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

Overview of Courses in Study Program

1st year: Electronics, Automation and Robotics						
1st semester			**Hours/week**			
No	**M/E**	**Course**	**L**	**NE**	**LE**	**ECTS**
1	M	Circuits and Signals in Systems	2	1	1	6
2	M	Industrial Process Automation	2	0	2	5
3	M	Methodology of Scientific Research	2	0	0	4
Select three courses from elective courses group A1 or E1						
Elective courses: A1						
1	E	Control of Electrical Drives	2	0	1	5
2	E	Robotic Sensors and Actuators	2	0	1	5
3	E	Mechatronic Systems	2	0	1	5
4	E	Discrete Event Systems	2	0	1	5
5	E	Networked Control Systems	2	0	1	5
6	E	Systems for Computerized Numerical	2	0	1	5
Elective courses: E1						
1	E	Multimedia Communication	2	0	1	5
2	E	VLSI Technology	2	0	1	5
3	E	Measurements and Sensors in Biomedicine	2	0	1	5
4	E	Digital Design	2	0	1	5
5	E	Biomedical Informatics	2	0	1	5
6	E	Advanced Power Electronics	2	0	1	5
2nd semester			**Hours/week**			
No	**M/E**	**Course**	**L**	**NE**	**LE**	**ECTS**
1	M	Acoustics in Communications	2	1	1	5
2	M	Renewable Energy Sources	2	0	1	5
Select four courses from elective courses group A2 or E2						
Elective courses: A2						
1	E	Robotics and Automation	2	0	1	5
2	E	System Identification	2	0	1	5
3	E	Computer Process Control	2	0	1	5

4	E	Real-time Operating Systems	2	0	1	5
5	E	Human Machine Interface	2	0	1	5
6	E	Analyzing Systems with Finite Elements	2	0	1	5
Elective courses: E2						
1	E	Biomedical Imaging Technologies	2	0	1	5
2	E	Digital and Analog Filters	2	0	1	5
3	E	Circuit Analysis and Optimization	2	0	1	5
4	E	Optical Communication Systems	2	0	1	5
5	E	Modern Power Supplies	2	0	1	5
6	E	Digital Microelectronic Circuits	2	0	1	5

2nd year: Electronics, Automation and Robotics						
3rd semester			**Hours/week**			
No	**M/E**	**Course**	**L**	**NE**	**LE**	**ECTS**
1	M	Optimal Control	2	1	1	5
Select five courses from elective courses group A3 or E3						
Elective courses: A3						
1	E	Remote Control Systems	2	0	1	5
2	E	Adaptive and Robust Systems	2	0	1	5
3	E	Artificial Intelligence	2	0	1	5
4	E	Mobile Robots	2	0	1	5
5	E	Machine Vision	2	0	1	5
6	E	Neural Network and Fuzzy Logic	2	0	1	5
Elective courses: E3						
1	E	Smart Grids	2	0	1	5
2	E	Microelectronic Systems	2	0	1	5
3	E	Machine Vision	2	0	1	5
4	E	Acoustics of Speech and Music	2	0	1	5
5	E	Computer Modeling of Physiological	2	0	1	5
6	E	Energy and Environment	2	0	1	5
4rth semester						
No	**M/E**	**Course**	**L**	**NE**	**LE**	**ECTS**
1	M	Master Thesis				30

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

This study program is fully comparable, both in terms of student weekly workload and ECTS, with similar field programs in regional universities:

- Faculty of Electrical Engineering, University of Ljubljana, > 80%, https://www.uni-lj.si/academies_and_faculties/faculties/2013052914482436/
- Faculty of Electrical Engineering, University of Zagreb, >50%, https://www.fer.unizg.hr/en

Short course descriptions

Course: Circuits and Signals in Systems

Lecturer: Prof. Ass. Dr. Vjosa Shatri

Course status: Mandatory, Semester I, 6 ECTS

Course content: Characteristics and limitations of linear circuitsw, 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 algebric equations and solution methods, sparse matrixes. 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, Telegen 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.

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;
- Analyse 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 analyse electrical circuits.

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

Literature:

- M. Bogdanov, B. Kastrati, *Teoria e qarqeve elektrike*, Prishtinë, 1985
- Farid N. Najm, *Circuit Simulation*, Wiley-IEEE, 2010
- B.P. Lathi, *Principles of Linear Systems and Signals*, Second Edition, Oxford University Press, 2009
- B. P. Lahti, *Linear Systems and Signals*, Oxford University Press, 2005
- Charles K. Alexander, Matthew Sadiku, *Fundamentals of Electric Circuits*, Sixth Edition, McGraw-Hill Education, 2017
- Muhammad H. Rashid, Hasan M. Rashid, *SPICE for Power Electronics and Electric Power*, Third Edition, CRC Press, 2012
- Steven T. Karris, *Circuit Analysis I: with MATLAB Computing and Simulink/ SimPowerSystems Modeling*, Orchard Publications, 2009
- Steven T. Karris, *Circuit Analysis II: with MATLAB Computing and Simulink/ SimPowerSystems Modeling*, Orchard Publications, 2009

Course: Industrial Process Automation

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

Course content: Introduction to programmable logic controllers. Their hardware structure and the flexibility in using them. Input/output modules and the necessary signal conditioning circuitry for connection to a PLC. The standard electronics in automation. Measuring weight and temperature. Strain gauges, thermocouples, RTDs and thermistors. Working principles and the wiring diagrams. Introduction to actuators. Motors, pistons and valves: their most frequent use and their wiring diagrams. Basic of PLC programming: ladder programming. PLC working cycle and functional block programming. Using microcontroller systems to perform process automation. Conventional control strategies: feedback controllers, PID controller and their tunin. Introduction to SCADA systems: types of processes and their control structures. Distributed sensory systems. Communication protocols.
Course objectives: The subject is a general introduction to various techniques of process automation. Practical examples of process automation will be introduced and their implementing details will be discussed.
Learning outcomes: On successful completion of the course, students will be able to:

- To have a detailed knowledge of PLC structured and their methods of programming. Identify situations where PLC use would be appropriate.
- Properly select sensor depending on what should me sensed (analog or digital)
- Program PLC in different programming methods including ladder logic programming and block programming.
- Understand the situations where microcontrollers and microcomputer systems should can be used to perform automation action.
- Understand the concept of SCADA systems, their general properties and the current level of their use.

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:

- Jonathan Love, *Process Automation Handbook: A Guide to Theory and Practice*, Springer, 2007
- Frank D. Petruzella, *Programmable Logic Controllers*, Fifth Edition, McGraw-Hill, 2017
- Shimon Y. Nof (Ed.), *Springer Handbook of Automation*, Springer, 2009

- Stuart A. Boyer, SCADA: Supervisory Control And Data Acquisition, ISA, 2004
- Stuart G. McCrady, *Designing SCADA Application Software: A Practical Approach*, Elsevier, 2013
- Gordon Clarke and Deon Reynders, *Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems*, Newnes, 2004

Course: Methodology of Scientific Research

Lecturer: Prof. Dr. Milaim Zabeli
Course status: Mandatory, Semester I, 4 ECTS

Course description: verview of experimental and engineering methodological approaches to research; Basics of research design (e.g., hypothesis formulation); The research process: documenting research, sources of information, research funding, creativity and intellectual discovery; Guidelines and a framework for efficient development of research; legal and ethical issues; protecting and exploiting research; Intellectual Property rights; Managing the research project: supervision, planning and organization; problems and pitfalls; Presentation skills (written, oral); Use of relevant research tools (technology, experimental infrastructure, mathematical methods, etc.).

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 problem 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. Approximately 75 hours of personal study, including homework exercises.

Evaluation methods: Homework (seminary work) 20%, Mid-term exams 30%, Final Exam 50%

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

Ratio between the theoretical and practical part: 30:70

Literature:

- Kothari B.L., Research Methodology: Tools and Techniques, New Age International Publishers, 2013.
- Boot C. W., The Craft of Research, University of Chicago Press, 2008.

Course title: Control of Electrical Drives

Lecturer: Prof. Asoc. Dr. Qamil Kabashi
Course status: Elective, Semester I, 5 ECTS

Course content: Introduction. Elements of electrical drive system. Dynamics of Electrical Drives DC Drives. Poly-phase induction machines. Scalar control of AC machines. Dynamic modelling and Vector control. Vector control structures with voltage and current inverter. Pulse with modulation and vector modulation. Vector model variable and parameters estimation of induction machine. Direct torque and flux control of AC induction machine. Control of the brushless DC motor. Improvement of the tracking accuracy using feedforward controller Applications of Electric Drives. Study case: Speed regulation of 3 phase induction motors with SPWM and SVPWM inverters.
The goals: The course goal is to provide advance 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.
- apply direct torque and flux control to induction machine
- apply vector control structure with voltage and current inverter
- 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

Teaching methodology: Lectures, Assignments, Lab Experiments, Lab report and presentation.
Evaluation methods: Midterm exams 40%, Project 30%, Final exam 30%.
Concretization means: Laptop, projector, practical part will be done in laboratory of the FECE and in the Kosovo Energy Corporation.
Ratio between the theoretical and practical part of teaching: 40:60

Literature:

- V. Subrahmanyam, *Electric Drives, Concept and application*, Tata McGraw Hill Education, 2nd ed. 2010.
- W. Leonhard *Control of Electrical Drives*, Springer, 2001.
- Gopal K. Dubey, Fundamentals of electric Drives, Narosa Publishing House", 2nd edition, 2011.
- Wach Piotr, *Dynamics and Control of Electrical Drives*, Springer, 2011.
- Siemens. Simovert Master Drive Vector Control, User manual (2012)

Course: Robotic Sensors and Actuators

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

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 system. Physical models and interconnection with control system, 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.

Course objectives: The goal of the course is to introduce students with structure of robots in 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:

- Peter Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Second Edition, Springer, 2017

- Clarence W. de Silva, *Sensors and Actuators: Engineering System Instrumentation*, Second Edition, CRC Press, 2016
- K.S. Fu, R.C. Gonzales, C.S.G. Lee, *ROBOTICS, Control, Sensing,Vision, and Intelligence*, McGraw-Hill
- Paul P., *Robot Manipulators Mathematics, Progrmming and Control*, MIT Press
- Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo, *Robotics: Modelling, Planning and Control*, Springer, 2009
- Bruno Sicilianoa and Oussama Khatib (eds.), *Springer Handbook of Robotics*, Second Edition, Springer 2016

Course: Mechatronic Systems

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

Brief overview: Mechatronics as cooperative integration of technical mechanics, electronics, computer engineering and information technology. Fundamentals of mechatronic design. Components and interfaces of mechatronic system, functional blocks. Microcomputer control block as control unit and connection with sensors and actuators, data exchange between control unit and process. Integrating smart units with mechatronic system. Real time operation and requirements from microprocessor block. Criteria for selecting control system. Integration of rotary and translational electromechanical systems as examples of mechatronic systems, modeling, simulation, controller synthesis (relay, PID, state) and real time control. Estimating influence of processing time delays, planning order of actions. Systems for rapid control system prototype development.

The goal: The goal of the course is to introduce students with mechatronical systems, structure with construction blocks, and composition elements. Introduction to mechatronic design, analysis and implementation, as a rapid prototype and as a concrete microcomputer system, together with adequate software support.
Learning outcomes: On successful completion of the course, students will be able to:

- know structure of mechatronic systems;
- according to requirements to select elements of mechatronic system;
- explain difference between classic and mechatronic approach for product design;
- by using modern computer tools to design mechatronic system;
- develop adequate control algorithm (relay, PID and state) for concrete system;
- analyse effectiveness of real implementation of control algorithm, including cases when smart elements with networked communication are used;
- develop rapid prototype with modern computer tools.

Teaching methodology: 30 hours of lectures, 15 hours of laboratory exercises. Approx. 75 independent working hours.
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:

- Clarence W. de Silva, *Mechatronics: A Foundation Course*, CRC, 2010
- Clarence W. de Silva, *Sensors and Actuators: Control System Instrumentation*, CRC, 2007

- Victor Giurgiutiu, Sergey Edward Lyshevski, *Micromechatronics: modeling, analysis, and design with MATLAB*, CRC, 2009
- Lavdim Kurtaj, *Mechatronical Project*, WUS-Austria and University of Prishtina, 2011
- Nikolay V. Kirianaki, Sergey Y. Yurish, Nestor O. Shpak, Vadim P. Deynega, *Data Acquisition and Signal Processing for Smart Sensors*, Wiley, 2002
- Abraham Silberschatz, Peter B. Galvin, Greg Gagne, *Operating System Concepts*. John Wiley & Sons, 2010

Course title: Discrete Event Systems

Lecturer: From industry
Course status: Electcve, Semester I, 5 ECTS

Course content: Introduction to discrete-event systems. Modeling: languages, automata. Analysis: safety, blocking. Synthesis: supervisory control, controllability, modular control. Petri nets: modeling, analysis. Timed DES models.

Course objectives: This course aims to provide an introduction to the modeling and analysis of discrete-event systems, and to cover some of the techniques that have been developed based on DES models for the design of supervisory control systems.

Learning outcomes: Upon the completion of the course students will be introduced to DES models, such as finite-state automata, that are used in the study of a wide range of problems in areas such as process control systems, communication networks, automated manufacturing systems, etc. For instance, in the context of control systems, DES models are used for studying sequencing and supervisory control.

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

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

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

Ratio between the theoretical and practical part: 40:60

Literature:

- Cassandras C.G. and S. Lafortune, "*Introduction to Discrete Event Systems*", Springer, 2008.
- Banks J., Carson II J., Nelson B., and Nicol D.; "*Discrete Event System Simulation*", Prentice Hall; 2009.

Course: Networked Control Systems

Lecturer:

Course status: Elective, Semester I, 5 ECTS

Course content: Network Models: graphs, random graphs, random geometric graphs, state-dependent graphs, switching networks. Decentralized Control: limited computational, communications, and controls resources in networked control systems. Multi-Agent Robotics: formation control, sensor and actuation models. Mobile Sensor Networks: coverage control, Voronoi-based cooperation strategies. LAN: mobile communications networks, connectivity maintenance. Simulation in MATLAB/Simulink of networked control systems. Design and implementation of distributed control system.

Course objectives: This course will provide an overview of the tools and techniques that have proven instrumental for studying networked control systems as well as outline potential development directions.

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

- Understand principles of decentralized control;
- Know models of different communication networks and how these can be used in complex distributed control systems;
- Know consequences of nonidealities of data exchange and how will they influence control system performance;
- Design and implement distributed control systems;
- Simulate networked control systems with MATLAB/Simulink.

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:

- Magdi S. Mahmoud, *Control and Estimation Methods over Communication Networks*, Springer, 2014
- Keyou You, Nan Xiao, Lihua Xie, *Analysis and Design of Networked Control Systems*, Springer, 2015
- Dimitrios Hristu-Varsakelis and William S. Levine (Eds.), *Handbook of Networked and Embedded Control Systems*, Birkhäuser, 2005
- Mesbahi M. and Egerstedt M., *Graph Theoretic Methods in Multiagent Networks*, Princeton University Press, 2010.
- Bullo F., Cortes J., and Martinez S., *Distributed Control of Robotic Networks*, Princeton, 2009.
- Renesas Synergy Development Kit, User's Manual, Renesas Electronics, 2015

Course: Systems for Computerized Numerical Control

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

Course content: Introduction to systems for computerized numerical control (CNC), and their structure, types of CNC machines. Mechanical structure, motors, and drive units. Control system for CNC axes and compensation for typical nonlinearities. Continual and discrete control for support and extension of functionality. Computer system for real time control, interfacing with drive-actuator units and with measurement sensors. Trajectory planning and interpolation between ending points. Decoupling control structure at real time critical and noncritical parts. Specific requirements depending on type of drive motor (DC, BLDC, AC, step). Low level programming, G and M codes, interpolation methods. Manual trajectory programming. Computer aided programming and translation form graphic description to low level CNC language. Open and proprietary sofware for controlling and programming CNC systems. CNC simulators. Designing personal computer based CNC systems as a base of open control systems and real time control, with corresponding software support (LinuxCNC). Requirements for interfacing with power units and disturbance imunity at hostile processing and industrial environments.

Course objectives: Objective of the course is to introduce students with computer numerical control systems, known for short as CNC, their mechanical structure, drive system, sensors, and methods for programming. Introduction to open systems and integration possibilities for building new systems.

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

- Know structure of CNC systems;
- Select elements for building CNC systems according to specifications;
- Integrate elements for functionalizing CNC system;
- Use gained knowledge to identify, maintain, and troubleshoot existing CNC systems;
- Extend with additional functionalities existing CNC systems;
- Design and implement advanced control systems based on PC;
- Understand relation between graphic and low level programming, and CNC programming.

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:

- Suk-Hwan Suh, *Theory and Design of CNC Systems*, Springer, 2009
- Yusuf Altintas, *Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design*, Second Edition, Cambridge University Press, 2012
- Alan Overby, *CNC Machining Handbook: Building, Programming, and Implementation*, McGraw-Hill/TAB Electronics, 2010
- Geoff Williams, *CNC Robotics: Build Your Own Workshop Bot*, McGraw-Hill, 2003
- Patrick Hood-Daniel, James Floyd Kelly, *Build Your Own CNC Machine*, Apress, 2009

Course title: Multimedia Communications

Lecturer: Prof. Ass. Dr. Hëna Maloku
Course status: Elective, Semeseter I, 5 ECTS

Course content: Introduction of international standards. Image coding: DCT/subband/VQ. Image coding: JPEG. Video coding: ITU-T H.261, H.263, H.263 Version 2. Video coding: ISO MPEG-1, MPEG-2. MPEG audio coding. ITU-T speech coding: G.72x. MPEG-4 Video. Systems: ITU-T H.320, H.323, H.324, etc. MPEG-4 Systems. Networking issues: error resilience, network characteristics, Quality of Service (QoS). Error resilience in video codecs: H.26x and MPEG. Multimedia over IP: Multimedia over ATM. Multimedia over wireless/mobile networks.
Course objective: This course introduces technologies for multimedia communications. We will address how to efficiently represent multimedia data, including video, image, and audio, and how to deliver them over a variety of networks. In the coding aspect, state-of-the art compression technologies will be presented. Emphasis will be given to a number of standards, including H.26x, MPEG and JPEG. In th networking aspect, special considerations will be given for sending multimedia over ATM, wireless, and IP networks, such as error resilience and quality of services. The H.32x series, standards for audiovisual communication systems in various network environments, will be described. Current research results in multimedia communications will be reviewed through student seminars in the last weeks of course.
Learning outcomes: On successful completion of the course, students will be able to:

- have an excellent understanding of multimedia enabling technologies, services and applications;
- master basic Internet concepts and protocols;
- analyze analog and digital video signals and systems;
- know the fundamental video processing techniques;
- acquire the basic skill of designing video compression;
- familiarize himself/herself with video compression standards;
- know the basic techniques in designing video transmission systems: error control and rate control.

Teaching methodology: 30 hours of lectures, 15 hours laboratory exercises and seminary work. Approximately 70 hours of personal study.
Evaluation methods: Seminars 50%, Final exam: 50%.
Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the multimedia laboratory.
Ratio between the theoretical and practical part: 40:60 (not including student independent homework and seminar work).
Literature:

- R. Steinmetz and K. Nahrstedt, Media Coding and Content Processing, Prentice Hall, 2002,
- Mário Marques da Silva, "Multimedia Communications and Networking" CRC Press, 1st edition, ISBN: 9781439874844, FL, USA, March 2012
- R. Steinmetz and K. Nahrstedt, Multimedia: Computing, Communications and Applications, Prentice Hall, 1995,
- P. K. Andleigh and K. Thakrar, Multimedia Systems Design, Prentice Hall, 1996.
- Myzafere Limani, Komunikimet multimediale,Universiteti i Prishtinës, ligjërata të autorizuara, 2012.

Course: VLSI Technology

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

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.

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

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

Course: Measurements and Sensors in Biomedicine

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

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 signals 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.

Course objectives: Overview of physical and physiological variables that are most commonly measured in clinical and medical research environment 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:

- describe various measurement methods and sensors in medicine and biotechnology
- describe some of the more important and often used measurement methods and procedures and explain their advantages and limitations
- explain the physical background of the measurement methods
- plan and perform biomedical measurements in other areas
- to critically defend the obtained measurement results.

Teaching methodology: At the lectures, students learn the theoretical basis and the physical background of the existing measuring methods and sensors along with the purposes and application examples. Familiarization with the procedures for the proper planning, implementation and evaluation of the measuring experiments. At laboratory work, students use sensors that are based on different physical principles, they calibrate them in the selected measurement regions and incorporate them in a simple measurement systems. Gain hands-on experience with the implementation of some selected non-invasive methods of measurement of physiological variables and the use of biochemical measurement methods. Students attend one or more excursions to medical institutions, where practical demonstrations of the use of biomedical measurement instrumentation are held.
Evaluation methods: Written exam, oral exam, laboratory exercises, Project. Negative grade is 5, positive grades: from 6 to 10. Positive evaluation of laboratory exercises is a prerequisite for the exam. Contributions to final grade: laboratory exercises, written exam and oral examination.
Concretization tools/IT: Computer, projector, table, and laboratory equipped.
Ratio between theoretical and practical part: 1:1.

Literature:

- Wang P, Liu Q. Biomedical Sensors and measurement. Zhejiang University Press, Springer, 2011.
- Togawa T, Tamura T, Ake Oberg P. Biomedical Transducers and Instruments. CRC Press, 2011.
- Khandpur RS. Biomedical Instrumentation: Technology and Applications. McGraw-Hill, 2004.
- Bronzino JD (editor). The Biomedical Engineering Handbook (3rd edition). CRC Press, 2006.
- Barth FG, Humphrey JAC, Secomb TW. Sensors and sensing in biology and enginnering. Springer, 2003.
- Tatsuo Tagawa, Toshiyo Tamura, P. Ake Oberg, Biomedical Sensors and Instruments 2nd Edition, CRC Press; 2 edition (March 22, 2011)
- John G. Webster Halit Eren , Measurement, Instrumentation, and Sensors Handbook Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement, second edition, CRC Press, 2014.

Course title: Digital Design

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

Course description: Writing VLDL designs for simple gate functions. Combinational logic circuit design with VHDL. Bistable memory device design with VHDL. Simple finite state machine design with VHDL (behavioral and structural modeling). Design of digital circuits on algorithmic level and RTL (register transfer level). Programmable PLD circuits. Fundamentals of programmable circuits FPGA. Complex finite state machine design with VHDL. Asynchronous circuits (synthesis, implementation). CORDIC algorithms. Microprocessor.
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 simple gate functions.
- Design complex digital circuits using advanced design tools on an advanced level.
- digital circuits design procedures and approaches.
- Design state machines for specific cases.

Teaching methodology: 30 hours of lectures + 15 hours of laboratory exercises. Approximately 80 hours of personal study and exercise including homework.
Evaluation methods: 1st Exam: 25%; 2nd Exam: 25%, Homework: 20%, Final exam: 30%
Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the laboratory.
Ratio between the theoretical and practical part: 40:60

Literature:

- 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.**
- Brown, Stephen D. Vranesic, Zvonko G, Fundamentals of digital logic with VHDL design, 2005 McGraw-Hill, ISBN 007-246085-7
- Mano, M. Morris, Kime, Charles R, Logic and computer design fundamentals, 2008 Upper Saddle River : Pearson Prentice Hall, 978-0-13-206711-9

Course: Biomedical informatics

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

Course description: Introduction into biomedical informatics - terms and concepts definitions. Properties and scope of medical and biomedical informatics. Health policy and structure of care delivery systems in Kosova and worldwide. Collection, processing and transport of patient medical data. Biomedical signal processing - basic concepts, features and characteristics. Examples of patient biomedical data processing - ECG, EEG, EMG. IT solutions in the domain of eHealth - examples, characteristics, key functional and technical criteria. Electronic healthcare record, integration and interoperability. Certification process. Standards for achieving full scope of eHealth solutions interoperability (DICOM, HL7, EN 13606, HISA, IHE). Telemedicine.
Course objectives: By attending the Biomedical Informatics course students will get an opportunity to learn about key concepts and definitions in the growing and expanding domain of biomedical informatics and eHealth. The course encompasses many aspects of this domain, including state of the world when it comes to definitions, research and developments in the field; biomedical data collection and processing techniques; adoption of IT technologies in the healthcare delivery systems; electronic healthcare records; aspects, benefits and challenges in the field of telemedicine and, other related topics.
Learning outcomes:

- Identify key parameters of health systems
- Give example of health information models based on world's leading standards initiatives (HL7, IHE, openEHR, Continua)
- Define mobile health and telemedicine application architectures
- Identify basic modules of integrated hospital information systems
- Identify basic modules and functionalities on national eHealth systems
- Identify basic components of Electronic Health Records

Teaching methodology:

- Exams: Middle exams, seminars and written exam.
- Consultations: Consultations for students are held once per week.
- Seminars: Confirmed. Group work with small number of students
- Internship visits: Visits to be organized to health providers facilities and institutions, which have stronger lines of initiatives when it comes to health informatics

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:

- H. Van Bemmel, M.A. Musen (1997). Handbook of Medical Informatics, Springer Verlag
- E.H. Shortliffe, L.E. Perreault (Eds.); (2001). Medical Informatics: Computer Applications in Health Care and Biomedicine, Springer; 4th ed. 2014 edition (December 4, 2013)
- Kenneth R. Ong, Medical Informatics: An Executive Primer, HIMSS Publishing; 3 edition (March 27, 2015)
- Sue Biedermann, Introduction to Healthcare Informatics, AHIMA; 2 edition (May 1, 2017)
- Linda Miner, Pat Bolding , et al., Practical Predictive Analytics and Decisioning Systems for Medicine: Informatics Accuracy and Cost-Effectiveness for Healthcare Administration and Delivery Including Medical Research, Academic Press; Paperback reprint of hardcover 1st ed., 2014 edition (September 2, 2016)
- Jules J. Berman, Methods in Medical Informatics: Fundamentals of Healthcare Programming in Perl, Python, and Ruby , Chapman and Hall/CRC; 1 edition (September 22, 2010)
- Gordon D. Brown, PhD, et al., Health Informatics: A Systems Perspective, Health Administration Press; First edition (September 12, 2012)
- Mark L. Braunstein, Health Informatics on FHIR: How HL7's New API is Transforming Healthcare, Springer; 1 edition (July 26, 2018)

Course title: Advanced Power Electronics

Lecturer: Prof. Asoc. Dr. Qamil Kabashi
Course status: Elective, Semester I, 5 ECTS

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.
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
- Understand solid state controllers for motor drives such as vector control and direct torque control of induction motor etc.

Teaching methodology: Lectures, auditoria exercises, Assignments, Lab Exp. report
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:

- Daniel W. Hart, Power Electronics, McGraw-Hill Education; 1st. Ed. 2010.
- N. Mohan, T. M. Undeland and W. P. Robbins, Power Electronics, Converter, Application and Design, 3rd ed, John Willey & Sons, 2007.
- Frede Blaabjerg, Control of Power Electronic Converters and Systems, Volume 1, Academic Press; 1st ed. 2018.
- Bin Wo, High Power Convertes and AC drives, IEEE press, 2006.
- B. K. Bose, Power Electronics and Variable Frequency Drive, Standard Publishers Distributors, 2000.

Course title: Acoustics in Communications

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

Course description: Fundamentals of physical acoustics. Sound. Theory of acoustic signals and field characteristics. Sounds and waves in enclosed spaces. Music and speech. Propagation of acoustic waves. Electrical, mechanical and acoustical analogies. Sound sources (spherical dipole). Resonators, absorbers, filters. Physiological Acoustics. Psychoacoustics. Architectural and building acoustics. Noise and vibrations. Electroacoustic transducers, microphones, loudspeakers, headphones. Sound reinforcement. Ultrasound and its applications in medicine and technology. Electro-acoustic measurements.
Course objectives: To present the fundamental concepts of acoustics and the analytical techniques required to solve a range of engineering problems in acoustics. This course provides an introduction to the physical principles of acoustics and their application. Fundamental topics include the generation, transmission, and reception of acoustic waves. Applications covered are selected from underwater acoustics, architectural acoustics, remote sensing, and nondestructive testing.
Learning outcomes: On successful completion of the course, students will be able to:

- effectively use the basic concepts of physical acoustics;
- analyze the characteristics of acoustic fields;
- recognize and apply basic laws of acoustics of closed spaces;
- have essential knowledge in speech, music and psychophysiological acoustics;
- know and apply modern technologies of ultrasound in medicine and technology.

Teaching methodology: 30 hours of lectures, 15 hours of numerical exercises, 15 hours laboratory exercises and seminary work. Approximately 80 hours of personal study.
Evaluation methods: 1st intermediary exam 20%, 2nd intermediary exam 20%, Attendance of lectures and exercises 10%, Final exam: 50%.
Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the multimedia laboratory.
Ratio between the theoretical and practical part: 40:60 (not including student independent homework and seminar work).
Literature:

- T. Jelaković , Zvuk, sluh i arhitektonska akustika Zagreb, 1978,
- Marshall Long, Architectural Acoustics; Elsevier, San Diego; 2006,
- D.T. Blackstock, Fundamentals of physical acoustics; Wiley Interscience publication; 2000,
- W. M. Hartmann, Signals, Sound and Sensation (Modern Acoustics and Signal Processing), Amazon 1997,
- M. Limani, Bazat e akustikës teknike, Prishtinë, 2005.

Course title: Renewable Energy Sources

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

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 electronics, transport, industry and buildings. Energy Management (Energy economics, energy audit, scope of alternative energy sources in Kosova).
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 will be used computer 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:

- F. M. Vanek, L. D. Albright, L. T. Angenent, Energy Systems Engineering: Evaluation and Implementation, 3rd edition, McGraw Hill, 2016.
- E. E. Michaelides, Alternative Energy Sources, (Springer, 2012

- E. F. Fuchs, M. A.S. Masoum, Power Conversion of Renewable Energy Systems, Springer, 2011
- B. Godfrey. *Renewable Energy: Power for a Sustainable Future*, Third Edition. Oxford University Press, 2012
- Tester, et al. *Sustainable Energy, Choosing Among Options*, 2nd Edition. MIT Press, 2012.
- B. Zohuri, Hybrid Energy Systems- Driving Reliable Renewable Sources of Energy Storage, Springer, 2018.

Course: Robotics and Automation

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

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 on 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 system, 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. Adaption 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.
Course Objektives: The goal of the course is to introduce students with usage of robots in different automation tasks, industrial, processing, and service. Accent will be on designing system, 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

Course: System Identification

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

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, persistency 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.

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.

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 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:

- R. Isermann, "*Identification of Dynamic Systems: An Introduction with Applications*", Springer, 2005.
- L. Ljung, "*System Identification: Theory for the User*", Prentice Hall, 1999.
- T. Soderstrom and P. Stoica, "*System Identification*", Prentice Hall, 1989.

Subject: Computer Process Control

Lecturers: Prof. Ass. Dr. Drilon Bunjaku,

Course status: Elective, Semester II, 5 ECTS

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.

The goal: The goal of the course is to introduce students with usage of computers fro process control, by using different forms of PID and digital controllers. It will be covered 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;
- to understand and analyze interconnected multivariable systems.

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:

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

Course: Real-time Operating Systems
Lecturer: Prof. Ass. Dr. Lavdim Kurtaj
Course status: Elective, Semester II, 5 ECTS

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.
Course objectives: The aim of the course is that students should learn how 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:

- Abraham Silberschatz, Peter B. Galvin, Greg Gagne, *Operating System Concepts*, John Wiley & Sons, 2010
- Jane W. S. Liu, *Real-Time Systems*, Prentice-Hall, 2000
- K.C. Wang, *Embedded and Real-Time Operating Systems*, Springer, 2017

- Insup Lee, Joseph Y-T. Leung , Sang H. Son, *Handbook of Real-Time and Embedded Systems*, CRC, 2007
- Jonathan Valvano, *Embedded Systems: Real-Time Operating Systems for Arm Cortex M Microcontrollers*, CreateSpace Independent Publishing Platform, 2012
- Renesas Synergy Development Kit, User's Manual, Renesas Electronics, 2015
- Rob Williams, *Real-Time Systems Development*, Butterworth-Heinemann, 2005
- Andrew S. Tanenbaum, Maarten Van Steen, *Distributed Systems: Principles and Paradigms*, Pearson Education, 2007.

Course: Human Machine Interface

Lecturer:
Course status: Elective, Semester II, 5 ECTS

Course description: Introduction to HMI. Natural communication, multimodality, types of human-machine interfaces. Human perception and recognition. Psychology of users, attention, thinking, perception of visual, sound and haptic incitements. Concept of combined reality, virtual reality, technologies, existing scientific and commercial projects. Sensing and tracking. Sensors for sensing of fingers, hands and touching. Interactive digital surfaces, manipulation of digital objects, displays with rear projection. Multimodal speech interface. Basics of multimodal dialog systems. Speech synthesis. Speech recognition. Talking head. Interface based on gestures. Sensing of movement, controlling by movement, examples of the interfaces. Sound interaction. Basics of acoustics. Psychoacoustics. Analysis and synthesis of sound. Haptic interfaces. Haptic perception and recognition. Technologies and concepts. Interfaces for visual and hearing-impaired people. Brain-computer interface. Medical applications, special sensors. Questions and problems in combining different modalities. Simultaneous and alternative using of modalities, influence of environment, task type and user.
Course objectives: The subject is aimed on student's survey in new trends and development philosophy in the area of human – machine interface. The student should obtain an overview of used technologies and technical background and apply the overall image in context of higher scholarly subjects.
Learning outcomes: On successful completion of the course, students will be able to:

- Understanding the natural communication and types of human-machine interfaces.
- Understanding the human perception and types.
- Knowledge in principle the basics of multimodal dialogue systems and to identify them according to the perceptive principle.
- Know the different types of interfaces by the nature perception nature.
- Know the realization of interfaces for people with special needs.

Teaching methodology: 30 hours of lectures + 15 hours of laboratory exercises. Approximately 80 hours of personal study and exercise including homework.
Evaluation methods: 1st Exam: 25%; 2nd Exam: 25%, Homework: 20%, Final exam: 30%
Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the laboratory.
Ratio between the theoretical and practical part: 40:60

Literature

- Alan Dix, Janet Finlay, Gregory Abowd, and Russell Beale, Human–Computer Interaction, 3rd Edition. Prentice Hall, 2007.
- Yvonne Rogers, Helen Sharp & Jenny Preece, Interaction Design: Beyond Human–Computer Interaction, 4th ed., John Wiley & Sons Ltd., 2015
- Ben Shneiderman and Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction, 5th ed., Pearson Addison-Wesley, 2009.

Course: **Analyzing Systems with Finite Elements**
Lecturer: Prof. Ass. Dr. Vjosa Shatri
Course status: Elective, Semester II, 5 ECTS
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.
Course objectives: Objectives of the course is to introduce students with numerical methods (finite element methods, FEM) and how to use them to analyse and solve different technical problems.
Learning outcomes: By finishing this course a student will:

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

Teaching methodology: Combined lectures with simulations and demonstrations, discussions, 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

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

Course: Biomedical Imaging Technologies

Lecturer: Prof. Dr. Sabrije Osmanaj
Course status: Elective, Semester II, 5 ECTS

Course description: Acquisition of biomedical images: digital photography and video cameras, optical techniques, microscopic techniques, X-ray imaging, computed tomography, magnetic resonance imaging, ultrasound, emerging imaging technologies – physical principles, acquisition technologies and geometries, implementations and characteristics of imaging devices, image artefacts and quality. Restoration, reconstruction and calibration: modelling and estimation of noise, image smoothing and sharpening, statistical and adaptive filtering, reconstruction algorithms, calibration and restoration of intensities, geometric calibration. Image registration and integration: classification and applications of image registration methods, modelling geometrical transformations and deformations, matching of control points, similarity based registration , similarity measures and optimization methods, analysis and evaluation of registration methods, image integration examples.
Course objectives: To introduce basic technologies for the acquisition of biomedical images and the procedures for their restoration, reconstruction, calibration and integration.
Learning outcomes: After successful completion of the course, students should be able to:

- explain physical backgrounds of biomedical imaging techniques
- describe technological limitations and artefacts
- interpret information content of biomedical images
- process digital images with computer programs
- execute calibration and integration of multimodal images
- evaluate image quality

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: Type: laboratory exercises, written exam, oral exam. Negative grade is 5, positive grades: from 6 to 10. Positive evaluation of laboratory exercises is a prerequisite for the exam. Contributions to final grade: Lab works (condition for written exam), Practical knowledge (written exam), Theoretical knowledge (oral exam).
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:

- Troy Farncombe and Kris Iniewski, Medical Imaging: Technology and Applications (Devices, Circuits, and Systems) by CRC Press; 1 edition (December 19, 2017)
- Paul Suetens, Fundamentals of Medical Imaging by Cambridge University Press; 3 edition (July 10, 2017)
- Andrew G. Webb, Introduction to Biomedical Imaging , Wiley-IEEE Press; 1 edition (December 26, 2002)
- Rongguang Liang , Rongguang Liang, Biomedical Optical Imaging Technologies: Design and Applications Springer; 2013 edition (September 21, 2012)
- 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)
- Jerry L. Prince and Jonathan Links, Medical Imaging Signals and Systems (2nd Edition), Pearson; 2 edition (March 28, 2014)
- 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)

Course title: Digital and Analog Filters

Lecturer: Prof. Ass. Dr. Vjosa Shatri
Course status: Elective**, Semester II, 5 ECTS**

Course content: Signals and systems at continuous and discrete time, Important discrete transforms, Transfer function and frequency response; Analysis of finite word length; Digital filters of finite impulse response (FIR); Design of FIR filters and realization structures; Optimal design methods of FIR filters; Digital filters of infinite impulse response (IIR); Elliptic transfer function of minimal Q factors; Half-band filters; IIR filters design without multipliers; Digital signal processing with different sampling frequencies; Digital filter-banks (QMF banks).
Course objectives: Students will be introduced in basic concepts of analog and digital filters design, mathematical models and software applications for the analysis and implementation of analog and digital filters.
Learning outcomes:

- Students will be introduced to the basic concepts of analogue and digital filter design, mathematical models, and software applications for digital filter analysis and implementation;
- Students gain the ability to use digital filter design tools and evaluate the results obtained.

Teaching methodology: 30 hours of lectures, 15 hours of laboratory exercises. Approximately 70 hours of personal study.
Evaluation methods: Intermediary evaluations 30%, Project 40%, Final exam 30%.
Concretization tools: During the lectures, a computer with video projector will be used, and the part of the auditory exercises will be conducted with discussions of the theory and application of calculations and graphing in Matlab. Laboratory experimental plants.
Ratio between the theoretical and practical part: 40:60

Literature:

1. Antoniou A., "*Digital Signal Processing: Signals, Systems, and Filters*", McGraw-Hill, 2005.
2. Alan V. Oppenheim, et al, "*Discrete -Time Signal Processing*", 2nd ed., 1998, Prentice Hall.
3. Mitra S. K., "*Digital Signal Processing: A Computer-Based Approach*", 4th Edition, McGraw-Hill, 2011.

Course: Circuit Analysis and Optimization

Lecturer:
Course: Elective, Semester II, 5 ECTS

Course description: Contemporary numerical methods for analog circuit analysis: modified nodal equations. LU decomposition. Newton Raphson iteration for nonlinear circuits, integration algorithms for dynamic circuits, pole zero analysis. Optimization algorithms: setting up cost functions, direct optimization methods, penalty functions. Hands-on laboratory work on real circuits with the SPICE OPUS tools: competent analyses.
Course objectives: Understanding numerical methods for analog circuit analysis, Understanding basic principles of parameter optimization. Practical hands-on laboratory work experience with SPICE OPUS analog circuit design tools.
Learning outcomes: At the end of this course, the students should be able to design the integrated analog circuit for specific cases..
Teaching methodology: Lectures, discussion groups, laboratory project work (group and individual). Approximately 80 hours of personal study and exercise including homework (seminary work).
Evaluation methods: 1st Exam: 25%; 2nd Exam: 25%; 50%, Homework: 25%, Final exam: 25%
Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the laboratory.
Ratio between the theoretical and practical part: 40:60

Literature

- T. Tuma, A. Buermen, Circuit Simulation with SPICE OPUS, Theory and Practice, ISBN: 978-0-8176-4866-4, A Birkhäuser book, Springer 2009.

Course: Optical Communication Systems

Lecturer: Prof. Dr. Milaim Zabeli

Course status: Elective, Semester II, 5 ECTS

Course description: Introduction (the history and actual state of optical communication systems). Optical fibers (structure and fabrication). Signal degradation in optical fibers (attenuation and , dispersion). Optical sources and transmitters (LEDs, laser diodes). Power launching and coupling and fiber-to-fiber joints. Photodetectors and optical receivers (pin and avalanche photodiodes; noises; preamplifiers). Digital transmission systems (link power budget and rise-time budget; NRZ and RZ line coding). Analog transmission systems. Wavelength-division multiplexing (WDM) concepts and components. Optical amplifiers. Optical networks (SONET/SDH). Measurements in fiber- optic communication systems. Optical fiber transmission systems in Kosovo and in the region.

Course objectives: This course introduces students into optical communication systems.

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

- Explain the phenomena and laws of propagation of light through optical fibers.
- Describe the construction and working principle of photo-emitters and photo-detectors used in optical communications systems: LEDs, photodiodes (pin and avalanche, APD), phototransistors; semiconductor lasers (laser diodes).
- Describe the construction of optical fibers and optical cables and main methods/techniques of their fabrication.
- Explain the problems that arise during the course of optical fibers and in their coupling with photo-emitters and photo-detectors.
- Describe digital and analog transmission systems with optical fiber.
- Describe multichannel WDM systems
- Explain the working principle and characteristics of optical amplifiers.
- Describe the topologies and the main features of optical networks.
- Perform measurements in fiber optic systems.

Teaching methodology: 30 hours of lectures + 15 laboratory exercises. Approximately 80 hours of personal study and exercise including homework.

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

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

Ratio between the theoretical and practical part: 40:60

Literature:

- Gerd Keiser, Optical Fiber Communications, 4th ed., McGraw-Hill, 2010.
- Govind P. Agrawal, Fiber-Optic Communication Systems, 4th edition., John Wiley & Sons, 2018.
- Nebi Caka, Optoelektronika, Universiteti i Prishtinës, 1996.

Course: Modern Power Supplies

Lecturer: Prof. Dr. Sabrije Osmanaj
Course status: Elective, Semester II, 5 ECTS

Course description: Introduction to high frequency switching converters, basic converter types and overview of basic terminology; Quasi-stationary operation of DC / DC converters (analysis of Vs and As equilibrium, circuit gain, output ripple); Introduction to open-loop and closed-loop procedures for controlling the converter (PWM, phase-shift PWM, DTM, hysteresis controller); Addressing the low-signal model of the DC / DC converter (transfer function, continuous and discontinuous current mode operation); Introduction to basic components (power transistors, driver and snubber circuits) and addressing the procedures for their design; Introduction to DC / AC converters for electric motor drives and for use in uninterruptible power supply systems (UPS) and photovoltaic systems (performance analysis, modulation principles, harmonic spectrum); Addressing the feedback effects of devices on the voltage source and burden (active and passive filtering measures, output quality factors); Addressing the basic concepts of electromagnetic compatibility (sources and methods of dissemination of interference) and measures (design of converters' PCB, selection criteria and calculation of electronic components) in order to reduce EM imitations. .

Course objectives: The objective of the course is to provide the student with knowledge about devices that convert electricity with high switching frequencies. The student learns the topology of devices and associated subunits, which are necessary for reliable and safe operation. The subject gives a more detailed insight into the operation and knowledge for designing switching power supply systems from the proper choice of power components to their optimization. The student learns about the basic procedures and the validity of simplifications taken during mathematical modelling, the importance of the parasitic of the embedded components, and the measures for eliminating and reducing the feedback effects on the surroundings of the conversion devices.

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

- develop a mathematical (steady-state and small-signal) model for the DC/DC and DC/AC converter,
- describe the main components' role,
- analyses the operation of the converter on the basis of the measured currents and voltages,
- calculate the current, voltage and power stress for each component,
- explain the influence of parasitic inductance and capacitance of components on the operation of the converter,

- argue the countermeasures for elimination or reduction of the converters' feedback effects on the voltage source, burden and adjacent devices.

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:

- B. K. Bose, Power Electronics and Motor Drives: Advances and Trends. Academic Press, 2010.
- J. Jacob, Power Electronics: Principles and Applications. Cengage Learning, 2001.
- T. L. Skvarenina, The Power Electronics Handbook. CRC Press, 2001.
- T. Williams, EMC for Product Designers. Elsevier Science, 2011.

Course: Digital Microelectronic Circuits

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

Course description: Introduction. CMOS digital circuits devices. MOS transistor models. CMOS process layout rules. CMOS inverter - static and dynamic characteristics, power. Combinational CMOS logic circuits - complementary, rationed, pass-transistor, dynamic circuits. Sequential CMOS circuits - latches and flip-flops. Wires and interconnections - parameters and models, lines distribution problems. Arithmetical CMOS circuits - adders, multipliers, shifters. Memory CMOS circuits - layout organization, memory core circuit implementations, peripheral circuits. Input/output circuits.
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 inverter.
- 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 + 15 laboratory exercises. Approximately 80 hours of personal study and exercise including homework (seminary work).
Evaluation methods: 1st Exam: 25%; 2nd Exam: 25%, Homework: 20%, Final exam: 30%
Concretization tools: During the lectures, the computer will be used with a video projector, and the practical part will be realized in the laboratory.
Ratio between the theoretical and practical part: 40:60
Literature:

- Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim, CMOS Digital Integrated Circuits 4th edition. New York, USA, McGraw-Hill, 2014
- R.J. Baker, CMOS - Circuit Design, Layout, and Simulation, 4th edition; IEEE Press & Wiley Interscience; 2019;
- N.H. E. Weste, D. Harris, CMOS VLSI Design - A Circuit Perspective and Systems Perspective, 4th edition, Pearson Education; 2010

Course: **Optimal Control**
Lecturer: Prof. Ass. Dr. Drilon Bunjaku
Course status: Mandatory, Semester III, 5 ECTS

Course content: The necessary condition for optimal control. Proper modeling of systems in order to apply the optimal control strategies. Performance index. Choosing a performance measure for problem of terminal control, minimum time and minimum control effort. Introduction to the method of dynamic programming. Applying the method of dynamic programming in decision-taking and routing problems. Discrete linear controller problems an optimal feedback controller. Hamilton-Jacobian-Bellman equations and the calculus of variations. Introduction to the concept of functional and their importance in optmal control problems. The solution to problems related to minimum time, terminal control and minimum control effort. Introduction to numerical methods for solving optimal control problems and deriving optimal control trajectories. Introduction to stochastic control problems and the probability approach to systems with excessive disturbances.
Course objectives: The course is an introduction to the principle of optimality and optimal control strategies and their use. The importance of optimal control strategies in systems with limited power supply is emphasized.
Learning outcomes: On successful completion of the course, students will be able to:

- Tell the difference between conventional control systems and optimal control systems.
- Understand the concept of the index of performance and make a proper selection of based on the problem nature.
- Fully understand the method of dynamic programming and be able to implement its algorithm in digital computers.
- Understand Pontryagin's minimum principle and it's importance regarding optimal control laws.
- Have and understating on the numerical methods used to solve optimal control problems of different natures.

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:

- D. E. Kirk, *Optimal Control Theory: An Introduction*, Dover Publications,

- Bryson, Arthur & Yu-Chi Ho, *Applied Optimal Control: Optimization, Estimation and Control*, Taylor & Francis,
- Maurizio Falcone, Roberto Ferretti, Lars Grüne and William M. McEneaney, *Numerical Methods for Optimal Control Problems*, Springer, 2018
- Andrés Ovalle, Ahmad Hably and Seddik Bacha, *Grid Optimal Integration of Electric Vehicles: Examples with Matlab Implementation*, Springer, 2018
- Jagannathan Sarangapani, Hao Xu, *Optimal Networked Control Systems with MATLAB*, Springer, 2015

Course: Remote Control Systems

Lecturer: From Telecomunications Department
Course status: Elective, Semester III, 5 ECTS

Course content: Introduction to the principles of remote control. Nonelectrical remote-control systems. Basics of signal and signal transmission. Transmitters and receivers. Introduction to transmission lines, RF lines, microwave lines, propagation methods and alternate structures. Current distribution and implementation details. Filtering in optimal control and their influence. Digital filters and their implementation. Different application of remote control. Implementing remote control system in microcomputer systems. Remote control, computer networks and wireless communications.
Course objectives: The course is an introduction to remote control systems. The students will be introduction to typical strategies and implementation schemes for remote control.
Learning outcomes: On successful completion of the course, students will be able to:

- Have an understanding of remote-control systems and its development with the development of digital electronics.
- Understand the implementing details of AM and FM circuits for signal transmission.
- Implement fully functional systems based on RF signal for remote control purposes.
- Understand different kind of circuits and their implementing issues for information exchange and remote-control purposes.

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

Literature:

- F. Carden, R. Jedlicka & R. Henry, *Telemetry Systems Engineering,* Artech House Publishing, 2002
- D. Patranabis, Telemetry Principles, McGraw Hill, 2013

Course: Adaptive and Robust Systems

Lecturer: Prof. Ass. Dr. Drilon Bunjaku

Course status: Elective, Semester III, 5 ECTS

Course description: Real-time parameter estimation. Regression models and the least squares method. The necessary experimental conditions for real-time estimation. Simulation of recursive estimation and result interpretation. Self-tuning deterministic controllers. Pole placement method, continuous self-tuners and design of controllers for disturbance rejection. Self-tuning deterministic PID controller and digital implementation. Technical details for implementation and performance estimation. Stochastic self-tuning controllers. Analysis of direct and indirect discrete time tuners. Introduction to stochastic adaptive controllers. Self-tuning techniques. Nonlinear systems dynamic and feedforward path adaption. Dual control and suboptimal strategies. Relay feedback method and process oscillations due to relay effect.

Course objectives: The course is an introduction to adaptive techniques used to control systems of time varying nature. Methods of designing and implementing adaptive controllers will also be discussed. The proper control of systems with changing parameters.

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

- Identify situations where conventional control strategies would be rendered ineffective due to the time varying nature of the system
- Implement basic principles of parameter estimation in digital computers.
- Have an understanding of the stochastic approach to systems with excessive disturbances and processes whose parameter change with operating conditions.
- Understand the basic principles of implementing time varying controllers and real time control.
- Understand auto-tuning controllers and real-time parameter estimation.

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

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

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

Ratio between the theoretical and practical part: 40:60

Literature:

- K. J. Astrom and W. Wittenmark, *Adaptive Control*, Second Edition, Addison-Wesley Publishing, Dover Publications, 2008
- V. VanDoren, *Techniques for Adaptive Control*, Elsevier Science
- Nhan T. Nguyen, *Model-Reference Adaptive Control: A Primer*, Springer, 2018
- Adam Spiers, Said Ghani Khan, Guido Herrmann, *Biologically Inspired Control of Humanoid Robot Arms: Robust and Adaptive Approaches*, Springer, 2016
- Dan Zhang, *Adaptive Control for Robotic Manipulators*, CRC Press, 2017

Subject: Artificial Intelligence

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

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.
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:

- S. Russell, P. Norvig, *Artificial Intelligence: A Modern Approach*, Prentice Hall, 2010
- Elaine Rich, Kevin Knight, *Artificial Intelligence*, McGraw Hill, 1991

- Dario Floreano, Claudio Mattiussi, *Bio-Inspired Artificial Intelligence*, MIT Press, 2008
- B. Siciliano, O. Khatib (Eds.), *Springer Handbook of Robotics*, Springer, 2008
- Sio-Iong Ao, Mahyar Amouzegar, Burghard B. Rieger, *Intelligent Automation and Systems Engineering*, Springer, 2011
- Dimitris Vrakas, Ioannis Pl Vlahavas, *Artificial Intelligence for Advanced Problem Solving Techniques*, Information Science Reference, 2008
- Ian Millington, John Funge, *Artificial Intelligence for Games*, Morgan Kaufmann, 2009

Course: Mobile Robots

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

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 sensors signals. Measurement uncertainty. Multiple sensors information fusion in order to improve quality and robustness of robots navigation through space. Control and navigation system structures. Algorithms for global path planning of mobile robot 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.
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:

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

Course: Machine Vision

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

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.
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 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, discusions, 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:

- L. Shapiro and G. Stockman, *Computer Vision*, Prentice-Hall, 2001

- Peter Corke, *Robotics, Vision and Control: Fundamental Algorithms in MATLAB*, Second Edition, Springer, 2017
- Richard Hartley, Andrew Zisserman, *Multiple View Geometry in Computer Vision*, Cambridge University Press, 2003
- Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis, and Machine Vision*, Nelson Education Limited, 2008
- Simon J. D. Prince, *Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 2012
- Berthold K.P. Horn, *Robot Vision*, MIT Pess, 1986
- Gary Bradski, Adrian Kaehler, *Learning OpenCV: Computer Vision with the OpenCV Library*, O'Reilly Media, Inc., 2008
- Hamed Habibi Aghdam, Elnaz Jahani Heravi, *Guide to Convolutional Neural Networks: A Practical Application to Traffic-Sign Detection and Classification*, Springer, 2017
- 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

Course: **Neural Network and Fuzzy Logic**
Lecturer: Prof. Ass. Dr. Lavdim Kurtaj
Course status: Elective, Semester III, 5 ECTS

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.
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:

- S. Haykin, *Neural Networks: A Comprehensive Foundation*, Macmillan College Publishing Company, 1994.

- D. T. Pham, X. Liu, *Neural Networks for Identification, Prediction and Control*, Springer, 1995
- John H. Lilly, *Fuzzy Control and Identification*, Wiley, 2010
- F. L. Lewis, J. Campos, R. Selmic, *Neuro-Fuzzy Control of Industrial Systems with Actuator Nonlinearities*, Society for Industrial Mathematics, 2002
- Lakhmi C. Jain, N.M. Martin, *Fusion of Neural Networks, Fuzzy Systems and Genetic Algorithms: Industrial Applications*, CRC Press, 1998
- Cong Wand, David J. Hill, Deterministic Learning Theory for Identification, Recognition, and Control, CRC Press, 2010
- Ragav Venkatesan, Baoxin Li, *Convolutional Neural Networks in Visual Computing: A Concise Guide*, CRC Press, 2018
- Mohit Sewak, Md. Rezaul Karim, Pradeep Pujari, *Practical Convolutional Neural Networks: Implement advanced deep learning models using Python*, Packt Publishing, 2018
- Lili Mou, Zhi Jin, *Tree-Based Convolutional Neural Networks: Principles and Applications*, Springer, 2018

Course title: **Smart Grids**
Lecturer: Prof. Asoc. Dr. Qamil Kabashi, Prof. Ass. Dr. Vezir Rexhepi
Course status: Elective, Semester III, 5 ECTS

Short description of the content: Communication Technologies for Power System (Fiber Optical Networks, WAN based on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Zigbee). Information System for Control Centers (Configuration, ICCS communication Network, ICCS Time Synchronization, E-Commerce of Electricity, GIS, GPS). **Integration, Control and Operation of Distributed Generation** (Distributed Generation Technologies and its benefits, Distributed Generation Utilization Barriers, Distributed Generation integration to power grid). **Monitoring the smart grid** (Load dispatch centers, wide-area monitoring system (WAMS), PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering; smart grid system monitoring; communication infrastructure and technologies; self-healing. **Micro grid** (Integration of distributed energy sources; concept, operation, control and protection of Micro grid). **Hybrid Power Systems** (Integration of conventional and non-conventional energy sources).
The goals: The objective of this course is to make the future grid intelligent, efficient, accommodating, motivating, quality-based, resilient, responsive, and green.
Learning outcomes: After the completion of the course, the students will be able to:

- Explain various aspects of the smart grid, including, Technologies, Components, Architectures and Applications;
- Explain communication infrastructureof smart grid;
- Explain various integration aspects of conventional and non-conventional energy sources.
- Explain distributed generation coordination including monitoring of smart grid using modern communication infrastructure;
- Analyze Microgrid as a hybrid power system with advantages and challenges in future.

Teaching methodology: Lectures, Lab Experiments, study visits to local companies that generate energy from renewable sources, Lab report and presentation.
Evaluation methods: Seminar work (30%), Midterm exams 60%, Attendance 10%.
Concretization means: video projector, and the practical part will be realized in enterprises for the production of renewable energy (depending on the realization of agreements with them).
Ratio between the theoretical and practical part of teaching: 50:50
Literature:

- K. Iniewski, *Smart Grid Infrastructure and Networking*, The McGraw-Hill Companies, Inc., 2013.

- J. Momoh, *Smart Grid: Fundamentals of Design and Analysis*, IEEE Computer Society Press, 2012.
- J. Ekanayake, K. Liyanage, J. Wu, A. Yokoyama, *Smart Grid: Technology and applications*, Wiley Publications, 2012.
- S. Borlase, *Smart Grids: Advanced Technologies and Solutions*, 2nd Edition, CRC Press, 2017.

Course: Microelectronic Systems

Lecturer: Prof. Dr. Milaim Zabeli

Course: Elective, Semester III, 5 ECTS

Short course description: Methodology of design (top-down and bottom-up microelectronic design methodology and the use of modern CAD tools. Complex analog/digital modules(A/D and D/A converters, phase locked loops, phase detectors, complex filters, etc.). Modeling of microelectronic systems (description and simulations of mixed-signal microelectronic systems including sensors and actuators, simulations of microelectronic systems on different levels, tools for co-simulations). Parasitic effects (basics 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). Basics of testing microelectronic systems (basics of testability, BIST and reliability of microelectronic systems).

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, sensors and actuators. 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 apply methods of modelling, analysis, synthesis and simulations using CAD equipment appropriate for complex mixed signal analog-digital microelectronic systems.

Teaching methodology: 30 hours of lectures + 15 laboratory exercises. Approximately 80 hours of personal study and exercise including homework (seminary work).

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

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

Ratio between the theoretical and practical part: 40:60

Literature:

- P.J. Ashenden, "The systems designers guide to VHDL-AMS," Morgan Kaufmann publ., 2003
- R. Plasche, "Integrated Analog-to-digital and Digital-to-analog Converters," Kluwer Academic publishers, 2002
- F. Maloberti, "Data Converters, " Springer, 2007

Course: **Machine Vision** (2+0+1) 5 ECTS
Lecturer: Prof. Ass. Dr. Lavdim Kurtaj
Course status: Elective , Semester III, 5 ECTS

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.
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 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, discusions, 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:

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

- Richard Hartley, Andrew Zisserman, *Multiple View Geometry in Computer Vision*, Cambridge University Press, 2003
- Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis, and Machine Vision*, Nelson Education Limited, 2008
- Simon J. D. Prince, *Computer Vision: Models, Learning, and Inference*, Cambridge University Press, 2012
- Berthold K.P. Horn, *Robot Vision*, MIT Pess, 1986
- Gary Bradski, Adrian Kaehler, *Learning OpenCV: Computer Vision with the OpenCV Library*, O'Reilly Media, Inc., 2008
- Hamed Habibi Aghdam, Elnaz Jahani Heravi, *Guide to Convolutional Neural Networks: A Practical Application to Traffic-Sign Detection and Classification*, Springer, 2017
- 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

Course title: Acoustics of Speech and Music

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

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.
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: Serminars 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:

- Huang, X., Acero, A., Hon, H.-W. Spoken Language Processing – A Guide to Theory, Algorithm and System Development, Prentice Hall, 2001,
- Lawrence Rabiner, B H Juang, Fundamentals of Speech Recognition, 2005
- John N. Holmes, Wendy J. Holmes, Speech Synthesis and Recognition, 2nd Edition, 2010
- Ben Gold, Nelson Morgan, Dan Ellis, Processing and Perception of Speech and Music, 2nd Edition, 2011

Course: Computer Modeling of Physiological Systems

Lecturer: Prof. Dr. Sabrije Osmanaj
Course status: Elective, Semester III, 5 ECTS

Course description: Modeling approaches for physiological systems: levels of modeling, classification of models, descriptive models, explanatory models. Physiome. Relations to genomics, bioinformatics and computational biology. Fundamental principles, processes and tools in model development. Models of linear systems. Models of nonlinear systems: Volterra and Wiener series. Application of fundamental laws of electromagnetism, mechanics and thermodynamics to physiological systems. Physical properties of tissue (electrical, mechanical, thermal, optical etc.). Examples and applications.
Course objectives: Bringing together knowledge in physics, mathematics, theory of signals and systems, modeling techniques, physiology and anatomy, the course will develop the students ability to appreciate the importance and application of physiological models, to develop differential equations to describe the dynamic behavior of physiological systems, to simulate and visualize dynamic responses of physiological models using computers, to solve and implement physiological models.
Learning outcomes: On successful completion of the course, students will be able to:

- Bringing together knowledge in physics, mathematics, theory of signals and systems, modeling techniques, physiology and anatomy
- Ability to appreciate the importance and application of physiological models
- Developing differential equations to describe the dynamic behavior of physiological systems
- Simulating and visualizing dynamic responses of physiological models
- Solving and implementation of physiological models
- Applying physical properties of tissue (electrical, mechanical, thermal, optical

Teaching methodology: Lectures, Exams, Exercises, Consultations, Other forms of group and self-study.
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, laboratory equipped
Ratio between theoretical and practical part: Ratio between the theoretical and practical part is 1:1.

Literature:

- James W. Haefner, "Modeling Biological Systems: Principles and Applications, Springer; 2nd edition (May 6, 2005)

- Robert Plonsey, Roger C. Barr, " Bioelectricity: A Quantitative Approach, Plenum US, 2000.
- Vincent C. Rideout (1991). Mathematical and Computer Modeling of Physiological Systems; Prentice Hall, New Jersey
- David T. Westwick, Robert E. Kearney (2003). Identification of Nonlinear Physiological Systems, IEEE Press, Wiley
- Suresh R. Devasahayam, Signals and Systems in Biomedical Engineering: Signal Processing and Physiological Systems Modeling Springer; 2 edition (November 8, 2012)

Course: Energy and Environment
Lecturer: Prof. Dr. Sabrije Osmanaj, Prof. Ass. Dr. Vezir Rexhepi
Course status: Elective, Semester III, 5 ECTS

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 efficiencies. 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.
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:

- Student will be capable to assess what are the needs for energy.
- Student will be capable to calculate how much electric energy is transformed from the primary sources of energy.
- Student will be capable to assess what are the related consequences to the environment.
- Student will be capable to assess, how the electric energy is transmitted and distributes to the customers.
- The student will be capable to mathematically model 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:

- Richard Wolfson, Energy, Environment, and Climate (Third Edition), W. W. Norton & Company; Third edition (August 15, 2017)
- Robert Ristinen, Energy and the Environment, 3rd Edition, Wiley; 3 edition (December 21, 2015),
- Roger A. Hinrichs and Merlin H. Kleinbach, Energy: Its Use and the Environment, Cengage Learning; 5 edition (January 1, 2012)
- 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)
- Peter E. Hodgson, Energy, the Environment and Climate Change, Imperial College Press, 2010
- M. J. Moran, Adrian Bejan, Peter Vadász, Detlev G. Kröger (eds.), Energy and the Environment, SPRINGER-SCIENCE+BUSINESS MEDIA, B.V., 1999.
- Md. Rabiul Islam, Naruttam Kumar Roy, Saifur Rahman (eds.), Renewable Energy and the Environment, Springer, 2018,
- Standard Handbook for Electrical Engineers, The McGraw-Hill, 2006
- B. Sorensen, Renewable Energy, Fourth Edition, Elsevier Inc., 2010
- Renewable Energy Conversion, Transmission and Storage, Elsevier Inc., 2007
- S. Pryja, D. J. Inman, Energy Harvesting Technology, Springer, 2009

Course: Master Thesis
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.
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.