BSc Study program: **ELECTRONICS, AUTOMATION AND ROBOTICS**

Departments:

1. **Electronics**
2. **Computerized Automation and Robotics**

These two departments offer a joint bachelor's degree program in **Electronics, Automation and Robotics**, with two modules (specializations):

1. **Electronics** and
2. **Automation and Robotics**.

Overview of Courses in Study Program

1st year: Electronics, Automation and Robotics						
1st semester			Hours/week			
No	M/E	Course	L	NE	LE	ECTS
1.	M	Linear Algebra and Calculus 1	3	3	0	7
2.	M	Physics 1	3	1	1	6
3.	M	Fundamentals of Electrical Engineering 1	3	1	1	7
4.	M	Fundamentals of Programming	2	0	2	5
5. *Select one of the following elective courses*						
	E	Technical English	2	1	0	5
	E	Communication Skills	2	1	0	5
	E	German Language	2	1	0	5
	E	Practical Mathematics	2	1	0	5
Total:			13	7	4	**30**
2nd semester			**Hours/week**			
No	M/E	Course	L	NE	LE	ECTS
1.	M	Calculus 2	3	3	0	7
2.	M	Physics 2	3	1	1	6
3.	M	Fundamentals of Electrical Engineering 2	3	1	1	7
4.	M	Algorithms and Data Structures	2	0	2	5
5.	M	Digital Circuits	2	1	1	5

2nd year: Electronics, Automation and Robotics						
3rd semester			Hours/week			
No	M/E	Course	L	NE	LE	ECTS
1.	M	Microprocessors and Microcontrollers	2	0	2	5
2.	M	Calculus 3E	2	2	0	5
3.	M	Signals and systems	3	1	1	6
4.	M	Automation	2	1	1	5
5.	M	Electronics	3	0	1	5
6.	M	Electronic measurements	2	0	1	4
4rth semester			Hours/week			
No	M/E	Course	L	NE	LE	ECTS
1.	M	Internet of Things	2	0	2	6
2.	M	Power Systems	2	1	1	5
3.	M	Electromagnetic Fields and Waves	2	1	1	5
4.	M	Discrete Signals and Digital Processing	2	0	2	5
5.	M	Computer Architecture	2	0	2	5
6. *Select one of the following non-technical electives (non-technical electives)*						
	E	Innovation and Business	2	1	0	4
	E	Project management	2	1	0	4

3rd year: Specialization ELECTRONICS						
5th semester			Hours/week			
No	M/E	Course	L	NE	LE	ECTS
1.	M	Electronic Devices	3	0	1	6
2.	M	Digital Electronics	2	0	2	6
3.	M	Power Electronics	2	0	2	5
4.&5. *Select two of the following technical electives (technical electives)*						
	E	Optoelectronics	2	0	2	5
	E	Sensors and Actuators	2	0	2	5
	E	Electronic Communication	2	0	2	5
	E	Measurement Instrumentation and DAQ	2	0	2	5
	E	Fundamentals of Mechatronics	2	1	1	5
	E	Biomedical Signals	2	1	1	5
6. Select one of the following non-technical electives (non-technical electives)						
	E	Entrepreneurship	2	0	0	3
	E	Microeconomics	2	0	0	3
6th semester						
No	M/E	Course	L	NE	LE	ECTS
1.	M	Microelectronics	2	1	1	5
2.	M	Analog Electronics	2	0	2	5
3.&4. *Select two of the following technical electives (technical electives)*						
	E	Fundamentals of Multimedia	2	0	2	5
	E	Fundamentals of Robotics	2	0	2	5
	E	Optical Communication Technology	2	0	2	5
	E	Embedded Systems	2	0	2	5
	E	Computer Aided Design of Electronic Systems	2	0	2	5
	E	Biomedical Instrumentation	2	0	2	5
5.	M	Internship	2	0	0	5
6.	M	Bachelor Thesis				5

3rd year: Specialization AUTOMATION AND ROBOTICS						
5th semester			Hours/week			
No	M/E	Course	L	NE	LE	ECTS
1.	M	Fundamentals of Control Systems	2	1	2	6
2.	M	Fundamentals of Robotics	2	0	2	5
3.	M	Programmable Logic Controllers	2	0	2	6
4.&5. *Select two of the following technical electives (technical electives)*						
	E	Sensors and Actuators	2	0	2	5
	E	Smart Actuators and Drives	2	0	2	5
	E	Smart Sensors	2	0	2	5
	E	Communications in Automation	2	0	2	5
	E	Finite Element Methods	2	0	2	5
	E	Operating Systems	2	0	2	5
6. *Select one of the following non-technical electives (non-technical electives)*						
	E	Entrepreneurship	2	0	0	3
	E	Microeconomics	2	0	0	3
6th semester			Hours/week			
No	M/E	Course	L	NE	LE	ECTS
1.	M	Modeling and Simulation	2	0	2	5
2.	M	Digital Control Systems	2	0	2	5
3.&4. *Select two of the following technical electives (technical electives)*						
	E	1. Nonlinear Control Systems	2	0	2	5
	E	2. Chemical Processes Control	2	0	2	5
	E	3. Continuous and Batch Processes	2	0	2	5
	E	4. Real-time Control Systems	2	0	2	5
	E	5. Computer Data Acquisition and Analysis	2	0	2	5
	E	6. Building Automation	2	0	2	5
5.	M	Internship	2	0	0	5
6	M	Bachelor Thesis				5

Note: M- Mandatory, E- Elective, L- Lectures, NE- Numerical exercises, LE-Laboratory exercises

Explanation

- The total number of credits (ECTS) accumulated for one year is 60 ECTS credits.

- The first and second years are the same for the two specializations.
- In all semesters besides the mandatory (M) there are also elective courses (E).
- After choosing the elective course it becomes a compulsory subject, the student or the professor will not be able to change the subject.
- Sixth semester professional internships will be pursued in industry (outside the faculty) and will be organized in the last semester of block studies totaling 120 teaching hours.

Comparison of study program with similar programs in the region:

1. University of Zagreb
- https://www.fer.unizg.hr/en/study_programs/undergraduate_study/computing, similarity 70-80%

2. Technical University of Vienna
- https://tiss.tuwien.ac.at/curriculum/public/curriculum.xhtml?dswid=7221&dsrid=430&key=46100, similarity 70-80%

Short course descriptions

Course title: Linear Algebra with Calculus I

Lecturer: Prof. Asoc. Dr. Qefsere Gjonbalaj, Prof. Asoc. Dr. Shqipe Lohaj, Prof. Asoc. Dr. Valdete Rexhëbeqaj Hamiti
Course status: Mandatory, Semester I, 7 ECTS

Short course description: In this course will be studied: complex numbers, parts from linear algebra, analytic geometry and functions with one-variable.

Course objectives: Students should be trained so that the knowledge gained through this course can be applied as an ancillary device in electrical and computer studies.

Learning outcomes:
Upon completion of this course the student will be able to:

1. describe, solve and design various problems in the field of his profession when dealing with complex number operations, through matrices and determinants;
2. describe and solve problems related to systems of linear equations;
3. find the functional connections of the magnitudes of various electrical problems and then with differential calculations, describe and examine those functional connections;
4. understand the concept of the derivative and is able to apply it to many problems in Geometry, Electronics, Telecommunication, Informatics and other areas;
5. demonstrate skills of mathematical modelling and problem solving.

Teaching methodology: Lectures, discussions, exercises, consultations, homework, seminar work, intermediate evaluations, final exam.

Evaluation methods: Seminar work and homework (10%), first intermediate evaluation (25%), second intermediate evaluation (25%), final exam (40%).

Concretization tools/IT: Pencil, whiteboard, projector and computer.

Ratio between theoretical and practical part: Ratio between the theoretical and practical part is 2:1.

Literature:

- Hamiti E. - Matematika I, Prishtinë 2008.
- Hamiti E. - Matematika II, Prishtinë 2008.
- Peci H, Doko M. - Përmbledhje detyrash të zgjidhura nga Matematika I, Prishtinë 1997.
- Loshaj Z. – Përmbledhje detyrash të zgjidhura nga Matematika II, Prishtinë 1996.

Course title: Physics I

Lecturer: Dr.sc. Valon Veliu
Course status: Mandatory, Semester I, 6 ECTS

Short course description: The course includes basic knowledge of physics necessary to gain general knowledge that is basic in engineering.

Course objectives: Using the physical laws to solve the basic problems of engineering.

Learning outcomes: On successful completion of the course, students will be able to:

- Analyze simple mechanical systems and solve equations of motion.
- Apply principles of conservation of energy and momentum to particle collisions.
- Explain the conditions of statics of rigid bodies and the equation of motion for rotation of the rigid body around fixed axis.
- Understand the first law of thermodynamics and analyze thermodynamic cycles.

Teaching methodology: 45 hours of lectures + 15 hours of auditorial exercises + 15 hours of laboratory exercises. Approximately 75 hours of personal study.

Evaluation methods: Seminar 10%, Mid-term exams 30 %, Final Exam 60 %.

Concretization tools/IT: Pencil, whiteboard, projector and computer.

Literature:

- S. Skenderi, R. Maliqi, "Physic for technical faculty", UP, Pristina, 2005.
- J. Serway, Physics for scientists and engineering, Thomson Books, 2004.
- D. Haliday, R. Resnick, J. Walker, Fundamentals of Physics, John Wiley &Sons, 2001

Course title: Fundamentals of electrical engineering 1
Lecturer: Prof. Dr. Luan Ahma, Prof. Dr. Enver Hamiti, Prof. Dr. Mimoza Ibrani, Prof. Ass. Dr. Vjosa Shatri
Course status: Mandatory, Semester I, 7 ECTS

Short Course description: Basics of electricity. Fundamental laws of electricity. Electric potential. An electric dipole and flux lines. Electrostatic induction. Electric generator. Polarization in dielectrics. Boundary conditions. Capacitance. Electrostatic networks. Energy and forces in electrostatic fields. Electrostatic field analysis using MATLAB. Concepts, elements and topology of electric circuits. Types of electrical circuits. Elementary DC circuits. Circuit Elements, Electrical resistance- Ohm's law. Construction of circuit model. Voltage and potential in electric circuit. Current source. Kirchhoff's laws. Analysis of a Circuit Containing Dependent Sources. Complex DC circuits. DC circuit analysis using SPICE.

Course objectives: The purpose of the course is to introduce the basic principles of electrical field and DC current circuits.

Learning outcomes: On successful completion of the course, students will be able to:

1. Understand fundamental laws of electricity.
2. Apply the fundamental laws of electricity for solving electric field problems.
3. Apply MATLAB software package for solving basic problems in electrical field.
4. Understand and apply methods for DC circuit analysis such as: Kirchhoff's lows, node
voltage method, mesh current method, superposition method, Thevenin's and Norton's theorem.
5. Understand transient response of first order circuits (series RC circuits).
6. Apply PSPICE Software for DC circuit analysis.
7. Apply gained knowledge in other electrical engineering fields.

Teaching Methodology: Presentations, tutorials, discussions, and laboratory works meaning: 60 hours presentations + 15 hours of tutorials, and 15 hours laboratory work.

Evaluation: First assesment:30%, Second assessment: 25%, Home exercises 10%, Attendance: 5%, Final exam, 30%, Total:100%.

Concretization tools: Computer, video projector, and equipped lab with necessary devices to illustrate all teaching material.

Literature:

- Nexhat Orana, Bazat e elektroteknikës 1, Prishtinë, 1994
- M.N. Sadiku, Elements of electromagnetic, Oxford University Press, New York, 2001
- Ch. Alexander, M.N. Sadiku, Electric Circuits, McGraw Hill, New York, 2000.

Course title: Fundamentals of Programming

Lecturer: Prof. Ass. Dr. Avni Rexhepi, Prof. Asoc. Dr.Kadri Sylejmani
Course status: Mandatory, Semester I, 5 ECTS

The goal: The purpose of the course is to introduce the basic principles of programming and algorithms, for solution of problems with computer and writing of respective programs (in C++ programming language).

Learning outcomes: On successful completion of the course, students will be able to write programs in C++ programming language, including the use of different functions.

Course content: Introduction to algorithms: sum, product, and factorial. Array operations and algorithms: sum/product of the array members, counting members, searching and sorting. Matrix manipulations: creation, sum/product of the members, searching, creating vector from the matrix members. Introduction to C++ programming language: variable types, operators, statements. Input and output: input of numbers, arrays, strings and their output, use of manipulators. Branching: if, goto, switch( ). Loops: while, do-while, for. Loops: breaking, continuing and exiting. Functions: defining and executing, parameters and arguments, mathematical and string functions. Using vectors and matrices with functions. Recursion, pointers, references. User defined types: enumerations, structures, classes.

Methods of teaching: 30 hours of lectures + 30 hours of auditory/lab exercises. Approximately 65 hours of personal study and exercise including home problems/tasks.

Grading System: Attendance lectures 10%, Attendance lab. 10%, Mid-term problems 30 %, Collocui/Final Exam 50 %

Literature:

- Agni Dika, "Algoritmet, me programe në C++", Universiteti i Prishtinës, Fakulteti Elektroteknik, Prishtinë, 2004, http://www.agnidika.net/algoritmetCpp.pdf
- Agni Dika Bazat e Programimit në C++, Universiteti i Europës Juglindore, Tetovë, ISBN 9989-866-23-6, http://www.agnidika.net/programimiCpp.pdf
- H.M. Deitel, P. J. Deitel, How to Program C++, Prentice Hall, Upper Saddle River, New Jersey, ISBN 0-13-111881-1.
- Robert Lafore, Object-Oriented Programming in C++, Sams, Indianopolis, Indiana, ISBN-10:0-672-32308-7.

Course title: Technical English

Lecturer: Lecturer from UP

Course status: Elective, Semester I, 5 ECTS

Short description: The focus of this course is to teach students to use English to clearly communicate and write engineering technical concepts.

Course goals: Enabling student to actively use the English language to communicate, orally and in writing, at the necessary level for the professional field of electrical and computer engineering.

Expected learning outcomes: Upon completion of this course the student will be able to:

1. actively use English in everyday life.
2. communicate both orally and in writing the English language at a desired level, specifically as it pertains to their professional field.
3. ask and answer questions in the field of electrical engineering in English.
4. translate texts related to the field of electrical and computer engineering.

Teaching methodology: 30 hours of lectures, 15 hours of exercises. Approximately 80 hours of independent work, including a seminar.

Assessment: Seminar 10%, Intermediary Evaluations 30%, Final Examination 70%.

Ratio between theoretical and practical parts of studying: 2:1

Primary literature:

- Day, Jeremy, *Cambridge English for Engineering*, Cambridge, UK

Course title: Communication skills

Lecturer: Prof. Dr. Blerim Rexha, Prof. Dr. Sabrije Osmanaj
Course status: Elective, Semester I, 5 ECTS

The goal: The goal of this course is to develop written and verbal communication skills and group work.

Learning outcomes: On successful completion of the course, students will be able to:

- write different official and business letters;
- write formal and informal emails,
- Using social media;
- write a five-paragraph essay;
- write different reports (visit r., field r., feasibility r., progress r.);
- write laboratory reports;
- use the Internet to find specific information;
- use the computer to write different reports;
- write minutes of meetings;
- write a paper on a particular problem or issue;
- write CVs and applications for work;
- hold oral presentations;
- respond to job interviews.

Course content: Introduction to communication skills. Words and sentences. Writing process. Technical information. Internet information and e-mail: World Wide Web (www) and Social media. Essays and exam answers. Laboratory reports. Reports. Proposals, specifications and manuals. Final year projects and reports. Spoken presentations. Group work and meetings. Letters. CVs and job applications. Interviews: Interview for job.

Methods of teaching: 30 hours of lectures + 15 hours of exercises. Approximately 80 hours of personal study and exercise including home-work.

Grading System: Test 1: 25 %,Test 2: 25 %, Test 3: 25%, Homework (seminar paper) 25 %.

Literature:

- Mike Markel & Stuart A. Selber, Technical Communication, 12th Edition, MacMillan, 2018
- John W. Davies, Communication Skills. A Guide for Engineering and Applied Science Students, Prentice Hall, 2011.
- Miller et al, How the World Changed Social Media, UCL Press, 2016
- Majlinda Nishku, Si të shkruajmë: procesi dhe shkrimet funksionale, CDE, Tiranë, 2004.

Course title: German language

Lecturer: Lecturer from UP

Course status: Elective, Semester I, 5 ECTS

Short description: The focus of this course is to teach students to use German to clearly communicate and write engineering technical concepts.

Course goals: Enabling student to actively use the German language to communicate, orally and in writing, at the necessary level for the professional field of electrical and computer engineering.

Expected learning outcomes: Upon completion of this course the student will be able to:

1. actively use German in everyday life.
2. communicate both orally and in writing the German language at a desired level, specifically as it pertains to their professional field.
3. ask and answer questions in the field of electrical engineering in German.
4. translate texts related to the field of electrical and computer engineering.

Teaching methodology: 30 hours of lectures, 15 hours of exercises. Approximately 80 hours of independent work, including a seminar.

Assessment: Seminar 10%, Intermediary Evaluations 30%, Final Examination 70%.

Ratio between theoretical and practical parts of studying: 2:1

Primary literature:

- Leitner, Arnold, *German Made Simple: Learn to speak and understand German quickly and easily*, New York, USA

Course: Practical Mathematics
Lecturer: Prof. Asoc. Dr. Valdete Rexhëbeqaj Hamiti
Course status: Elective, Semester I, 5 ECTS

Short course description: In this course will be studied algebraic expressions, polynomials, equations with an unknown, inequations, arithmetic and geometrical strings, trigonometry and analytic geometry.

Course objectives: Students should be trained so that the knowledge gained through this course can be applied to acquiring knowledge from the following subjects.

Learning outcomes:
Upon completion of this course the student will be able:

- to design and solve different problems in the field of equations with an unknown and their implementation;
- to operate with polynomials;
- to apply basic concepts from analytical geometry and trigonometry to various engineering problems.

Teaching methodology: Lectures, discussions, exercises, consultations, homework, seminar work, intermediate evaluations, final exam.

Evaluation methods: Seminar work and homework (20%), first intermediate evaluation (30%), second intermediate evaluation (30%), final exam (20%).

Concretization tools/IT: Pencil, whiteboard, projector and computer.

Ratio between theoretical and practical part: Ratio between the theoretical and practical part is 1:1.

Literature:

- Hamiti E., Peci H., Loshaj Z., Gjonbalaj Q., Lohaj Sh. - Përmbledhje detyrash nga matematika, Prishtinë 2001.
- M. Berisha, D. Kamberi, R. Gjergji, R. Zejnullahu, Përmbledhje detyrash nga matematika, Prishtinë 1990.

Course title: Calculus II

Lecturer: Prof. Asoc. Dr. Qefsere Gjonbalaj, Prof. Asoc. Dr. Shqipe Lohaj, Prof. Asoc. Dr. Valdete Rexhëbeqaj Hamiti
Course Status: Mandatory, Semester II, 7 ECTS

Course description
In this subject we work: Integral computation and its implementation, functions with two or more variables and ordinary differential equations.

Course objectives
The student should be able to apply the knowledge gained through this course as an auxiliary device in the studies of electrical engineering and computer engineering subjects

Expected results
After completion of the course, student will be able to

1. Understand the concept of indefinite and definite integral as well as their application in the measurement of various measures in Geometry, Electrotechnics, Telecommunication, Informatics and other fields;
2. Generalize concepts related to functions with one variable into multi variable functions and in particular into those with two variables. Also be able to apply every concept related to the differential calculation for the one variable function in the case of two variable functions;
3. Think logically about various differential equations, solve concrete examples step by step and model different practical problems through differential equations.

Methodology of teaching: Lectures, discussions, exercises, consultations, homework, midterm exams, final exams.

Methods of assessment: Homework and seminar (10%), First periodic exams (25%), Second periodic exams (25%), Final exams (40%).

Concretization tools: pencil, whiteboard, projector and computer.

Ration between Theoretical part and exercises: 2:1

References

- Hamiti E. - Matematika I, Prishtinë 2008.
- Hamiti E. - Matematika II, Prishtinë 2008.
- Hamiti E. - Matematika III, Prishtinë 2008.
- Peci H, Doko M. - Përmbledhje detyrash të zgjidhura nga Matematika I, Prishtinë 1997.
- Loshaj Z. - Përmbledhje detyrash të zgjidhura nga Matematika II, Prishtinë 1996.
- Hamiti E, Lohaj SH.- Përmbledhje detyrash të zgjidhura nga Matematika III, Prishtinë 2008.

Course title: Physics II

Lecturer: Dr.sc. Valon Veliu
Course status: Mandatory, Semester II, 6 ECTS

Short course description: The course includes basic knowledge of physics necessary to gain general knowledge that is basic in engineering.

Course objectives: Using the physical laws of modern physics in modeling and solving specific engineering problem.

Learning outcomes: On successful completion of the course, students will be able to:

1. Apply the linearization technique to equations of motion of oscillatory.
2. Explain the wave equation in non-dispersive medium.
3. Analyze optical systems using the methods of geometrical optics.
4. Explain the phenomena of interference, diffraction, and polarization of light.
5. Explain Planck's law of black body radiation.
6. Relate the atomic spectrum to quantization of energy levels.

Teaching methodology: 45 hours of lectures + 15 hours of auditorial exercises + 15 hours of laboratory exercises. Approximately 75 hours of personal study.

Evaluation methods: Seminar 10%, Mid-term exams 30 %, Final Exam 60 %.

Concretization tools/IT: Pencil, whiteboard, projector and computer.

Literature:

- S. Skenderi, R,Maliqi, “Physic for thechnical faculty”, UP, Pristina, 2005.
- J. Serway, Physics for scientists and engineering , Thomson Books, 2004.-D. Haliday, R.Resnick, J.Walker, Fundametals of Physics, John Wiley &Sons, 2001

Course title: Fundamentals of electrical engineering 2

Lecturer: Prof. Dr. Luan Ahma, Prof. Dr. Enver Hamiti, Prof. Dr. Mimoza Ibrani, Prof. Ass. Dr. Vjosa Shatri
Course status: Mandatory, Semester II, 7 ECTS

Short Course description: Basics of magnetism. Magnetic flux density. Lorentz force. Biot-Savart's law. Forces due to magnetic field. Magnetic torque and moment. Ampere's law. Magnetic dipole. Magnetization in materials. Generalized Ampere's law. Magnetic boundary conditions. Magnetostatic field analysis using MATLAB. Faraday's law. Inductors and inductances. Magnetic energy. Magnetic circuits. Current and voltage waveforms. Techniques of Circuit Analysis. Sinusoidal Steady-State Analysis. The Sinusoidal Response, The Passive Circuit Elements in the Frequency Domain, Sinusoidal Steady-State Power Calculations, Maximum Power Transfer. AC circuit analysis using SPICE. Magnetically coupled circuits. Response of First-Order *RL* and *RC* Circuits. Transient circuit analysis using SPICE. Balanced Three-Phase Circuits. SPICE analysis of three phase circuits.

Course objectives: The purpose of the course is to introduce the basic principles of magnetic field and AC current circuits analysis.

Learning outcomes: On successful completion of the course, students will be able to:

1. Understand fundamental laws of magnetism.
2. Apply the fundamental laws of magnetism for solving magnetic field problems.
3. Apply MATLAB software pavckage for solving basic problems in magnetic field.
4. Understand and apply methods for AC circuit analysis such as: Kirchhof's lows, node voltage method, mesh current method, superposition method, Thevenin's and Norton's theorem.
5. Understand transient response of first order circuits (series RL circuits).
6. Apply PSPICE Software for AC circuit analysis.
7. Apply gained knowledge in other electrical engineering fields.

Teaching Methodology: Presentations, tutorials, discussions, and laboratory works meaning**:** 60 hours presentations + 15 hours of tutorials, and 15 hours laboratory works.

Evaluation: First assesment:30%, Second assesment: 25%, Home exercises 10%, Attendance: 5%, Final exam, 30%, Total:100%.

Concretization tools: Computer, video projector, and equiped lab with neccessary devices to ilustrate all teaching material.

Literature:

- Nexhat Orana, Bazat e elektroteknikës 2, Prishtinë, 1994
- M.N. Sadiku, Elements of electromagnetic, Oxford University Press, New York, 2001
- Ch. Alexander, M.N. Sadiku, Electric Circuits, McGraw Hill, New York, 2000.

Course title: Algorithms and Data Structures
Lecturer: Prof. Ass. Dr. Avni Rexhepi, Prof. Asoc. Dr. Kadri Sylejmani
Course status: Mandatory, Semester I, 5 ECTS

The goal: The purpose of the course is to help students in advancing their knowledge of different algorithms, data structures and use of classes and objects in programming.

Learning outcomes: On successful completion of the course, students will be able to compile advanced algorithms, to define structures and classes and to use them in writing advanced programs.

Course content: Definition and use of advanced functions, inline functions, macro functions, function overloading, templates. User defined types. Object oriented programming. Structures: definition of different structures, with different functions as their components, operating structure components. Classes and objects: class definition, classes and member functions. Using public and private members. Declaring objects and operating with their components. Class constructor and destructor. Inheritance, arrays within objects and arrays of objects. Pointers and functions with pointers. References and functions with references. Algorithms, analysis of algorithms, algorithm's growth rate, classification. Data structures. Stack. Queue. Linked lists, adding/deleting nodes. List searching and sorting. Binary tree, tree traversal algorithms, insertion, search and deletion, BST-binary search tree, heap, balanced trees. Graphs, traversal algorithms, minimum spanning tree (Dijkstra-Prim, Kruskal), shortest path algorithm (Dijkstra). Searching and sorting algorithms (Insertion sort, Selection sort, Bubble sort, Shell sort, Merge sort, Quick sort, Heap sort, Bucket sort, Radix sort).

Methods of teaching: 30 hours of lectures + 30 hours of auditorial/lab exercises. Approximately 65 hours of personal study and exercise including home problems/tasks.

Grading System: Attendance lectures 10%, Attendance lab. 10%, Mid-term problems 30 %, Collocui/Final Exam 50 %

Literature:

- Agni Dika, Programimi i Orientuar në Objekte, me programe në C++, UEJL, Fakulteti i Shkencave Bashkëkohore, Tetovë, ISBN 9989-866-25-2, http://www.agnidika.net/programimiobjekte.pdf
- D. S. Malik, C++ Programming: Program Design Including, Data Structures, Course Technology, Thomson Leraning, Boston, Massachusetts, ISBN 0-619-03569-2
- H.M. Deitel, P. J. Deitel, How to Program C++, Prentice Hall, Upper Saddle River, New Jersey, ISBN 0-13-111881-1
- Robert Lafore, Object-Oriented Programming in C++, Sams, Indianopolis, Indiana, ISBN-10:0-672-32308-7
- D. S. Malik, Programming: From Problem Analysis To Program Design, Course Technology, Thomson Leraning, Boston, Massachusetts, ISBN 0-619-06213-4

Course title: Digital Circuits

Lecturer: Prof. Dr. Sabrije Osmanaj, Prof. Ass. Dr. Artan Mazrekaj
Course status: Mandatory, Semester II, 5 ECTS

Short course description: Number systems and codes: number systems, codes, encoding, error detection and correction. **Boolean algebra:** propositional logic, Boolean variables, basic operations, derived operations, axioms and theorems, proofs of theorems. **Boolean functions and logic gates:** representations, methods of simplification and conversion, Karnaugh map and truth table, logic gates and circuits, functionally complete sets of operations, timing hazards, logic families and technologies and their characteristics.
Combinational logic circuits: encoders and decoders, multiplexers and demultiplexers, comparators, adders, multipliers, arithmetic and- logic units. **Computer-aided digital design:** minimizers, schematic editors, circuit simulators, hardware description languages, PCB layout designers, IC layout designers. **Sequential logic circuits:** latches and flip-flops, truth table and excitation table, registers, counters, shift registers, ring counters, excitation equations, state table and state diagram, analysis and synthesis of sequential logic circuits. **Three-state buffers and buses:** buffer, Schmitt trigger buffers, three-state buffers, serial buses, parallel buses. **Programmable logic circuits:** storage matrix, ROM, PROM, EPROM, EEPROM, Flash, PLA, PAL, GAL, SRAM, DRAM, CPLD, FPGA. Use of hardware description languages for implementation of combinational and sequential logic in CPLD and FPGA circuits **Additional topics (in case of spare time, but not required in exams):** microcontrollers, microprocessors, analog-digital and digital-analog converters, clock generators.

Course objectives: To gain a basic theoretical understanding of functioning of digital structures. To acquire the knowledge and basic experience of practical design, implementation and testing of digital structures.

Learning outcomes: After successful completion of the course, students will be able to:

- describe the basic combinational and sequential structures of digital circuits;
- explain the functioning of such structures;
- describe this functioning in one of the hardware description languages;
- detect flaws in such functioning;
- eliminate the basic among such flaws;
- choose the optimal design of a digital structure, taking into account the requirements of size, cost and reliability of functioning;
- design combinational and sequential circuits using the methods of abstract and structural synthesis;
- build a prototype of the designed structure in the form of a printed circuit board;
- test the functioning of such a prototype;
- Formulate the strengths and weaknesses of the chosen design.

Teaching methodology: Lecture classes with examples of problem solving and tutorials to illustrate the theoretical concepts, laboratory work for acquisition of practical skills in design, implementation and testing of digital structures.

Evaluation methods: Final rating represents the sum of: The successful practical work: 25%, First intermediate evaluation: 15%, Second intermediate evaluation: 20%, Regular attendance and involvement in discussions and seminars 10%, Oral test or final exam: 30%, Total: 100%

Concretization tools/IT: Computer, projector, lab, table.

Ratio between theoretical and practical part: Ratio between the theoretical and practical part is 1:1.

Literature:

- Floyd Thomas L., Digital Fundamentals (10th Edition), Prentice Hall, 2008.
- M. Morris Mano, M. D. Ciletti. Digital Design, 6th ed. Pearson/Prentice Hall, 2017.
- Fundamentals of Digital Circuits, 3rd Edition, by A. ANAND KUMAR, 2014, Delhi.
- S.M. Deokar, A. A. Phadke, “Digital Logic Design and VHDL”, Wiles, 2009
- Digital Circuit Analysis and Design with SIMULINK Modeling: And Introduction to CPLDs and FPGAs, Second Edition, Steven T. Karris, Orchard Publications 2007.
- J. F. Wakerly. Digital Design: Principles and Practices, 5th ed. Pearson/Prentice Hall, 2017.
- C. Maxfield. Bebop to the Boolean Boogie, 3rd ed. Newnes, 2009.

Course title: Microprocessors and microcontrollers

Lecturer: Prof. Ass. Dr. Lavdim Kurtaj

Course status: Mandatory, Semester III, 5 ECTS

Course content: Motivation and introduction to microprocessor systems. Logical circuit and microprocessor system design. Microprocessor systems and details about communication between units, time diagrams. Internal structure of 8051 and ARM, variations among different producers. Introduction to the development system. Instruction set. Input/output ports and communication with peripherals. Programming in assembler and C/C++. Keyboard and display. Program structure. State diagrams. Timer function and programming. Interrupts - generation and processing. Serial communication. A/D and D/A conversion. Programming in higher level languages, Basic, C, C++.

Course objectives: Familiarity with parts of computer hardware. Uses of microprocessors and/ or microcontrollers in different applications. Basic microcontrollers concepts. Familiarity with architecture of 8051 and ARM family of microcontrollers. Familiarity with software development systems. Microcontroller programming in assembler, Basic, C, C++. Programming and utilization of peripheral devices.

Learning outcomes: On successful completion of the course, students will be able to:

- know structure of microprocessor systems that are faced with;
- design microprocessor and microcontroller based systems for specific application;
- write program for specific application;
- find and repair defects in microprocessor systems.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, laboratory exams, projects.

Assessment: Intermediary evaluations 15%+15%, Project 40%, Final exam 15%+15%.

Concretization tools/IT: Computer, projector, simulator, experimental development systems.

Ratio between the theoretical and practical part: 40:60

Literature:

- S. MacKenzie, The 8051 microcontroller, 4th Edition, Prentice-Hall, 2007
- Muhammad Tahir and Kashif Javed, ARM Microprocessor Systems: Cortex-M Architecture, Programming, and Interfacing, CRC Pess, 2017
- Renesas Synergy Development Kit, User’s Manual, Renesas Electronics, 2015
- D. V. Hall, Microprocessors and digital systems, McGraw-Hill
- Muhammed Ali Mazidi, The 8051 Microcontroller And Embedded Systems Using Assembly and C, Pearson Education, 2007
- Vinod G. Shelake, Rajanish K. Kamat, Jivan S. Parab, Gourish M. Naik, Exploring C for Microcontrollers: A Hands-on Approach, Springer, 2007
- Manufacturers manuals for microprocessors and microcontrollers

Course title: Calculus 3E

Lecturer: Prof. Asoc. Dr. Shqipe Lohaj

Course status: Mandatory, Semester III, 5 ECTS

Course description: Double, triple, line and surface integral. Basic concepts of numerical, polynomial, functional series and Fourier series. Part of vector analysis, gradient, tangent plane, divergence and rotor. Probability, random variable and distribution functions.

Course objectives: The student should be able to apply the knowledge gained through this course as an auxiliary apparatus in studying electrical engineering courses.

Learning outcomes: After end of this course the student will be able to:

- solve and formulate various professional problems when dealing with double, triple, line and surface integrals, vector space functions, scalar and vector fields and Fourier series;
- describe and solve problems related to energetics and the theory of electrical circuits. With the acquired knowledge the student will be able to make mathematical models related to specific professional problems;
- research various electrical phenomena and transform problems from one field to another to facilitate their solution and interpretation.

Teaching methodology: Lectures, numerical exercises, presentations, homework.

Assessment: In order to pass the course, the students has to achieve at minimum 50% of the total score. Attendance & classroom activity (10%), Seminar work & homework (10%), First intermediate evaluation (20%), Second intermediate evaluation (20%), Final exam (40%).

Ratio between the theoretical and practical part: 40:60

Literature:

- Hamiti E. - Matematika III, Prishtinë 2008.
- Hamiti E. - Matematika IV, Prishtinë 2008.
- Hamiti E, Lohaj SH.- Përmbledhje detyrash të zgjidhura nga Matematika III, Prishtinë 2008.
- Hamiti E, Lohaj SH.- Përmbledhje detyrash të zgjidhura nga Matematika IV, Prishtinë 2008.

Course title: Signals and Systems

Lecturer: Prof. Ass. Dr. Vjosa Shatri
Course status: Mandatory, Semester III, 5 ECTS

Course description: Introduction to basic theoretical concepts of signal and systems. Impulse response and convolution. Differential and difference equations. Fourier series and signal decomposition in harmonic components. Fourier transformation, spectrum of continuous signal and its properties. Amplitude modulation and sampling. System analysis in the frequency domain. Ideal filters. Demodulation and reconstruction of sampled signals. Fourier analysis of signals and systems in discrete time. Laplace transformation and its applications in the analysis of signals and systems. z-transform, properties, transfer function, stability and analysis in z domain.

Course objectives: The objectives of the course are to introduce students to the basic concepts of signals, system modeling, and system classification; to develop students' understanding of time-domain and frequency domain approaches to the analysis of continuous and discrete systems; to provide students with necessary tools and techniques to analyze systems; and to develop students' ability to apply modern simulation software to system analysis.
Learning outcomes: After finishing the course:

- Student will learn properties of signals and systems and the ways how to represent them in time and frequency domain.
- Student will be familiar with fundamental methods of signal and system analysis, in time and transform domain, through problem solving and performing corresponding simulations.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, numerical exercises, laboratory exercises.
Evaluation methods: Laboratory exercises 10%, Intermediary evaluations 25%+25%, Final exam 40 %
Concretization tools: Computer, projector, simulator, experimental plants.
Ratio between the theoretical and practical part: 50:50

Literature:

- Hwei P. Hsu, *Schaum's Outline of Theory and Problems of Signals and Systems*, Second Edition, McGraw-Hill, 2010
- Alan V. Oppenheim, Alan S. Willsky, with S. Hamid, *Signals and Systems*, 2nd ed., Prentice Hall, 1996.
- Bonnie S. Heck, Edward W. Kamen, *Fundamentals of signals and systems using the Web and MATLAB*, Third Edition, Pearson Education Limited, 2014
- B.P. Lathi, Principles of Linear Systems and Signals, Second Edition, Oxford University Press, 2009

Course title: Automation

Lecturer: Prof. Ass. Dr. Drilon Bunjaku

Course status: Mandatory, Semester III, 5 ECTS

Course description: Introduction. History of automatic control. Basic concepts and definitions. System, experiment, model, simulation, identification. Demo of the experimental platform QET. Principles of automatic control. Systems classifications. Feedback. Steps for designing an automatic control system. Mathematical modeling, analogies, elements for modeling. Model/system types. Modeling examples. Linearization. System order. Systems of order 0, 1 and 2. Concept of states. State equations. Physical state variables. Solving differential equations. Standard input signals. Response and specifications in the time domain. Stability. Solving state equations. Discrete state equations. Laplace transform. Frequency domain. Poles and zeros. Solving differential equations and state equations with Laplace. Systems representations. Block diagrams and signal flow graphs. Frequency domain analysis. Frequency characteristics. Polar diagrams. Nyquist's diagram. Stablity. Bode diagrams. System features and stability. Characteristics of the control system. Algebraic criteria for stability. Types of systems (astatism). Steady state errors. Controllers and impact on system behavior. Controllers time and frequency characteristics. Advanced control methods. Digital control. Neural and fuzzy control.

Course objectives: Familiarity with concepts of automatic control. Familiarity with the structure of automatic control system. Familiarity with mathematical methods for systems modeling. Familiarity with time and frequency domain analysis methods. Familiarity with the basic ways to influence the behavior of the system. Basic knowledge of advanced automatic control methods.

Learning outcomes: On successful completion of the course, students will be able to:

- be familiar with the concept of automatic control and standard control structures;
- assess the relevance of feedback concept and its impact on the process control;
- find mathematical model of the system and corresponding block diagrams;
- perform analysis on the properties of the system in the time and frequency domain;
- make measurements and draw conclusions about the system from experimental recordings.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, numerical exercises, laboratory exercises.

Assessment: Laboratory exercises, 10%, Intermediary evaluations 15%+15%, Final exam 50%.

Concretization tools/TI: Computer, projector, simulator, experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature:

- Farid Golnaraghi and Benjamin C. Kuo, *Automatic Control Systems*, Tenth Edition, McGraw-Hill Education, 2017
- Constantine H. Houpis, Stuart N. Sheldon, *ALinear Control System Analysis and Design with MATLAB*, Sixth Edition, CRC Press, 2014
- John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, *Linear Control System Analysis and Design: Fifth Edition, Revised and Expanded*, Marcel Dekker, 2003

Course title: Electronics

Lecturer: Prof. Asoc. Dr. Qamil Kabashi
Course status: Mandatory, Semester III, 5 ECTS

Course description: Semiconductors, semiconductor diodes, Zener diodes, diode circuits, and various diode circuits for signal processing. Bipolar transistors, basic configurations of circuits with bipolar transistors, models for small signals. Basic amplifier configurations: common emitter, shared base, and common collector. Field effect transistor, working principles, small signal patterns. MOSFET transistors. Basic amplifier configurations: with common source, with common gate and with common drain. Operational amplifiers, ideal and realistic features, basic circuits with operational amplifiers, OA applications.

Course objectives: To introduce the basic concepts in the field of electronics. This course will be one of the fundamental courses in all areas of electrical engineering and will prepare students for more advanced electronics courses.

Learning outcomes: On successful completion of the course, students will be able to:

- understand the basics of electronics within the field of electrical engineering;
- understand the diode circuits and their models;
- understand circuits with bipolar and FET transistors and their models;
- analyze and design transistor circuits for small signals;
- analyze and utilize operational amplifiers;
- continue studies in advanced electronics and microelectronics courses.

Teaching methodology: 45 hours of lectures, problem-solving examples as well as 15 hours of laboratory exercises. Approximately 80 hours of personal study including homework and seminar papers.
Assessment: Test 1: 10%, Test 2: 10%, Test 3: 10%, Attendance to lectures 10%, Laboratory exams 10%, Final exam 50%. Success in preliminary assessments is a prerequisite for the final exam.
Concretization tools/TI: For lectures, computers, projectors and tables are used, while the practical part will take place at the Electronics lab.

Ratio between the theoretical and practical part: 40:60
Literature

- D. Neamen, Electronic Circuit Analysis and Design, McGraw-Hill Education, fourth edition, 2009
- Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, Oxford University Press, seventh edition, 2014.
- M. Limani, Q. Kabashi, Elektronika, Universiteti i Prishtinës, ligjërata të autorizuara, 2018.

Course: Electronic Measurements

Lecturer: Prof. Dr. Milaim Zabeli

Course status: Mandatory, Semester III, 4 ECTS

Course description: Basics of measurements. Bridge measurement. Electronic instruments for measuring Basic Parameters. Oscilloscopes: Oscilloscope measurement techniques, Special oscilloscopes – Storage oscilloscope, Signal generators. Signal Analysis: Wave Analyzer, Spectrum Analyzer. Frequency counters. Transducers. Amplifiers. Noise. Voltage references. Analog-to-digital conversion. Measurement data communication. Digital data acquisition system.

Course objectives: To introduce the basic principles of measurement of most important quantities in engineering, properties of measurement signals. Acquiring knowledge to interpret instrument specifications, estimate measurement uncertainty, express complete measurement results and make decisions on the basis of complete measurement results. Gaining skills to handle PC based measuring systems.

Learning outcomes: On successful completion of the course, students will be able to:

- Understanding of measurements as basic discipline for acquisition and evaluation of information.
- Understanding of methods how to measure basic electrical quantities.
- To know how to express the measurement results with measurement uncertainty.
- To know how to collect, interpret and evaluate measurement results.
- Select an analog to digital converter and estimate the device error.

Teaching methodology: 30 hours of lectures (including the solutions of practical problems) + 15 hours of laboratory exercises. Approximately 60 hours of personal study and exercise including homework.

Assessment: 1st Exam: 25%; 2nd Exam: 25%, Homework: 20 %, Final exam: 20%

Concretization tools/IT: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the laboratory.

Ratio between the theoretical and practical part: 40:60

Literature:

- P. Purkait, B. Biswas, S. Das, Electrical and Electronics Measurements and Instrumentation, McGraw Hill Education, 2013
- U.A.Bakshi, A.V.Bakshi, Electronics Measurements And Instrumentation, Technical Publication PoneTechnical, 2009
- David B. Bell, Electronic Instrumentation and Measurements, Oxford University Press; 2013

Course title: Internet of Things

Lecturer: Prof. Ass. Dr. Drilon Bunjaku
Course status: Mandatory, Semester IV, 6 ECTS

Course description: The rapid growth of the "Internet of Things" is changing our world and the rapid drop in price for typical IoT components is allowing people to innovate new designs and products at home.
Therefore, this subject focuses on: Introduction to the fundamentals of Internet of Things. Sensing, actuation, networking basics, communication protocols, sensor networks, Machine-to-Machine communications, IoT definition, characteristics. IoT functional blocks, physical design of IoT, logical design of IoT, communication models. From M2M to IoT. M2M vs IoT an architectural overview. Domain applications of IoT: home automation, industry applications, surveillance applications, etc. Privacy and security issues in IoT. Introduction to Arduino and Raspberry Pi, hardware characteristics, GPI/O, programming etc. Sensors and Actuators. Implementation of sensors and actuator with Arduino and Raspberry Pi in Home Automation. NodeMCU ESP 8266, hardware configuration, technical specifications and features. Wireless communication between two and more NodeMCUs ESP8266 through ESPNow protocol. Creating web interface with Blynk to control Arduino and/or Raspberry Pi through NodeMCU. Monitoring light, temperature, door lock, and controlling them remotely. Presentation and defense of the projects.

The goal: The goal of the course is to introduce students with various components of Internet of things such as sensors, actuators, interconnecting modules, communications, internetworking and web interface. At the end students will experience to design and implement IoT circuits and solutions.

Learning outcomes: On successful completion of the course, students will be able to:

- Understand general concepts of Internet of Things (IoT),
- Apply design concept to IoT solutions,
- Analyze various M2M and IoT architectures,
- Recognize various devices, sensors and applications,
- Evaluate design issues in IoT applications,
- Create IoT home automation solutions using sensors, actuators and devices.

Teaching methodology:
30 hours of lectures, 30 hours of laboratory exercises. Approx. 75 independent working hours, including home works (or seminar paper).

Grading system: Class and lab. activity 10%+10%, Mid-term exams 10%+10%, Project 30%, Final exam 30%.

Necessary tools: During lecture sessions a computer with projector is needed, while the practical session will be realized in the laboratory of Electronics.

The ratio between theoretical and practical work: 40:60

Literature:

- Adeel Javed, "Building Arduino Projects for the Internet of Things. Experiments with Real-World Applications". Apress Media LLC, 2016.
- Marco Schwartz, "Internet of Things with ESP8266". Packt Publishing Ltd, 2016.
- Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-onApproach)", 1st Edition, VPT, 2014.
- Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
- Francis da Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
- Cuno Pfister, Getting Started with the Internet of Things, O‟Reilly Media, 2011, ISBN: 978-1-4493- 9357.

Course title: Power Systems

Lecturer: Prof. Ass. Dr. Arben Gjukaj, Prof. Ass. Dr. Vezir Rexhepi
Course status: Mandatory, Semester IV, 5 ECTS

Course description: Power System and its component parts. Power plants, transmission and distribution system. Thermal power plants, nuclear power plants, hydro power plants, wind power plants, solar plants. Single-phase and three-phase circuits analysis. Cables and transmission lines. Principles of energy conversion. The operating principle of transformer, equivalent schemes, determination of transformer parameter. The operating principle of DC Machines. Types of excitations. Control of voltage and speed. Models of AC machines. The operating principle of induction machines. Equivalent schemes, the induced voltage, torque and starting of induction motor. The operating principle of synchronous machine.

Course objectives: The purpose of the course is to introduce the basic principles of operation of the power system and electrical machines.

Learning outcomes: On successful completion of the course, students will be able to:

- Have knowledge of the power system, its components (power plants, transmission and distribution networks, substations).
- Have knowledge of transformers, operating principle, equivalent schemes, types of transformers and their application.
- To know the principles of energy conversion and operating principle of the DC Machines.
- To recognize principles of operating of AC machines with special emphasis on induction motors and synchronous generator.

Teaching methodology: Lectures, auditoria exercises, Assignments, Lab Experiments, Lab report and presentation.
Assessment: First midterm exam 25%, Second midterm exam 25 %, Lab experiments (20%), Attendance 10%, Final exam 20%.
Concretization means/IT: Laptop, projector, and practical part will be done in the laboratory.
Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- George G. Karady & Keith Holbert, *Electrical Energy Conversion and Transport*, 2nd ed. John Wiley, 2013
- Guru, B.S and Hiziroglu, H.R. *Electric Machinery and Transformers*, third edition, Oxford University Press, New York- Oxford 2001.
- G. Latifi, *Shndërrimi i energjisë elektrike*, Prishtinë 1997
- V. Komoni, Gani Latifi, *Elektronenergjetika*, ligjëratat, Prishtinë 2008

Course: Electromagnetic Fields and Waves

Lecturer: Prof. Ass. Dr. Vjosa Shatri
Course status: Mandatory, Semester IV, 5 ECTS

Course content: Vector Analysis: Gradient, Divergence and Curl, Laplacian operator. Electrostatics: Maxwell's equations, Charge and current distributions, Gauss Law, Electrical scalar potential, Electrical properties of materials, Method of images, Electrostatic potential energy. Magnetostatics: Magnetic forces and torques, Maxwell's magnetostatic equations, Vector magnetic potential, Boundary conditions, Inductance, Magnetic energy. Maxwell's equation for time varying fields: Faraday Law, Displacement current, Retarded potentials. Electromagnetic Waves: Derivation of the wave equation, solution of wave equation for TEM case, plane wave concepts, wavelength, attenuation and phase constants, propagation of waves in lossless and lossy media. Transmission Lines: Derivation of transmission line parameters, attenuation and phase coefficients, characteristic impedance, SWR definition, lossless and lossy lines and matching techniques.

Course objectives: To provide students with the background necessary to understand the interplay between electricity and magnetism, the electromagnetic wave properties and its propagation in different media through various junctions.

Learning outcomes: On successful completion of the course, students will be able to:

- Apply vector calculus to analyze the behavior of static electric fields and magnetic fields in standard configurations;
- Describe the parameters of quasistatic and time varying fields, guided and free space wave propagation and the underpinning role of Maxwell's equations.
- Explain examples of the interaction between waves and media and to be able to relate these to engineering design considerations and function;
- Illustrate and analyze transmission lines;
- Practice calculation of electromagnetic filed to solution of practical problems.

Teaching methodology: Lectures combines with simulation and demonstration, discussions, numerical exercises, laboratory experiments.
Assessment: Laboratory experiments 10%, Intermediary exams 25%+25%, Final exam 40%.
Concretization means/IT: Laptop, projector, simulations, laboratory experiments.
Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- Fawwaz T. Ulaby, Eric Michielssen and Umberto Ravaioli, *Fundamentals of Applied Electromagnetics*, Sixth Edition, Prentice Hall, 2010
- Magdy F. Iiskander, *Electromagnetic Fields and Waves*, Waveland Press, 2012

Course title: Discrete Signals and Digital Processing

Lecturer: Prof. Ass. Dr. Drilon Bunjaku
Course status: Mandatory, Semester IV, 5 ECTS

Course content: Discrete signals and systems, impulse response, convolution, difference equations, correlation. Discrete-Time Fourier transform and sampling. z-Transform. Discrete Fourier Transform. Fast Fourier Transform. Discrete system implementation structures. Design of recursive and non-recursive digital filters. Multi-rate signal processing. Random signals and discrete linear systems, introduction to optimal filtering.

Course objectives: Getting a deeper insight into the discrete signal processing and system analysis. Getting acquired with different system structures, DFT, FFT, multi-rate DSP, IIR and FIR digital filter design methods. To introduce students to basics of discrete random signal processing.

Learning outcomes: Students should be able to do the following upon completion of this course:

- To understand and to use different methods for discrete signal and system analysis in
- discrete time and frequency domain.
- To understand circular convolution, its relationship to linear convolution, and how linear convolution can be achieved via the discrete Fourier transform.
- To master digital filter (IIR and FIR) design.
- To understand multi-rate discrete systems and multi-rate signal processing techniques.
- To understand basics of discrete random signal processing.

Teaching methodology: Lectures, auditoria exercises, Assignments, Lab Experiments, Lab report and presentation.
Assessment: Lab experiments 15%, Intermediary exams 25%, Final exam 60%.
Concretization means/IT: Laptop, projector, and practical part will be done in the laboratory.
Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- Alan V. Oppenheim, et al, Discrete -Time Signal Processing, 2nd ed., 1998, Prentice Hall.
- Schaum's Outline of Theory and Problems of Digital Signal Processing", Monson H. Hayes, McGraw-Hill, 2011.
- John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing - Principles, Algorithms and Applications 3rd ed., 1996, Prentice Hall.

Course title: Computer Architecture

Instructor: Prof. Asoc. Dr. Qamil Kabashi
Course status: Mandatory, Semester IV, 5 ECTS

Course content: Introduction to computer organization and architecture. Designing for Performance. Pentium and PowerPC evolution. Top-level view of computer function and interconnection structures. BUS interconnection. Cache memory and elements of cache design. Internal memory. Input/output devices. Programmed and interrupt driven I/O. Direct memory access. RISC versus CISC architecture. CPU structure and function, Instruction Pipelining, Multi-core processors. Parallel processing and multiple processor organization.

Course objectives: The objective of this course is to provide students with a fundamental understanding of the functional components of a computer system. The focus of the course is on the hardware aspects of a system during the execution of software.
Learning outcomes: On successful completion of this course, students should be able to:

- Explain computer architecture, organization, and structure relating to contemporary design for performance.
- Analyze the program execution process through instruction cycles, and the functioning of hardware components during this process using von Neumann architecture as a model.
- Classify various types of buses, their signals, and the different arbitration techniques.
- Illustrate internal and cache memory mapping including parameters of cache design.
- Differentiate and analyze interrupt-driven I/O, programmed I/O, and direct memory access mechanisms
- Explain the different architectural and organizational design issues that can affect the performance of a computer such as Pipelining, Superscalar architecture, RISC, Multi-core processors, and Multiple Processor Organization.
- Implement simple assembly program and C / C ++ using development plates (ARM, ARM-Coretex, 8051).
- Complete assignments, experiments in laboratory, and present a technical report.

Teaching methodology: Lectures, auditoria exercises, Assignments, Lab Experiments, Lab report and presentation.
Assessment: First midterm exam 25%, Second midterm exam 25 %, Lab experiments (20%), Attendance 10%.
Concretization means/IT: Laptop, projector, and practical part will be done in the laboratory
Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- W. Stallings, Computer Organisation and Architecture, 11th Edition, Pearson, 2019
- S. Tanenbaum, Structured Computer Organization, 6th Edition, Pearson, 2013

Subject: Innovation and Business

Lecturer: From industry
Course status: Elective, Semester IV, 4 ECTS

Course content: Overview, objectives, requirements, introductions, team building exercise. Exploring innovation and creativity. Innovation as a core competence. Managing for innovation; "Design Thinking". Entrepreneurship fundamentals. Creating and selling differentiated products/services. Business Model Innovation. Understanding Customers. Venture Capital financing. Growth strategies; Mass Challenge. Embedding innovation and execution. Strategy in context. The value of stories; Business Plan Presentations.

Couse objectives: The objective of the course is to trigger the curiosity of the student on the following questions: How can we prepare ourselves to be leaders of innovation? Which tools can we use to generate ideas? How can we test our ideas? The aims of the course are to understand the concept of innovation, its components and its importance for the company and organizations in general. Develop a practical framework for the design and implementation of a systematic innovation strategy. Incorporate adequate tools for formulation of a business model and a business plan. Connect the theoretical issues with the concrete reality through work on actual experiences of companies that have a culture in innovation and studying successful study cases.

Learning outcomes: On successful completion of the course, students are expected to:

- Understand and identify strategies to promote ideas on innovative products or services,
- Take necessary actions on implement their strategies successfully,
- Get familiar on promoting entrepreneurial culture,
- Be encouraged to develop their own business.

Teaching methodology: 30 hours of lectures, 30 hours of laboratory exercises. Approx. 75 independent working hours, including homework (or seminar paper).
Assessment: Class assignments and activity 20%, Project 40%, Final exam 40%.
Concretization tools/IT: During lecture sessions a computer with projector is needed, and personal computers for preparation and presentation of the projects.
The ratio between theoretical and practical work: 30:70

Literature:

- Mauborgne, René, *Blue Ocean Strategy (Expanded Edition)*, Boston: Harvard Business School Press 2015.
- Schrage, Michael, *The Innovator's Hypothesis*, Boston: MIT Press 2014.
- Westerman et al., *Leading Digital*, Boston: Harvard Business School Press 2014.
- Charles Hampden-Turner, *Teaching Innovation and Entrepreneurship: Building on the Singapore Experiment.* Cambridge University Press 2009.

Course title: Project Management

Lecturer: Prof. Ass. Dr. Sevdie Alshiqi

Course status: Elective, Semester IV, 4 ECTS

Course content: Introduction to project management. Project integration and field management. Project time management. Project Cost Management. Project quality management. Project human resource and communication management. Project risk management. Agile project management. Different project management methodologies. Scrum Components. Process: sprints. Reporting. Comparison of different agile methodologies.

Course objectives: The aim of the course is to provide the necessary knowledge and practical skills for the high-quality product development process, providing project control and management.

Learning outcomes: Upon successful completion of this course, the student will be able to:

- Understand and explain project management processes;
- Understand and explain various agile methodologies (SCRUM, Kanban, Extreme Programming, Lean);
- Recognize the advantages and disadvantages of these methodologies;
- Have in-depth knowledge of the Scrum project management method using the project management terminology correctly;
- Select the appropriate project management methods depending on the project;
- Plan project activities in terms of time and budget;
- Implements SCRUM methodology in practice and uses the Planio.io tool;
- Uses the MS Project package for classic project management processes;
- Express the project and its idea;
- Prepare project documentation;
- Communicates with each other through teamwork;
- Works in a team, assumes responsibility for the quality of the assigned task;
- Manage project team, evaluate team leader, members responsibly;
- Understands the importance of development skills for their professional growth;
- Develops the need to independently improve his project management skills.

Teaching methodology: 30 hours of lectures. Approximately 70 hours of freelance work including seminar work.

Assessment: Attendance and classroom activity: 10%, Intermediary exams 30%, Final exam 60%.

Concretization means/IT: Laptop, projector, different software.
Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- Schwalbe, K. (2015). Information Technology Project Management. 8th edition. Cengage Learning
- Robert, K. Wysocki (2013). Effective Project Management: Traditional, Agile, Extreme. 7th Edition. Wiley.
- Kenneth, S., R. (2012). Essential Scrum: A Practical Guide to the Most Popular Agile Process. Addison-Wesley.

Specialization ELECTRONICS

Course: Electronic Devices

Lecturer: Prof. Dr. Milaim Zabeli

Course status: Mandatory, Semester V, 6 ECTS

Course content: Energy Band Model, Bonding Model, Carrier Energy, Carrier Concentrations Distributions, Fermi Level in Equilibrium, Carrier Drift in Electric Fields, Recombination & Carrier Lifetime, Quasi-Fermi Levels, Carrier Diffusion, Drift & Diffusion, p-n Contact, Contact Potential, Forward & Reverse Bias, Diode Equation, Reverse Bias Breakdown, Junction Capacitance, MOSFET Basic Concepts, Ideal MOS Capacitor, Threshold Voltage Capacitance vs. Gate Voltage MOSFET Voltage/Current Relations, BJT Basic Concepts, Current Distribution Diagrams, Current Amplification Factor, Emitter Injection Efficiency, Base Charge Transit Time/Lifetime, Common Emitter Amplification.

Course objectives: The course is designed to teach the physical principles and operational characteristics of advanced semiconductor electronic devices with emphasis on metal-oxide systems, bipolar, high-electron mobility, and field-effect transistors. Topics also include quantum point contact and tunneling devices. The course provides advanced background for microelectronics and optoelectronics.

Learning outcomes: On successful completion of the course, students will be able to:

- understand the details of operation of the advanced semiconductor electronic devices;
- know the parameters of electronic devices that govern their performance and limitations,
- be familiar with tendency in contemporary microelectronics and principles of nano-scale electronic devices.

Methods of teaching: 30 hours of lectures, 15 hours of auditorial exercises, 30 hours of laboratory exercises. Approximately 100 hours of personal study.

Assessment: Test 1: 10%, Test 2: 10%, Test 3: 10%, Attendance to lectures 10%, Laboratory exams 10%, Final exam 50%. Success in preliminary assessments is a prerequisite for the final exam.

Concretization tools/IT: For lectures, computers, projectors and tables are used, while the practical part will take place at the Electronics lab.

Ratio between the theoretical and practical part: 3:2 (not including independent student work in doing homework and seminar works)

Literature:

- Ben Streetman and Sanjay Banerjee: Solid State Electronic Devices, Sixth Edition, Pearson, Prentice Hall, 2009,
- Donald A. Neamen, Semiconductor Physics and Devices, Irwin, Chicago, 2004,
- Myzafere Limani, Komponentet Elektronike – ligjërata të autorizuara, Universiteti i Prishtinës, 2009.

Course: Digital Electronics

Lecturer: Prof. Dr. Sabrije Osmanaj

Course status: Mandatory, Semester V, 6 ECTS

Course description: Introductory concepts, MSI logic circuits, FF timing considerations, propagation delay, critical path. Introduction to HDL and CAD tools, circuit design with Verilog HDL. Circuit design with HDL, Sequential circuit analysis with state diagrams, Finite State Machine, Hazards in digital circuits. IC logic family, TTL characteristics, Interfacing digital systems with the analog environment, D/A and A/D conversion, Inverter Operation. Memory devices, DRAM, SRAM, ROM, Circuit design with HDL. Memory devices, Programmable logic devices, PLA, FPGA.

Course objectives: The main purpose of the course is to study the principles and applications of modern Digital Electronics. The course will cover the fundamentals of digital system design (i.e. combinational and sequential circuit elements) using both traditional and modern design techniques. Introductory concepts of Hardware Description Language (HDL) will be taught and small digital circuits will be built using Verilog HDL.

Learning outcomes: On successful completion of the course, students will be able to: demonstrate the knowledge of operation of basic types of flip-flops, registers, counters, decoders, encoders, multiplexers, and de-multiplexers, analyze and design digital combinational circuits including arithmetic circuits (half adder, full adder, multiplier), demonstrate knowledge of the nomenclature and technology in the area of memory devices: ROM, RAM, PROM, PLD, FPGAs, etc.

Teaching methodology: Previously prepared material discourse, Discussions, Laboratory work, Seminar work, Internship visits

Evaluation methods: Final rating represents the sum of: The successful practical work: 25%, First intermediate evaluation: 15%, Second intermediate evaluation: 20%, Regular attendance and involvement in discussions and seminars 10%, Oral test or final exam: 30%, Total: 100%

Concretization tools/IT: Computer, projector, table, and laboratory equipped

Ratio between theoretical and practical part: 1:1.

Literature:

- Anil K. Maini, Digital Electronics: Principles And Integrated Circuits 1st Edition, Wiley India, 2008
- Roger L Tokheim, Digital Electronics: Principles and Applications 8th Edition, Mc Graw Hill, 2008.
- G. K. Kharate, Digital Electronics, Oxford University Press, 2012
- Anant Agarwal, Jeffrey Lang, Foundations of analog and digital electronic circuits, 2005,
- John Crowe, Barrie Hayes-Gill, Introduction to Digital Electronics (Essential Electronics Series), 1998
- Thomas L. Floyd, Digital Fundamentals, 11th Edition, Pearson, 2015.

Course: Power Electronics
Lecturer: Prof. Dr. Sabrije Osmanaj
Course status: Mandatory, Semester V, 5 ECTS

Course content: Power semiconductor diodes, rectifiers, Thyristors, converters three-phase converters, thyristor's commutation techniques, power transistors, inverters, inverters with supplementary switching, alternative converters (AC/AC), Cycle converters, DC/DC converter, UPS (uninterruptable power sources), Static switches.
Course objectives: to provide knowledge on theoretical and applied power electronic devices and power electronic switches, expansion of knowledge on the theory and applications of power convertors, understand the concepts of application of thyristors, analyze and design various power converter circuits (DC/AC, AC/AC and DC/DC and AC/DC).
Learning outcomes: Upon completion of this course the student will be able to:

- Understand the power electronic devices;
- Understand power rectifiers;
- Have sufficient knowledge for the analysis and implementation of different types of thyristors;
- Describe the operational principles of various circuits such as power converters, inverters, AC/AC and DC/DC converters;
- Analyze the characteristics and to draw the voltage and currents wave forms for different working conditions,
- Analyze, discuss and design different types of power converters to meet the required specifications.

Methods of teaching: 30 hours of lectures, 30 hours of laboratory exercises. Approximately 80 hours of personal study.
Assessment: Test 1: 10%, Test 2: 10%, Test 3: 10%, Attendance to lectures 10%, Laboratory exams 10%, Final exam 50%. Success in preliminary assessments is a prerequisite for the final exam.
Concretization tools: For lectures, computers, projectors and tables are used, while the practical part will take place at the Electronics lab.
Ratio between the theoretical and practical part: 40:60

Literature:

- M. Rashid, Power electronics, Prentice Hall, 2007,
- Hemann, K, Basic Principles of Power Electronics, New York, 1986,
- Mazda, R, Power Electronics, Addison Wesley, Inc., 1998,
- Myzafere Limani, Elektronika Energjetike, Universiteti i Prishtinës, libër universitar, 2001.

Course: Optoelectronics

Lecturer: Prof. Dr. Milaim Zabeli
Course status: Elective, Semester V, 5 ECTS

Course description: The nature of light. Characteristic properties and phenomena of light. Radiometric and photometric main concepts. Thermodynamics of radiation and interactions of radiation with material. Photo-emitters. Photo-detectors. Lasers. Optical resonators. Main types of lasers. Modulation of light. Optical-disk systems. Optoelectronics sensor systems. Optical waveguide systems (fiber-optic systems). Signal degradation in optical fibers. Optical fiber fabrication. Fiber-optic communication systems. Integrated optics. Optical information-processing systems. Holography. Optical computer.
Course objectives: The goal of this courseis to introduce the main optoelectronic components, devices, and phenomena of optical radiation to which they are based.
Learning outcomes: On successful completion of the course, students will be able to:

- Explain phenomena and laws of optical radiation
- Describe the construction and working principle of main optoelectronic components, such as: LEDs, photodiodes, phototransistors, photo-couplers, different types of lasers (solid, gaseous, liquid, etc.) optical-disks, optical waveguides etc.
- Describe the construction and working principle of main optoelectronic devices, such as: modulators (electro-optical, magneto-optical and acusto-optical), laser printer, barcode reader.
- Describe the construction of optical fibers and optical cables.
- Explain the problems that arise during the course of optical fibers and in their coupling with photo- emitter and photo-detector.
- Show areas of use of lasers, illustrating with a concrete implementation.
- outline, roughly, the operation of a telecommunications system based on fibre optic cable.
- Draft a paper on a particular issue or issues in the field of optoelectronics.

Teaching methodology: 30 hours of lectures + 15 hours laboratory exercises. Approximately 75 hours of personal study and exercise including home-work.
Evaluation methods: 1st Exam: 25%; 2nd Exam: 25%; Homework: 20%, Final exam: 30%
Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the laboratory.
Ratio between the theoretical and practical part: 40:60
Literature:

- Nebi Caka, Optoelektronika, Universiteti i Prishtinës, 1996.
- John Wilson, John Hawkes, Optoelectronics, 3rd edition, Prentice Hall, 2018, ISBN-13:978-9352866663.
- Saleh, B.E.A.; Teich, M.C. Fundamentals of photonics. 2nd ed., New York , John Wiley& Sons, 2007. ISBN 9780471358329.

Course title: **Sensors and Actuators**
Lecturer: Prof. Ass. Dr. Drilon Bunjaku
Course status: Elective, Semester V, 5 ECTS

Course description: Introduction to the course, control systems structure and place of sensors and actuators in them. Measurement and usage of measured values. Performance specification and time and frequency domain analysis, static and dynamic characteristics, nonlinearities. Analog signal processing, amplifiers, analog filters, and modulations. Interconnection with digital systems, sampling and holding, multiplexing, A/D and D/A converters. Digital processing, digital filters. Circuit and program based linearization. Circuit for specific alternation of signals. Display devices. Analog motion sensors. Torque, force, and tactile sensors. Temperature, pressure, and flow sensors. Digital motion sensors. Actuators and power drives, logic (On/Off) and proportional, linear, phase and pulse, with analog and digital command. Step motors and drive methods. DC motors. Induction and synchronous motors, variable frequency drives. Linear electric, hydraulic, and pneumatic actuators. Interconnection with acquisition, monitoring, and control units (microcomputer systems, computers, PLC).
Course objectives: The goal of the course is to introduce students with different types of sensors and actuators that are used for process monitoring, instrumentation, and control, together with their signals and processing for successful cooperation with other parts of the system.
Learning outcomes: On successful completion of the course, students will be able to:

- Know sensors and signals at their output;
- Select proper sensors that fulfill task requests;
- Design and implement necessary circuit for adaption of signals between units;
- Make actuator selection according to requested specifications;
- Select adequate drive for actuator and to configure it;
- Develop drive circuits of basic structure and complexity;
- Program basic functionalities for interconnecting sensors and actuators for execute monitoring, acquisition, and control tasks.

Methods of teaching: 30 hours of lectures, 15 hours of laboratory exercises
Evaluation methods: Mid-term exams 30%+30%, Lab. works 10%, Project 20%, Attend. 10%.
Concretization means: Computer, projector, Lab works.
Ratio between the theoretical and practical part of teaching: 40:60
Literature:

- Clarence W. de Silva, Sensors and Actuators: Engineering System Instrumentation, 2ed, CRC, 2015
- John Vetelino, Aravind Reghu, Introduction to Sensors, 1st ed, CRC, 2010
- Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, 5th ed. Spinger, 2015

Course: Electronic Communications

Lecturer: Prof. Ass. Dr. Vjosa Shatri

Course status: Elective, Semester V, 5 ECTS

Course content: General model of communication system. Communication media: types, characteristics, and applications. Concept of modulation, techniques of analoge and digitale modulation. Multiplexing, switching, and techniques for multiple access to media. OSI model and communication networks. Architecture and characteristics of telecommunication networks. Use of sotware tools, SPICE and MATLAB/Simulink, to analyse communication systems and circuits. Summary of wireless systems and commercial technologies. Classification of services and usage.

Course objectives: Presenting fundamental concepts and knwoledge related to characteristics and architecture of electronic communication systems. Using software tools to simulate and analyse communication systems and circuits. Measurements and experiments with communication circuits.

Learning outcomes: On successful completion of the course, students will be able to:

- To explain elements of electronic communication systems and define information transmission parameters on different types of communication systems;
- To identify and know main characteristics of digital and analog modulation;
- To select modulation parameters for a given communication;
- To recognize multiplexing techniques and techniques for accessing to communication channel;
- To analyse possibilities and limitations of different communication systems;
- To use SPICE and MATLAB/Simulink software tools to analyse communication systems;
- To perform measurements on communication systems.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, laboratory exercises, projects.

Evaluation methods: Laboratory exams 10%, Intermediary evaluations 15%+15%, Project 30%, Final exam 30%.

Concretization tools: Computer, projector, simulator, development systems and experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature:

- R: E. Ziemer, W. H. Tranter, *Principles of Communications*, Wiley, 2008
- John G. Proakis, Masoud Salehi, *Fundamentals of Communication Systems*, 2nd Edition, Prentice Hall, 2013
- John G. Proakis, Masoud Salehi, Gerhard Bauch, *Contemporary Communication Systems Using MATLAB*, Cengage Learning, 2013
- J. G. Proakis, M. Salehi, *Fundamentals of Communication Systems*, Prentice Hall, 2005

- Kwonhue Choi, Huaping Liu, *Problem-Based Learning in Communication Systems Using MATLAB and Simulink*, Wiley-IEEE Press, 2016
- Donald O. Pederson, Kartikeya Mayaram, *Analog Integrated Circuits for Communication*, Springer, 2008
- Jack R Smith, *Modern Communication Circuits*, McGraw-Hill, 1997
- R. Horak, *Communications Systems and Networks*, Wiley, 2002

Course title: Measurement Instrumentation and DAQ

Instructor: Prof. Asoc. Dr. Qamil Kabashi
Course status: Elective, Semester V, 5 ECTS

Course content: Measurement & Automation Explorer. Data Neighborhood. DAQmx Tasks. Devices and Interfaces. Self-Test. Test Panels. Scales. DAQ Custom Scales Wizard. Software. IVI Drivers. DAQ Assistant. Automatic Code Generation

Course objectives: Students will learn about the basics of data acquisition (DAQ). They will become familiar with the components in the computer and their settings by using Measurement and Automation Explorer. Then the students will write data acquisition programs using both software and hardware timing. The automatic code generation and DAQ Assistant features of LabVIEW will enable the students to write these programs faster and with a better understanding of the timing concepts, allowing them to draw conclusions about the results of their programs.

Learning outcomes: Upon successful completion of this course, the student should be able to:

- Become familiar with the data acquisition hardware your computer;
- Understand, analyses and apply LabVIEW data acquirement from the DAQ hardware;
- Differentiate between hardware timed finite acquisition;
- Hardware timed continuous acquisition; and
- Software timed on demand acquisition

Methods of teaching: 30 hours of lectures + 15 hours lab. Approximately 80 hours of personal study and exercise.
Evaluation methods: Mid-term exams 20%+20%, Lab. works 20%, Project 30%, Attendance 10%.
Concretization means: Computer, projector, LabVIEW software and NI USB-6009 multifunction DAQ USB Device.

Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- Robert H. Bishop, *LabVIEW Student Edition*, Pearson; 1st ed. 2014
- Behzad Ehsani, *Data Acquisition Using LabVIEW*, Packt Publishing Limited, 2016

Course: Fundamentals of Mechatronics

Lecturer: Prof. Ass. Dr. Drilon Bunjaku
Course status: Elective, Semester V, 5 ECTS

Course overview: Introduction of Mechatronics. Mechanical Components and Motion Systems. Power and Driving Systems. Sensing, Numerical Control, and Programming (Microcomputer control block). Modeling and Simulation. System Integration. Introduction of Robotics. Fundamental of Kinematics and Dynamics of wheeled mobile robots. Robotic Programming and Control. Human and Robot Interaction. Independent study on mechatronic design.

Course objectives: The goal of the course is to introduce students with mechatronic products. Nowadays modern products are mostly mechatronic products, where mechanical components are integrated with electrical, electronic, and control components to fulfill high-level system functionalities. Especially, robots are critical components in modern manufacturing and their roles to our societies are becoming increasingly of importance. The design, manufacture, assembly, and operation of mechatronic products require engineers to understand a wide scope of engineering knowledge and to be able to design and integrate mechanical, electric, electronics and control subsystems.

This course is designed to: 1. understand the concept of mechatronics, 2. learn design principles to integrate multidisciplinary components as a system to meet requirements of products, 3. gain the fundamental knowledge about robots and automation, 4. have hand-on skills in developing basic mechatronic products.

Learning outcomes: On successful completion of the course, students will be able to:

- identify, select, and integrate mechatronic components to meet product requirements,
- use kinematic, dynamic and control models for robots,
- use commercial software tools for modeling and simulation of mechatronic systems,
- design and analyze mechatronic products,
- write technical reports and present engineering design solutions efficiently,

Teaching methodology: 30 hours of lectures, 30 hours of laboratory exercises. Approx. 75 independent working hours, including homework (or seminar paper).

Assessment: Class and lab. activity 10%+10%, Mid-term exams 10%+10%, Project 30%, Final exam 30%.

The ratio between theoretical and practical work: 40:60

Literature:

- William Bolton, *Mechatronics-Electronic Control Systems in Mechanical and Electrical Engineering*, Sixth Edition, Pearson, 2015.
- Clarence W. de Silva, *Mechatronics: A Foundation Course*, CRC, 2010.
- Lavdim Kurtaj, *Mechatronical Project*, WUS-Austria and University of Prishtina, 2011.
- Victor Giurgiutiu, Sergey Edward Lyshevski, *Micromechatronics: modeling, analysis, and design with MATLAB*, CRC, 2009.

Course: Biomedical Signals

Lecturer: Prof. Dr. Sabrije Osmanaj

Course status: Elective, Semester V, 5 ECTS

Course description: The discipline of biomedical engineering, historical perspectives, and contemporary trends. The human body: an overview. Basic electrophysiology. Cell and cellular mechanisms. Bioelectricity. Physiologic systems. Nervous system. Muscular system. Circulatory system. Respiratory system. Sensing systems. Homeostasis. Body as a control system. Bioelectric potentials and their main features (ECG, EEG, EMG, ENG and ERG). Registration techniques and problems. Electrodes. Overview of other biomedical signals. Therapeutic electromedical equipment. The most important techniques and devices. Diagnostic medical imaging. Equipment and techniques. Fundamental physical and medical limitations. Methods for quality evaluation processing. Estimation of diagnostic value processing. Patient safety and safety assurance in modern medical facilities.

Course objectives: The purpose of this course is to serve as an introduction to and an overview of the field of biomedical engineering. Considering this purpose, a link between biomedicine and electrical engineering will be given. Students should be able to understand and define the discipline of biomedical engineering, basic physiological and electrophysiological mechanisms, basic bioelectric signals, electrodes and registration techniques. They will also acquire an introductory knowledge about the most important diagnostic and therapeutic electromedical equipment and safety assurance in medical facilities.

Learning outcomes: Upon completion of course, the student should be able to:

- describe physiological systems in the human body
- distinguish main features of biomedical signals
- describe biomedical signal registration techniques
- compare biomedical signals registration and analysis methods for the particular problem solving
- explain functioning of diagnostic medical imaging systems
- appraise applicability of the particular medical imaging method

Teaching methodology: Discussions, Laboratory work, Seminar work, Internship visits.

Evaluation methods: Final rating represents the sum of: The successful practical work: 25%, First intermediate evaluation: 15%, Second intermediate evaluation: 20%, Regular attendance and involvement in discussions and seminars 10%, Oral test or final exam: 30%, Total: 100%

Concretization tools/IT: Computer, projector, table, and laboratory equipped

Ratio between theoretical and practical part: 1:1.

Literature:

- Šantić (1995). Biomedicinska elektronika, Školska knjiga, Zagreb
- Suresh R. Devasahayam, Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling , Springer; 2nd ed. 2013.

- Robert B. Northrop, Signals and Systems Analysis In Biomedical Engineering, CRC Press; 2 edition (March 26, 2010)
- Steve Hales, Signals and Systems Analysis In Biomedical Engineering Kindle Edition, Amazon Digital Services LLC, June 11, 2019.
- Rangaraj M. Rangayyan, Biomedical Signal Analysis, A Case-Study Approach, IEEE Press Series on Biomedical Engineering, 2015.
- John Semmlow, Circuits, Signals, and Systems for Bioengineers: A MATLAB-Based Introduction (Biomedical Engineering), Academic Press, 2005.
- Katarzyn J. Blinowska and Jaroslaw Zygierewicz, Practical Biomedical Signal Analysis Using MATLAB® (Series in Medical Physics and Biomedical Engineering), CRC Press; 1 edition (September 12, 2011)
- Fabian J. Theis and Anke Meyer-Bäse, Biomedical Signal Analysis, The MIT Press Cambridge, 2010.
- K. J. Blinowska, J. Zygierewicz, Practical Biomedical, Signal Analysis Using MATLAB, 2012 by Taylor & Francis Group.

Course: Entrepreneurship

Lecturer: External lecturer from industry
Course status: Elective, Semester V, 3 ECTS

Course content: Promoting a culture of creativity, innovation and collaboration. Promoting entrepreneurial culture both professional and student. Generating, disseminating and sharing knowledge on innovation and entrepreneurship. Develop strategic alliances with agents that structure the innovation ecosystem and entrepreneurship. Building transnational networks with emblematic actors. Know the tools and strategies that will be applied to startups and projects. Applying new concepts and theoretical frameworks own strengths and knowledge. Managing creativity and innovation. Failure and learning from failure. Understanding and managing innovation processes and their impacts on the environment.

Course objectives: In this course students will learn about the context of customer development in real life and acquire the skills to develop their business idea all the way from conceptual to market stage to their entrepreneurship and innovation. This course articulates an innovation space that aims to be the successor to Kosovo's entrepreneurial incubation projects. The purpose of this course is for students to be able to realize their dreams and develop the skills to achieve them in Innovation and Entrepreneurship. The course is designed to encourage students' ability to think differently about developing new products, services and organizations.

Learning outcomes:

- Interdisciplinary work, real and virtual environments;
- Teaching abroad in a multicultural environment;
- Transfer of knowledge into day-to-day mentoring by leading experts;
- Experience in learning about innovation;
- Learning together with entrepreneurs;
- The creativity imposed on excellent management of time and resources;
- Creating and utilizing an invaluable network of like-minded ambitious talents.

Teaching methodology: 30 hours of lectures and approximately 45 hours of independent work including seminar work.

Evaluation methods: Regular attendance and involvement in discussions and seminars 10%, intermediary evaluations: 30%, Final exam: 60%.

Concretization tools/IT: Computer, projector, different software.

Ratio between theoretical and practical part: 40:60

Literature:

- John Bessant, "Entrepreneurship and innovation", 2019, Publisher: John Wiley & Scons Inc.
- Peter F. Drucker, "Innovation and Entrepreneurship, 2006
- Charles Hampden-Turner, "Teaching Innovation and Entrepreneurship", 2009, Cambridge University Press
- Lubar and Halpern, "Leadership Presence", 2004 Process. Addison-Wesley.

Course: Microelectronics

Lecturer: Prof. Dr. Milaim Zabeli
Course status: Mandatory, Semester VI, 5 ECTS

Course description: Introduction to Microelectronics. Planar silicon (Si) technology for fabrication of monolithic integrated circuits. Isolation techniques of components in monolithic integrated circuits. Components of bipolar integrated circuits. Components of unipolar (MOS) integrated circuits. Components of integrated circuits based on GaAs. Designing of monolithic integrated circuits. Hybrid integrated circuits (thin-film and thickfilm). Basic stages of analog monolithic integrated circuits. Basic stages of digital monolithic integrated circuits. Design for testability (DFT) methods in integrated circuit. Introduction to nanotechnology.
Course objectives: The goal of this courseis to introduce the modern technologies of fabrication of monolithic and hybrid integrated circuits, and basic stages of analog and digital monolithic integrated circuits.
Learning outcomes: On successful completion of the course, students will be able to:

- Describe in detail the main stages of fabrication of monolithic integrated circuits.
- Compare with each other different isolation techniques of integrated circuits.
- Describe the main features of bipolar transistors and unipolar transistors and other components of integrated circuits.
- Present the main design rules of monolithic integrated circuits.
- Make the difference between monolithic circuits and hybrid circuits (thin-film and thick-film).
- Explain the functioning of basic stages of analog integrated circuits and digital integrated circuits.
- Solve numerical problems related to the technology of fabrication of integrated circuits.
- Draft a paper on a particular issue or issues in the field of microelectronics.

Teaching methodology: 30 hours of lectures (including the solutions of practical problems) + 30 hours of auditorial and laboratory exercises. Approximately 70 hours of personal study and exercise including home-works.
Evaluation methods: 1st Exam: 25%; 2nd Exam: 25%; Homework: 20%, Final exam: 30%
Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the laboratory.
Ratio between the theoretical and practical part: 40:60

Literature:

- Nebi Caka, Mikroelektronikë, (dispensë), UP-FIEK, Prishtinë, 2006.
- Cui Zheng, Micro-Nanofabrication: Technologies and Applications, Spinger, 2005.
- Sami Franssila, Introduction to Microfabrication, John Wiley & Sons Ltd., 2010.

Course: Analog Electronics

Lecturer: Prof. Asoc. Dr. Qamil Kabashi
Course status: Mandatory, Semester VI, 5 ECTS

Course content: Frequency characteristics of amplifiers, power amplifiers, feedback and stability, frequency compensation, amplifiers with feedback, negative feedback and effects on linear amplifiers, operational amplifiers real and ideal, basic circuits with operational amplifiers, oscillators, active filters, integrated analog circuits, design and implementation of integrated circuits.

Course objectives: To provide an introduction to basic concepts in the field of analog electronics and expanding the theoretical and applicative analysis of analog electronic circuits with emphasis on the characteristics of amplifiers and their frequency response, power amplifiers, theory and applications of operational amplifiers and integrated circuits, familiarity with the concepts and design feedback, oscillators, and active filters.

Learning outcomes: Upon completion of this course the student will be able to:

- adopt linear analysis tools such as Bode techniques, the constant time techniques, concepts of feedback (positive and negative);
- identify basic amplifier topologies;
- analyze basic amplifier topologies;
- design the basic amplifiers;
- apply concepts of feedback analysis for analog amplifiers design,
- analyze and design power amplifiers;
- analyze and design analog electronic circuits with OA, like active filters and oscillator.

Methods of teaching: 30 hours of lectures, 30 hours of laboratory exercises. Approximately 80 hours of personal study.

Grading System: Test 1: 10%, Test 2: 10%, Test 3: 10%, Attendance to lectures 10%, Laboratory exams 10%, Final exam 50%. Success in preliminary assessments is a prerequisite for the final exam.
Concretization tools: For lectures, computers, projectors and tables are used, while the practical part will take place at the Electronics lab.
Ratio between the theoretical and practical part: 40:60

Literature:

- Donald Neamen, Electronic Circuit Analysis and Design, McGraw-Hill Education, 2009
- Adel S. Sedra, Kenneth C. Smith, Microelectronic Circuits, Oxford University Press, 2007,

Course title: Fundamentals of Multimedia

Lecturer: Prof. Ass. Dr. Hëna Maloku

Course status: Elective, Semester VI, 5 ECTS

Course content: Multimedia systems. History of multimedia systems. The multimedia software tools. Photo and Video Editing. Technical design. The presentation of multimedia data. Digitalization of sound. MIDI. Basics of digital video. Elements of information theory. Computer networks. Independent work in the lab.

Course objectives: To provide basic knowledge for the development and use of multimedia - combining text, graphics, sound, animation, video images, To enhance the knowledge of students about the nature of various media, capture and creation, digitization and modification of any type of media, architecture and technology of multimedia systems, the principles behind effective multimedia presentations, to enable students to analyze, design and develop multimedia presentations through software packages; treat the fundamental concepts of contemporary technologies and develop new technologies.

Learning outcomes: Upon completion of this course the student will be able to:

- Essentially know the nature of the text, image, sound, video and animation;
- Have knowledge for creating, editing and storage of various media;
- Have knowledge to implement digitization and compression in multimedia;
- Have knowledge and skills to use the tools for creating multimedia products;
- Have knowledge of web-based multimedia systems;
- Use and develop various software packages for the design of multimedia presentations that complement and expand those requirements.

Methods of teaching: 30 hours of lectures, 30 hours of laboratory exercises. Approximately 80 hours of personal study.

Grading System: Test 1: 10%, Test 2: 10%, Test 3: 10%, Attendance to lectures 20%, Lab. (multimedia presentation) 50%.

Concretization tools: For lectures, computer simulations, projectors, speakers and tables, while the practical part of preparing multimedia presentations is carried out in the multimedia lab.

Ratio between the theoretical and practical part: 40:60

Literature:

- Myzafere Limani: Bazt e Multimedias – Universiteti i Prishtinës, dispencë, Prishtinë, 2006,
- Ze-Nian Li, Mark S. Drew, Fundamentals of Multimedia, Pearson Prentice Hall, 2004.

Course title: Fundamentals of Robotics

Lecturer: Prof. Ass. Dr. Lavdim Kurtaj

Course status: Elective, Semester V, 5 ECTS

Course content: Introduction and historic development of robotics. Direct kinematics problem. Rotation and composite matrix. Image geometry. Inverse kinematics problem and methods, analytic, geometric, and numeric. Robot arm dynamics. Lagrange-Euler formulation. Newton-Euler formulation. Manipulator trajectory planning. Interpolated trajectories at different levels. Planning trajectories in Cartesian space. Planning trajectories under different constraints. Controlling robotic manipulator. Controlling PUMA and CRS Catalyst-5 robot. Computed torque technique. Other control methods. Adaptive control. Sensors in robotics. Visual information processing. Robot programming.

Course objectives: Familiarity with robotic concepts. Describing relative positions and motions in space. Methods for calculating dynamic interactions. How to do joint control and reactions between then. Failiarity with mathods for task decomposition at different execution levels. Familiarity with sensors and processing of their information. Robot programming.

Learning outcomes: On successful completion of the course, students will be able to:

- identify robot structure and characteristic elements;
- describe motions and to calculate dynamic interactions;
- design robot joint controller;
- make transition from given problem to necessary executive details;
- get engaged into advanced control and information processing from different sensors, as foundation for making "intelligent" robots.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, laboratory exams, projects.

Evaluation methods: Intermediary evaluations 15%+15%, Project 40%, Final exam 15%+15%.

Concretization tools: Computer, projector, simulator, development systems and experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature

- K.S. Fu, R.C. Gonzales, C.S.G. Lee, *ROBOTICS, Control, Sensing,Vision, and Intelligence*, McGraw-Hill
- Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Second Edition, Springer, 2017
- Paul P., *Robot Manipulators Mathematics, Progrmming and Control*, MIT Press
- Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer, 2009
- Bruno Sicilianoa and Oussama Khatib (eds.), *Springer Handbook of Robotics*, Second Edition, Springer 2016

Course title: Optical Communication Technology

Lecturer: Prof. Dr. Milaim Zabeli

Course status: Elective, Semester VI, 5 ECTS

Short course description: Introduction to fiber optic systems; Optical fibers: SM, MM, POF. Optical transmission line. Optical sources: LED, LD. Optical transmitter. Photodiodes: PIN, APD. Optical receiver. Optical modulators. Optical interconnection. Splicing. Examples of optical communication systems.

Course objectives: The course deals with the basic phenomena associated with the technology that enables optical transmission of information.

Learning outcomes: On successful completion of the course, students will be able to:

- Distinguish between different fiber types.
- Determine parameters of optical sources LEDs and LDs.
- Determine parameters of photo-detectors PIN and APD.
- Perform splicing of optical fibers.
- Give examples of optical communication systems.

Teaching methodology: 30 hours of lectures + 15 hours laboratory exercises. Approximately 60 hours of personal study and exercise including home-works.

Evaluation methods: 1st Exam: 25%; 2nd Exam: 25%, Homework (seminar): 20%, Final exam: 30%

Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the laboratory.

Ratio between the theoretical and practical part: 40:60

Literature:

- John Crisp, Barry Elliott, Introduction to Fiber Optics; Newnes, 2005, ISBN: 0 7506 675679
- G.P. Agrawal, Fiber-Optic Communication Systems, 4th edition, John Wiley, 2018, ISBN: 978- 0-470-50511-3
- Rozeta Mitrushi, Komunikimet me fibra optike, Tiranë, 2007.

Course title: Embedded Systems

Lecturer: From industry

Course status: Elective, Semester VI, 5 ECTS

Course content: Introduction to embedded systems. Parallel and serial communication. I/O ports and specialized communication units. Communication between "smart" units, Cyber-Physical Systems, and the Internet of Things. Case Study 8051 microcontroller. Case Study MSP 430 microcontroller. Case Study ARM family of microcontrollers. Case Study Arduino development board. Case Study Raspberry Pi development board. Network toplogies, ISO layers. BUS communication protocols for networked devices. Interrupt service mechanism. System timers. Device drivers. Cooperative and preemptive multitasking. Inter-process communication and synchronization, "Threads" and "Tasks". Real-time operating system.

Course objectives: To elaborate on the basic concepts of embedded systems, communications, synchronization processes, and operating systems.

Learning outcomes: On successful completion of the course, students will be able to:

- Understand the concepts of embedded systems;
- Understand the interfacing with input / output devices and other peripheral devices;
- Programming driver units and interrupt service mechanisms;
- Understand inter-process communication and process synchronization;
- Learn functional principles of Operating System and Real-time Operating System;
- Be able to use microcontrollers along with other analogue and digital peripherals.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, laboratory exercises, projects.

Evaluation methods: Laboratory exercises 10%, Intermediary evaluations 15%+15%, Project 30%, Final exam 30%.

Concretization tools: Computer, projector, simulator, development systems and experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature:

- Tianhong Pan, Yi Zhu, Designing Embedded Systems with Arduino - A Fundamental Technology for Makers, Springer, 2018
- Jonathan Valvano, Embedded Systems: Real-Time Operating Systems for ARM Cortex M Microcontrollers, 2nd Edition, CreateSpace Independent Publishing Platform, 2012
- Manuel Jiménez, Rogelio Palomera, Isidoro Couvertier, Introduction to Embedded Systems: Using Microcontrollers and the MSP430, Springer, 2014
- Alexander Barkalov, Larysa Titarenko, Małgorzata Mazurkiewicz, Foundations of Embedded Systems, Springer, 2019
- Raj Kamal, Embedded Systems: Architecture, Programming and Design, 2nd edition, McGraw Hill, 2010
- James K. Peckol, Embedded Systems: A Contemporary Design Tool, Wiley, 2019

Course: Computer Aided Design of Electronic Systems

Lecturer: Prof. Dr. Milaim Zabeli
Course status: Elective, Semester VI, 5 ECTS

Short course description: Analysis and design of analog and digital electronic circuits with the CAD tools. Electronic equipment development and life cycle. Printed circuit board (PCB) fabrication and surface mount technologies. Technical documentation. Board level design.

Course objectives: This course introduces students into the overall process of computer aided design of electronic equipment and systems.

Learning outcomes: On successful completion of the course, students will be able to:

- Describe the fabrication of printed circuit board (PCB).
- Describe fabrication and surface mount technologies.
- Prepare technical documentation.
- Use software program (CAD) for analysis and simulation of electronic circuits
- Design electronic circuits at the board level.

Teaching methodology: 30 hours of lectures + 15 hours laboratory exercises. Approximately 60 hours of personal study and exercise including home-works (seminary work).
Evaluation methods: 1st Exam: 25%; 2nd Exam: 25%; Homework: 20%, Final exam: 30%
Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the laboratory.
Ratio between the theoretical and practical part: 40:60

Literature:

- Electronic Instrument Design: Architecting for the Life Cycle; Kim R. Fowler; Oxford University Press; 1996.
- The Circuit Designer's Companion; Peter Wilson; 4th edition Newnes; 2017;
- Analog Design and simulation using OrCAD capture and Pspice, Dennis Fitzpatrik, Newnes, 2017
- Complete PCB Design Using OrCAD Capture and PCB Editor, Kraig Mitzner, Newnes, 2009.

Course: Biomedical Instrumentation

Lecturer: Prof. Dr. Sabrije Osmanaj

Course status: Elective, Semester VI, 5 ECTS

Short course description: Biomedical sensors and transducers. Bioelectric amplifiers. Electromagnetic interference suppression techniques. Electrocardiographs. Physiological pressure and other cardiovascular measurements and devices. Instrumentation for measurement brain parameters. Biological impedance measurement. Respiratory system and its measurement. Intensive and coronary care units. Pacemakers and defibrillators. Electrosurgery. Lasers. Medical imaging equipment. Radiology and nuclear medicine equipment. Medical ultrasound. Magnetic resonance imaging.

Course objectives: Main purpose of this course is to give the students a basic knowledge in the field of electromedical equipment manufacturing and design, including an outline of characteristics and types of modern electromedical diagnostic and therapeutic equipment. An overview of specific requirements for this equipment, including designing principles and standards, is presented. After the completion of obligations within the course, students should be able to understand and define basic performances of most important electromedical diagnostic and therapeutic equipment, including some practical skills of its use. It could be expected that, with the acquired knowledge, they could be working as clinical or biomedical engineers.

Learning outcomes:

- classify Biomedical sensors and transducers.
- design bioelectric amplifiers. Use Electromagnetic interference suppression techniques.
- design electrocardiographs. Physiological pressure and other cardiovascular measurements and devices.
- design of biological impedance measurement and respiratory system parameters
- compare pacemakers and defibrillators, understand principles of operation of electrosurgery and laser operating modes.
- compare medical imaging methods and equipment in radiology, nuclear medicine and medical ultrasound and MRI

Teaching methodology: Exams, Discussions, Laboratory work, Seminar work, Internship visits.

Evaluation methods: Final rating represents the sum of: The successful practical work: 25%, First intermediate evaluation: 15%, Second intermediate evaluation: 20%, Regular attendance and involvement in discussions and seminars 10%, Oral test or final exam: 30%, Total: 100%

Concretization tools/IT: Computer, projector, lab, table.

Ratio between theoretical and practical part: Ratio between the theoretical and practical part is 1:1.

Literature:

- Šantić (1995.), Biomedicinska elektronika, Školska knjiga, Zagreb
- Andrew G. Web, Principles of Biomedical Instrumentation (Cambridge Texts in Biomedical Engineering), Cambridge University Press; 1 edition (February 7, 2018)
- J. G. Webster (2009.), Medical Instrumentation: Application and Design, John Wiley&Sons, N.Y.
- ANANDA R. NATARAJAN, BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS, PHI Learning (December 14, 2015)
- Robert B. Northrop, Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation (Biomedical Engineering), Routledge; 2 edition (March 31, 2017)
- R. S. Khandpur, Biomedical Instrumentation: Technology and Applications, McGraw-Hill Education; 1 edition (November 26, 2004)
- Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology (4th Edition), Pearson; 4 edition (June 9, 2000)
- Richard C. Fries (2001.), Handbook of Medical device designe, Marcel Dekker, Inc.

Course: Internship

Lecturer: Prof. Ass. Dr. Sevdie Alshiqi
Course status: Elective, Semester VI, 5 ECTS

Course content: The content of this course depends on the company where the student shall finish 120 working hours. As a result, the content is drafted jointly from the coordinator of professional internships, appointed from the company, and the student who is going to work in such company. The coordinator of professional internships, who is appointed from the company, guides the student throughout the duration of his/her work in the company, and participates as a member of the commission in the presentation of the professional paper.

Course objectives: The students gain professional experience, depending on the field of study, in one of the local companies.
Learning outcomes: To be qualified for professional work, in the relevant field of study, and to be more prepared for the labor market.
Teaching methodology: 120 working hours in the company, 30 working hours for the preparation of the presentation of professional internship.
Evaluation methods: Presentation evaluation 40%, Presentation of the paper: 60%. Total:100%
Ratio between the theoretical and practical part: 0:100

Course title: Bachelor Thesis

Course status: Mandatory, Semester VI, 5 ECTS

Course content: The thesis could be proposed by the supervisor or can be chosen by the student and should be in the accordance with the qualification profile. The bachelor thesis is a comprehensive and independent task where the student has to demonstrate the ability to analyze the given problem from theoretical and practical aspects, devise a solution using the knowledge acquired in multiple courses and literature, and provides instructions for use and directions of future development.

Course objectives: The bachelor thesis is a comprehensive and independent task where the student must demonstrate the ability to analyze the given problem from theoretical and practical aspects, devise a solution using the knowledge acquired in multiple courses and literature.

Learning outcomes: Upon completion of this course the student will be able to:

- Gain confidence in knowledge gained;
- Have the ability for further studies of mandatory additional literature;
- Consult with mentor with questions well prepared and structured;
- Present their work in written form, with a standard language and guidelines for this type of work, with a volume of at least 30 sheets of A4 format;
- Present the work in time of ten minutes with presentation prepared in PowerPoint.

Methods of teaching: Compliant with the actual regulation at the faculty level on how to conduct a bachelor thesis.

Literature: Depending on the bachelor thesis, will be offered different literature from mentor.

Specialization AUTOMATION AND ROBOTICS

Course title: Fundamentals of Control Systems

Lecturer: Prof. Ass. Dr. Drilon Bunjaku
Course status: Mandatory, Semester V, 6 ECTS

Course description: Transfer function analysis and the influence of pole/zero position on the system response. Stability system through Routh-Hurwirz method and Mihajlov criterion. Introduction to the concept of controllers and their influence of the quality of system dynamic response. Techniques for designing controller in time and frequency domain. Controller tuning to achieve time specification. Using Bode diagrams to design controllers in the frequency domain to achieve the desired level of phase margin and steady state error. Controller design using the root locus method. Introduction to controller design in state space.
Course objectives: The purpose of the course is to introduce the students with the impotant concept of controllers and become capable to use the different techniques to tune the controllers.
Learning outcomes: On successful completion of the course, students will be able to:

- To fully understand the concept of controller and their influence in the general performance of control systems.
- Use different methods of designing controller in the time and frequency domain.
- Analyze unstable systems and the improvement of their performance by integrating the controller in the control system structure.
- Notice the relation between designing controllers in time and frequency domain
- Introduction to controller design in state space.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, numerical exams, laboratory exams, seminary work.
Evaluation methods: Seminar 10%, Laboratory exams 10%, Intermediary evaluations 15%+15%, Final exam 50 %
Concretization tools: Computer, projector, simulator, experimental plants.
Ratio between the theoretical and practical part: 40:60

Literature:

- Farid Golnaraghi and Benjamin C. Kuo, *Automatic Control Systems*, Tenth Edition, McGraw-Hill Education, 2017
- Constantine H. Houpis, Stuart N. Sheldon, *ALinear Control System Analysis and Design with MATLAB*, Sixth Edition, CRC Press, 2014
- John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, *Linear Control System Analysis and Design: Fifth Edition, Revised and Expanded*, Marcel Dekker, 2003
- A. Grapci, Rregullimi Automatik i sistemeve lineare, Universiteti i Kosovës në Prishtinë.

Course title: Fundamentals of Robotics

Lecturer: Prof. Ass. Dr. Lavdim Kurtaj
Course status: Mandatory, Semester V, 5 ECTS

Course content: Introduction and historic development of robotics. Direct kinematics problem. Rotation and composite matrix. Image geometry. Inverse kinematics problem and methods, analytic, geometric, and numeric. Robot arm dynamics. Lagrange-Euler formulation. Newton-Euler formulation. Manipulator trajectory planning. Interpolated trajectories at different levels. Planning trajectories in Cartesian space. Planning trajectories under different constraints. Controlling robotic manipulator. Controlling PUMA and CRS Catalyst-5 robot. Computed torque technique. Other control methods. Adaptive control. Sensors in robotics. Visual information processing. Robot programming.

Course objectives: Familiarity with robotic concepts. Describing relative positions and motions in space. Methods for calculating dynamic interactions. How to do joint control and reactions between then. Failiarity with mathods for task decomposition at different execution levels. Familiarity with sensors and processing of their information. Robot programming.

Learning outcomes: On successful completion of the course, students will be able to:

- identify robot structure and characteristic elements;
- describe motions and to calculate dynamic interactions;
- design robot joint controller;
- make transition from given problem to necessary executive details;
- get engaged into advanced control and information processing from different sensors, as foundation for making "intelligent" robots.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, laboratory exams, projects.

Evaluation methods: Intermediary evaluations 15%+15%, Project 40%, Final exam 15%+15%.

Concretization tools: Computer, projector, simulator, development systems and experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature

- K.S. Fu, R.C. Gonzales, C.S.G. Lee, *ROBOTICS, Control, Sensing,Vision, and Intelligence*, McGraw-Hill
- Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Second Edition, Springer, 2017
- Paul P., *Robot Manipulators Mathematics, Progrmming and Control*, MIT Press
- Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer, 2009
- Bruno Sicilianoa and Oussama Khatib (eds.), *Springer Handbook of Robotics*, Second Edition, Springer 2016

Course title: Programmable Logic Controllers

Instructor: Prof. Asoc. Dr. Qamil Kabashi

Course status: Mandatory, Semester V, 5 ECTS

Course description: Introduction to the course. Programmable logic controller (PLC) structure. Types of PLCs. Siemens PLCs: LOGO and S7-200. Basic PLC programming. Programming software. Wiring schematics. Functional Blocks and ladder diagram. Sensors with logical/digital output. Logical/digital input modules. Wiring sensors to input modules. Actuators and their logical/digital control. Logical/digital output modules. Wiring actuators to output modules. PLC operation and working cycle. Timer function blocks and their programming. Counter function blocks and their programming. Time diagrams. Writing programs based on time diagrams. Sequential programs and sequential bits. Writing programs based on algorithm and on state diagrams. Analog sensors and actuators. Analog input and output modules. Open systems. Programming languages according to IEC61131 standard. Specialized input and output modules. Feedback control. PID controller. Standards for communication with PLCs and networking. Human-machine interface (HMI).

Course objective: Familiarity with programmable logic controllers (PLC). Familiarity with using PLCs in automation. Familiarity with methods for crating programs for PLCs. Implementation of a project based on PLC - procedure from idea to hardware and software implementation. Familiarity with advanced structures: modules, network, and human-machine communication.

Learning outcomes: On successful completion of this course, students should be able to:

- Understand the purpose, functions, and operations of a PLC,
- Identify the basic components of the PLC and how they function,
- Select proper PLC system for solving automation problem,
- Run a PLC processor file using PLC programming software,
- Create/Edit a PLC project using PLC software,
- Configure the I/O for a PLC project using PLC software,
- Present knowledge on PLC communication possibilities and on human-machine communication.

Methods of teaching: Lectures, PLC Programming Exercises, Consultations, projects, Industry Visits

Evaluation methods: Mid-term exams 10% +10%, Lab. work 10%, Project 30%, Final exam 30%, Attendance 10%.

Concretization means: Computer, projector, Lab work with PLC programming and hardware connections.

Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- Frank D. Petruzella, *Programmable logic controllers*, fifth ed, McGraw-Hill Education, 2017
- W. Bolton, *Programmable Logic Controllers*, 6th Ed, Vital source Technologies, 2015
- User manuals of LOGO! and S7-200 Siemens.

Course title: Sensors and Actuators

Lecturer: Prof. Ass. Dr. Drilon Bunjaku

Course status: Elective, Semester V, 5 ECTS

Course content: Introduction to the course, control systems structure and place of sensors and actuators in them. Measurement and usage of measured values. Performance specification and time and frequency domain analysis, static and dynamic characteristics, nonlinearities. Analog signal processing, amplifiers, analog filters, and modulations. Interconnection with digital systems, sampling and holding, multiplexing, A/D and D/A converters. Digital processing, digital filters. Circuit and program based linearization. Circuit for specific alternation of signals. Display devices. Analog motion sensors. Torque, force, and tactile sensors. Temperature, pressure, and flow sensors. Digital motion sensors. Actuators and power drives, logic (On/Off) and proportional, linear, phase and pulse, with analog and digital command. Step motors and drive methods. DC motors. Induction and synchronous motors, variable frequency drives. Linear electric, hydraulic, and pneumatic actuators. Interconnection with acquisition, monitoring, and control units (microcomputer systems, computers, PLC).

Course objectives: The goal of the course is to introduce students with different types of sensors and actuators that are used for process monitoring, instrumentation, and control, together with their signals and processing for successful cooperation with other parts of the system.

Learning outcomes: On successful completion of the course, students will be able to:

- Know sensors and signals at their output;
- Select proper sensors that fulfill task requests;
- Design and implement necessary circuit for adaption of signals between units;
- Make actuator selection according to requested specifications;
- Select adequate drive for actuator and to configure it;
- Develop drive circuits of basic structure and complexity;
- Program basic functionalities for interconnecting sensors and actuators for execute monitoring, acquisition, and control tasks.

Methods of teaching: 30 hours of lectures, 15 hours of laboratory exercises

Evaluation methods: Mid-term exams 30%+30%, Lab. works 10%, Project 20%, Attendance 10%.

Concretization means: Computer, projector, Lab works.

Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- Clarence W. de Silva, Sensors and Actuators: Engineering System Instrumentation, 2ed, CRC, 2015
- John Vetelino, Aravind Reghu, Introduction to Sensors, 1st ed, CRC, 2010
- Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, 5th ed. Spinger, 2015

Course title: Smart Actuators and Drives

Lecturer: Prof. Ass. Dr. Lavdim Kurtaj

Course status: Elective, Semester V, 5 ECTS

Course content: Introduction to the course, structure of modern control systems, distributed control structure. Communication networks and communication with distant sensors and actuators. Smart actuators and structure, drive block, measurement block, digital processing block, communication block. Local block for monitoring configuring and commanding. Measurement and using measured values for advanced and sensorless drives. Static and dynamic characteristics, nonlinearities. Analog signal processing, amplifiers, analog filters, and modulations. Interconnection with digital systems. Digital processing system (with microprocessor, microcontroller, DSP, programmable digital circuits, CPLD, FPGA), digital processing, digital controllers (circuit and software based). Linear and pulse drives with microprocessor digital control. Specific functional processing, self-diagnosing, learning and adaption, coding, security, fail-safe. Communicating with human (HMI), local devices for display and for accepting commands. Standard sensor and actuator communication networks, wired (AS-i, Profibus, DeviceNet, Industrial ethernet, ModBus) and wireless (ZigBee, WiFi), protocols. Access to other maintenance functions from distance.

Course objectives: To introduce students with structure of distributed systems for monitoring, instrumentation, and control, when using smart actuators with integrated drives. Introduction with architecture and functionality of smart actuator construction blocks. Communication networks, standards, and protocols.

Learning outcomes: On successful completion of the course, students will be able to:

- know smart actuators and ways of communication with them;
- select proper actuator that fulfill task requests;
- design and implement functional systems with smart actuator;
- make smart actuator selection according to requested specifications;
- configure smart actuators for interplay in network;
- design and implement smart actuator (electronic part for driving and processing, programming part) with basic structure based on microcontroller.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, numerical exams, laboratory exams, projects.

Evaluation methods: Intermediary evaluations 10%+10%, Laboratory exercises 20%, Project 30%, Final exam 15%+15%.

Concretization tools: Computer, projector, simulator, development systems and experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature:

- Clarence W. de Silva, Sensors and Actuators: Engineering System Instrumentation, Second Edition, CRC Press, 2016

- Gerard Meijer (Ed.), Smart Sensor Systems, Wiley, 2008
- Victor Giurgiutiu, Sergey Edward Lyshevski, Micromechatronics: Modeling, Analysis, and Design with MATLAB, CRC Press, 2009
- Lavdim Kurtaj, Mechatronical Project, WUS-Austria and University of Prishtina, 2011
- Muhammad Tahir and Kashif Javed, ARM Microprocessor Systems: Cortex-M Architecture, Programming, and Interfacing, CRC Pess, 2017
- Renesas Synergy Development Kit, User's Manual, Renesas Electronics, 2015
- Nikolay V. Kirianaki, Sergey Y. Yurish, Nestor O. Shpak, Vadim P. Deynega, Data Acquisition and Signal Processing for Smart Sensors, Wiley, 2002
- Ned Mohan, First Course On Power Electronics And Drives, MNPERE, 2003

Course title: Smart Sensors

Lecturer: Prof. Ass. Dr. Drilon Bunjaku

Course status: Elective, Semester V, 5 ECTS

Short description of the content: Introduction to the course, structure of modern control systems, distributed control structure. Communication networks and communication with distant sensors and actuators. Smart sensors and structure, measurement block, digital processing block, communication block. Local block for monitoring and configuring. Measurement and usage of measured values. Performance specification with time and frequency domain analysis. static and dynamic characteristics, nonlinearities. Analog signal processing, amplifiers, analog filters, and modulations. Interconnection with digital systems, sampling and holding, multiplexing, A/D and D/A conversion. Digital processing system (with microprocessor, microcontroller, DSP, programmable digital circuits, CPLD, FPGA), digital processing, digital filters, linearization 9circuit and program based). Specific functional processing, self-diagnosing, learning and adaption, coding, security. Communicating with human (HMI), local devices for display and for accepting commands. Standard sensor and actuator communication networks, wired (AS-i, Profibus, DeviceNet, Industrial ethernet, ModBus) and wireless (ZigBee, WiFi), protocols. Access to other maintenance functions from distance.

The goals: The goal of the course is to introduce students with structure of distributed systems for monitoring, instrumentation, and control, and with smart sensors as part of them. Introduction with architecture, functionality construction blocks and communication networks, standards and communication protocols.

Learning outcomes: On successful completion of the course, students will be able to:

- Know smart sensors and ways of communication with them;
- Select proper actuator that fulfill task requests;
- Design and implement functional systems with smart sensors;
- Make smart sensor selection according to requested specifications;
- Configure smart sensors for interplay in network;
- Design and implement smart sensor (electronic part programming part) with basic structure based on microcontroller

Methods of teaching: 30 hours of lectures, 15 hours of laboratory exercises.

Evaluation methods: Mid-term exams 30%+30%, Lab. works 10%, Project 20%, Attendance 10%.

Concretization means: Computer, projector, Lab works

Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- Clarence W. de Silva, *Sensors and Actuators: Engineering System Instrumentation,* 2ed, CRC, 2016
- Gerard Meijer (Ed.), *Smart Sensor Systems*, Wiley, 2008
- Randy Frank, *Understanding Smart Sensors*, 3rd ed., Artech House, 2013.

Course title: Communications in Automation

Lecturer: Prof. Ass. Dr. Lavdim Kurtaj

Course status: Elective, Semester V, 5 ECTS

Course content: Control systems with communication networks: design, telemetry, remote control, controllability and operation in real time. ISO/OSI reference model: overview of layers function, protocols, connection and connectionless services, transparency and virtual links. Physical links between distributed control building blocks: wired transmission media, fiber optics, radio links, topologies, serial/parallel transmission, simplex, half-duplex and full-duplex links, standards of physical layer (RS-232, RS-485), synchronization, channel coding (parity, CRC). Logical links; connection, connectionless and connection less with confirmation, protocols. Fieldbuses: purposes and use, operation in real time, and synchronization, Profibus, ModBus, CAN, TTP. Wireless networks, ZigBee. Local area networks: concept of ISO standards 8802, Ethernet family (standard, fast, giga, industrial, hyperLAN). Local area building blocks.

Course objectives: The objective of this course is to gain general knowledge about data telecommunication networks, knowledge about particular communication systems used in automation and their specifications, to learn systematic approach in design of complex systems.

Learning outcomes: On successful completion of the course, students will be able to:

- demonstrate knowledge and understanding of specifics of the industrial communication networks;
- identify type of network to be used depending on nature of the problem;
- evaluate network properties for working in real time;
- to design communication systems for telemetry, remote control, control of equipment with decentralized structure;
- to develop, maintain, and use industrial networks;

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, numerical exams, laboratory exams, projects.

Evaluation methods: Intermediary evaluations 10%+10%, Laboratory exams 20%, Project 30%, Final exam 15%+15%.

Concretization tools: Computer, projector, simulator, development systems and experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature:

- Michael Duck, Richard Read, Data Communications and Computer Networks: For Computer Scientists and Engineers, Prentice Hall, 2003
- Bogdan M. Wilamowski and J. David Irwin, Industrial Communication Systems, The Industrial Electronics Handbook, CRC, 2011

- Steve Mackay, Edwin Wright, Deon Reynders, John Park ASD, Practical Industrial Data Networks: Design, Installation and Troubleshooting, Newnes, 2004
- Deon Reynders, Steve Mackay, Edwin Wright, Practical Industrial Data Communications: Best Practice Techniques, Newnes, 2004
- Marco Di Natale, Understanding and Using the Controller Area Network Communication Protocol: Theory and Practice, Springer, 2012
- Lavdim Kurtaj, Mechatronical Project, WUS-Austria and University of Prishtina, 2011
- Renesas Synergy Development Kit, User's Manual, Renesas Electronics, 2015

Course title: Finite Element Methods

Lecturer: Prof. Ass. Dr. Vjosa Shatri

Course status: Elective, Semester V, 5 ECTS

Course content: Introduction. Theory of numerical methods (FEM). Medelling with FEM. FEM wtih MATLAB. Modelling techniques. Applications of FEM in analysing different systems. Electrical systems. Magnetic systems. Thermal systems. Mechanical systems. Computation of electromagnetic components: resistors, inductivities, forces, etc. Computation of thermal parameters: thermal flux, temperature distribution, influence of temperature to system characteristics. Computation of mechanical parameters: mechanic stability, mechanical stress, mechanic vibrations, noise. Co-simulation methods. Analysing systems with co-simulation.

Course objectives: Objectives of the course is to introduce students with numerical methods (finite element methods, FEM) and how to use them to analyse and solve different technical problems.

Learning outcomes: By finishing this course a student will:

- Know theory of finite element methods and their application in solving different electrical, magnetic, thermal, and mechanics problems;
- Learn necessary steps for modeling different components by using numerical methods, starting from building real geometry, selecting materials and defining corresponding characteristics, setting boundary conditions, and defining resulting quantities;
- Know techniques for simulating real systems by using co-simulation methods;
- Be able to apply numerical methods to model and analyse some given system and document it.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, laboratory exercises, projects.

Evaluation methods: Laboratory exams 10%, Intermediary evaluations 15%+15%, Project 30%, Final exam 30%.

Concretization tools: Computer, projector, simulator, experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature

- José Roberto Cardoso, *Electromagnetics through the Finite Element Method: A Simplified Approach Using Maxwell's Equations*, CRC Press, 2016
- Daryl L. Logan, *First Course in the Finite Element Method*, Sixth Edition, Cengage Learning, 2006
- E. Madenci, I. Guven, *The Finite Element Method and Applications in Engineering Using Ansys*, Springer, 2007
- G. Dajaku, *FEM in der Antriebstechnik*, Lecture script, University of Federal Defence Munich, Germany
- Ozlem Ozgun and Mustafa Kuzuoglu, *MATLAB-based finite element programming in electromagnetic modeling*, CRC Press, 2019

Course title: Operating Systems

Lecturer: Prof. Ass. Dr. Artan Mazrekaj

Course status: Elective, Semester V, 5 ECTS

Short description of the content: Computer systems in general (including basic elements). Multicore and multiprocessor organization of computer. Operating systems in general (operating system objectives, operating system evolution, modern operating systems, virtual machines). Process and control description (process states, process control). Threads (processes and threads, thread types, Windows 10 threads, processes in Linux and thread management). Concurrent systems - mutual exclusion (principles of competitiveness, hardware support, semaphores, monitors, message passing). Memory management. Virtual memory. Disk management. File management.

The goals: The student will be taught principles of modern operating systems.

Learning outcomes: The students who succeeded in this course will be able to;

- Understand the logical structure of OS,
- Learn the principles modern operating systems,
- Processes and their states,
- Understand the thread and multi-threaded applications,
- Understand the relationship between subsystems of a modern operating system,
- Understand kernel and microkernel,
- Understand the principle of concurrent processes and mutual exclusion,
- Evaluate the efficiency aspect of using system resources (processor, cache, memory, virtual memory and disk).

Methods of teaching: Lectures, exercises, tutorials and team work accompanied with assignments.

Evaluation methods: Mid-term exams 25%+25%, Lab. works 10%, Project 30%, Attendance 10%.

Concretization means: Computers, projector, Lab works.

Ratio between the theoretical and practical part of teaching: 50:50

Literature:

- W. Stallings, *Operating Systems- Internals and Design Principles.*9 th edition, Pearson, 2019.
- A.S. Tanenbaum, H. Bos, *Modern operating systems*, 8th edition, Prentice Hall, 2008
- Silberschatz, P.B. Galvin & G Gag*ne,* Operating system concepts. *10th edition, Addison Wesley, 2018*.

Course title: Modeling and Simulation

Lecturer: Prof. Ass. Dr. Drilon Bunjaku

Course status: Mandatory, Semester VI, 5 ECTS

Course content: Fundamental principles for modeling dynamical systems. Methods for transforming one model type to the other. Model linearization. Simulation of dynamical systems, fundamentals of MATLAB and Simulink. Models of electrical processes, circuits and electromagnetic systems. Models for mechanical processes. Thermal processes. Simulation and design of control systems.

Course objectives: Objectives of this course are to introduce details of several analytical and practical methods of modeling. Students will improve skills in using MATLAB/Simulink for building and simulating models of dynamical systems.

Learning outcomes: On successful completion of this course, students should be able to:

- Develop different types of models for dynamical systems;
- Derive linearized model at a given working point for nonlinear models;
- Use MATLAB and Simulink, and related software, for modeling and simulation;
- Model, simulate, analyse systems of different physical domains, electromagnetic, thermal, mechanic.
- Model and simulate control systems.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, numerical exams, laboratory exams, seminary work.

Evaluation methods: Seminar 10%, Laboratory exams 10%, Intermediary evaluations 15%+15%, Final exam 50 %

Concretization tools: Computer, projector, simulator, experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature:

- "*Simulation of Dynamic Systems with MATLAB and Simulink*", Klee, H., CRC Press, Boca Raton, FL., 2007.
- "*Modeling and Simulation of Dynamic Systems*", Woods, R. L., and Lawrence, K. L., Prentice-Hall, Upper Saddle River, NJ, 1997.
- "*System Dynamics*", Palm III, W.J., McGraw-Hill, NY, 2010.

Course title: Digital Control Systems (2+0+2) 5 ECTS

Lecturer: Prof. Ass. Dr. Lavdim Kurtaj

Course status: Mandatory

Course content: Introduction to the subject. Examples of discrete and digital control. Signal conversion and processing. Typical digital sensors. Connection with actuators. Step-motors. Structure of digital control systems. Modeling. z-Transform. Modified z-transform. Signal between sampling instants. Transfer function, block diagram and signal flow graphs. State variable method. Controllability, observability and stability. Time domain and z domain analysis. Frequency domain analysis. Digital simulation and digital redesign. Cascade compensation with digital controller equivalent to continuous one. Digital controllers. Root locus in z plane. Implementation of digital control systems. Software implementation of digital controllers. Finite word length. Digital signal processors (DSP).

Course objectives: Familiarity with concepts of digital control. Familiarity with structure of digital control systems. Familiarity with analysis and design methods for digital control systems. Implementation of microprocessor based digital controllers, hardware and software part. Familiarity with advanced digital control devices.

Learning outcomes: On successful completion of the course, students will be able to:

- understand digital control systems;
- evaluate performances of digital control systems and be able to take necessary measures to improve them;
- design microprocessor-based system for implementing digital controller;
- write software support for implementing digital controllers;
- get involved in streams of advanced digital control.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, numerical exams, laboratory exams, seminary work.

Evaluation methods: Intermediary evaluations 15%+15%, Project 40%, Final exam 15%+15%.

Concretization tools: Computer, projector, simulator, development systems, and experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature:

- B.C. Kuo, Digital Control Systems, Saunders College Publishing, Florida
- C.H. Houpis, G.B. Lamont, Digital Control Systems: Theory, Hardware, Software, McGraw-Hill, New York.
- R.C. Dorf and R.H. Bishop, Modern Control Systems, Prentice Hall, 2005
- G.F. Franklin, J.D. Powell, and M. Workman, Digital Control of Dynamic Systems, Addison Wesley, 3rd Ed., 1998
- G. C. Goodwin, Stefan F. Graebe and M. E. Sagado, Control System Design, Prentice-Hall, Inc., 2001
- Lavdim Kurtaj, Mechatronical Project, WUS-Austria and University of Prishtina, 2011
- Renesas Synergy Development Kit, User's Manual, Renesas Electronics, 2015

Course: Nonlinear Control Systems

Lecturer: Mr.sc. Arben Mashkulli

Course status: Elective, Semester VI, 5 ECTS

Brief overview: Introduction to general concepts of nonlinear dynamic systems. The linearization, it's role and importance on analysis of nonlinear systems. The difference between the mathematical apparatus used in the linear and nonlinear control systems. The influence of nonlinear components and other forms on nonlinear in the study of control systems. Methods of analyzing nonlinear systems. Stability testing of nonlinear dynamic systems based to Lyapunov stability theory. Limit cycles and their properties. Types of singular point and their analysis. Nonlinear system analysis in the phase plane and their phase trajectories. Phase trajectories for typical nonlinear components. Nonlinear system analysis using the isoclines method. The describing function: nonlinear system study using the describing function. Deriving describing functions for typical nonlinear elements.

The goal: The purpose of this course is to introduce the students with the nonlinear counter part of control systems. The discussions will focus on the influence of typical nonlinear components and other form on nonlinearity on the response of control systems. Different forms of analyzing nonlinear systems will be introduced.

Learning outcomes: On successful completion of the course, students will be able to:

- Tell the difference between linear systems (modeled in the working point) and systems with nonlinearities in them.
- Observe the distortions that nonlinear components introduce in control systems and the influence of these distortions in the performance of control systems
- Apply the phase plane method and the isoclines method to analyze system features.
- Understand special effects that are only found in nonlinear systems (such as limit cycles)
- Fully understand the concept of describing function and its importance in the study of nonlinear control systems.

Teaching methodology

30 hours of lectures, 15 hours of numerical exercises, 15 hours of laboratory exercises.

Approximately 60 hours of personal study and exercise including seminars.

Grading System:

Seminar 10%, Mid-term exams 30 %, Final Exam 60 %

Necessary tools: During lecture sessions a computer with projector is needed, while the practical session will be realized in the numerical class session (laboratory).

The ratio between theoretical and practical work: 60:40

Literature:

- J. J. Slotine & W. Li, *Applied Nonlinear Control*, MIT Press, 1991.
- H. K. Khalil, *Nonlinear Systems*, Pearson, *2002.*
- H. K. Khalil, *Nonlinear Control*, Pearson, 2015.
- S. H. Strogatz, *Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering,* Westview Press; CRC Press, 2018.

Course: Chemical Process Control

Lecturer: Ass. Dr. Sc. Drilon Bunjaku
Course status: Elective, Semester VI, 5 ECTS

Brief overview: Mathematical models of chemical engineering systems. Examples of mathematical models of chemical engineering systems: Series of isothermal, constant and variable holdup CSTRs; two heated tanks; reactor with mass transfer; ideal binary distillation column; pH systems. Computer simulation: numerical methods. Examples: gravity-flow tank, non-isothermal CSTR, multi-component distillation column, batch reactor. Time-domain dynamics and control. Frequency-domain dynamics and control. Multivariable process control.
Course objectives: This course aims to provide an introduction to control of chemical engineering processes.
Learning outcomes: Upon the completion of the course students will be able to model and implement control solutions for common chemical processes that arise in practice, such as reactor with mass transfer, distillation column; pH systems, etc.
Teaching methodology: 30 hours of lectures, 15 hours of numerical exercises and 15 hours of laboratory exercises. Approximately 60 hours of personal study, including homework exercises.
Grading System: Homework 10%, Mid-term exams 30 %, Final Exam 60 %
Necessary tools: During lecture sessions a computer with projector is needed, while the practical session will be realized in the numerical class session (laboratory).
The ratio between theoretical and practical work: 40:60

Literature:

- Luyben, W., "*Process Modeling, Simulation, and Control for Chemical Engineers*", McGraw-Hill, 1996
- Stephanopoulos G., "*Chemical Process Control, an Introduction to theory and practice*", Prentice-Hall, 1984.
- Coughanowr, D., "*Process system analysis and control*", McGraw–Hill, 2008.
- Chau, P. C., *Chemical Process Control: A First Course with MATLAB*, Cambridge University Press, 2002.

Course title: Continuous and Batch Processes

Lecturer: From Industry

Course status: Elective

Course content: Characteristics of continuous and batch processes: Introduction to ontinuous and batch processes, fundamental and other important variables. Control of processes: final control element, control algorithms. Signal transmission and instrumentations. Control strategies for continuous and batch processes: feedback control, cascade control, feed-forward control.

Course objectives: The course teaches students the characteristics of continuous and batch processes as well as the requirements for control strategies and instrumentation associated with these types of processes.

Learning outcomes: Upon completion of this course the student will be able to:

- Understand the essential differences between continuous and group operations.
- apply the most modern methods of supervision, control techniques and optimization in industrial processes.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, laboratory exercises, projects.

Evaluation methods: Intermediary evaluations 30%, Project 40%, Final exam 30%.

Concretization tools: Computer, projector, simulator, development systems and experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature:

- Carlos A. Smith, Armando B. Corripio; "Principles and Practices of Automatic Process Control". John Wiley & Sons, 2005.
- Dale E. Seborg, Duncan A. Mellichamp, et al.; "Process Dynamics and Control", Wiley, 2010.
- Terrence Blevins, and Mark Nixon; "Control Loop Foundation-Batch and Continuous Processes", International Society of Automation, 2010.

Course title: Real-time Control Systems

Lecturer: Prof. Ass. Dr. Lavdim Kurtaj
Course status: Elective, Semester VI, 5 ECTS

Course content: Introduction to Real-Time Systems. Definitions of Real-time systems. Embedded systems. Designing and Developing Real-time Systems. Architecture. Interrupts and Exceptions. Timers and Real-time Facilities. Real-Time Devices. Event driven activities, state machines. I/O Devices and Buses: Serial devices and parallel devices, Peripheral serial buses. Multitasking in Real-Time Systems: Scheduling, Synchronization, Inter-task communication. Real-time kernels and operating systems. Data Acquisition and Control Systems: Analog to digital conversion and digital to analog conversion, multi-threaded real-time data acquisition, applications using real-time data acquisition and control. Periodic and event-based control tasks. Integrated Control and Scheduling. Implementation aspects. Control over networks.
Course objectives: The aim of the course is that the student should learn how to design and implement computer-based control systems that meets task real-time requirements.
Learning outcomes: On successful completion of the course, students will be able to:

- implement a computer-based control systems using concurrent programming techniques;
- apply basic scheduling analysis for real-time systems;
- use state machines for implementation of event-based control systems;
- design multitask programs where communication and synchronization is realized using semaphores, monitors, and messages;
- design and program a computer-based control system on PID form and state-space form;
- understand how time-delays and jitter affect control performance;
- understand the problems associated with control over networks.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, laboratory exams, projects.
Evaluation methods: Intermediary evaluations 10%+10%, Laboratory exams 20%, Project 30%, Final exam 15%+15%.
Concretization tools: Computer, projector, simulator, development systems and experimental plants.
Ratio between the theoretical and practical part: 40:60

Literature:

- Jiacun Wang, *Real-Time Embedded Systems*, Wiley, 2018
- Jane W. S. Liu, *Real-Time Systems*, Prentice-Hall, 2000

- Amitava Gupta, Anil Kumar Chandra, Peter Luksch, *Real-Time and Distributed Real-Time Systems: Theory and Applications*, CRC Press, 2016
- Sam Siewert and John Pratt, *Real-time embedded components and systems : with Linux and RTOS*, Mercury Learning and Information, 2016
- Insup Lee, Joseph Y-T. Leung, Sang H. Son, *Handbook of Real-Time and Embedded Systems*, CRC Press, 2007
- Tian Seng Ng, *Real Time Control Engineering: Systems And Automation*, Springer, 2016
- Kim R. Fowler, *What Every Engineer Should Know About Developing Real-Time Embedded Products*, CRC Press, 2008
- Rob Williams, *Real-Time Systems Developmen*, Butterworth-Heinemann, 2005
- Lavdim Kurtaj, *Mechatronical Project*, WUS-Austria and University of Prishtina, 2011
- Renesas Synergy Development Kit, User's Manual, Renesas Electronics, 2015
- Asif Mahmood Mughal, *Real Time Modeling, Simulation and Control of Dynamical Systems*, Springer, 2016

Subject: **Computer Data Acquisition and Analysis**
Lecturer: Ass. Dr. Sc. Drilon Bunjaku
Course status: Elective, Semester VI, 5 ECTS
Brief overview: Introduction to structure of data acquisition systems. Concentrated local systems. Input units for different types of data sources: discrete and analog, slow and fast, periodical and transitory, with small and large amount of data. Storing media, volume, access time, and security. Processing software with general dedication (MATLAB and LabVIEW). Development user dedicated applications (C, C++, VB, assembler and specialized software). Distributed systems and communication infrastructure. Clock synchronization (time). Communication over wired networks (RS-232, RS-485, CAN, Ethernet). Communication over power lines and optical fibers. Wireless communication and exploitation of existent communication networks (radio links, ZigBee, WiFi, GPS, GPRS). Communication protocols (IEC, DNP, ModBus) and protocol converters for communication over heterogeneous networks. Remote terminal units. Systems for supervisory control and data acquisition. Units for presenting data and analysis results as well as communicating with human.
The goal: The goal of the course is to provide an introduce to computer systems for data acquisition from different sources by type, speed, amount and space distribution, storing collected data, analysing and presenting results of analysis.
Learning outcomes: On successful completion of the course, students will be able to:

- estimate type of data and to select adequate acquisition system;
- design and implement local system for data acquisition;
- use different mechanisms for transporting data to distance, with wires ore wireless;
- understand and use systems for storing massive amount of data;
- develop applications for data processing;
- design and program systems for presenting results in as much as possible human friendly form.

Teaching methodology: 30 hours of lectures, 15 hours of numerical exercises and 15 hours of laboratory exercises. Approx. 75 independent working hours, including home works (or seminar paper).
Grading System: Mid-term exams 10%+10%, Lab. work 20%, Project 30%, Final exam 30%.
Necessary tools: During lecture sessions a computer with projector is needed, while the practical session will be realized in the numerical class session (laboratory).
The ratio between theoretical and practical work: 40:60
Literature:

- John Park, Steve Mackay, *Practical Data Acquisition for Instrumentation and Control Systems*, Newnes, 2003
- David Bailey, Edwin Wright, *Practical SCADA for Industry*, Newnes, 2003
- Viktor Boed, *Networking and Integration of Facilities Automation Systems*, CRC Press, 1999
- Michele Vadursi (Ed.), *Data Acquisition*, Sciyo, 2010

Course title: Building Automation

Lecturer: Prof. Ass. Dr. Lavdim Kurtaj

Course status: Elective, Semester VI, 5 ECTS

Course content: Common electrical installation. System structure in home and buildings. Topologies, potential and importance of automation. Intelligent buildings. Comfort, security, and energy savings. Historical development and integrated communication infrastructure. Direct digital control. Residential building automation as distributed control system. Collecting information from sensors. Recording, monitoring, and alarming. Actuators and interconnection with communication infrastructure. Functional interconnection of sensors and actuators over communication network. Control centers and accessing from distance. Ways of communication: dedicated wires, over power lines, wireless, optical fibers. Open and proprietary communication standards (X10, BACnet, LonTalk, KNX/EIB, ZigBee). Configuring and programming. Programming languages: ladder diagram, functional blocks, instruction list, structured text, and structured functional diagrams. Designing and documenting. Integration with future smart networks.

Course objectives: The goal of the course is to introduce systems for home, building, and other objects were people live and work, as road toward so called smart buildings. Introduction to topology, communication infrastructure, and constituent elements. Fulfillment of requests for configuration, programming, and documenting the system.

Learning outcomes: On successful completion of the course, students will be able to:

- know functional details of building automation;
- know topologies of building automation systems and their potential;
- design automation system according to given specifications;
- according to gained knowledge to select proper sensors and actuators;
- understand and implement selected communication structure;
- configure and program systems constituents so they can operate as a whole;
- document and understand documentation of automation systems.

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, laboratory exams, projects.

Evaluation methods: Intermediary evaluations 10%+10%, Laboratory exams 20%, Project 30%, Final exam 15%+15%.

Concretization tools: Computer, projector, simulator, development systems and experimental plants.

Ratio between the theoretical and practical part: 40:60

Literature:

- Shengwei Wang, *Intelligent Buildings and Building Automation*, Spon Press, 2010
- Hermann Merz, Thomas Hansemann, Christof Hübner, *Building Automation: Communication systems with EIB/KNX, LON und BACnet*, Springer, 2009
- Viktor Boed, *Networking and Integration of Facilities Automation Systems*, CRC Press, 1999
- Robert McDowall, *Fundamentals of HVAC Control Systems*, Butterworth-Heinemann, 2006