beograd 2006
4. Chapra S.C., Canale R.P., Numerical Method for Engineers with Software and Programming Applications, McGraw Hill Higher Education, ISBN 0-07-243193-8, 2002.
5. Snyman J. A.: Practical Mathematical Optimization : An Introduction to Basic Optimization Theory and Classical and New Gradient-Based Algorithms (Applied Optimization), Springer, 2005

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Theoretical lectures are conducted in the classroom. Practical exercises are carried out in a computer lab, where students receive brief explanations and then work individually.

Knowledge assessment (maximum number of points 100)			
Pre-exam obligations	points	**Final exam**	points
midterm exam(s)	60	oral exam	40

Study programme:	Electrical Engineering and Computer Science
Course title:	Innovation management and entrepreneurship
Instructor/Instructors:	Snežana Nestić, Aleksandar Aleksić
Subject status:	elective
ECTS:	6
Condition:	

Course objective

The course is designed to equip the engineering students with knowledge in the field of innovation management and entrepreneurship taking into account the creation of a business venture, development of an entrepreneurial state of consciousness, entrepreneurial skills, and personal qualities.

Course outcome

The students should develop the entrepreneurial skills of an engineer; acquire conceptual and practical knowledge in the field of innovation management and technology transfer; understand the typical problems of starting one's own business; accept and design principles that are key to the process of creation of innovations in the company and bringing new products or services to market.

Course contents

Lectures

The importance and role of entrepreneurship for the development of companies and the economy. Entrepreneur - characteristics, and skills. Entrepreneurship of the new age - new business models, new jobs, and business skills of engineers; innovation and entrepreneurship in new economic conditions. Entrepreneur and entrepreneurship (concept and definition, characteristics and skills). Integration of knowledge of engineers, managers, and entrepreneurs. The importance of an idea for an entrepreneurial venture; turn ideas into business. Exploring the entrepreneurial environment. The connection between entrepreneurship and innovation. Theory of innovation. Typology of innovations. Models of innovation processes. Innovation strategies. Innovation management. Innovation and technological trajectories. Innovative enterprise - characteristics, indicators, measurement, and monitoring of key elements of enterprise innovation. Intellectual property. The relationship between innovation and research and development activities.

Exercises

It includes the analysis and application of creative methods of idea generation, forecasting, evaluation, and selection of innovative ideas. The exercises are auditory and involve the preparation, development, and defense of team's seminar paper.

Literature

1. Levi Jakšić M., Marinković S., Petković J., Menadžment inovacija i tehnološkog razvoja, Fakultet organizacionih nauka, Univerzitet u Beogradu, Beograd, 2015.
2. Levi Jakšić M., Marinković S., Petković J., Rakićević J., Jovanović M., Tehnološko preduzetništvo, Fakultet organizacionih nauka, Univerzitet u Beogradu, Beograd, 2018
3. Babić M., Ninković R., Preduzetništvo, teorija proces i praksa, Mašinski fakultet u Kragujevcu i Unija poslodavaca Srbije, 2007.
4. Ćulibrk R., Upravljanje razvojem preduzeća i preduzetništvo u nestabilnim uslovima privređivanja, Univerzitet u Novom Sadu, Građevinski fakultet Subotica, 2005.
5. Van den Ende, Jan. Innovation Management. Bloomsbury Publishing, 2021.

Hours per week of active teaching	**Lectures:**	3	**Exercises:**	2

Teaching methods

Teaching is realized as an active type and consists of lectures and exercises. This includes: lectures with the use of multimedia tools, guest lecturers from successful entrepreneurs, case studies, independent and group activities of students, use of Internet resources, and performance of all student duties during exercises with the consultation of teachers and associates. A part of the exercises takes place through the visits to business entities and relevant institutions.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	5	written exam	30
midterm exam(s)	45	oral exam	

homework(s) and seminar(s)	20		

Study programme:	Electrical Engineering and Computer Science
Course title:	Modeling and simulations
Instructor/Instructors:	Živković M. Miroslav, Filipović D. Nenad, Dunić Lj. Vladimir
Subject status:	elective
ECTS:	6
Condition:	none

Course objective

The aim of this course is to acquaint students with computer modeling and simulation of the behavior of technical systems using modern software solutions in system analysis and design.

Course outcome

The acquired knowledge should enable students to successfully model technical problems as well as to solve and optimize the presented models with the aim of using the results for successful design of structures and solving problems of physical fields.

Course contents

Lectures

Introduction to computer modeling and simulation. Modeling of engineering systems and analogous phenomena described by differential equations of the same form: Coulomb's law, Fourier's law, Darcy's law, Stokes' law, Hooke's law. Approximate methods of solving fields of physical quantities.
Basics of numerical methods and simulations using computer programs. 3D, 2D, 1D finite elements. Incremental equations for the finite element and for the structure. Simple examples of modeling with an analytical solution. Simulation as a system of system optimization and reliability.
Modeling problems in solid mechanics, heat conduction and analogous phenomena. Solving thermomechanical coupled problems: strong and weak coupling. Modeling problems in fluid mechanics, diffusion, mass and heat transport. Modeling of coupled problems in thermodynamics and fluid mechanics. Modeling of coupled fluid-solid interaction problems.

Exercises

Solving problems: solid mechanics, heat conduction and analogous phenomena, thermo-mechanical coupled problems, fluids, solid-fluid interaction.

Literature

1. KJ Bathe, Finite element procedures, KJB Watertown MA, 2016
2. M. Kojić, N. Filipović, B. Stojanović, N. Kojić, Computer Modeling in Bioengineering: Theoretical Background, Examples and Software, Wiley, 2008
3. Kojić, M., Slavković, R., Živković, M., Grujović, N., Metod Konačnih Elemenata I, Linearna analiza, Mašinski fakultet, Kragujevac, 1998
4. Osnovi bioinženjeringa, Fakultet inženjerskih nauka, ISBN 978-86-86685-66-7, Kragujevac, 2012.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures, auditory exercises, laboratory exercises, independent work.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activities during lectures	10	oral exam	30
colloquiums	60		

Study programme:	Mechanical Engineering, Electrical Engineering and Computer Science
Course title:	Engineering of informational systems
Instructor/Instructors:	Milan Erić, Aleksandar Đorđević
Subject status:	elective
ECTS:	6
Condition:	/

Course objective

The goal of the course is for students to acquire a broad understanding of the fundamentals of information systems engineering and to grasp the significance and usage of modern information systems in various domains within organizations.

Course outcome

Students should understand the significance of modern information systems across a wide range of organizations, subdomains of information systems, and their interconnections. They should be able to design an information system and discuss the obtained results.

Course contents

Lectures

The theoretical instruction covers the following thematic content: fundamentals of information and communication technologies, architecture of information systems, data management, communication management, information system development process, information system management, intelligent systems, and decision support.

Exercises

The practical instruction includes the following thematic content: application of the Unified Modeling Language (UML) for modeling, application of the IDEF0 methodology for business process modeling, and the use of ARIS Express tool for business process integration.

Literature

1. Arsovski Z., Informacioni sistemi. Mašinski fakultet, CIM centar, Kragujevac, 2000.
2. James A. S., Informaciona tehnologija – principi, praksa, mogućnosti, Kompjuter biblioteka, Beograd, 2007.

Hours per week of active teaching	**Lectures:** 3	**Exercises:**	2

Teaching methods

Lectures and computer classroom exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during lectures	10	written exam	30
midterm exam(s)	50	oral exam	
seminars	10		

Study programme:	Electrical Engineering and Computer Science
Course title:	Internship
Instructor/Instructors:	
Subject status:	compulsory
ECTS:	4
Condition:	/

Course objective

The acquisition of direct knowledge about the functioning and organization of companies and institutions operating in the field for which the student is being prepared, as well as the application of previously acquired knowledge in practice.

Course outcome

Enabling students to apply their previously acquired theoretical and practical knowledge to solve specific engineering problems within a selected company or institution. Familiarizing students with the activities, business operations, management, and the role of engineers within the organizational structures of the chosen company or institution.

Course contents

An individual program is formed for each candidate in agreement with the management of the company or institution where the professional practice takes place. The program is designed according to the specific needs of the field in which the student is being trained.

Literature

1. Relevant literature for solving a specific engineering problem.

Hours per week of active teaching	**Lectures:**	**Exercises:**	6

Teaching methods

Consultations and keeping a diary of professional practice, in which the student describes the activities and tasks performed during the professional practice.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
activity during internship	70	oral exam	30

Study programme:	Electrical Engineering and Computer Science
Course title:	Diploma thesis research work
Instructor/Instructors:	
Subject status:	compulsory
ECTS:	3
Condition:	/

Course objective

Application of fundamental theoretical, methodological, scientific, and professional-applied knowledge and methods to solve specific problems within the chosen field. In this part of the final thesis, the student examines the problem, its structure, and complexity, and based on conducted analyses, draws conclusions about possible ways to solve it. By studying the literature, the student becomes familiar with methods designed for solving similar tasks and engineering practices in their resolution. The goal of the student's activities in this part of the thesis is to gain necessary experience through solving complex problems and tasks, and to recognize opportunities for applying previously acquired knowledge in practice.

Course outcome

Enabling students to independently apply previously acquired knowledge from various fields they have studied to understand the structure of a given problem and conduct systematic analysis in order to draw conclusions about possible approaches to its resolution. Through self-guided exploration of literature, students expand their knowledge in the chosen field and study various methods and works related to similar issues. This develops students' ability to conduct analyses and identify problems within the given topic. Through practical application of acquired knowledge from different areas, students develop the ability to understand the role and position of an engineer in the chosen field, the need for collaboration with other disciplines, and teamwork..

Course contents

It is formed individually according to the needs and the field covered by the topic of the final thesis. The student explores professional literature, professional and thesis papers of students who have dealt with a similar topic, and conducts analyses in order to find a solution to the specific task defined by the final thesis assignment.

Literature

1. Current journals from all publication years and approved final theses in the given field.

Hours per week of active teaching	**Lectures:**	**Exercises:**	3

Teaching methods

Lectures and computer classroom exercises.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
seminary	50	oral exam	50

Study programme:	Electrical Engineering and Computer Science
Course title:	Diploma Thesis Preparation and Defense
Instructor/Instructors:	
Subject status:	compulsory
ECTS:	5
Condition:	/

Course objective

The aim of completing and defending the final thesis is for the student to demonstrate a satisfactory ability to apply theoretical and practical knowledge in practice.

Course outcome

By completing and defending their final thesis, students who have completed their studies should be capable of solving real-world practical problems and continue their education if they choose to do so. Competencies include, above all, the development of critical thinking skills, the ability to analyze problems, synthesize solutions, predict the behavior of the chosen solution with a clear understanding of its strengths and weaknesses. Graduates also have the ability to solve specific problems using scientific methods and approaches. The ability to connect fundamental knowledge from different areas and apply it is particularly important. Graduates are proficient in the intensive use of information and communication technologies. Graduates at this level of study possess the competence to apply knowledge in practice, stay updated with professional advancements, and collaborate with local and international environments.

Course contents

It is individually formed according to the needs and scope covered by the assigned topic of the final thesis. In consultation with the mentor, the student prepares the final thesis in written form in accordance with the prescribed standards of the Faculty of Engineering Sciences. The student prepares and defends the written final thesis publicly, in agreement with the mentor and in accordance with the prescribed standards. The student studies professional literature, as well as theses and dissertations of other students dealing with similar topics, and conducts analyses to find a solution to the specific task defined by the final thesis assignment.

Literature

1. Current journals from all publication years and approved final theses in the given field.

Hours per week of active teaching	**Lectures:**	**Exercises:**	3

Teaching methods

The mentor formulates the topic with tasks for the preparation and defense of the final thesis. The candidate independently works on the problem assigned to them in consultation with the mentor and collaborator. After completing the thesis and receiving the mentor's approval that it has been successfully done, the candidate defends the thesis before a committee composed of at least three members. During the preparation of the final thesis, the mentor may provide additional guidance to the student, refer them to specific literature, and offer additional direction to ensure the production of a high-quality thesis. In the theoretical part of the thesis, the student engages in consultations with the mentor and, if necessary, with other instructors who specialize in the issues related to the topic of the final thesis.

Knowledge assessment (maximum number of points 100)

Pre-exam obligations	points	**Final exam**	points
thesis preparation	50	defense	50