Electrical Engineering

Winter semester

Key to the list of courses:
L: Total number of lectures for the course
AP: Total number of auditory practices for the course
LP: Total number of lab practices for the course

Code	Subject	L	AP	LP	ECTS
64101	Mathematics I	60	45	0	9
64102	Physics I	60	45	0	8
64103	Fundamentals of Electrical Engineering I	60	30	15	8
64104	Introduction to Computer Programming	30	15	15	5
64111	Mathematics III	60	30	15	9
64112	Measurements	45	0	45	7
64125	Signal Processing	45	0	30	6
64126	Introduction to robotics	30	0	30	5
64127	Optoelectronics	30	0	30	5
64144	Linear Electronics	45	0	30	6
64145	Signals and Systems	45	15	30	7
64146	Electronic components	45	30	15	6
64155	Electric Power Networks and Devices	45	15	30	7
64156	Control Engineering	60	0	30	7
64157	Electric machines modeling	45	0	30	6
64166	Continuous signals and systems	45	45	0	7
64619	Modeling and simulation	45	0	30	6
64634	Development of digital systems	45	0	30	6
64640	Analog and Digital Electronics	45	0	30	5
64644	Technology of Materials	45	0	15	5
64651	Telecommunication Networks	30	0	30	5
64652	Communications electronics	45	0	30	5
64653	Microprocesor Systems inTelecommunications	30	0	30	5
64684	Computer tools	30	0	30	5
64685	Embedded Systems	45	0	30	5
64692	Telecommunication Engineering	45	0	30	5
64695	Telecommunication protocols	45	0	30	5
11105	Neurocybernetics	45	0	15	5.5
10318	Biomedical Signal Processing	45	15	30	7
10317	Medical Informatics and Diagnostics	45	15	30	7
10316	Measuring systems II (Automatic and virtual measurement systems)	45	15	45	7
10315	Robot sensing and artificial intelligence (Haptic robots)	45	15	15	6
10313	Artificial Intelligent Systems	60	15	0	6.5
10311	Multivariable systems	60	30	15	8
10266	Circuit Analysis and Optimization	45	15	30	7
10260	Robotics I (Robot kinematics and dynamics)	60	15	30	9
10136	Electrical Drives	60	30	15	7
10107	Integrated Circuits	60	30	15	7.5
10104	Biomechanics	45	15	45	7.5
10097	Robotics II (Robot mechanisms)	45	15	30	7
10091	Digital Computer Control of Processes	60	15	0	6.5
10038	Information Theory	45	15	15	6
10033	Control Systems II	45	15	0	5

Title: Analog and Digital Electronics
(Analogna in digitalna elektronika, 1.stopnja VS, 2.letnik)

Lecturer: doc. dr. Zajec Peter

Aim of the course:
Acquiring knowledge of the passive, discrete and integrated, linear and nonlinear components. Reparcelling the knowledge on the structure and optimal choice of sensors, transducers and their adaptation to other electronic systems from the viewpoint of applications in mechatronics.

Required (pre)knowledge:
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Contents:
Acquaintance with the characteristics of real electronic components and circuits. Deepen insight into the:

a) Review of passive and active components of electronic circuits in the field of power electronics and control technique. Linear and nonlinear resistors, capacitor. Pulse operation of passive components, the deviations of real components. Semiconductor discrete components (diodes, bipolar and unipolar transistors) in analog and digital circuits. The design and sizing of circuits and their performance evaluation.
b) Processing of analog signals with operational amplifiers. The basic linear and nonlinear circuits with operational amplifiers. Active filters, reference sources, voltages stabilizers in the analog version.
c) Digital logic circuits components. Basic logic gates, decoders, multiplexers, and others.
d) Discrete sensors for transducers. Static and dynamic characteristics. Criteria for selection of sensors applied for the design of complex sensor systems. Matching circuits, discrete and integrated components.
e) Systems integration of electronic sub-assemblies.

Selected references:
T.E. Price: Analog Electronics, Prentice Hall, London, 1997.
H. Bernstein: Sensoren und Messelektronik, München, Pflaum, 1998.

Title: Artificial Intelligent Systems

Lecturer: Prof. Nikola Pavešić, Asst. Prof. Simon Dobrišek

Aim of the course: Providing students with the knowledge and understanding of the principles and elements of artificial intelligent systems; extending their knowledge of pattern recognition and machine learning; getting them acquainted with computer tools and platforms for developing vital components of artificial intelligent systems.

Required (pre)knowledge: The basics of pattern recognition, machine learning, and computer programming.

Contents:

- Introduction to artificial intelligent systems: artificial intelligence, artificial perception, robots, intelligent agent, intelligent systems, ambient intelligence.

- Artificial neural networks: biological paradigm, multilayer perceptron, learning algorithms, Hopfield model, stochastic networks, Kohonen networks.

- Intelligent problem solving: problem decomposition and reduction, the basics of graph theory, graph representation of problems, graph search algorithms.

- Genetic algorithms: process optimizations, evolution, chromosome encoding, evolutionary programs.

- Classification and prediction: construction of decision and regression trees.

- Fuzzy logic and fuzzy sets: crisp versus fuzzy logic, fuzzy sets, fuzzy set operations, computing with words, written language classification.

- Expert systems: procedural and declarative knowledge, knowledge representation inference process, reasoning by chaining, knowledge processing systems.

- Multi-agent systems: intentional systems, intelligent agents, multi-agent systems, utility function, agent communication, multi-agent platforms, BDI programming.

- Knowledge representation in intelligent systems: propositional calculus, first-order predicate calculus, logical inference, logical programming, Prolog.

Selected references:

Russel S., Norvig P.: Artificial Intelligence, A Modern Approach (Third edition), Prentice Hall. 2010.
Bratko, I.: Prolog Programming for Artificial Intelligence (Third edition). Pearson Education, Addison-Wesley, 2001
Kasabov, N. K.: Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering, MIT Press, 1996.

Title: Biomechanics

Lecturer: Prof. Dr. Roman Kamnik

Aim of the course:
To familiarize students with fundamental laws of mechanics and to present how these can be applied to understanding and analyzing the living systems. The foundations of biomechanics that are developed in this course include the mechanics of materials and structures, fluid dynamics and locomotion, particularly those pertaining to sport and rehabilitation.

Required (pre)knowledge:
none

Contents:
Introduction (development of biomechanics trough history, approach to the research, fields of biomechanical research); Body analysis in static conditions (static analysis, analysis of elastic materials, deformations, strength of materials); Motion analysis (linear and angular kinematic analysis (position, displacement, velocity, acceleration), linear and angular kinetics (force, torque, Newton's laws of motion, inertial parameters, anthropometric parameters of human body, fluid dynamics), Mechanics of locomotion (human muscle and joint mechanics, standing, walking, running, rowing).

Practical work is predominantly related to measurements in sport biomechanics.

Selected references:
Huston RL, Principles of Biomechanics, CRC Press, Taylor & Francis Group, Boca Raton, 2009.
Chapman AE, Biomechanical Analysis of Fundamental Human Movements, Human Kinetics, Champaign, 2008.

Title: Biomedical Signal Processing

Lecturer: Prof. Dr. Tomaž Jarm

Aim of the course:
To learn about the origin, nature and specific characteristics of commonly encountered biomedical data and signals, to get insight into theoretical background of various methods for processing of stochastic signals, and to get practical experience in applying signal processing methods for extraction of clinically relevant information from biomedical data and signals.

Required (pre)knowledge:
Note that this is not an introductory course to signal processing. Solid knowledge of college mathematics and basic system theory and signal processing principles is therefore expected.

Contents:
Random variable, probability functions, random processes, moment functions. Parameter estimation from time-limited random signals. The principle of stationarity and ergodicity, assessment of stationarity of random signals. Power spectral density and its estimates based on classical (Fourier-based) and modern approaches (based on parametric modeling of random signals). Coherence and correlation. Parametric modeling of random processes. Sources and types of biomedical signals. Common electrophysiological signals and their general properties: EKG, EMG, EEG. Noise in biomedical signals and filtering. Optimal and adaptive filtering. Event and wavelet detection. Cepstrum and homomorphic deconvolution. Time-frequency analysis using short-time Fourier transform and wavelet transform.

Selected references:
H. Stark, J.W. Woods: Probability and random processes with applications to signal processing (3rd ed.). Prentice Hall, 2002.
L. Soernmo, P. Laguna: Bioelectrical signal processing in cardiac and neurological applications. Academic Press, 2005.
E.N. Bruce: Biomedical signal processing and signal modeling. Wiley-Interscience, 2001.
R.M. Rangayyan: Biomedical signal analysis: a case-study approach. Wiley-IEEE Press, 2001.
J.L. Semmlow: Biosignal and biomedical image processing: MATLAB-based applications. CRC Press, 2004.

Title: Circuit Analysis and Optimization

Lecturer: Prof. Dr. Tadej Tuma
Assistant: Assoc. Prof. Dr. Arpad Buermen

Aim of the course:
This is a compulsory course in the 1. semester of the Master's degree curriculum "Electronics". The aim is to introduce students to the theoretical background of analog circuit simulation. The course also involves laboratory work in the advanced field of circuit simulation and optimization with SPICE OPUS.

Required (pre)knowledge:
Basics in mathematics and analog circuits.

Lectures:
In three-hour weekly lectures the following themes are covered:

- Numerical methods in modern circuit simulation tools: Modified nodal equations, LU decomposition, Newton Raphson iterations for nonlinear circuits, integration algorithms for dynamic circuits, frequency domain and pole-zero analysis.
- Practical use of parametric optimization tools: Parameter identification, matching, cost function definition, overview of constrained and unconstrained optimization methods, penalty functions, design corners, mismatch analysis.

Laboratory work:
There are two-hour weekly sessions of laboratory work, where the following is covered:

- Introduction to the circuit simulator SPICE OPUS (group work).
- A comprehensive tutorial of all analyses types and output post-processing (group work).
- Introduction to the circuit optimization GUI with simple case studies (group work).
- The analysis or optimization of a selected analog case (individual project).

Examination:
The students have to complete and present their individual laboratory projects. Then they apply for an oral examination covering the lecture topics.

Selected references:

- T. Tuma, A. Buermen, Circuit Simulation with SPICE OPUS, Theory and Practice, Springer, 2009
- Webpage of analog circuit simulator SPICE OPUS (www.spiceopus.si)

Title: Communications electronics

Lecturer: assist. prof.dr. Matej Zajc, assist. prof. dr. Drago Strle

Aim of the course:

Understandingarchitecture and operation of fundamental electronic circuits in telecommunication and multimedia systems.

Required (pre)knowledge:
Circuits analysis, Electronics

Contents:

Analog circuits and systems: signal representations and characteristics, linear circuits, passive and active components, amplifier. Digital circuits and systems: number systems, elementary combinational and sequential logic.Overview of current semiconductor technologiesand semiconductor devices. Computer-aided design: electronic circuit analysis and design.

Analog electronic circuitsand analog systems building blocks.High-frequency electronics fundamentals.Digital electronic circuits and digital systems building blocks.Introduction to VLSI systems design:signal integrity fundamentals. Selected case studies: analysis of selected telecommunication and multimedia circuits and systems.

Selected references:

T. L. Floyd, Electronics Fundamentals: Circuits, Devices and Applications, Prentice Hall, 2003.
T. E. Price, Analog electronics, Prentice Hall, 1997
J. Wakerly, Digital electronics, Wiley, 2001.

Title: Computer tools

Lecturer: Asst. Prof. Dr. Marko Jankovec

Aim of the course:
To get acquainted with computer-aided electronic design tools and develop skills necessary to use computer tools in the process of design and implementation of electronic circuits and systems.

Required (pre)knowledge:
Computers, Programming, Basics of analog and digital electronics

Contents:
Introduction to graphical programming. Graphical programming languages, G-language, LabVIEW programming concepts. LabVIEW environment. Concept of Virtual Instrument (VI) and sub-instrument (SubVI). Program and data flow. Software constructs in LabVIEW. Programming VIs and functions. Error handling, VI editing and debugging. Memory, performance, and determinism. Design patterns of VIs and subVIs. LabVIEW mathematic and analysis functions. LabVIEW connection to physical world. Data acquisition systems. Automatic measuring environment.
The LABVIEW part of the course complies with National Instruments LabVIEW Academy program. The students that pass this course are granted to make a free of charge CLAD (Certified LabVIEW Associate Developer) exam.
Electronic design automation. Tools for analysis, simulation and optimization of electronic circuits. The structure of the SPICE program for simulation of electronic circuits. Textual and graphical interface. Basic analyses. Numerical methods for basic analyses. Advanced analyses. Models and model editor. Optimization of circuits. Modeling and simulation of digital circuits. Circuit simulation of mixed signals. Examples and laboratory exercises are performed using LT spice from Linear Technologies.
General information about tools for PCB design. Rules for design of electrical schemes. Net list. The organization and use of libraries. Printed circuit board design. Components layout and routing of printed circuit boards. Automatic generation of documentation. Signal integrity tools. Hardware and software co-design. Simulators and emulators, in-circuit debugging. Tools for automatic testing of electronic circuits. Examples and laboratory exercises are performed using Altium designer.

Selected references:

- Robert H. Bishop, Learning with Labview 7 Express, Pearson Prentice-Hall Int., 2004, ISBN 0-13-117605-6
- LabVIEW Core 1 and Core 2 Course Manual and Exercises, 2009.
- NI LabVIEW Academy Student Workbook, 2009.
- Laung-Terng Wang, Yao-Wen Chang, Kwang-Ting (Tim) Cheng, Electronic design automation : synthesis, verification, and test, 2009, ISBN: 978-0-12-374364-0
- Kenneth S. Kundert, The Designer's Guide to SPICE and Spectre, 1995. ISBN 0-7923-9571-9

Title: Continuous signals and systems

Lecturer: Prof. Dr. Andrej Košir

Aim of the course:
To provide knowledge about continuous electrical circuits and different techniques for analyzing electrical circuits. To provide basic knowledge of LTI systems and knowledge about analyzing linear system (including a selection of linear system phenomenon).

Required (pre)knowledge:
Analysis and calculus

Contents:
Definition, properties and limitations of a linear circuit. Characteristics of idela circuit components (resistor, inductor, capacitor..). Topological circuit description and associated methods (incidence matrix, reduced incidence matrix). Different circuit analysis methods, such as mesh analysis method and node analysis method. Duality and Tellegen’s theorem.
Introduction of polar coordinates, pointers and frequency. Calculating with pointers and converting back to time-based values. Basic circuit element characteristics with regards to frequency. Determining transmission functions.
Single-input circuits: Thevenin and Norton Equivalent Circuits. Maximum power transmission theorem, resonance.
Dual-input circuits: reciprocity theorem, Modeling circuit as a quadripole and determining different quadripole parameters (impedance-based, admittance-based, hybrid…). Calculating input impedance.

Continuous signals (definitions, presentation of different existing types, characteristic values). Using Fourier’s transform and Laplace’s transform to represent different signals. Continuous signal analysis (correlation and auto-correlation functions, amplitude and phase spectrum, energy and power spectrum).

Continuous systems (types, linear and time-independent systems, system functions, transmission function). Analyzing continuous systems using impulse respons and convolution. Analyzing continuous systems using Fourier sum and Fourier transformation. Analyzing continuous systems using Laplace’s transformation.

Selected references:
Y.S. Shamliy: Continuous-Time Singals, springer 2006
Desoer and Kuh: Basic Circuit theory, McGraw Hill, 1969
B. P. Lahti: Linear Systems and Signals, Oxford university press, 2005
P. D. Cha, J. I. Molinder: Fundamentals of Signals and Systems, Cambridge university press, 2006

Title: Control Systems II

Lecturer: Prof. Dr. Borut Zupančič

Aim of the course:
To broaden and deepen the knowledge of design and implementation of control systems

Required (pre)knowledge:
Mathematics, physics, basis of systems and signals, basis of control systems.

Contents:

Root locus analyse.

Analyse in frequency domain, Bode and polar plots, stability, Nyquist stability criteria, relative stability, frequency characteristics of closed loop systems.

Compensation, lead, lag and lead-lag compensators, design with root locus and Bode plots.

Analyse of control systems in state space. Trajectories, equilibrium points, Ljapunov stability criteria, canonical forms and transformations, observability and controllability.

Control design in state space, state controller, pole placement, state observer.

Selected references:

Ogata, K. : Modern Control Engineering, Fifth edition, Prentice Hall, 2010

Dorf, R.C, R.H. Bishop: Modern Control Systems, Eleventh edition,
Prentice Hall, 2008.

Univerzitetni dodiplomski študijski program 1. stopnje Elektrotehnika

Naslov:	**Regulacijska tehnika**
Letnik:	**3.**
Semester:	**zimski**
ECTS:	**7**
Predavanja (ur):	**60**
Avditorne vaje (ur):	**0**
Laboratorijske vaje (ur):	**30**

Title: Control Engineering

Lecturer: Prof. Dr. David Nedeljković

Aim of the course:
Student will master fundamental topics in the field of control engineering, with emphasis on linear systems. He will meet a variety of methods to design control systems and learn how to use these methods with state-of-the-art software tools.
Student will become aware of the modeling inadequacies and will develop a critical approach to design of control systems, especially in the field of power electronics and electrical drives.

Required (pre)knowledge:
Mathematics I-IV, Physics I-II, Electrical Engineering Fundamentals I-II, Measurements, Electrical Machines.

Contents:
Linear systems and their descriptions: differential equations, state space, Laplace transform and transfer function, frequency response (Bode, Nyquist, Nichols plots), step response.
Block diagrams, open-loop, closed-loop systems and corresponding transfer functions.
Linearization and normalization.
Stability, steady state error, dynamic error.
Features of elements of control systems in power electronics and electrical drives.
PID controllers, their realization with operational amplifiers and microcontrollers.
Optimization of controllers' parameters.
Cascade control systems, process control systems.
Features of digital control, Z-transform.
Influence of nonlinearities, limit cycles, integrator wind-up.
Basics of simulations and use of appropriate tools in control system design.
Examples of control systems in power electronics and electrical drives.

Selected references:
Gene F. Franklin, J. David Powell, Abbas Emami-Naeini: Feedback Control of Dynamic Systems, Addison-Wesley, 1994.
Dogan Ibrahim: Microcontroller Based Applied Digital Control: J. Wiley & Sons, 2006.
Werner Leonhard: Control of Electrical Drives, Springer; 2001.

Title: Development of digital systems

Lecturer: doc dr. Matej Možek, Prof. dr. Slavko Amon

Aim of the course:
To present the theoretical foundations of digital circuits and components used in electronic and computer systems. Acquire development methods and gain practical skills for designing contemporary digital systems using modern CAD tools.

Required (pre)knowledge:
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Contents:

Logic signals and gates with technology designs and characteristics, logic functions their simplification and realization. Analysis and structure of decision circuits: encoder, decoder, multiplexer, demultiplexer, comparators, adder, arithmetic logic unit, multiplier and divider.
Programmable circuits, its elements and realization of logic functions using programmable circuits. Synchronous circuits − introduction of time dependent state variables and implementation of memory cells.
Presentation of the characteristic equations and state transition diagrams. Analysis, description and design of asynchronous and synchronous sequential circuits (counter, register, LFSR). Finite state machines, model of synchronous machine (Mealy, Moore). Memory elements read-only and read/write - static and dynamic. Transducers, Input / output devices, Interfaces, Bus (parallel and sequential data transfer). Single−cycle−processor.

Selected references:

1. *Fundamentals of digital logic with VHDL design* / Stephen Brown, Zvonko Vranesic,.McGraw-Hill, 2005, ISBN 007-246085-7

2. *Logic and computer design fundamentals* / M. Morris Mano, Charles R. Kime. Upper Saddle River : Pearson Prentice Hall, 2007 ISBN 978-0-13-198926-9

3. *Digital design : principles and practices* / John F. Wakerly Upper Saddle River : Pearson/Prentice Hall, 2006 ISBN 0-13-186389-4

Title: Digital Computer Control of Processes

Lecturer: Prof. Dr. Drago Matko, Prof. Dr. Stanko Strmčnik

Aim of the course:
To broaden and deepen the knowledge of design of computer control systems.

Required (pre)knowledge:
Control elements, Control systems, Discrete systems, Identification.

Contents:

Introduction and review of digital control systems. Information structures for process control. Programmable logic controllers, hierarchical and distributed control. Discrete PID control algorithms and their implementations. Pole positioning. Compensation controllers. Minimal variance controllers. Observers. Kalman filter. Adaptive and robust control. Modern control algorithms. Expert systems. Fuzzy systems. Neural nets. Process interfaces. Design and implementation of process control.

Selected references:
Aström, Wittenmark; Computer Controlled Systems: Theory and Design (3rd Edition), Prentice Hall, 1996.
Isermann, Lachmann, Matko; Adaptive control systems, Prentice Hall, 1992.
Franklin, Powell, Workman; Digital Control of Dynamic Systems (3rd Edition), Ellis-Kagle 1997.

Title: Electric machines modeling

Naslov: Modeliranje električnih strojev (Univerzitetni študijski program 1. stopnje Elektrotehnika, smer: Energetika in mehatronika, letnik:3, semester:5, šifra predmeta: 35)

Lecturer: Prof. Dr. Damijan Miljavec

Aim of the course:

The aim of the subject is to upgrade theoretical knowledge and functional understanding of electrical machines. To prepare the students for independent synthesis and analysis of electric machines model circuits and their application to address steady state and transient electro-mechanical condition. To attain the ability to determine the circuit model parameters based on electromechanical testing of electrical machines. Upgraded theoretical knowledge of electrical machines will enable the students to design the electrical machines, integrate electrical machines in drive systems and using electric machines in mechatronic systems and power conversion.

Required (pre)knowledge:

Electric machines - basics

Contents:

The use of basic electromagnetic laws in description of electric machines (the energy in the magnetic field, energy conversion, force and torque). The electromagnetic properties of materials used in electrical machines. Magnetic and electric circuits' analogy used to describe electric machine.
The circuit models of transformers, DC machines, synchronous machines, brushless machines and induction machines. Steady state analysis of electric machines based on circuit models.
The general circuit theory used to describe electric machines and principles of models transformation.
Transformations of circuit models of synchronous machines, brushless machines and induction machines in to the models based on the general theory of electric machines. Addressing the steady state and transient electromechanical states of electric machines, described by the general theory of electric machines.

Selected references:

Chee-Mun Ong: **Dynamic simulation of Electric Machinery Using Matlab**, Prentice Hall, 1998

P. C. Krause, O. Wasynczuk, S. D. Sudhoff **Analysis of Electric Machinery and Drive Systems** IEEE Press, (2nd edition), 2002 (ISBN 047114326X)

P. C. Krause, O. Wasynczuk, S. D. Sudhoff: **Analysis of Electric Machinery** McGraw-Hill, 1986; Ponatis: IEEE Press, 1995

P. S. Bimbhra: **Generalized Theory of Electric Machinery**, Khanna Publishers, Delhi, 2004

Title: Electric Power Networks and Devices

Lecturer: Prof. Dr. Igor Papič

Aim of the course:
To acquire the knowledge of main elements and devices of electric power networks; to enhance the knowledge of modeling and parameters of electric power elements for mathematical analysis of power systems.

Required (pre)knowledge:
Fundamentals of electrical engineering

Contents:
Development of electric power networks and general division of power networks. Mechanical parameters of overhead power lines, construction of lines, and electrical parameters of overhead power lines.

Composition of high voltage power cables, construction of power cables, impedances of single-core and three-core cables. Loading criteria of power networks. Electrical parameters of two winding and three winding transformers, synchronous generators and induction machines.

Types of power substations with different implementations of switchyards. High voltage switching technology – circuit breakers and other switching devices.

Classical power factor correction devices, passive filters and reactors. Modern compensation devices with power electronics modules.

Distributed power sources and active networks.

Selected references:
Kiessling, F., Nefzger P., Nolasco J.F., Kaintzyk U., Overhead Power Lines: Planning, Design, Construction, Springer Verlag, 2003.
Papič I., Žunko P., Elektroenergetska tehnika I (Electric Power Engineering I), Založba FE in FRI, 2009.
Bergseth F.R., Introduction to Electric Energy Devices, Prentice Hall, 1988.

Slovenski naslov: Pogonski sistemi z elektromotorji
Študijski program: UNI študijski program elektrotehnike (stari program)
Letnik, semester: 4. letnik, 7. semester
Šifra predmeta: 10136

Title: Electrical Drives

Lecturer: Prof. dr. Rastko Fišer

Aim of course:
Student will be provided with the knowledge and procedures for design and maintenance of grid supplied and controlled electrical drives in industrial systems.

Required (pre)knowledge:
Fundamentals of Electrical Engineering, Electical machines, Power electronics.

Contents:
Components of electrical drive. Past, present and future trends in drive systems. Static and transient states of electrical drives. Characteristics of electric motors. Load characteristics. Moment of inertia. Stability problem of drive system.

Electric motors: DC (commutator and brushless) machines. Induction (slip ring, squirrel cage, solid rotor) machines. Synchronous (field winding, permanent magnet, reluctance) machines. Speed-torque characteristics, starting and breaking dynamics, classical and modern principles of speed and motion control. 4Q operation.

Methods for electric motors selection. Thermal conditions, cooling, duty cycles. Energy efficient motors and drive systems – technical and economical aspects. Reactive power compensation.

Special electrical drive systems: linear motor drives, ultra-high speed drives, drives for automotive applications, electrical traction system, electrical shaft, crane and elevator drives.

Protection of drive systems and power supply infrastructure. Motor thermal protection. Modern methods for predictive protection - condition monitoring and diagnostics of electrical drives.

Selected references:
1. B. Drury, The Control Techniques Drives and Controls Handbook, IET, 2009.
2. M. El-Sharkawi, Fundamentals of Electric Drives, Brooks/Cole, 2000.
3. N. Mohan, Electric Drives - An Integrative Approach, MNPERE, 2003.
4. M. Barnes, Practical Variable Speed Drives and Power Electronics, Newnes, 2003.
5. I. Boldea, S.A. Nasar, Electric Drives, CRC Press, London, 1999.
6. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press Taylor&Francis, 2010.
7. R. S. Carrow, Variable Frequency Drives, Delmar Thomson Learning, 2001.
8. A. Emadi, Energy-Efficient Electric Motors, Marcel Dekker, 2005.
9. A. M. Trzynadlowski, Control of Induction Motors, Academic Press, 2001.

Title: Electronic components

Lecturer: Prof. Dr. Slavko Amon, Doc. Dr. Matej Možek

Aim of the course:
To give understanding of basic effects, structures, technologies and applications of electronic components and sensors, and to provide methods and skills for realization of advanced electronic systems.

Required (pre)knowledge:
Basic courses in electrical engineering, mathematics and physics

Contents:
Standardization: Definition. Standardization Organizations. Review of Standards.

Reliability: Definition. Failure Rate. Mathematical models.

Aging: Definition. Degradation. Accelerated aging. Acceleration Factor. Determination of lifetime and activation energy of degradation.

Resistors: Introduction. Color Code. Tolerance classes. Renard scales. Maximal power dissipation and Nominal Power. Electrical-thermal problems analogy. Stability and longterm operation. Impulse operation. Temperature coefficient. Sheet resistivity. High frequency operation. Noise. Review of structures, properties and applications of resistor families.

Nonlinear resistors: NTC thermistors, PTC thermistors, Varistors – overview of basic effects, properties and applications.

Capacitors: Introduction. Basic effects in dielectrics. Dielectric polarization. Dielectric absorption. Real capacitor. Loss/heat dissipation. Equivalent circuit, loss factor and impedance. High frequency operation. Temperature coefficient. Breakdown. Review of structures, properties and applications of capacitor families: Paper, Plastic, Ceramic, Mica, Glass. Electrolytic - aluminum and tantalum, wet and dry(solid). Special structures: thin and thick film technologies, semiconductor technologies (PN-junction, MOS, thin film, ferroelectric).

Coils: Introduction. Basic effects. Magnetic domains. Magnetization. Initial and complex permeability. Analogy between electrical and magnetic circuits. Coils without cores. Improved expressions. Coils with ferrite core. Diagram of normalized losses. Core with a slot. C-factors. Effective permeability. Inductance factor. Resistance factor. Desaccomodation. Losses. Temperature coefficient. Coil design. Sinus and pulse transformer design.

Piezoelectric elements: Piezoelectric effects. Stress induced voltage. Piezoelectric actuators. Quartz crystals. SAW (Surface Acoustic Wave) devices.
Displays: Introduction. Types. Luminescence, phosphorescence, scintillation. Cathode ray tube. LED displays: types, equivalent circuits, power supply, smart display with decoder. LCD (Liquid Crystal Display): effects, structures, operation, power supply. Addressing(direct, passive and active matrix). Light sources (fluorescent bulb, LED). Electroluminescent displays. Fluorescent displays. Plasma displays. FED (Field Emission Displays). Touch Screens.
Switches and relays: Introduction. Types: electromagnetic, semiconductor, optoelectric (optocouplers).
Sensors: Introduction. Basic sensor parameters: Characteristics, Sensitivity, Accuracy, Resolution, Nonlinearity, Dynamic Response etc. Processing of sensor signals. Sensor systems: basic units (sensor, amplifier, filter, sample and hold circuit, A/D converter, microcomputer). Description of basic units. Basic sensor circuits based on operational amplifiers (inverting and noninverting amplifier, follower, integrator, differentiator, differential and instrumentation amplifier, adding amplifier). Converters. Sensor technology: microelectronic technologies and micromachining. Review of sensor families (resistance, capacitance, inductance, and voltage). Sensors of displacement, strain, pressure, acceleration, level and flow meters, temperature, ligh, color, energetic particles and radiation, moisture, gas and bio/chemical.

Selected references:
S.Amon, Elektronske komponente, Internetna stran (Home page), 2010

J.P.Bentley, Principles of Measurement Systems, Prentice Hall, ISBN 0 130 43028 5, 2005

P.Horowitz, W.Hill: The Art of Electronics, Cambridge University Press, 1997

J.W.Gardner: Microsensors, Wiley, 1995

Title: Embedded Systems

Lecturer: Prof. Dr. Tadej Tuma
Assistant: Assist. Prof. Dr. Janez Puhan

Aim of the course:
This is a compulsory course in the 5. semester of the Bachelor's degree curriculum "Applicative Electronics". It is an advanced course based on the course "Basic Microprocessor Electronics" from the 4. semester. The aim of this course is to introduce students to advanced embedded system architecture and programming.

Required (pre)knowledge:
Basic knowledge of digital structures, the course "Basic Microprocessor Electronics"

Lectures:
In three-hour weekly lectures the following themes are covered:

- Short overview and a quick recap of the course "Basic Microprocessor Electronics" from the previous semester.
- External microcontoller bus: address bus design, complete/incomplete, symmetric/asymmetric, implicit/explicit, static/dynamic decoding schemes.
- Memory with serial/direct/random access, cache memory.
- Central processing unit: command pipelines, registers, stack, interrupts, machine coding.
- The principle of time slicing and the consequences: Preemptive and non-preemptive context switching, performance assurance, assembly language level vs. C level, multi-stack structures, stochastic interrupts, response time analysis and scheduling.

Laboratory work:
There are two-hour weekly sessions of laboratory work, where the following is covered:

- Introduction to the development prototype system S-ARM.
- Connecting peripherals to the microcontroller (group work).
- Designing and presenting a selected embedded system (individual project).

Examination:
The students have to complete and present their individual laboratory projects. Then they apply for an oral examination covering the lecture topics.

Selected references:

- J. Puhan, T. Tuma, Introduction to Microcontroller Systems – Architecture and Programming, Založba FE/FRI, 2007, (PDF)
- Webpage of the development system S-ARM (www.s-arm.si).
- LPC213xx Users Manual, Philips, 2005, (PDF).

Title: Fundamentals of Electrical Engineering I

Lecturer: Assist. Prof. Dr. Iztok Humar (VSP), Assoc. Prof. Dr. Anton R. Sinigoj (UNI),

Aim of the course:
To acquire fundamental knowledge on electrostatic field, current field and DC electric circuits.

Required (pre)knowledge:
Physics, Mathematics (secondary school level), Final/Matura Exam

Contents:
Electric charge and current. Charge distributions. Electric current density. Conservation of charge. Continuity equation. Kirchhoff's current law.
Electric force. Coulomb's law. Electric field. Electric field strength. Gauss law of electric field. Work of electric force. Electric potential energy. Electric potential. Voltage. Kirchhoff's voltage law. Electric dipole. Conductor and electric field. Electric influence. Image theory. Dielectric material and electric field. Electric polarization. Electric flux, Electric flux density. Dielectric permittivity. Boundary conditions of electric field. Dielectric breakdown. Capacitance. Capacitor. Partial capacitances. Electric field energy. Forces and torques. Capacitor circuits.
Current field. Ohm's law. Joule's law. Specific electric conductivity. Boundary conditions of current field. Resistance and conductance. Grounding resistance. Resistor. Non-linear resistor. Voltage-Current characteristic. Voltage and current sources. DC electric circuits. Analyses and theorems.

Selected references:

Duffin W. J.: Electricity and magnetism, McGraw-Hill, London, 1990.
Notaros B.M.: Electromagnetics. Pearson Education. 2010.
Halliday D, Resnick R., Walker J., Fundamentals of Physics, Wiley, 1997.
Popović D. B.: Osnovi elektrotehnike 1 in 2, Građevanska knjiga, Beograd, 1986.
Purcell E. M.: Electricity and magnetism, McGraw-Hill, New York, 1965.
Albach M.:Grundlagen der Electrotechnik, Pearson Studium, Muenchen, 2005.
Web page: http://torina.fe.uni-lj.si/oe/

Title: Information Theory

Lecturer: Prof. Nikola Pavešić

Aim of the course: The objective of this course is to introduce the most important concepts and methods of information theory, source coding, secrecy coding, and channel coding.

Required (pre)knowledge: Basic knowledge of mathematical analysis, algebra and probability theory.

Content:

- Introduction: definition of information, code, coding and communication system.
- Entropy: entropy of a discrete random process, entropy of a discrete variable, entropy of a continuous variable.
- Information: average information, mutual information of two discrete variables, mutual information of two continuous variables.
- Discrete information sources: entropy of stationary source, ergodic stationary sources, memoryless sources, sources with memory, redundancy.
- Information source coding: fixed-length and variable-length coding, Kraft – McMillan inequality, Huffman code, arithmetic code, LZW code.
- Secrecy coding: cryptosystems with secret key, DES and AES cryptosystems, cryptosystems with public key, RSA cryptosystem, digital signature.
- Communication channels: continuous communication channels and their capacity, discrete communication channels and their capacity, error-detecting codes, error-correcting codes, optimal decoding, Shannon theorem of secure coding, inversion of Shannon theorem.
- Channel coding: linear block codes, cyclic codes, Hamming codes, Golay codes, convolutional codes, Turbo codes.

Selected references:

Roberto Togneri, Christopher J. S. deSilva*: Fundamentals of information Theory and Coding Design*, Chapman & Hall / CRC, 2002.
Douglas R. Stinson: *Cryptography, Theory and Practice*, Chapman & Hall / CRC, 2002.

Title: Integrated Circuits

Lecturer: Prof. Dr. Andrej Zemva

Aim of the course:
To broaden and deepen the knowledge of design and implementation of integrated circuits.

Required (pre)knowledge:
Semiconductor devices, Digital techniques, Electronics.

Contents:

Introduction to integrated circuits, evolution of complexity, performance and power consumption. Inverter: operation and properties, static CMOS inverter, performance and reliability. Design of combinational circuits in different technologies: static CMOS circuits, dynamic CMOS circuits, pass-transistor gates. Design of sequential circuits: static sequential circuits, dynamic sequential circuits. Design of arithmetic logic blocks: adders, mutipliers, shifters. Memory classification, memory architectures and building blocks. Memory core, memory peripheral circuitry. Memory classes and their implementation.

Case studies of design and implementation: digital camera, JPEG encoder, MPEG4 decoder, controller circuits, datapath logic.

Selected references:

J. Rabaey, A. Chandrakasan, B. Nikolic, Digital Integrated Circuits: A Design Perspective, Prentice Hall, 2003.
D. A. Johns, K. Martin: Analog Integrated Circuits, John Wiley and Sons, Inc., 2007.

Title: Introduction to Computer Programming

Lecturer: Prof. Dr. Iztok Fajfar

Aim of the course:
To master basic computer programming skills

Required (pre)knowledge:
Basic computer skills (Windows or similar OS)

Contents:
Students learn basic elements of a typical high-level programming language using JavaScript as a concrete example. As JavaScript typically relies on a certain environment to provide the ability to include or import scripts, we first learn some HTML in which JavaScript scripts will run.

Then we move to basic computer program elements such as variables, expressions, statements, control structures and functions. In order to help understand the logic behind algorithm development we support our first steps using flow chart representations of few solutions to simple real-world problems.

JavaScript Object Oriented Features provide user with some simple yet effective tools to develop dynamic web pages. This is not the focus of our course, nevertheless we cover some of the features in order to make learning more realistic and thus appealing.

In order to be able to interact with user input or to use timers we learn about events and event handling, which leads us to the basic multitasking concepts.

As we move along, we soon find ourselves frustrated with some hard-to-detect syntax or run-time errors (bugs) in our programs. Basic debugging tools and techniques are therefore discussed and used throughout the course.

Selected references:

- W3 Schools Web Page (www.w3schools.com)
- John Pollock: JavaScript: A Beginner's Guide, Osborne McGraw-Hill, 2003
- James Jaworski: Mastering JavaScript, SYBEX, 2001
- T.H. Cormen: Introduction to Algorithms, MIT, 2001
- Steve S. Skiena: The Algorithm Design Manual, Springer-Verlag, 1998

1st degree University program ELECTRICAL ENGINEERING

Title: Introduction to robotics

Lecturer: Prof. Dr. Tadej Bajd

Aim of the course: To acquire thorough knowledge of geometry of bodies which is not only useful in robotics, but also in computer vision, virtual environments and computer graphics; To learn how to program advanced industrial robots.

Required (pre)knowledge:
none

Contents:
Rotation and orientation (quaternions); Pose (position and orientation) and displacement (translation and rotation); Homogenous transformation matrix; Geometrical model of robot (Denavit Hartenberg parameters); Direct robot model; Inverse robot model.

Selected references:
Bajd T, Mihelj M, Lenarčič J, Stanovnik A, Munih M: Robotics, Springer, 2010
Sciavico L, Siciliano B: Modeling and Control of Robot Manipulators, Springer, 2002

Title: Linear Electronics

Lecturer: Asst. Prof. Dr. Arpad Bűrmen

Aim of the course:

To attain basic knowledge of linear electronic system analysis and design.

Required (pre)knowledge:
Fundamentals of electrical engineering, fundamentals of nonlinear electronic devices, complex numbers, linear algebra, calculus.

Contents:
Modeling of linear electronic systems. Voltage, current, and power gain. Input and output admittance. Active/passive linear electronic systems and stability. Systematic approach to writing down circuit equations.

Modeling of nonlinear electronic components, Operating point of nonlinear electronic systems. Small-signal circuit model. Bipolar junction transistor orientations: common emitter, common collector, and common base. Unipolar transistor orientations: common source, common drain, and common gate. Darlington pairs, cascode amplifier, and differential amplifier.

Transfer function. Zeros and poles of a linear system. Bode diagram. Frequency-domain characteristics of linear circuits resulting from external capacitances. Nonlinear capacitances in linear electronics. Hybrid pi-model of bipolar and unipolar transistors. Miller transformation. Frequency-domain characteristic resulting from charge storage in transistors.

Linear feedback systems. Feedback in linear electronics. Frequency-domain characteristics of feedback systems. Stability and Nyquist criterion. Phase and gain margin.

Sine wave oscillators. Transient response and the poles of a linear system. Conditions for oscillation startup and stable oscillation. Barkhausen criterion for stable oscillation. Analysis of oscillator circuits.

Selected references:
Burns, Stanley G., Bond, Paul R., Principles of electronic circuit, PWS Publishing company, 1997.
Green, D.,C., Electronics, Logman group Limited, London, 1995.
Hambley, Allan,r., Electronics, Macmillan Publishing Company, 1994.
Tuma, T., Bűrmen, A., Circuit simulation with SPICE OPUS: Theory and Practice, Birkhäuser, Boston, 2009.

Title: Mathematics 1

Lecturer: Prof. Dr. Gregor Dolinar

Aim of the course:
Students acquire and broaden the understanding of the basic concepts of mathematical analysis. They develop analytical thinking skills. The acquired knowledge is indispensable for the study of electrical engineering.

Required (pre)knowledge:
Basic undergraduate mathematical knowledge.

Contents:
Number sets: natural numbers, integers, rational numbers, real numbers, complex numbers, mathematical induction.
Sequences: convergent sequences / limit of a sequence, bounded sequence.
Series: partial sum of the series, convergence, convergence tests, alternating series.
Functions: domain and the codomain, image, odd and even functions, injection, surjection, bijection, function composition, inverse function, elementary functions, limit, continuous function.
Derivative: differentiation rules, geometric interpretation, differential, applications of derivatives.
Integral: indefinite and definite integral, methods for computing integrals, applications of integrals.

Selected references:
G. B. Thomas: Thomas' Calculus, Pearson Education, 2005

Title: Mathematics 3

Lecturer: Prof. Dr. Gregor Dolinar

Aim of the course:
Students broaden the understanding of the basic concepts of mathematical analysis, procedures and rules. They apply the knowledge of these concepts to technical problems. They develop analytical thinking skills and critical reasoning.

Required (pre)knowledge:
Mathematics 1, Mathematics 2

Contents:
Differential geometry: space curves (parametrization, tangent vector, length), surfaces (parametrization, coordinate curve, normal vector).
Multiple integrals: integrals with parameters, double and triple integrals.
Vector analysis: directional derivative, gradient, divergence, curl, nabla operator.
Line and surface integrals: Green's theorem, Gauss's theorem, Stokes's theorem.
Complex analysis: analytic functions, elementary complex functions, integral of a complex function, Cauchy's integral formula, Laurent series, residue theorem, conformal maps.

Selected references:
E. Kreyszig: Advanced engineering mathematics, John Wiley & Sons, 2006
G. B. Thomas: Thomas' Calculus, Pearson Education, 2005

1st degree University program ELECTRICAL ENGINEERING

Title: Measurements

Lecturer: Prof. Dr. Janko Drnovšek, Prof. Dr. Dušan Agrež

Aim of the course:
To study the fundamentals of metrology and metrological systems; To introduce the basic principles of measurement of most important quantities in engineering; To learn the approaches and methods of measurement of basic electric quantities; To extend the concepts of measurement and comprehension and interpretation of the measuring results; Besides its theoretical aspects it helps the preparation for laboratory practices.

Required (pre)knowledge:
None

Contents:
Fundamental principles of measurement and information content of signals; Measuring accuracy and uncertainty; Measurement of electrical quantities; Application of basic measuring instrumentation; Measurement of non-electrical quantities.

Selected references:
Morris A.S., Measurement and Instrumentation Principles. Oxford: Butterworth-Heinemann, 2001.
Tumanski S., Principles of Electrical Measurement, Taylor & Francis, CRC Press, 2006.
Evaluation of measurement data - Guide to the expression of uncertainty in measurement (GUM 1995 with minor corrections), International Organization for Standardization, 2008 (http://www.bipm.org/en/publications/guides/gum.html).
Agrež D., Begeš G., Geršak G., Batagelj V., Hudoklin D., Meritve - laboratorijske vaje (ver. 1), University of Ljubljana, Faculty of Electrical Engineering, 2010.

2^{nd} degree: ROBOTICS

Title: Measuring systems II (Automatic and virtual measurement systems)

Lecturer: Prof. Dr. Janko Drnovšek, Prof. Dr. Jovan Bojkovski

Aim of the course:
To get acquainted with communication interfaces; To study the requirements of digital signal analysis from the measurement point of view; To learn about the automation of measurements in industrial and research development environments; To learn the details of virtual measuring instruments and their usefulness

Required (pre)knowledge:
Measurements, Measuring instrumentation

Contents:
Structure of automated and virtual measuring systems; Quantization in analog-digital conversion; Communication interfaces; Software and development tools for automation of measurements; Application of data bases in automatization of measurements; Hardware; Quality of software in measurements

Selected references:
Morris, AS: Measurement and Instrumentation Principles, Oxford: Butterworth-Heinemann, 2001
Regtien PPL: Measurement Science for Engineers, London, Sterling: Kogan Page Science, 2004

Title: Medical Informatics and Diagnostics

Lecturer: Prof. Dr. Boštjan Likar

Aim of the course:
To understand the process of acquisition, enhancement, manipulation, processing and analysis of medical data and information for automated computer-aided diagnosis.

Required (pre)knowledge:
Physics, Mathematics, Programming skills

Contents:
Introduction to the field of biomedical informatics, systems and devices for the acquisition of biomedical images, techniques for visualization, manipulation and compression of multidimensional data, processing and analysis of biomedical images, methods for pattern recognition and computer-aided diagnosis.

Selected references:
Biomedical Informatics. Computer Applications in Health Care and Biomedicine. E.H. Shortliffe, J.J. Cimino (Eds.), Springer, 2006.
Medical Imaging Signals and Systems, Jerry L. Prince, Jonathan Links, Prentice Hall, 1st edition, 2005.
Medical Informatics. Knowledge Management and Data Mining in Biomedicine. H. Chen, S.S. Fuller, C. Friedman and W. Hersh (Eds.), Springer, 2005.

Title: Microprocessor Systems in Telecommunications

Lecturer: Asst. Prof. Dr. Arpad Bűrmen

Aim of the course:

To attain basic knowledge of microprocessor systems in telecommunication.

Required (pre)knowledge:
Fundamentals of electrical engineering, digital structures, digital techniques, C, JavaScript, HTML.

Contents:
History of computing. Basics of digital circuits and microprocessors. Coding of integer numbers. Operations with integers. Machine language and the execution of programs in machine language. Components of a microprocessor from programmer's point of view. Communication in microprocessor-based systems. Building blocks of microprocessor based-systems. Interrupts. Programming, compilation, and program execution. Uploading and debugging a program. Microcontrollers. Embedded systems. Digital signal processors. Floating point numbers. Network processors. Introduction to cryptography. Operating systems and multitasking. Real-time systems.

Selected references:
LPC213x User Manual, Philips, 2005, PDF file.
A.Clements: The Principles of Computer Hardware, Oxford University Press, 1999.
D. Seal: ARM Architecture Reference Manual, Addison-Wesley, 2000.
A.P.Godse, D.A.Godse: Advanced Microprocessors, Technical Publication Pune, 2009.
P. Lekkas, Network Processors: Architectures, Protocols and Platforms, McGraw-Hill, 2003.
P. Lapsley, DSP Processor Fundamentals: Architectures and Features, Wiley, 1997.

Title: Modeling and simulation (VSP-I-2-3-A)

Lecturer: Assoc. Prof. Dr. Maja Atanasijević-Kunc

Aim of the course:

To present basic knowledge regarding modeling and simulation of continuous, dynamical systems.

Required (pre)knowledge:

Basic course of mathematics, basic course of physics.

Contents:

Description of model classification, approaches to modeling, cyclic modeling procedure, model verification and validation. Survey of mathematical model descriptions, transformations and system analysis.

Introduction to continuous systems simulation principals and basic simulation schemes development. Matlab and Simulink usage description.

Presentation of simple identification approaches and model optimization.

Theoretical modeling, description of analog systems and their importance regarding system engineering. Illustration examples from electrotechnics, mechanics, hydraulics, pneumatics and termodynamics.

Case studies of design using laboratory pilot plants.

Selected references:

François E. Cellier: Continuous System Modeling, Springer-Verlag, New York, 1991.

François E. Cellier, Ernesto Kofman: Continuous System Simulation, Springer Science + Business Media, New York, 2006.

Drago Matko, Rihard Karba, Borut Zupančič: Simulation and modelling of continuous systems, A case study approach. New York: Prentice Hall, 1992.

Title: Multivariable systems (UNI-I-5-9-A)

Lecturer: Assoc. Prof. Dr. Maja Atanasijević-Kunc

Aim of the course:

To present some important aspects regarding the presentation, analysis and control design of multivariable dynamical systems, representing a special class of dynamical systems with multi - inputs and multi - outputs.

Required (pre)knowledge:

Mathematics, Modeling and simulation, Basics of control design of single – input and single - output systems.

Contents:

Survey of multivariable systems (examples, mathematical presentations and transformations, important differences and parallelisms regarding SISO systems).

Analysis of MIMO systems, extensions to computer aided concepts using Matlab with toolboxes, description of important quality criterion in time and frequency domain.

Presentation of selected control design approaches:

- transitions from SISO techniques, parallelisms to SISO techniques,
- controller tuning,
- optimization in time and frequency domain,
- decoupling,
- INA method (inverse Nyquist array and diagonal dominance),
- pole placement,
- observer design.

Case studies of design using laboratory pilot plants and e-learning facilities.

Selected references:

R. V. Patel, and N. Munro, Multivariable Systems Theory and Design, Pergamon Press, Oxford, 1982

J. M. Maciejowski, Multivariable Feedback Design, Addison - Wesley Publishers Ltd., 1989.

M. Morari and E. Zafiriou, Robust Process Control, Prentice-Hall International, Inc., 1989.

S. Skogestad, and I. Postlethwaite, Multivariable Feedback Control, Analysis and Design, John Wiley and Sons Ltd, Chichester, 2005.

Qing-Guo Wang, Zhen Ye, Wen-Jian Cai, Chang-Chieh Hang: PID Control for Multivariable Processes (Lecture Notes in Control and Information Sciences), Springer - Verlag, Berlin, 2008.

Title: Neurocybernetics

Lecturers: Prof. Dr. Damijan Miklavčič, Prof. Dr. Alenka Maček-Lebar

Aim of the course:
To understand the fundamental role of the mammalian nervous system: gathering information from sensory inputs, which detect signals from external environment or internal organs and analyzing them in order to choose the required type of response.

Required (pre)knowledge:
Basic knowledge of system theory and signal processing methods is expected.

Contents:
Nervous system: structure, major divisions of the vertebrate nervous system, structure of a typical neuron. Nernst equation, transmembrane voltage and resting potential, action potential development, action potential propagation. Synapses, neurotransmitters. Formal neuron, neural networks. Muscles, Hill equation, the process of muscle fatigue, cardiac muscle, smooth muscles. Sensory receptors, sensory organs, perception. Pain. Reflex action. Sensory integration, sound and visual patterns and their recognition. Memory, learning, brain functions. Neuroprosthetics, electronic devices that replace human body parts.

Selected references:
S. Deutsch, A. Deutsch: Understanding the nervous system An engineering perspective. Wiley-IEEE Press; 1993.
A. C. Guyton, J. E. Hall: Textbook Of Medical Physiology. W.B. Saunders Company: 10th edition; 2000.
G. Knoblich, I.M. Thornton , M. Grosjean, M. Shiffrar: The human body. Perception from the inside out. Oxford University Press; 2005.
J. Keener, J. Sneyd: Mathematical Physiology, Springer 1998.

Title: Optoelectronics

Lecturer: Assoc. Prof. Dr. Janez Krč

Aim of the course:
To acquire and deepen the knowledge of optoelectronic and photovoltaic devices and technologies

Required (pre)knowledge:
Principles of semiconductor devices, physics, electronics

Contents:
Theory of light.
Radiometry and photometry.
Colours and colour spaces.

Interaction of light with semiconductors. Light absorption, light emission.

Detection of light: principles of detection, photo-detectors, colour-detectors. CCD, CMOS and amorphous silicon detector arrays. Digital cameras.
Light sources. LEDs and LDs. Displays.
Systems with optical fibers. Photonic crystals. Biomedical photodetectors.

Photovoltaics: Solar spectrum. Conversion of solar energy to electricity. Operation of a solar cell. Types and structures of solar cells. Current conversion efficiency tables. State-of-the-art technological trends. Optical design of thin-film solar cells. PV modules. PV systems and power plants. Environmental and economical aspects of photovoltaics.

Selected references:
S. O. Kasap, Optoelectronics and Photonics: Principles and Practices, Prentice Hall, 2001.
D. Malacara, Color Vision and Colorimetry – Theory and Applications, Spie press, 2002.
W. J. Smith, Modern Optical Engineering, Mc-Gray Hill books, 2008.
A. Luque, S. Hegedus, Handbook of Photovoltaic Science and Engineering, John Wiley & Sons Ltd., 2006.

Title: Physics 1

Lecturers: Tomaž Gyergyek, Miha Fošnarič

Aim of the course:
To broaden the basic understanding of physical phenomena required for engineering practice.

Required (pre)knowledge:
Basic knowledge of high-school mathematics.

Contents:
Basics of Scientific Measurements, Errors and Uncertainty, Kinematics, Dynamics, Gravitation, Linear Momentum, Angular Momentum, Torque, Work, Energy, Oscillatory Motion, Wave Motion, Sound Waves, Basics of Thermodynamics, The Kinetic Theory of Gases, Heat Engines, Entropy, Phase Transitions.

Selected references:
R.A. Serway and J.W. Jewet: Physics for scientists and engineers with modern physics, Brooks Cole Publishing, 2010
D.C. Giancoli: Physics for scientists and engineers with modern physics, Prentice Hall, 2008
D. Halliday, R. Resnick, J. Walker: Principles of Physics, John Wiley, 2010

2nd degree: ROBOTICS

Title: Robot sensing and artificial intelligence (Haptic robots)

Lecturer: Prof. Dr. Matjaž Mihelj

Aim of the course: To get acquainted with the usage of robots in direct contact with human; Understanding of the human responses to synthetic haptic inputs; To use the knowledge gathered in teleoperation systems and medical and rehabilitative robot systems

Required (pre)knowledge:
none

Contents:
Introduction into virtual reality; Introduction into haptics; Human haptic system; Haptic interfaces; Haptic detection of contact; Haptic presentation of contact; Control of haptic interfaces; Stability of haptic interfaces; Teleoperation; Micro/Nanomanipulation

The teams of students work with several different advanced haptic robots. The concept of projects is interdisciplinary, so that each student is solving particular problem of human-robot interaction

Selected references:
Burdea G, Coiffet P, Virtual Reality Technology, Wiley, 2003
Burdea G: Force and Touch Feedback for Virtual Reality, John Wiley & Sons, 1996

2nd degree: ROBOTICS

Title: Robotics I (Robot kinematics and dynamics)

Lecturer: Prof. Dr. Marko Munih

Aim of the course: To learn basics of kinematics, statics and dynamics of robot mechanisms; To examine the coupling of particular variables from the aforementioned areas in real robot mechanisms; To use the equations relating those variables.

Required (pre)knowledge:
Introduction to robotics

Contents:
Differential displacements; Jacobian matrix of robot manipulator; Statics in robotics; Lagrangian dynamics of rigid robot; Newton Euler dynamics of rigid robot; Properties of dynamic robot models.

The students test the interactive influences between various variables from the areas of kinematics, statics, and dynamics in real robot mechanisms. Practical work runs in smaller groups with advanced robot mechanisms.

Selected references:
Sciavico L, Siciliano B: Modeling and Control of Robot Manipulators, Springer, 2002
Sciavico L: Modeling and Control of Robot Manipulators: Solutions Manual, The McGraw – Hill Companies, Inc., New York, 1995
Choset H, Lynch KM, Hutchinson S, Kantor G, Burgard W, Kavraki LE, Thrun S: Principles of robot motion, MIT Press, 2005.

2nd degree: ROBOTICS

Title: Robotics II (Robot mechanisms)

Lecturer: Prof. Dr. Tadej Bajd, Prof. Dr. Jadran Lenarčič, Prof. Dr. Roman Kamnik

Aim of the course: To become cognizant of advanced robot mechanisms, such as parallel robots, multi-fingered hands, redundant systems and humanoid robots.

Required (pre)knowledge:
Introduction to robotics

Contents:
Redundant mechanisms; Parallel mechanisms; Robot contact; Robot grasp; Tendon systems; Humanoid robots.

Students work in laboratory with redundant systems (e.g. mobile robot with manipulator), robot grippers, measuring gloves and humanoid robots.

Selected references:
Bajd T, Lenarčič J: Robotski mehanizmi (Robot mechanisms), Založba FE in FRI, Ljubljana, 2009 (English translation available)

Title: Signal Processing

Lecturer: Prof. France Mihelič

Aim of the course: Providing students with the knowledge of different signal types and descriptions and processing methods.

Required (pre)knowledge: The basics of mathematical analysis, algebra and probability theory.

Contents:

- Introduction: basic definitions, short history of the signal processing theory, position of the signal processing theory in electrotechnical and other sciences.
- Signals classification: signals with finite energy and finite average power, periodical a-periodical, deterministic and random signals.
- Signals representations: the use of the signals representations, types of representations and representations, quality measures, examples of basic function sequences.
- Frequency analysis: Fourier series and Fourier transform.
- Random signals: approaches to the random signal processing, stationary random process, correlation and covariance functions, sampling and time averages, ergodicity.
- Signals correlation and convolution: correlation and convolution definitions and properties for different types of signals, similarity measures, random signal spectrum evaluations, convolution and linear stationary systems, detection of periodic components in combinations of signals.
- Sampling and quantization: purpose of the sampling and quantization, sampling theorem, representation of sampling and reconstruction, types of quantization, quantization error signal and its properties, quantization examples.
- Digital signal processing: discrete Fourier transform.

Selected references:

Haykin , S. S., Van Veen , B.: Signals and Systems, Wiley, 2003.
Phillips, C. L., Parr, J. M., Riskin, E. A.: Signals, Systems and Transforms, Prantice Hall, 2003.
Gray, R. M., Davisson, L. D.: An Introduction to Statistical Signal Processing, Cambridge University Press, 2004.
Ifeachor, E. C., Jervis, B. W.: Discrete transforms, Digital Signal Processing - A practical Approach, Prentice Hall, 2002.

Title: Signals and Systems

Lecturer: Prof. Dr. Franc Smole

Aim of the Course:
To recognize various signal forms and methods for their description and processing. To acquire basic knowledge about systems theory, which enables systematic analysis and design of the systems. To learn about the use of modern computer tools for systems analysis and simulation. To present the implementation of basic systems theory into systematic solutions for analysis and design of electric circuits and filters.

Required (pre)knowledge:
Basic knowledge of electrical engineering and mathematics

Contents:
Classification of signals and systems. System modeling concepts, input-output description, linearity, time-invariance, causality. Unit impulse and unit step response. Superposition and convolution integrals. Fourier and Laplace representation of signals. Laplace transforms and system functions. Frequency responses, responses of systems to periodic signals. Bode plots, polar plots. Interconnections of systems. Linear feedback systems. The Nyquist stability criterion. Gain and phase margins. State-variable concepts. Form of the state equations. Time-domain and frequency-domain solution of the state equations. Finding the state transition matrix. State equations for electric circuit. Circuit topology and general circuit analysis. Continuous-time filters. Distortionless transmission. Ideal filters. Approximation of ideal filters. Frequency transformations. Properties and synthesis of passive networks. Basics of active filters. Biquad circuits. High-order active filters. Active simulation of passive filters. Switched-capacitor filters.

Selected references:
R. D. Sturm, D. E. Kirk, Contemporary Linear Systems Using MATLAB, BookWare companion series, 1999.
Douglas K. Lindner, Introduction to Signals and Systems, WCB/McGraw-Hill, 2003.
C. L. Phillips, J. M. Parr, Signals, Systems, and Transforms, Prentice Hall, 2007.
K. L. Su, Analog Filters, Kluwer Academic Publishers Group, 2010.
Rolf Schaumann, Mac E. Van Valkenburg, Design of analog filters, Oxford University Press, 2003.

Slovenski naslov: Tehnologija materialov
Letnik, semester: 2. letnik VSP Aplikativna elektrotehnika (ETAP), 3. semester
Št. predmeta: 29

Title: Technology of Materials

Lecturer: Prof. dr. Danjel Vončina

Aim of course:

The course gives an overview of electrical properties of materials and technologies.

Required (pre)knowledge:
Fundametals of physics

Contents:

Classification of electrotechnical materials. Determination of material properties. Fundamentals of crystallography. Selected crystal structures of metals. Synthesis and properties of alloys. Thermoelectrically effects of metal junctions, electrical contacts. Electrochemical principles and reactions, batteries and fuel cells. Materials for resistors. Superconductivity. Soldering alloys and fluxes. Soft and permanent magnet materials. Properties of isolation materials, Thermoplastic and duroplastic materials.

Selected references:

E. Ivers-Tiffee, W. von Munch: Werkstoffe der Elektrotehnik, Teubner, 2004
Hoogers G.: Fuel Cell Technology, CRC Press, USA, 2003
Larminie J., Dicks, A.: Fuel Cell System Explained, John Wiley&Sons, Chichester, West Sussex, England, 2003
P. Campbell: Permanent Magnet Materials and their Application, Cambridge University Press, 1994.
E. Steingroever, G. Ross: Magnetization, Demagnetisation and Calibration of Permanent Magnet Systems, Magnet-Physik, Köln, 1997.
C. P. Poole: Handbook of Supeconductivity, Academic Press, 2000
D. Pletcher, F. C. Walsh: Industrial Electrochemistry, Blackie Academic & Professional, Glasgow, UK, 1993.
Carl H. Hamann, Andrew Hamnett, Wolf Vielstich: Electrochemistry, Wiley-VCH, Weinheim, 1998.
Michaeli, Greif, Wolters, Vossebürger: Technologie der Kunststoffe, Carl Hanser Verlag München, 1998.

Title: Telecommunication Networks

Lecturer: Prof. Dr. Drago Hercog

Aim of the course:
To explain the basics of telecommunication networks operation and to present some characteristic network examples

Required (pre)knowledge:
Basic physics, basic computer science

Contents:
Basics of information transfer: types of information; modes of information transfer (analog and digital, circuit- and packet-oriented, synchronous and asynchronous, connection oriented and connectionless, signaling); communication traffic and efficiency; quality of service (errors, losses, delays, delay variation); information type versus transfer mode; circuit emulation; communication systems architecture (network, topology, protocol stack, communication planes); message synchronisation (with synchronous and asynchronous transfer); multiplexing/demultiplexing (SDM, FDM, TDM, CDM, statistical multiplexing, packet multiplexing); addressing; routing (principles, routing tables, routing algorithms, examples of routing algorithms); switching (principles, control, circuit switching, packet switching); medium acces control (principles, classification of methods); flow/congestion control; service integration.

Examples of telecommunication networks: telephone networks (services, structure, access networks, multiplexing in transport networks, signaling and SS7, data transfer); Internet; ATM; Voice over IP.

Selected references:

1. Stallings, W., Data and Computer Communications, 9th Ed., Pearson Prentice Hall, Upper Saddle River, N.J., 2011
2. Olifer, N., Olifer, V., Computer Networks: Principles, Technologies, and Protocols for Network Design, John WIley & Sons, 2006
3. Stevens, W. R., TCP/IP Illustrated, Volume I.: The Protocols, Addison Wesley, Reading, MA., 1994
4. Gibson, J. D., The Communications Handbook, CRC Press and IEEE Press, 1997

Title: Telecommunication protocols (programme VSP)

Lecturer: Prof. Dr. Drago Hercog

Aim of the course:
To understand the principles and methods of message transfer in a telecommunication system, the meaning of telecommunication services and protocols, as well as protocol stacks, protocol specification and design. To acquire an overview of some important communication protocols.

Required (pre)knowledge:
Basics of physics, basics of computer science and programming, basics of communication networks.

Contents:
Basics: telecommunication service (service user, service provider, service specification, service access point, service primitives); telecommunication protocol (protocol as service implementation, protocol entities, protocol as a language, protocol specification); communication messages (service data unit, protocol data unit, payload and overhead); protocol stack (principles, OSI, TCP/IP, ATM, SS7, communication planes).

Specification of communication systems and protocols: structure specification; abstract and concrete syntax of messages; functionality specification; (extended) finite state machine; SDL.

Communication protocols and communication traffic: protocol efficiency; efficiency of protocol stack.

Protocol tasks: message structure; connection management (two-way handshake, three-way handshake, resolution of collisions, negotiation); error detection and correction; automatic repeat request protocols (sliding window protocols, stop-and-wait, go-back-N, selective-repeat); flow/congestion control (need for control, flow vs. congestion control, congestion avoidance, congestion recovery, control methods); message segmentation.

Protocol examples: LAPB/LAPD, TCP, IP, some application-layer protocols...

Selected references:

1. Stallings, W., Data and Computer Communications, 9th Ed., Pearson Prentice Hall, Upper Saddle River, N.J., 2011
2. Sharp, R., Principles of Protocol Design, Prentice-Hall, New York, N.Y., 1994
3. Doldi, L., Validation of Communication Systems with SDL, Wiley, Chichester, 2003

Title: Telecommunication Engineering

Lecturer: Assist. Prof. Dr. Iztok Humar (VSP)

Aim of the course:
To acquire fundamental knowledge on design, planning, modeling and management of telecommunications networks to avoid congestions and provide quality.

Required (pre)knowledge:
Telecommunications Networks, Network Services, Telecommunication Protocols, Mathematics (Probability & Statistics).

Contents:
Introduction to design, planning, modeling and management of telecommunication systems. Telecommunication system design. Elastic and non-elastic applications. Traffic theory and queuing. Design in circuit switched networks (Erl B, Erl C model). Design in packet switched networks (M/M/1). Network bottlenecks and Congestion control. Efficiency and performance evaluation. Network simulation and emulation. Quality of Service (QoS): statistical multiplexing, overprovisioning, resource reservation, admission control, service differentiation. QoS mechanisms and protocols in contemporary networks. User perceived quality, Quality of Experience (QoE). QoE evaluation and measurements. Mean opinion score (MOS). Network traffic characterization and measurements, performance evaluation and conformance testing. Management and control of telecommunication networks and systems. Management models (TM, eTOM, ITIL), protocols and information models (CMIP, SNMP, CIM, MIB). Accounting and Billing.

Selected references:
Villy B. Iversen: Teletraffic Engineering and Network Planning, Technical University of Denmark, 2007.
Alexander Clemm: Network management Funtamentials, Cisco System, 2007.
Alberto Leon-Garcia, Indra Widjaja: Communication Networks, Fundamental Concepts and Key Architectures, McGraw-Hill, 2000.
Haojin Wang: Telecommunications Network Management, McGraw Hill, 2000.
Papers on state-of-the-art technologies in *IEEE Communications Surveys & Tutorials*: http://www.comsoc.org/livepubs/surveys/index.html