

**SYLLABI OF THE MASTER STUDY PROGRAM IN ELECTRONICS, AUTOMATION  
AND ROBOTICS (2024–2027)**

**First Semester**

**Course:**                   **Circuits and Signals in Systems (3+1+1) 7 ECTS**  
**Lecturer:**               **Prof. Ass. Dr. Faton Maliqi**  
**Course status:**       **Mandatory**

**Course content:** Characteristics and limitations of linear circuits, characteristics of ideal elements. Basic electrical signals, information signals, power signals. Topology of electrical circuits, graphs. Contour and node methods for derivation of circuit equations. Linear algebraic equations and solution methods, sparse matrices. Modified nodal analysis, element stamps. Computer based circuit analysis, programs of SPICE family and MATLAB/Simulink program with toolboxes. DC and AC analysis, system of differential equations, convolution, Laplace transform, transfer function, complex power, Tellegen theorem. Time and frequency domain analysis with SPICE and MATLAB/Simulink, frequency response. Single input circuits, maximal power transfer, resonance. Two input networks. Z, Y, S parameters, hybrid parameters H, transmission parameters. Electrical lines as distributed parameter circuits. Impedance matching, phenomenon of reflections in lines. Nonlinear components, linearization and companion model, working point, small signal analysis, solution of nonlinear system of equations. Energetic conversions. Simulation of nonlinear circuits with SPICE and MATLAB/Simulink. Signal integrity, couplings, disturbances, noise.

**Prerequisites:** Solid foundation in basic electrical circuits, including Ohm's law, Kirchhoff's laws, and fundamental circuit analysis techniques. A working knowledge of linear algebra, differential equations, and Laplace transforms is essential for understanding circuit behavior in time and frequency domains. Familiarity with signals and systems, Fourier analysis, and basic computer-based circuit simulation (MATLAB/Simulink, SPICE) will be beneficial. While prior exposure to electromagnetic and transmission lines is recommended, it is not mandatory.

**Course objectives:** Objective of the course is to present advanced methods for electrical circuit analysis. Introducing computer methods for solving linear and nonlinear electrical circuits, in time and frequency domain. Using programs of SPICE family and MATLAB/Simulink for electrical circuit analysis.

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

- Know basic concepts of graph theory and using them for computer analysis of electrical circuits;
- Analyze circuits in time and frequency domain;
- Know and identify two input networks that are widespread in use at all subjects of electrotechnics, especially in electronics, telecommunication, automation, and energetics;

- Know characteristics of lines, as electrical circuits with distributed parameters, electromagnetic processes present in lines, telephone lines, high frequency transmission lines, and energetic lines;
- Use programs of SPICE family and MATLAB/Simulink to analyze electrical circuits;
- Characterize systems based on S-Parameters;
- Understand concepts of signal integrity;

**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 (smart board), simulator, development systems and experimental plants.

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

**Literature:**

1. John Semmlow, “*Circuits, signals and systems for bioengineers – A Matlab based Introduction*”, 3<sup>rd</sup> edition, Academic Press, 2018.
  2. Farid N. Najm, *Circuit Simulation*, Wiley-IEEE, 2010
  3. Alex Palamides and Anastasia Veloni, “*Signals and Systems Laboratory with MATLAB*”, CRC Press, 2011;
  4. B.P. Lathi, *Principles of Linear Systems and Signals*, Second Edition, Oxford University Press, 2009
  5. Charles K. Alexander, Matthew Sadiku, *Fundamentals of Electric Circuits*, Sixth Edition, McGraw-Hill Education, 2017
  6. Steven T. Karris, *Circuit Analysis I: with MATLAB Computing and Simulink/SimPowerSystems Modeling*, Orchard Publications, 2009
  7. Steven T. Karris, *Circuit Analysis II: with MATLAB Computing and Simulink/SimPowerSystems Modeling*, Orchard Publications, 2009
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**Course:** **Industrial IoT (2+0+2) 6 ECTS**  
**Lecturer:** **Prof. Ass. Dr. Drilon Bunjaku**  
**Course status:** **Mandatory**

**Course content:** **Industrial IoT** (The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Smart Factories). **Implementation systems for IIoT** (Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Microcontrollers and Embedded PC roles in IIoT, Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols and IoT Hub systems). **IIoT Data Monitoring & Control** (IoT Gate way, IoT Edge Systems and It's Programming, Cloud computing, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology). **Cyber Physical Systems** (Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis). **Industrial IoT- Applications** (Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management). **Case Studies of IIoT Systems** ( IIoT application development with Embedded PC based development boards, Development of mini Project on new version of Operating systems and Edge development board. That project should also address to the current societal needs).

**Prerequisites:** Basic understanding of automation, data analysis, and programming. Knowledge of Internet of Things (IoT) and industrial technologies, such as sensors, actuators, and sensor networks. Proficiency in programming embedded systems, microcontrollers, and communication protocols.

**Course objectives:** To provide students with a good depth of knowledge of Designing Industrial IOT Systems for various applications. Knowledge for the design and analysis of Industry 4.0 Systems for Electronics Engineering students. Learn to implement IIoT systems effectively, including sensor networks, process automation, and microcontrollers, as well as wireless sensor nodes and IoT hub systems. Gain proficiency in IIoT data monitoring and control, including IoT gateways, edge systems programming, cloud computing, real-time dashboard design, data analytics, and predictive maintenance techniques.

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

- demonstrate a comprehensive understanding of the fundamentals of Industrial IoT, including its historical context, the role of IoT and IIoT in Industry, and the impact of Industry 4.0 revolutions on manufacturing processes.
- Identify, formulate and solve engineering problems by using Industrial IoT.
- implement IIoT solutions using sensors, actuators, sensor networks, automation, and data acquisition, addressing industrial challenges.

- analyze IIoT data using various tools and techniques to support informed decision-making in industrial settings.
- design and present IIoT case studies demonstrating their understanding of IIoT application development and project management, addressing real-world industrial needs.

**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 (smart board), simulator, development systems and experimental plants.

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

**Literature:**

1. Alasdair Gilchrist, *Industry 4.0: The Industrial Internet of Things*, Publications: Apress, 2016.
  2. Bartodziej, Christoph Jan, *The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics*, Springer, Springer Gabler; 1st ed. 2017
  3. Raj Kamal, *Embedded System: Architecture, Programming and Design*, McGraw Hill Education, third edition, 2017
  4. Ovidiu Vermesan, Peter Friess, *Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems*”, CRC Press, 2022
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**Course:** **Methodology of Scientific Research (2+1+0) 5 ECTS**  
**Lecturer:** **Prof. Dr. Milaim Zabeli**  
**Course status:** **Mandatory**

**Course description:** Meaning of research and objectives. Types of scientific research. Overview of experimental and engineering methodological approaches to research. Scientific research methods/techniques. The research process (formulating the research problem, sources of information, developing the working hypotheses, preparing the research design, collecting the data, execution of the project, data analysis, testing of hypotheses, generalization and interpretations, preparation of the report or thesis). Publication channels, research funding, creativity and intellectual discovery. Guidelines and a framework for efficient research development, legal and ethical issues, protection and exploitation of research. Intellectual property rights; Research project management: supervision, planning and organization, problems and drawbacks, Presentation skills (written, oral), use of relevant research tools (technology, experimental infrastructure, mathematical methods, etc.).

**Prerequisites:** Enrolment in the academic year.

**Course objectives:** To introduce some key elements of research methodology to first time research students.

**Learning outcomes:** At the end of this course, the students should be able to:

- Understand some basic concepts of research and its methodologies.
- Identify appropriate research topics.
- Select and define appropriate research problems and parameters.
- Prepare a project proposal (to undertake a project).
- Organize and conduct research (advanced project) in a more appropriate manner.
- Write a research report and thesis
- Write a research proposal (grants).

**Teaching methodology:** 30 hours of lectures + 1 hour exercise.. Approximately 75 hours of personal study, including homework exercises.

**Evaluation methods:** Homework (seminary work) 30%, Mid-term exams 30%, Attendance 10%, Final Exam 30%

**Concretization tools:** During the lectures, the computer will be used with a video projector (smart board).

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

**Literature:**

1. Kothari B.L., Research Methodology: Tools and Techniques, New Age International Publishers, 2013.
  2. Boot C. W., The Craft of Research, University of Chicago Press, 2008.
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**Course title:** Control of Electrical Drives (2+0+) 6 ECTS

**Lecturer:** Prof. Dr. Qamil Kabashi

**Course status:** Elective

**Course content:** Introduction. Elements of electrical drive system. Dynamics of Electrical Drives DC Drives. Poly-phase induction machines. Scalar control of AC machines. Dynamic modeling and Vector control. Vector control structures with voltage and current inverter. Pulse Width Modulation and Vector modulation. Vector model variable and parameters estimation of induction machine. Direct torque and flux control of an AC induction machine. Control of the brushless DC motor. Improvement of tracking accuracy using feedforward controller Applications of Electric Drives. Study case: Speed regulation of 3 phase induction motors with SPWM and SVPWM inverters.

**Prerequisites:** Strong background in electrical engineering, particularly in AC and DC motor systems. Knowledge of control theory and basic principles of power electronics. Familiarity with dynamic modeling and simulation of electrical machines and their control systems.

**The goals:** The course goal is to provide advanced knowledge for control of electrical drives.

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

- Select a drive for a particular application based on power rating.
- Select a drive based on mechanical characteristics for a particular drive application.
- Advanced understanding and design of DC electrical drive control systems
- Apply direct torque and flux control to induction machine
- Advanced understanding and design of AC electrical drive control systems
- Operate and maintain solid state drives for speed control of DC and AC machines.
- Operate and maintain solid state drives for speed control of various special electrical machines
- Systematic simulation of electrical drive control systems
- Experimental testing of modern industrial complex electrical drive control systems.

**Teaching methodology:** Lectures, Assignments, Lab Experiments, Lab report and presentation.

**Evaluation methods:** Two midterm exams 40%, Project 30%, Final exam 30%.

**Concretization means:** Laptop, projector, practical part will be done in the laboratory of the FECE and in the Kosovo Energy Corporation.

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

**Literature:**

1. V. Subrahmanyam, *Electric Drives, Concept and application*, McGraw Hill Education; 2nd edition, 2017.
  2. W. Leonhard *Control of Electrical Drives*, Springer, 2001.
  3. Gopal K. Dubey, *Fundamentals of electric Drives*, Narosa Publishing House”, 2nd edition, 2011.
  4. **Wach Piotr**, *Dynamics and Control of Electrical Drives*, Springer, 2011.
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**Course:** **Robotic Sensors and Actuators (2+0+2) 6 ECTS**

**Lecturer:** **Prof. Ass. Dr. Lavdim Kurtaj**

**Course status:** **Elective**

**Course content:** Introduction to the subject, structure of robot in working environment. Structure of control system and dependence on type of sensor as source of information. Actuator types, electric (motor) drives, hydraulic drives, pneumatic drives, mechanisms for connection with systems. Physical models and interconnection with control systems, nonlinearities and limitations. Servomechanisms and sensors for internal robot state (proprioceptive), multiple control loops, motion sensors (position, speed), force and torque, pressure, tactile sensors. Orientation (inertial) sensors, gyroscopes, acceleration sensors. Sensors for monitoring surrounding space and objects in it, external state (exteroceptive), localization (GPS, beacons), object distance (optic, laser, ultrasound) and speed (Doppler). Vision sensors, grey and color (BW, RGB), passive and active for depth (stereo, TOF, Kinect). Information processing for spatial motion, orientation, and recognition. Higher level control loops, visual feedback.

**Prerequisites:** Knowledge of electrical engineering principles, including motor drives and sensor technologies. Basic knowledge in control systems, programming, and microcomputer systems.

**Course objectives:** The goal of the course is to introduce students with the structure of robots in a working environment. Introduction to drives and adequate actuators, as well as sensors for internal state and for surround space, including necessary data processing for using them into control loop.

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

- know robot control structure;
- select and use adequate actuators for robot implementation;
- select and process sensor data for predicting internal state of robot and using them into control loop;
- know, to select, and to use sensors for navigation and orientation in space;
- use visual sensors and extract basic information from them;

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

1. Peter Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Second Edition, Springer, 2017
2. Clarence W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, Second Edition, CRC Press, 2016
3. K.S. Fu, R.C. Gonzales, C.S.G. Lee, *ROBOTICS, Control, Sensing, Vision, and Intelligence*, McGraw-Hill
4. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer, 2009
5. Bruno Siciliano and Oussama Khatib (eds.), *Springer Handbook of Robotics*, Second Edition, Springer 2016

**Course:** Cyber Physical Systems (2+0+2) 6 ECTS

**Lecturer:** Prof. Ass. Dr. Artan Mazrekaj

**Course status:** Elective

**Course description:** As computers and communication bandwidth becomes ever-faster and ever-cheaper, computing and communication capabilities will be embedded in all types of objects and structures in the physical environment. Applications with enormous societal impact and economic benefit will be created by harnessing these capabilities in time and across space. We refer to systems that bridge the cyber-world of computing and communications with the physical world as cyber-physical systems (CPS). This course covers important areas from the research literature on CPS. Three application domains are emphasized: medical devices for health care, smart transportation systems, and smart buildings. Several key cross-cutting principles, independent of the application domain, are also covered, including formal modeling, embedded systems, real-time systems, feedback control, and sensor networks.

**Prerequisites:** Background in operating systems and computer networking is necessary.

**Course objectives:** By the end of this course, students will have an understanding of the cyber physical systems and the corresponding important research challenges in this area. More specifically, one objective is to learn the current state of art in CPS domain. CPS is multidisciplinary with the need for new underlying principles. Another objective is to learn details regarding several necessary principles required for future CPS. A third objective is improving critical reading, presentation, and research skills.

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

- Explain Role of Cyber Physical System.
- Describe the main features of the Cyber Physical System .
- Describe the CPS Applications and Systems.
- Application of Sensors and Actuators for Physical Processes.
- Apply System Modelling, Model based Design, and Timed-Automata
- Know about Real-time Scheduling with Resource-constrained Platform.
- Know the role of the Feedback Control for Computing Systems.
- Know the role and application of the Networked System Composition

**Teaching methodology:** 30 hours of lectures + 30 laboratory exercises. Approximately 80 hours of personal study and exercise including homework (seminary work).

**Evaluation methods:** 1st Exam: 20%; 2nd Exam: 20%, Homework: 20%, Attendance 10%, Final exam: 30%

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

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

**Literature:**

1. E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach, 2014.
2. R. Rajkumar, D. de. Niz and M. Klein, Cyber Physical Systems, Addison-Wesely, 2017
3. E.A.Lee and S A Shesia, Embedded system Design: A Cyber-Physical Approach, Second Edition, MIT Press, 2018.
4. A.Platzer, (2017), Logical Foundations of Cyber Physical Systems, Springer, 2017

**Course:** **VLSI Technology (2+0+2) 6 ECTS**  
**Lecturer:** **Prof. Dr. Milaim Zabeli**  
**Course status:** **Elective**

**Course description:** Progress and development of electronics and semiconductor technology. Principles and implication of scaling and Moore's law. Silicon crystal structure. Crystal growth and production of silicon wafers. Planar technology. Principles of process integration. Modern CMOS technology. Integration of fabrication steps in planar technology. Semiconductor doping methods: diffusion and ion implantation. Doping distributions in silicon. Physical mechanisms of doping. Selectivity in semiconductor technology, lithography. Principles of isolation and passivation, thermal oxidation. Material removal in semiconductor technology, etching. Deposition of materials in semiconductor technology. Methods of on-chip interconnections of devices and circuit blocks. Metallization systems. Limitations of semiconductor technology. Advanced materials. Nanotechnology.

**Prerequisites:** Background in microelectronics is necessary.

**Course objective:** Principles of semiconductor technology and advanced micro- and nano-electron devices. Technology of modern VLSI chip design.

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

- Describe the scaling of semiconductor electron devices.
- Explain the silicon crystal structure.
- Explain the process steps in semiconductor fabrication technology.
- To understand the processes of oxidation, diffusion, lithography, implantation, metallization,
- Analyze the cross-sections of transistor structures; Identify physical principles of fabrication steps in semiconductor technology.
- Point out the limitations of modern semiconductor technology.
- Integrate the process steps for the MOS and bipolar transistor fabrication.

**Teaching methodology:** 30 hours of lectures (including the solutions of practical problems) + 30 hours of laboratory exercises. Approximately 100 hours of personal study and exercise including homework.

**Evaluation methods:** 1st Exam: 20%; 2nd Exam: 20%; Homework: 20%, Attendance 10%, Final exam: 30%.

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

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

**Literature:**

1. James D. Plummer, Michael Deal, Peter B. Griffin, Silicon VLSI Technology: Fundamentals, Practice, and Modeling, Prentice Hall, 2009.
2. Stanley Wolf, Richard N. Tauber, Silicon Processing for the VLSI Era, Vol. 4: Process Technology, Lattice Press, 2002
3. P. Biljanović, Mikroelektronika Integrirani elektronički sklopovi, Školska knjiga, 2001

**Course:** **Measurements and Sensors in Biomedicine (2+0+2) 6 ECTS**  
**Lecturer:** **Prof. Dr. Sabrije Osmanaj**  
**Course status:** **Elective**

**Course description:** Basic concepts: sources of biomedical signals, types of signals, noise characteristics of the measuring system. Physical and physiological quantities that are measured in medicine and related units. Interesting ways of signal acquisition in nature. The basic physical principles of sensors: resistive, inductive, capacitive, piezoelectric, chemical, optical. Measurement of pressure (direct and indirect measurements, the use of catheters). Measurement of blood flow and respiration (electromagnetic, ultrasound, Doppler, plethysmography, indicator dilution techniques and other methods). Measuring of movement, speed, acceleration, force and torque. Measurement of temperature, humidity and heat flow (contact and non-contact measurements, infrared meters). The measurement of bioelectric potentials (electrocardiography, electroencephalography, electromyography), bio impedance, electrodes. Laboratory and clinical biochemical measuring methods, biosensors. Sources of light and light sensors, sensors based on optical fibers, optical measuring methods.

**Prerequisite:** Basic knowledge of electronics and physics.

**Course objectives:** Overview of physical and physiological variables that are most commonly measured in clinical and medical research environments with a strong focus on the specific purposes of their measurement. Understanding of the physical principles, methods of measurement as well as sensors for measuring these quantities in medical diagnostic and research. Acquisition of knowledge and practical experience of qualitative and safe capture of the most common bioelectrical signals that can be captured on the surface of the body (ECG, EMG and EEG) and various types of nonelectric biological signals (eg. optical measurement methods). Basic knowledge of the concepts for measuring chemical parameters and biosensors. Practical experience with measuring methods in the laboratory. Knowledge of the advantages and limitations of the existing measuring methods with the aim of selecting the most appropriate method for a specific use.

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

- know concepts and principles of biomedical sensors and measurement.
- explained the basic theory and technology, followed by details of the physical sensors, chemical sensors, biosensors and their typical applications in biomedicine.
- to know how to present the interface technology of the sensors and the typical measurement systems.
- to know the Biomedical Measurement Technology
- to describe various measurement methods and sensors in medicine and biotechnology
- to describe some of the more important and often used measurement methods and procedures and explain their advantages and limitations
- to explain the physical background of the measurement methods

**Evaluation methods:** 1st Exam: 20%; 2nd Exam: 20%; Homework: 20%, Attendance 10%, Final exam: 30%.

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

**Ratio between theoretical and practical part:** 1:1.

**Literature:**

1. Wang P, Liu Q. Biomedical Sensors and measurement. Zhejiang University Press, Springer, 2011.
  2. Olfa Kanoun, Nabil Derbel, Advanced Sensors for Biomedical Applications, Springer, Year: 2021,
  3. Khandpur RS. Biomedical Instrumentation:Technology and Applications. McGraw-Hill, 2004.
  4. Bronzino JD (editor). The Biomedical Engineering Handbook (3rd edition). CRC Press, 2006.
  5. Tatsuo Tagawa, Toshiyo Tamura, P. Ake Oberg; Biomedical Sensors and Instruments, Second Edition; CRC Press, 2011
  6. Barth FG, Humphrey JAC, Secomb TW. Sensors and sensing in biology and engineering. Springer, 2003.
  7. Tatsuo Tagawa, Toshiyo Tamura, P. Ake Oberg, Biomedical Sensors and Instruments 2nd Edition, CRC Press; 2 edition (March 22, 2011)
  8. John G. Webster Halit Eren , Measurement, Instrumentation, and Sensors Handbook Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement, SECOND EDITION, CRC Press, 2014.
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**Course title:** **Advanced Power Electronics (2+0+2) 6 ECTS**

**Lecturer:** **Prof. Dr. Qamil Kabashi**

**Course status:** **Elective**

**Course description:** This course includes the advanced topics of power electronics such as some of the latest devices, their control and applications. This course will be covered in five modules. I – Advanced solid state devices such as MOSFETs, IGBT, GTO, IGCT etc, intelligent power modules, thermal design, protection, gating circuits, DSP used in their control. II – Non-isolated and isolated DC-DC converters such as: buck, boost, buck-boost, flyback, forward, Cuk, SEPIC, half bridge, push-pull and bridge in DCM and CCM, power factor correction at AC mains in these converters, their application in SMPS, UPS, welding and lighting systems. III – Improved power quality AC-DC converters. IV – Conventional HVDC (High voltage direct current), VSC based flexible HVDC systems. V – This module consists of solid-state controllers for motor drives such as vector control and direct torque control of induction motor, synchronous motor, permanent magnet sine fed motor, synchronous reluctance motor, permanent magnet brushless DC (PMLDC) motor, LCI (load commutated inverter) fed large rating synchronous motor drives, energy conservation and power quality improvement in these drives.

**Prerequisites:** Solid understanding of basic power electronics concepts, including DC-DC converters, AC-DC converters, and motor drives. Familiarity with control techniques for power devices, such as MOSFETs, IGBT. Knowledge of electrical machines.

**The goals:** In this course, students will be introduced to the latest power electronic devices and their applications in power conversion systems.

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

- Understand semiconductor devices in power electronic systems;
- Understand the operation of electronic power converter circuits ;
- Learn recent developments in power electronic;
- Formulate models of various power DC/DC and DC/AC electronic converters.
- Understand solid state controllers for motor drives such as vector control and direct torque control of induction motor etc.
- Generate simulations of power converters and various ancillary services in the power system.

**Teaching methodology:** Lectures, auditoria exercises, Assignments, Labs report and presentation.

**Evaluation methods:** Midterm exams 30%, Project 30%, Final exam 40%.

**Concretization means:** Laptop, projector, practical part will be done in laboratory of the FECE

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

**Literature:**

1. Daniel W. Hart, Power Electronics, McGraw-Hill Education; 1st. Ed. 2010.
2. Frede Blaabjerg, Control of Power Electronic Converters and Systems, Volume 1, Academic Press; 1st ed. 2018.
3. Bin Wo, High Power Convertes and AC drives, IEEE press, 2006.
4. B. K. Bose, Power Electronics and Variable Frequency Drive, Standard Publishers Distributors, 2000.

**Course title:** Cyber Security (2+0+2) 5 ECTS  
**Lecturer:** Prof. Dr. Blerim Rexha  
**Course status:** Elective

**Course content:** Introduction to Cyber Security and various challenges in cyber security. Cyber Security Vulnerabilities and attacks. Access Control and Security Policies Securing. Web Application, Services and Servers. Internet of Things (IoT) Security. Intrusion Detection and Prevention. Encryption and Cryptography. Risk Management and Emergency Planning. Cyberspace and the Law. Cyber Forensics and Incident Management.

**Prerequisites:** Basic knowledge of computer networks, operating systems, and internet protocols. Understanding of cryptography principles and security measures like encryption and access control. Familiarity with risk management and legal aspects of cyber security.

**Course objectives:** Understand cybersecurity basics and challenges, such as threats, attacks, and vulnerabilities in the digital world. Identify access control methods, security policies, and best practices to safeguard networks, systems, and cyber data from unauthorized access and breaches. Master skills to detect, prevent, and address cyber threats, including unauthorized access, hacker intrusions, and security breaches. Apply encryption and cryptography techniques to secure digital data and communications, including using security algorithms and digital certificates. Develop skills in risk management and emergency planning to respond to cybersecurity breaches, including identifying, assessing, and managing risks, as well as preparing for emergencies and recovering from damage.

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

1. Evaluate fundamental cyber security concepts, theories, and strategies as they apply to real world case studies.
2. Identify, implement, and describe effective access control techniques, security policies, and best practices to safeguard networks, systems, and data from unauthorized access and security breaches.
3. Explain technical and non-technical security solutions on different types of cyber systems.
4. Assess risks, vulnerabilities, and threats to sample cyber systems.
5. Identify attributes associated with cyber security professionals.

**Prerequisites:**

- Fundamentals of computer software and hardware.
- Basic concepts of operating system and networking.
- Practical knowledge of internet and use of networks.

**Teaching Methods:** Lectures and in-class discussions (30 hours) + 30 hours of lab exercises. Case studies and practical projects, Readings and analysis of written materials, Practical demonstrations of cybersecurity tools.

**Grading System:** Classroom Assessment 10%, Projects 40%, Final assessment 50 %

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

**Literature:**

1. Charles J. Brooks, Christopher Grow, Philip A. Craig Jr., Donald Short. Cybersecurity Essentials, Sybex, 1<sup>st</sup> Edition, 2018.
2. Robin Sharp. Introduction to Cybersecurity: A Multidisciplinary Challenge. 1<sup>st</sup> Edition Springer, 2024.
3. [Yuri Diogenes](#), Erdal Ozkaya. Cybersecurity. Attack and Defense Strategies, 3<sup>rd</sup> Edition, Packt Publishing, 2022.

## Semester II

**Course title:** Digital Design (2+0+2) 6 ECTS  
**Lecturer:** Prof. Dr. Milaim Zabeli  
**Course:** Mandatory

**Course description:** Elements of logic circuits, design of synchronous and asynchronous logic circuits. Implementation of digital circuits (counters, registers) with high modulus using integrated circuits with fixed function (synchronous and asynchronous). VHDL design, codes for simple logic gate functions. Designing combinational logic circuits with VHDL. Designing of bistable memory circuits with VHDL. Designing simple state machines with VHD. Design of digital circuits at the algorithmic and RTL level. Programmable PLD circuits. Fundamentals of FPGA Programmable Circuits. Designing complex state machines with VHDL.

**Prerequisites:** Background in logic gates, combinational logic, Flip\_Flops and counters is necessary.

**Course objectives:** Design of complex digital circuits using advanced design tools; RTL system description and digital system design using HDL approach.

**Learning outcomes:** On successful completion of the course, students will be able to know and understand:

- Design the simple gate functions.
- Design the complex digital circuits using advanced design tools on an advanced level.
- Designing with VHDL,
- Digital circuits design procedures and approaches.
- Design the state machine for specific cases.
- Designing conventional and unconventional sequential circuits
- To design PLD circuits.

**Teaching methodology:** 30 hours of lectures (including the solutions of practical problems) + 30 hours of laboratory exercises. Approximately 80 hours of personal study and exercise including homework.

**Evaluation methods:** Individual assignments completed in class 30%; Individual assignments completed at home 30%; Attendance 10%, Exam 30%.

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

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

### **Literature:**

1. Richard S. Sandige, Michael L. Sandige, Fundamentals of Digital and Computer Design with VHDL, McGraw-Hill, New York, NY 10020, 2013, ISBN 978-0-07-338069-8.
  2. Thomas Floyd, Digital Fundamentals, eleventh edition, Pearson Education Limited, 2015.
  3. Mano, M. Morris, Kime, Charles R, Logic and computer design fundamentals, 2008 Upper Saddle River : Pearson Prentice Hall, ISBN 978-0-13-206711-9
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**Course title:** Embedded Systems (2+0+2) 6 ECTS  
**Lecturer:** Prof. Ass.Dr. Faton Maliqi  
**Course:** Mandatory

**Course description:** Introductory lectures on possibilities with single capsule computers and embedded systems. The student determines a special area within embedded systems in consultation with the teacher responsible for the course and the supervisor appointed for the student. The student also has the opportunity to choose a special area within embedded systems in collaboration with companies.

**Prerequisites:** Microcomputer Systems Fundamentals. Programming Skills (e.g., C/C++, Python). Digital Electronics and Microcontroller Basics (Arduino, Raspberry Pi etc).  
Simulation and Implementation Tools: (p.sh., Keil, Proteus, MPLAB, Simulink).

**Course objectives:** Develop appropriate solutions for specific applications based on given specifications. Independent Research: Collect and present independently acquired knowledge in a chosen area within embedded systems. Critical Evaluation: Discuss and evaluate key theses from books or research reports in the chosen area. Practical Application: Apply or simulate acquired knowledge through concrete examples where applicable.

**Learning outcomes:** The purpose of this course is to provide the opportunity for such knowledge in depth within embedded systems that is not covered by the regular course. On completion of the course, the student should be able to:

- propose appropriate solutions for applications, given a specification,
- summarize and present independently acquired knowledge in a chosen special area within embedded systems,
- discuss and evaluate the central theses, for example, in books or research reports in the chosen area,
- where applicable, apply acquired knowledge through implementation or simulations of concrete examples,
- **Teaching methodology:** 30 hours of lectures (including the solutions of practical problems) + 30 hours of laboratory exercises. Approximately 80 hours of personal study and exercise including homework.
- **Evaluation methods:** Individual assignments completed in class 30%; Individual assignments completed at home 30%; Attendance 10%, Exam 30%.
- **Concretization tools:** During the lectures, the computer will be used with a video projector (smart board), and the practical part will be realized in the laboratory.
- **Ratio between the theoretical and practical part:** 40:60

**Literature:**

1. Peter Marwedel, Embedded System Design: Embedded Systems, Foundations of Cyber-Physical Systems, and the Internet of Things, Springer, 2018.
2. Tianhong Pan, Yi Zhu, Designing Embedded Systems with Arduino - A Fundamental Technology for Makers, Springer, 2018

3. Alexander Barkalov, Larysa Titarenko, Małgorzata Mazurkiewicz, Foundations of Embedded Systems, Springer, 2019
4. James K. Peckol, Embedded Systems: A Contemporary Design Tool, Wiley, 2019
5. Alan Holt, Chi-Yu Huang, Embedded Operating Systems: A Practical Approach, Springer, 2018

**Course:** Robotics and Automation (2+0+2) 6 ECTS  
**Lecturer:** Prof. Ass. Dr. Lavdim Kurtaj  
**Course status:** Mandatory

**Course content:** Introduction to the course and types of automation: fixed, changeable, programmable. Industrial robots (manipulators), mobile, modular, cooperating. Use of robots and action space. Automation in industry and processing, NC, CNC, robots. Working cell with robots. Robots for auxiliary and service tasks. Acting in dangerous environments. Robots for education and entertainment. Robot specifications. Industrial robots and construction, structure, kinematics, dynamics, control, hand, and gripper. Movement and working task, trajectory planning, point-to-point, continuous path, with contact and force application on environment. Robot programming, on-line, off-line, teach pendant and learning. Industrial robots and interconnection with automation systems, PLCs, levels of interconnection (signal and communication interface). Methods of control (with or without surrounding sensor) and coordination with other devices (transport, machines, cooperants). Structured and unstructured environment. Adaptation to changes, vision sensors and systems. Visual feedback. Action planning and utilization of artificial intelligence. Education robots and games (Lego NXT, FIRA). Simulators, graphics, and computer games.

**Prerequisites:** Knowledge of electrical engineering principles, including motor drives and sensor technologies. Basic knowledge in control systems, automating with PLCs, programming, and microcomputer systems.

**Course objectives:** The goal of the course is to introduce students to the usage of robots in different automation tasks, industrial, processing, and service. Accent will be on designing systems, implementation with PLC or dedicated computer, and programming for execution of requested actions.

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

- know structure of automatic systems and place for robots on them;
- know possibilities of using robots different tasks and relevant specifications;
- integrate robots with automation systems (PLCs) with signals or with communication interface;
- program different working tasks on integrated systems;
- understand and use for feedback control information from surrounding sensors (presence, distance, tactile, vision).

**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:**

1. Thomas R. Kurfess, *Robotics and Automation Handbook*, CRC Press, 2005
  2. A.K. Gupta, S.K. Arora, Jean Riescher Westcott, *Industrial Automation and Robotics: An Introduction*, Mercury Learning & Information, 2016
  3. Zongwei Luo and Zongwei Luo, *Robotics, Automation, and Control in Industrial and Service Settings*, IGI Global, 2015
  4. Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer, 2009
  5. K.S. Fu, R.C. Gonzales, C.S.G. Lee, *ROBOTICS: Control, Sensing, Vision, and Intelligence*, McGraw-Hill
  6. Peter Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Second Edition, Springer, 2017
  7. Bijoy K. Ghosh, Ning Xi, T.J. Tarn, (Eds.), *Control in Robotics and Automation: Sensor-Based Integration*, Academic Press, 1999
  8. Bruno Siciliano and Oussama Khatib (eds.), *Springer Handbook of Robotics*, Second Edition, Springer 2016
  9. Frank D. Petruzella, *Programmable Logic Controllers*, Fifth Edition, McGraw-Hill, 2017
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**Course:** **System Identification (2+0+2) 6 ECTS**

**Lecturer:** **Prof. Ass. Dr. Faton Maliqi**

**Course status:** **Elective**

**Course content:** Model building approaches, mathematical models. Black box model representation. Nonparametric identification: time domain identification by correlation analysis, frequency response analysis, frequency response analysis by the correlation method, Fourier analysis, persistence of excitation. Parametric identification: prediction error methods, prediction models, least-squares method, analysis of the linear LS estimate, convergence and consistency. Model structure selection. Model validation.

**Prerequisites:** Fundamental understanding of signals and systems, including continuous and discrete-time models, system response, and frequency domain analysis. A solid grasp of linear algebra, least-squares estimation, and basic probability and statistics is essential for parametric and nonparametric identification techniques. Familiarity with MATLAB or other computational tools for system modeling and simulation will be beneficial. Prior exposure to control systems and optimization concepts is recommended but not mandatory.

**Course objectives:** This course concerns the description of identification techniques, with particular reference to the family of equation errors models used for prediction and control. At the end of the course the students should achieve the capability of using identification tools in modeling real processes and in evaluating the quality of the obtained models.

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

- Introduce students to the fundamentals of continuous and discrete systems modeling and basic identification procedures;
- To understand the tools for signals and systems simulation and identification, using by time, frequency and complex domain;
- Provide students with the ability to use the computer for simulation, modeling and systems identification.
- Propose and implement solutions to simple identification problems;
- Validate a model of system that has been identified, and compare different simple models;
- Design an experiment to identify a simple system;
- Develop a deeper understanding of system identification by him/herself if necessary in order to solve more complex problems;

**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:** During the lectures the computer will be used with a video projector, while the practical part will be realized in the laboratory through modeling and identification of laboratory systems models and verification of identification methods on the computer.

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

**Literature:**

1. R. Isermann, "*Identification of Dynamic Systems: An Introduction with Applications*", Springer, 2005.
  2. L. Ljung, "*System Identification: Theory for the User*", Prentice Hall, 1999.
  3. T. Soderstrom and P. Stoica, "*System Identification*", Prentice Hall, 1989.
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**Subject:** **Computer Process Control (2+0+2) 6 ECTS**

**Lecturers:** **Prof. Ass. Dr. Drilon Bunjaku,**

**Course status:** **Elective**

**Brief overview:** Introduction. Structure of the process control system based on computer, system elements, process types (batch or sequential, continuous, combined or hybrid), types of computer systems (supervising, direct digital control), architecture of computer system (centralized, distributed, hierarchical), human-machine interface (monitoring and control panels). Constructive and software structure of process control computer, data acquisition, processing, acting, network connection and communication, software for real time operation, auxiliary software. Control system specifications, controller design, tuning. Digital PID controller, integrator windup, variations, tuning methods. Modeling and identification, parametric models, test process. Relay feedback method, self-tuning PID. digital controllers with minimum delay time, dead-beat, increased order dead-beat. State controllers. Controllers for processes with dead-time (with pure dead-time). Behavior on disturbances, two degrees of freedom PID. Interconnected and multivariable control systems, PID and digital controllers. Digital controller implementation, quantization, filtering. Combining control algorithm with actuator. Rapid prototyping.

**Prerequisites:** Foundation in control systems, including PID control, digital controllers, and system modeling techniques. Understanding of computer systems used in process control. Familiarity with process dynamics, including types of processes and data acquisition.

**The goal:** The goal of the course is to introduce students with usage of computers for process control, by using different forms of PID and digital controllers. It will cover the process from design to final implementation, with dedicated computer and as a fast prototype.

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

- know structure of computer system that is used for process control;
- model processes and to control them with PID controller;
- implement electronic and software part of auto-tuning PID controller based on relay feedback method;
- design digital conventional and state controller for given processes;
- design two degrees of freedom PID for control and disturbance rejection;
- understand and analyze interconnected multivariable systems;
- implement a hands-on project that relates design, implementation, and analysis of a computer process control system.

**Teaching methodology:** 30 hours of lectures, 15 hours of laboratory exercises. Approx. 80 independent working hours, including homeworks (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:**

1. S. K. Singh, *Computer-Aided Process Control*, Prentice-Hall, 2005
  2. Rolf Isermann, *Digital Control Systems*, Springer-Verlag, 1981
  3. Karl J. Åström, Tore Hägglund, *Advanced PID Control*, ISA, 2006
  4. Su Whan Sung, Jietae Lee, In-Beum Lee, *Process identification and PID control*, IEEE Press, 2009
  5. Cheng-Ching Yu, *Autotuning of PID Controllers: A Relay Feedback Approach*, Springer, 2006
  6. Qing-Guo Wang, Zhen Ye, Wen-Jian Cai, Chang-Chieh Hang, *PID Control for Multivariable Processes*, Springer, 2008
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**Course:** Real-time Operating Systems (2+0+2) 6 ECTS

**Lecturer:** Prof. Ass. Dr. Lavdim Kurtaj

**Course status:** Elective

**Course content:** Introduction, operating systems, history, computer hardware, real-time vs. non real-time operating systems, proprietary, free, open source. Basic concepts, sequential processes, process cooperation, process communication, semaphores, conditional critical regions, event queues, deadlock, processor management, scheduling algorithms, queuing system model, memory storage management, I/O programming and interrupt structures, device management, information management, security. Analysis of real time system requirement, functional decomposition, hardware-software tradeoffs, embedded system concepts. Distributed operating systems concept, file systems, mode of computation, load balancing, event ordering, synchronization, distributed mutual exclusion, drinking philosophers problem, deadlocks in distributed systems.

**Prerequisites:** Basic knowledge of computer architecture, hardware, and basic operating system concepts. Familiarity with embedded systems and control systems.

**Course objectives:** The aim of the course is that students should learn how to use, design and implement Real-Time Operating Systems, especially as applicable to embedded systems, including a relevant hardware review. Students will build a simple but relatively complete real-time operating system over the course duration.

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

- list characteristics of real-time operating systems (RTOS) and compare hard and soft real-time systems;
- build embedded system with some ready-made RTOS;
- write applications that create and delete tasks, control task scheduling, and obtain task information;
- design and program simple RTOS for specific computer system;
- test and verify performance of RTOS;
- understand and use distributed operating systems.

**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:**

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, *Operating System Concepts*, John Wiley & Sons, 2010
  2. Jane W. S. Liu, *Real-Time Systems*, Prentice-Hall, 2000
  3. K.C. Wang, *Embedded and Real-Time Operating Systems*, Springer, 2017
  4. Insup Lee, Joseph Y-T. Leung, Sang H. Son, *Handbook of Real-Time and Embedded Systems*, CRC, 2007
  5. Jonathan Valvano, *Embedded Systems: Real-Time Operating Systems for Arm Cortex M Microcontrollers*, CreateSpace Independent Publishing Platform, 2012
  6. Renesas Synergy Development Kit, User's Manual, Renesas Electronics, 2015
  7. Andrew S. Tanenbaum, Maarten Van Steen, *Distributed Systems: Principles and Paradigms*, Pearson Education, 2007.
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**Course:** **Analyzing Systems with Finite Elements (2+0+2) 6 ECTS**

**Lecturer:** **Prof. Ass. Dr. Vjosa Shatri**

**Course status:** **Elective**

**Course content:** Introduction. Theory of numerical methods (FEM). Modeling with FEM. 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.

**Prerequisites:** Foundation in mathematical methods, including linear algebra, differential equations, and numerical analysis techniques. Understanding of basic principles in electrical, magnetic, thermal, and mechanical systems.

**Course objectives:** The objective of the course is to introduce students with numerical methods (finite element methods, FEM) and how to use them to analyze 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, numerical exams, laboratory exams, 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:**

1. Albert E. Ruehli, Giulio Antonini, Lijun Jiang. *Circuit Oriented Electromagnetic Modeling using the PEEC Techniques*. IEEE Press / Wiley, 2017.
  2. Dennis Michael Sullivan and Jennifer E. Houle. *Electromagnetic Simulation Using the FDTD Method with Python*. IEEE Press / Wiley, 2020.
  3. Daryl L. Logan, *First Course in the Finite Element Method*, Sixth Edition, Cengage Learning, 2006
  4. E. Madenci, I. Guven, *The Finite Element Method and Applications in Engineering Using Ansys*, Springer, 2007
  5. Ozlem Ozgun and Mustafa Kuzuoglu, *MATLAB-based finite element programming in electromagnetic modeling*, CRC Press, 2019
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**Course:** **Biomedical Imaging Technologies (2+0+2) 6 ECTS**  
**Lecturer:** **Prof. Dr. Sabrije Osmanaj**  
**Course status:** **Elective**

**Course description:** Biomedical imaging offers an unprecedented view into the structure and function of a living body, and as such plays an essential role in medical practice and research. This course will provide students with an overview of the key concepts underlying the primary diagnostic biomedical imaging modalities, including: ultrasound, x-ray, computed tomography and magnetic resonance imaging. Students will gain an understanding of the physical principles and theoretical bases governing the operation of each imaging modality, the technology that translates theory into practice, and the basic methods involved in image formation. Students will also learn the limitations of each imaging procedure, while being exposed to their applications in the clinic and research.

**Prerequisites:** This subject does not require specific knowledge of bioengineering. However, the course presents concepts that require some basic background in the fields of electronics, physics and mathematics.

**Course objectives:** To introduce basic technologies for the acquisition of biomedical images and the procedures for their restoration, reconstruction, calibration and integration.

**Learning outcomes:** By the end of this course, students should be able to:

- Evaluate the operation and function of different biomedical imaging instruments on molecules, cells, and organs.
- Describe and apply the principles of advanced biomedical imaging concepts and their application in health sciences.
- Analyze the limitations of each biomedical imaging modalities and also how they complement each other for molecular, cellular and organ-level systems.
- Apply advanced image processing to quantify biomedical images, critique the factors that contribute to analysis and evaluate their effectiveness.
- Describe the fundamental principles governing the operation of common imaging modalities.
- Demonstrate an understanding of the concepts and methods in image acquisition and reconstruction.
- Explain the basic engineering and technology underlying each imaging modality.
- Explain and evaluate the influences of image quality for each modality.
- The procedure of operation and upkeep of Medical Imaging equipment's.

**Teaching methodology:** Basic theory, procedures and practical examples are considered at lectures, while practical knowledge is gained through problem-solving tasks at lab works.

**Evaluation methods:** 1st Exam: 20%; 2nd Exam: 20%, Homework: 20%, Attendance 10%, Final exam: 30%.

**Concretization tools/IT:** Computer, projector, table, laboratory equipped.

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

## Literature:

1. Troy Farncombe and Kris Iniewski, Medical Imaging: Technology and Applications (Devices, Circuits, and Systems) by CRC Press; 1 edition (December 19, 2017)
  2. Paul Suetens, Fundamentals of Medical Imaging by Cambridge University Press; 3 edition (July 10, 2017)
  3. Andrew G. Webb, Introduction to Biomedical Imaging , Wiley-IEEE Press; 1 edition (December 26, 2002)
  4. Paul Suetens, Fundamentals of Medical Imaging by Cambridge University Press; 3 edition (July 10, 2017)
  5. Bushberg, Jerrold T., and John M. Boone. The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011
  6. **Prince JL and Link JM. Medical imaging signals and systems, 2nd ed., Pearson, 2015.**
  7. McRobbie et al, MRI: From Picture to Proton, 3rd ed., Cambridge University Press, 2017
  8. Andrew G. Webb, Introduction to Biomedical Imaging , Wiley-IEEE Press; 1 edition (December 26, 2002)
  9. Rongguang Liang , Rongguang Liang, Biomedical Optical Imaging Technologies: Design and Applications Springer; 2013 edition (September 21, 2012)
  10. Nadine Barrie Smith, Andrew Webb, Introduction to Medical Imaging: Physics, Engineering and Clinical Applications (Cambridge Texts in Biomedical Engineering) 1st Edition, by Cambridge University Press; 1 edition (November 18, 2010)
  11. Timothy G. Feeman, The Mathematics of Medical Imaging: A Beginner's Guide (Springer Undergraduate Texts in Mathematics and Technology), Springer; 2nd ed. 2015 (November 20, 2015)
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**Course:** **Digital Microelectronic Circuits (2+0+2) 6 ECTS**  
**Lecturer:** **Prof. Dr. Milaim Zabeli**  
**Course status:** **Elective**

**Course description:** Introduction. MOS transistors. MOS inverters: static characteristics, switching characteristics. Combinational MOS logic circuits: MOS logic circuits with depletion NMOS loads, CMOS logic circuits, NMOS logic, pseudo-NMOS logic, PTL logic, TG logic. Sequential MOS logic circuits: Latches, Flip-Flops. Wires and interconnections - parameters and models, lines distribution problems. Semiconductor memories Dynamic logic circuits.

**Prerequisites:** Background on digital electronics is necessary.

**Course objectives:** The goal of this course is to provide the basic principles of digital microelectronic circuits.

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

- Describe the MOS transistor models.
- Present the main characteristics of CMOS inverters.
- Describe the main features of combinational CMOS logic circuits.
- Describe the main features of sequential CMOS circuits.
- Explain the problems with distribution lines.
- Analyze arithmetic CMOS circuits.
- Present the main memory circuits.
- Outline Input/output circuits.
- Draft a paper on a particular issue or issues in the field of digital microelectronic circuits.

**Teaching methodology:** 30 hours of lectures + 30 laboratory exercises. Approximately 80 hours of personal study and exercise including homework (seminary work).

**Evaluation methods:** 1st Exam: 20%; 2nd Exam: 20%, Homework: 20%, Attendance 10%, Final exam: 30%

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

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

**Literature:**

1. Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim, CMOS Digital Integrated Circuits 4<sup>th</sup> edition. New York, USA, McGraw-Hill, 2014
  2. R.J. Baker, CMOS - Circuit Design, Layout, and Simulation, 4th edition; IEEE Press & Wiley Interscience; 2019;
  3. N.H. E. Weste, D. Harris, CMOS VLSI Design - A Circuit Perspective and Systems Perspective, 4th edition, Pearson Education; 2010
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**Course title:** [Advanced topics in Machine Learning](#) (2+0+1) 5 ECTS  
**Lecturer:** Prof. Ass. Dr. Faton Maliqi  
**Course status:** Elective

**Course content:** This course delves into advanced concepts and techniques in machine learning, focusing on recent developments and cutting-edge research. Topics include deep learning, generative models, reinforcement learning, and advanced model evaluation and deployment strategies.

**Prerequisites:** Strong understanding of basic machine learning concepts and algorithms; Proficiency in programming, especially in Python; Familiarity with linear algebra, probability and statistics.

**Course objectives:** This course in Advanced Topics in Machine Learning aims to equip students with advanced knowledge and skills in deep learning, generative modeling, reinforcement learning, and model evaluation and deployment. Students will delve into cutting-edge concepts and techniques, including neural network architectures, CNNs, RNNs, VAEs, GANs, and deep reinforcement learning. Through hands-on assignments and a research project, students will gain practical experience in implementing and applying these techniques to solve complex problems. Additionally, the course will explore current research trends and ethical considerations in machine learning, preparing students for advanced studies and research in the field.

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

- Understand and explain advanced machine learning concepts and algorithms;
- Implement and apply advanced machine learning algorithms to solve complex problems;
- Evaluate and interpret advanced machine learning models;
- Explore current research trends and directions in machine learning;
- Discuss issues such as bias, fairness, and privacy in machine learning applications.

**Teaching Methods:** Lectures and in-class discussions (30 hours) + 15 hours of lab exercises. Case studies and practical projects, readings and analysis of written materials, practical demonstrations of machine learning tools associated with Python.

**Grading System:** Classroom Assessment 10%, Projects 40%, Midterm Exam 20%, Final exam 30%.

**Concretization tools/TI:** For lectures, computers, projector and tables are used, while the practical part will take place at the lab.

**Literature:**

1. Maxim Lapan, “Deep Reinforcement Learning Hands-On”, Packt Publishing, 2018;
2. David Foster, “Generative Deep Learning”, O’Reilly Media, 1<sup>st</sup> ed, 2019;
3. Andriy Burkov, “Machine Learning Engineering”, True Positive Inc., 2020;
4. Christoph Molnar, “Intepretable Machine Learning”, Lulu.com, 2019;

### Semester III

**Course title:** **Renewable Energy Sources (2+0+2) 6 ECTS**

**Lecturer:** **Prof. Dr. Qamil Kabashi**

**Course status:** **Mandatory**

**Description of content:** Technology of transformation of various energy sources into electrical energy (wind energy, geothermal energy, energy from waste, energy from biomass, hydrogen technology, fuel cells, thermal solar energy, solar energy from photovoltaic). Means of conservation of energy. Comparison of technology of renewable sources with technology of conventional sources. Efficiency of transformations of energy. Hybrid design of renewable/alternative energy systems for electric power generation. Power Transformation and Transmission. Energy saving technologies for the electronics, transport, industry and buildings. Energy Management (Energy economics, energy audit, scope of alternative energy sources in Kosova).

**Prerequisites:** Strong foundation in basic electronics engineering principles, including semiconductor devices, energy conversion and power systems. Understanding energy management and the economic aspects of energy systems.

**The goals:** Students will become familiar with technologies of power generation from **renewable** sources. They will be able to compare the renewable with conventional sources. Students will learn the technical, economic and environmental impacts of technologies of electric energy generation from renewable sources.

**Learning outcomes:** Upon completion of this course, students should be able to:

- Describe the main characteristics of renewable energy sources and their differences comparing to fossil energy sources;
- Analyze basic components of different renewable energy systems;
- Understand the importance of exploring renewable energy sources from technological, environmental and economical aspects;
- Compare different renewable energy technologies and choose the most appropriate based on local conditions
- Design of renewable hybrid power systems that satisfy environmentally and economically reasonable requirements;
- Competently analyze the utilization of domestic energy sources (renewable and non-renewable) to achieve a sustainable energy system.

**Teaching methodology:** Lectures, Lab experiments, study visits to local companies that generate energy from renewable sources, lab report and presentation.

**Evaluation methods:** Seminar work (20%), Midterm exams 30%, Final exam 50%.

**Concretization means:** During the lectures computers will be used with video projector, and the practical part will be realized in laboratory as well as in enterprises for the production of alternative energy (depending on realization of agreements with them).

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

**Literature:**

1. F. M. Vanek, L. D. Albright, L. T. Angenent, Energy Systems Engineering: Evaluation and Implementation, 3rd edition, McGraw Hill, 2016.
  2. E. E. Michaelides, Alternative Energy Sources, (Springer, 2012
  3. E. F. Fuchs, M. A.S. Masoum, Power Conversion of Renewable Energy Systems, Springer, 2011
  4. B. Godfrey. *Renewable Energy: Power for a Sustainable Future*, Third Edition. Oxford University Press, 2012
  5. Tester, et al. *Sustainable Energy, Choosing Among Options*, 2nd Edition. MIT Press, 2012.
  6. B. Zohuri, Hybrid Energy Systems- Driving Reliable Renewable Sources of Energy Storage, Springer, 2018.
  7. T. Ch. Seng, Energy Management and Economics, The Institution of Engineers, Singapore and National Environment Agency, 2016.
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**Course:** Machine Vision (2+0+2) 6 ECTS  
**Lecturer:** Prof. Ass. Dr. Lavdim Kurtaj  
**Course status:** Mandatory

**Course content:** Introduction to machine vision. Tools for machine vision, Matlab and toolboxes, OpenCV. Binary image processing. Morphology. Image acquisition. Image calibration, transformation, interpolation. Image enhancement. Spatial filtering. FFT and frequency domain filtering. Edge detection. Color and color image processing. Multi/hyper spectral image analysis. Texture and shape analysis. Segmentation. Feature extraction. Hough transform. Recognition. Classification. Motion/video processing. Tracking - Kalman filtering. 3D vision techniques and sensors, Kinect, stereo vision. 3D calibration, registration and transformation. 3D reconstruction. Soft computing techniques: neural network, fuzzy logic, genetic algorithm. Vision for control, visual feedback, robot vision, position and orientation from vision, visual navigation, depth perception.

**Prerequisites:** Linear algebra and calculus. Programming skills in C/C++ and Matlab. Microcomputer systems. Signal processing.

**Course objectives:** The major objective of course is to help students understand and apply image processing techniques and machine vision systems to solve engineering and scientific problems of their interest. Particular focus will be on industrial, robotic, and game interface systems through adequate examples and applications. However, the concepts learned in this class can be applied to solve a wide range of problems in all disciplines of science, engineering and medicine.

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

- understand the basics of image acquisition and processing techniques;
- use specific, well known, machine vision methods, algorithms and results;
- understand camera geometry and calibration;
- use feature detection and tracking algorithms;
- extract 3-D information from single, two, and multiple views;
- estimate camera and object motion;
- use Matlab and OpenCV for real-time vision applications.

**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:**

1. L. Shapiro and G. Stockman, *Computer Vision*, Prentice-Hall, 2001
2. Peter Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Second Edition, Springer, 2017

3. Richard Hartley, Andrew Zisserman, *Multiple View Geometry in Computer Vision*, Cambridge University Press, 2003
  4. Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis, and Machine Vision*, Nelson Education Limited, 2008
  5. Simon J. D. Prince, *Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 2012
  6. Berthold K.P. Horn, *Robot Vision*, MIT Press, 1986
  7. Gary Bradski, Adrian Kaehler, *Learning OpenCV: Computer Vision with the OpenCV Library*, O'Reilly Media, Inc., 2008
  8. Hamed Habibi Aghdam, Elnaz Jahani Heravi, *Guide to Convolutional Neural Networks: A Practical Application to Traffic-Sign Detection and Classification*, Springer, 2017
  9. Klevis Ramo, *Hands-On Java Deep Learning for Computer Vision: Implement machine learning and neural network methodologies to perform computer vision-related tasks*, Packt, 2019
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**Course title:** Cloud Computing (2+0+2) 6 ECTS  
**Lecturer:** Prof. Asst. Dr. Artan Mazrekaj  
**Course status:** Mandatory

**Course goal:** The purpose of the course is to equip students with basic knowledge of virtualization and cloud integration services. Knowing and understanding the platforms and communications in the cloud environment. Efficient use of hardware resources, assessment of the performance of the Cloud resources.

**Prerequisites:** Good knowledge of data structures, computer organization, and computer networks, Proficiency in Python, Java, Javascript or .Net.

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

1. To understand the key concepts and structure of the cloud.
2. To compare and analyze the methods and algorithms for cloud exploitation.
3. To configure and build a cloud platform by familiarizing in depth with service-oriented architecture.
4. To understand the role and capabilities of cloud services integration.
5. To configure platforms in order to have an efficient use of resources.

**Contents:** Introduction to Cloud Computing. Types of Cloud Computing. Cloud Computing Models. Virtualization, Infrastructure as a Service- IaaS. Platform as Service - PaaS. Software as Service - SaaS. Services Oriented Architecture (SOA). Migration of Cloud Services. Managing the SLA. Cloud Resource Allocation. Introduction to big data management. Cloud Security. Cloud Challenges. Case studies with different frameworks. Analysis and study on cloud computing platforms, using of simulators, etc.

**Methods of teaching:** Lectures, laboratory exercises/simulations. Personal study by students and independent project work.

**Grading System:** Attendance 10%, Seminar paper 10%, Project 20 %, Final Exam 60 %

**Literature:**

1. Thomas Erl, "Cloud Computing: Concepts, Technology, Security and Architecture", , Eric Barcelo, second edition, Pearson, 2023.
2. Dan C. Marinescu, "Cloud Computing: Theory and Practice", third edition, Elsevier-MK, 2022
3. Edited by: Rajkumar Buyya, James Broberg, Andrzej Goscinski, "Cloud Computing: Principles and Paradigms", Wiley, 2011.

**Subject:** Artificial Intelligence (2+0+2) 6 ECTS

**Lecturer:** Prof. Ass. Dr. Faton Maliqi

**Course status:** Elective

**Brief overview:** Artificial intelligence, introduction, intelligent agents. Problems, problem spaces, and search. Problems in automation, robotics, and games. Solving problems by searching, search techniques. Knowledge and reasoning, logical agents, first-order logic, inference in first-order logic, classical planning, planning and acting in the real world, knowledge representation. Uncertain knowledge and reasoning, quantifying uncertainty, probabilistic reasoning, probabilistic reasoning over time, making decisions. Learning, learning from examples, knowledge in learning, learning probabilistic models, reinforcement learning. Neural networks and fuzzy systems. Communicating, perceiving, and acting. Game playing. Planning. Natural language processing. Vision systems. Real-time search, perception, action, industrial problems, robotics. Expert systems.

**Prerequisites:** Have a foundational understanding of discrete mathematics, logic, and basic probability theory to grasp AI concepts such as search algorithms, probabilistic reasoning, and machine learning. Familiarity with programming, particularly in Python or MATLAB, is essential for implementing AI techniques. A background in algorithms, data structures, and basic optimization methods will be beneficial. While prior exposure to machine learning, control systems, or robotics is helpful, it is not mandatory.

**Course objectives:** The goal of the course is to give an introduction to artificial intelligence and efforts to implement intelligence in computer hardware and software.

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

- understand the fundamental concepts of artificial intelligence and intelligent agents;
- know basic concepts, methods, techniques, and tools for the use of intelligent agents in computer-based systems;
- apply principles and methods of intelligent agents to a small-scale practical problem as part of individual or group project;
- solve game problem with artificial intelligence methods;
- design and program neural networks and fuzzy logic for some specific problem;
- understand and explain natural language processing and vision systems;
- implement simple real-time perception-action robotic agent.

**Teaching methodology:** 30 hours of lectures, 15 hours of laboratory exercises. Approximately 75 hours of personal study and exercise including project

**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:**

1. S. Russell, P. Norvig, *Artificial Intelligence: A Modern Approach*, Prentice Hall, 2010
2. Elaine Rich, Kevin Knight, *Artificial Intelligence*, McGraw Hill, 1991
3. Dario Floreano, Claudio Mattiussi, *Bio-Inspired Artificial Intelligence*, MIT Press, 2008

4. B. Siciliano, O. Khatib (Eds.), *Springer Handbook of Robotics*, Springer, 2008
  5. Sio-Iong Ao, Mahyar Amouzegar, Burghard B. Rieger, *Intelligent Automation and Systems Engineering*, Springer, 2011
  6. Dimitris Vrakas, Ioannis Pl Vlahavas, *Artificial Intelligence for Advanced Problem Solving Techniques*, Information Science Reference, 2008
  7. Ian Millington, John Funge, *Artificial Intelligence for Games*, Morgan Kaufmann, 2009
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**Course:** **Mobile Robots (2+0+2) 6 ECTS**

**Lecturer:** **Prof. Ass. Dr. Lavdim Kurtaj**

**Course status:** Elective

**Course content:** General considerations regarding mobile robots: basic terms, definitions, classifications, historical development, applications and examples of mobile robots. Mobile robots hardware, drive mechanisms, actuators. Mobile robots locomotion. Mobile robots kinematics. Proprioceptive and non-visual perceptive sensors for mobile robots. Visual perceptive sensors for mobile robots. Processing and interpretation of robots' sensor signals. Measurement uncertainty. Multiple sensor information fusion in order to improve the quality and robustness of robots navigation through space. Control and navigation system structures. Algorithms for global path planning of mobile robots in space. Algorithms for obstacle avoidance and global path following. Robots relative and absolute localization in space. Environment modeling: occupancy grid maps, geometrical properties maps, topological maps, hybrid maps. Introduction to self-learning mobile robots and human-robot communication. Basics of coordinated work of multiple autonomous mobile robots.

**Prerequisites:** Essentials of electrical engineering and control systems. Programming skills (e.g., C/C++, Matlab, Python). Basics of sensors, actuators and signal processing.

**Course content:** The aim of the course is to provide an introduction to the fundamentals of mobile robotics, examining the basic principles of locomotion, kinematics, sensing, perception, and cognition that are key to the development of autonomous mobile robots.

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

- classify mobile robots according to various criteria;
- analyze driving mechanisms and sensor system suitable for intended application;
- assemble sensors and actuators with the embedded computer system on mobile robot;
- develop sensor fusion algorithms;
- develop motion planning algorithms;
- develop motion of mobile robots localization;
- develop algorithms of environment 2D map building.

**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:**

1. Roland Siegwart, Illah R. Nourbakhsh, *Introduction to Autonomous Mobile Robots*, The MIT Press, 2004.

2. Thomas Bräunl, *Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems*, Springer, 2008
  3. Gerald Cook, *Mobile Robots: Navigation, Control and Remote Sensing*, IEEE, 2011
  4. John Holland, *Designing Autonomous Mobile Robots: Inside the Mind of an Intelligent Machine*, Newnes, 2004
  5. Stefan Florczyk, *Robot Vision: Video-based Indoor Exploration with Autonomous and Mobile Robots*, Wiley-VCH, 2005
  6. Francesco Bullo, Jorge Cortés and Sonia Martínez, *Distributed Control of Robotic Networks: A Mathematical Approach to Motion Coordination Algorithms*, Princeton University Press, 2009
-

**Course:** **Neural Network and Fuzzy Logic (2+0+2) 6 ECTS**

**Lecturer:** **Prof. Ass. Dr. Lavdim Kurtaj**

**Course status:** **Elective**

**Course content:** Artificial neural systems, fundamental concepts, models, learning rules (Hebbian, perceptron, delta Widrow-Hoff learning rules). Single layer perceptron classification: classification model, features and decision regions, training and classification using discrete perceptions. Single layer continuous perceptron networks for linear separable classification. Multilayer neural networks, generalized delta learning rule, back propagation training, learning factors. Single layer feedback networks, Hopfield networks. Radial basis function NN, CMAC. Neural network in control system, neuro-control approaches. Training algorithm, evaluation through simulation. Self tuning neuro-control scheme, self tuning PID neural controller. Introduction of fuzzy control, introduction of fuzzy control from an industrial perspective, mathematics of fuzzy control, fuzzy sets, fuzzy relations. Non-linear fuzzy control, fuzzy-PID control. Fuzzy knowledge based controller. Convolutional networks. Deep learning.

**Prerequisites:** Linear algebra and calculus. Programming skills (e.g., C/C++, Matlab, Python). Basics of automatic control.

**Course objectives:** The aim of the course is to provide basic knowledge of neural and fuzzy methods for the modeling and control of nonlinear systems. The participants will have the opportunity to design and implement neuro and fuzzy controllers with rapid prototyping technique based on Matlab/Simulink/QuARC system.

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

- understand the basic neural networks and fuzzy logic paradigms;
- understand the basic concepts of training in neural and fuzzy networks;
- use neural and fuzzy networks for identification and control of the nonlinear processes;
- design fuzzy and neural networks for successful applications;
- design RBF and CMAC neural networks for control problems;
- design and implement combined fuzzy-PID controllers;
- implement neural and fuzzy controllers on-line for process control.

**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:**

1. S. Haykin, *Neural Networks: A Comprehensive Foundation*, Macmillan College Publishing Company, 1994.
  2. D. T. Pham, X. Liu, *Neural Networks for Identification, Prediction and Control*, Springer, 1995
  3. John H. Lilly, *Fuzzy Control and Identification*, Wiley, 2010
  4. F. L. Lewis, J. Campos, R. Selmic, *Neuro-Fuzzy Control of Industrial Systems with Actuator Nonlinearities*, Society for Industrial Mathematics, 2002
  5. Lakhmi C. Jain, N.M. Martin, *Fusion of Neural Networks, Fuzzy Systems and Genetic Algorithms: Industrial Applications*, CRC Press, 1998
  6. Cong Wand, David J. Hill, *Deterministic Learning Theory for Identification, Recognition, and Control*, CRC Press, 2010
  7. Ragav Venkatesan, Baoxin Li, *Convolutional Neural Networks in Visual Computing: A Concise Guide*, CRC Press, 2018
  8. Mohit Sewak, Md. Rezaul Karim, Pradeep Pujari, *Practical Convolutional Neural Networks: Implement advanced deep learning models using Python*, Packt Publishing, 2018
  9. Lili Mou, Zhi Jin, *Tree-Based Convolutional Neural Networks: Principles and Applications*, Springer, 2018
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**Course:** **Microelectronic Systems (2+0+2) 6 ECTS**  
**Lecturer:** **Prof. Dr. Milaim Zabeli**  
**Course:** **Elective**

**Short course description:** Methodology of design (top-down and bottom-up microelectronic design methodology and the use of modern CAD tools. Modeling of microelectronic systems Parasitic effects (basic effects of leakage, noise, crosstalk in integrated circuits). Limits of CMOS technology (effects of reducing the channel length, new elements, influence to the design process of digital and analogue integrated circuits and microelectronic systems, power consumption optimisation). High-performance CMOS circuits. Low-power CMOS logic circuits. Basics of testing microelectronic systems (basics of testability, BIST and reliability of microelectronic systems).

**Prerequisites:** Strong understanding in digital electronics. Familiarity on microelectronics circuits based on MOSFETs.

**Course objectives:** The main objectives are: to learn the basics of the design of mixed-signal integrated circuits and systems, to understand the problems related to the design of mixed-signal integrated VLSI microelectronic systems and to learn modern description language, modern CAD tools, the simulation of mixed signal microelectronic systems. In addition, the students will get insight into the trends of implementation practices of microelectronic systems in the future.

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

- Understanding theoretical background for the design of mixed signal analog-digital microelectronic systems.
- To understand the limits of CMOS technologies,
- To understand the effects of parasitic components,
- To build equivalent models of interconnections between circles,
- Designing high-performance CMOS circuits and their features.
- To optimize the design of low-power circuits,
- Apply modeling, analysis, synthesis and simulation methods using CAD equipment suitable for complex analog-digital microelectronic systems.

**Teaching methodology:** 30 hours of lectures + 30 laboratory exercises. Approximately 80 hours of personal study and exercise including homework (seminary work).

**Evaluation methods:** 1st Exam: 20%; 2nd Exam: 20%, Homework: 20%, Attendance 10%, Final exam: 30%.

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

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

**Literature:**

1. P.J. Ashenden, "The systems designers guide to VHDL-AMS," Morgan Kaufmann publ., 2003
2. Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim, CMOS Digital Integrated Circuits 4<sup>th</sup> edition. New York, USA, McGraw-Hill, 2014.

3. R.J. Baker, CMOS - Circuit Design, Layout, and Simulation, 4th edition; IEEE Press & Wiley Interscience; 2019;
  4. R. Plasche, "Integrated Analog-to-digital and Digital-to-analog Converters," Kluwer Academic publishers, 2002.
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**Course title:** **Acoustics of Speech and Music (2+0+2) 6 ECTS**  
**Lecturer:** **Prof. Ass. Dr. Vjosa Shatri**  
**Course status:** **Elective**

**Course content:** Acoustic characteristics of speech system. The mechanism of speech production. Speech elements and its important features for speech transfer and processing. Speech analysis (articulation, analytical, experimental). Mechanical and electronic speech synthesizer. Digital speech and music processing. Speech transfer systems using the analysis-synthesis method (channel, triggered voice, formant, prediction). Speech coding. Text and speech synthesis. Speech recognition equipment. Speaker recognition. The main features of the musical tone. Digital audio coding. Standards for digital audio coding. Musical instruments.

**Prerequisites:** Basics of electrical engineering, signals and systems, microcomputer systems. Programming skills (e.g., C/C++, Matlab, Python).

**Course objectives:** To present the characteristics of speech and music, the analysis, processing and synthesis of speech and music. Special emphasis is given to coding and recognition equipment of speech and music.

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

- Effectively utilize the basic features of speech and music for application in various transmission systems;
- Analyze and synthesize speech and music with the application of modern methods and technologies.

**Teaching methodology:** 30 hours of lectures, 15 hours of laboratory exercises. Approximately 80 hours of personal study.

**Evaluation methods:** Seminars 40%, attendance to lectures and exercises 10%, Final exam 50%.

**Concretization tools:** During lectures computers, projectors and table will be used, and the practical part will take place at the multimedia lab.

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

#### **Literature:**

1. Philippe Martin. *Speech Acoustic Analysis*. Wiley-ISTE, 2021.
  2. Huang, X., Acero, A., Hon, H.-W. *Spoken Language Processing – A Guide to Theory, Algorithm and System Development*. Prentice Hall, 2001.
  3. Lawrence Rabiner, B H Juang, *Fundamentals of Speech Recognition*. 2005.
  4. John N. Holmes, Wendy J. Holmes, *Speech Synthesis and Recognition*. Second Edition, 2010.
  5. Ben Gold, Nelson Morgan, Dan Ellis, *Processing and Perception of Speech and Music*. Second Edition, 2011.
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**Course:** **Biomedical Instrumentation (2+0+2) 6 ECTS**  
**Lecturer:** **Prof. Dr. Sabrije Osmanaj**  
**Course status:** **Elective**

**Course description:** Introduces the principles of medical instrumentation. Covers biomedical sensors and transducers; temperature, displacement, acoustical and radiation measurements; biopotential amplifiers and signal processing; origin of biopotentials; bio-potential electrodes; measurement of bio-potentials such as ECG, EEG and EMG; blood pressure measurements; electrical safety.

**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.

**Prerequisite:** Knowledge of Instrumentation and Measurement.

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

- Acquaint basic design concepts essential to the understanding of biomedical engineering.
- Understand the different problem types and problem solving approaches in engineering, biology, and medicine.
- Describe the generalized static and dynamic characteristics of instrument performance.
- Understand and analyze sensor and electrode designs for recording bio-signals.
- Understand biopotential amplifiers.
- Understand the engineering methods used to measure blood, Pressure and sound.
- Understand the principles of electrical safety in medical equipment and clinical environment

**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:** 1:1.

1. Introduction To Biomedical Equipment Technology, Fourth Edition; Joseph J. Carr, John M. Brown. 2001 by Prentice-Hall, Inc.
2. Principles of Biomedical Instrumentation and Measurement. R. Aston; Merrill.
3. Introduction to Biomedical Electronics. J. Dubovy; McGraw-Hill.

4. "Bio-Medical Electronics and Instrumentation", Onkar N. Pandey, Rakesh Kumar, Katson Books.
  5. Andrew G. Web, Principles of Biomedical Instrumentation (Cambridge Texts in Biomedical Engineering), Cambridge University Press; 1 edition (February 7, 2018)
  6. J. G. Webster (2009.), Medical Instrumentation: Application and Design, John Wiley&Sons, N.Y.
  7. ANANDA R. NATARAJAN, BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS, PHI Learning (December 14, 2015).
  8. Robert B. Northrop, Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation (Biomedical Engineering), Routledge; 2 edition (March 31, 2017)
  9. R. S. Khandpur, Biomedical Instrumentation: Technology and Applications, McGraw-Hill Education; 1 edition (November 26, 2004).
  10. J. G. Webster (2009.), Medical Instrumentation: Application and Design, John Wiley&Sons, N.Y.
  11. Richard C. Fries (2016.), *Reliable Design of Medical Devices*, CRC Press
  12. Journal of Medical Engineering and Technology
  13. Annals of Biomedical Engineering
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**Course:** Energy and Environment (2+0+2) 6 ECTS  
**Lecturer:** Prof. Dr. Sabrije Osmanaj, Prof. Ass. Dr. Nuri Berisha  
**Course status:** Elective

**Course description:** The energy needs. The role of energy in society. The primary sources of energy. Fundamentals of energy conversion into electric energy. Conventional sources of electric energy. Renewable sources of electric energy. Alternative sources of electricity. The energy conversion efficiency. Impact of electric power generation on the environment. The role and the basic characteristics of electric power systems. Fundamentals of the operation of electric power systems. The features of electric energy transmission. Distribution of electric energy. Characteristics of electric energy consumption. Rational use of energy. The current issues of electric power supply. Increasing transmission capacity (investments not finished, environmental protection). Reliability of electric power supply. Power quality. Electricity market and its impacts. Design of power systems. Maintenance of power systems. New technology for generation, transmission, distribution and consumption of electric energy.

**Prerequisite:** Fundamental on Power systems and Engineering Physics.

**Course objectives:**

- Students will get a comprehensive view of energy demand and exploitation of primary energy resources.
- They will acquire basic knowledge in the field of electric power supply through learning about the electric energy generation, its transmission and distribution.
- The subject highlights the environmental aspects, the impact of the electricity market, the development of new technologies, renewable energy sources (wind, water, solar, biomass) and efficient use of energy.

**Learning outcomes:**

- Students will be capable of assessing what are the needs for energy.
- Students will be capable of calculating how much electric energy is transformed from the primary sources of energy.
- Students will be capable of assessing what are the related consequences to the environment.
- Students will be capable of assessing how the electric energy is transmitted and distributed to the customers.
- The student will be capable of mathematically modeling the main problems in the field of energy and to solve them.
- The problem area includes efficient use of energy, existing and new Technologies considering the quality of electric energy and the electric market.

**Teaching methodology:** Discussions, Laboratory exercises, Seminar work.

**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

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

**Literature:**

1. Richard Wolfson, Energy, Environment, and Climate (Third Edition), W. W. Norton & Company; Third edition (August 15, 2017)
  2. Robert Ristinen, Energy and the Environment, 3rd Edition, Wiley; 3 edition (December 21, 2015),
  3. Roger A. Hinrichs and Merlin H. Kleinbach, Energy: Its Use and the Environment, Cengage Learning; 5 edition (January 1, 2012)
  4. James A. Fay and Daniel S. Golomb, Energy and The Environment: Scientific and Technological Principles (MIT-Pappalardo Series in Mechanical Engineering), Oxford University Press; 2 edition (January 27, 2011)
  5. Peter E. Hodgson, Energy, the Environment and Climate Change, Imperial College Press, 2010
  6. M. J. Moran, Adrian Bejan, Peter Vadász, Detlev G. Kröger (eds.), Energy and the Environment, SPRINGER-SCIENCE+BUSINESS MEDIA, B.V., 1999.
  7. Md. Rabiul Islam, Naruttam Kumar Roy, Saifur Rahman (eds.), Renewable Energy and the Environment, Springer, 2018,
  8. Standard Handbook for Electrical Engineers, The McGraw-Hill, 2006
  9. B. Sorensen, Renewable Energy, Fourth Edition, Elsevier Inc., 2010
  10. Renewable Energy Conversion, Transmission and Storage, Elsevier Inc., 2007
  11. S. Pryja, D. J. Inman, Energy Harvesting Technology, Springer, 2009
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**Course:** Strategic Management (2+2+0) 6 ECTS  
**Lecturer:** Prof. Ass. Dr. Nora Sadiku Dushi  
**Course status:** Elective

**Course content:** Introduction to Strategic Management. The nature of strategic management. Managers and Strategic Management. The process of strategic decision making. Analysis of the external environment. Internal business environment. Mission and Vision. The strategy formulation. Business Strategies. International Strategies. Strategy selection. Strategy Implementation. Strategy control. Change management

**Prerequisites:** Basics of Management: Essential for understanding strategic management concepts. Introduction to Economics. Organizational Behavior: (Important for change management and strategy implementation). Analytical Thinking Skills: Needed for strategic decision-making and strategy formulation.

**Course objectives:** The main goal of this course is to equip students with essential strategic management skills, fostering the ability to analyze, formulate, implement, and control effective strategies for organizational success in a dynamic business environment.

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

- To describe the nature of the strategic management
- To explain the decision-making process
- To recognize the factors of external and internal organizational environment
- To formulate the mission and vision of an organization;
- To describe the different types of business strategies
- To explain the strategy implementation and control
- To apply gained knowledge in real life scenarios

**Methods of teaching:** 30 hours of lectures + 30 hours of numerical exercises. Approximately 80 hours of personal study and exercise including homework.

**Grading System:** Attendance and classroom activity 10%, Practical assignments 30 %, Final Exam 60 %

**Literature:**

- Izet Zeqiri, Menaxhimi strategjik (2016), Prishtinë
- Kennedy B. Reed, Virginia Tech. Strategic Management. 2020. Virginia Tech Publishing
- Richard Lynch. Strategic Management 9th Edition. 2021. Sage Publication

**Course:** **Master Thesis 30 ECTS**

**Course status:** **Mandatory**

**Course content:** The student, based on the in-depth knowledge and skills in the scientific research methodology gained from the subject matter and personal interest, in collaboration with the tutor, proposes the subject of the degree. The student collects and reviews relevant literature on the proposed topic to understand the specific problem. The student under the supervision of a mentor will perform laboratory experiments, computer simulations and field research necessary for the thesis work. At the end, the student will process the results, discuss the results presented and finalize the writing of the topic according to the FECE Master's Study Regulation.

**Prerequisites:** Research Methodology: Essential for conducting scientific research, literature review, and data analysis. Deep understanding of the field related to the master's thesis topic. Academic Writing Skills: Necessary for structuring, writing, and presenting the thesis according to academic standards. Data Analysis and Tools (e.g., Simulation Software, Statistical Tools): Important for processing experimental/simulation results and drawing valid conclusions.

**Course objectives:** To be trained for independent work and research in the chosen field of study, to demonstrate the ability to use research methodologies in the selected field, to analyze, evaluate and discuss key findings from the study. Demonstrate ability to write publications according to international standards.

**Learning outcomes:** After completing this course the student will be able:

- to learn by using scientific and review articles;
- to plan and implement laboratory experiments, computer simulations and data collection;
- to document and interpret findings during research work;
- to analyze critically and compare the results obtained with other data;
- to explain and discuss the results obtained;
- to write and present the results found.

**Teaching methodology:** Independent student work under the supervision of a mentor.

**Evaluation methods:** Evaluation of the written topic and defense before the Commission. Defense of master thesis is public.

**Concretization tools:** Computer, projector, table, laboratory.

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

**Literature:** According to the field of research the scientific papers will be selected for review.

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