Faculty of Electrical Engineering,
Computer Science and Telecommunications

University of Zielona Góra

INFORMATION BOOKLET

Subject Area: **ELECTRICAL ENGINEERING**

First-cycle Level Studies
(Full-time, Part-time)

Academic Year 2011/2012

European Credit Transfer System ECTS

Part II.A

ECTS COURSE CATALOGUE
ELECTRICAL ENGINEERING

FIRST-CYCLE LEVEL STUDY (B.Sc.Degree)

SPECIALIST SUBJECT

SPECIALIST SUBJECTS

SPECIALIST SUBJECTS

COMPUTER SCIENCE I

Course code: 11.3-WE-E-I1-PP19_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Dr inż. Piotr Mróz
Name of lecturer: Dr inż. Andrzej Popławski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Full-time studies					4
Lecture	15	1	I	Exam	
Laboratory	30	2		Grade	

COURSE CONTENTS:

Introduction to digital electronics. Primary logical gates. Logical functions.
Numerical systems and codes.
Construction and structure *of computers.* Synchronous systems. Computer's architecture. Microprocessors.
Peripheral's devices. Kinds of peripheral's devices. Kinds of connections of peripheral's devices. Communication with peripheral's devices.
Memories. Kinds of memories. Kinds of memories' connections. Methods of memories testing.
A/C & C/A converters. What do converters are? How to match converters to needs of gauges. Kinds of converters connections with microprocessor's systems. Methods of converters services.
Address' decoders. What does address' decoder is? Methods of address decode planning. Methods of address' determination basing on a schematic diagram.
One chip microcontrollers. Characteristic of microcontrollers. Applications' rules.
Assistance of programming & setting working microprocessors systems.
Software. Kinds of programs. Engineer's software. Programs to simulations.
Data bases. Data formats. Data bases – planning & administration.
Relation data bases. Data bases' security.
Areas of informatics's usage. Actual areas of informatics's usage. Expected ways of informatics's evaluation.

LEARNING OUTCOMES:

Skills and competences in: classic and objected programming; operating devices in real time by a programmed using data bases; using computer's techniques in engineer's activity.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Chmiel K.: *Teoria układów logicznych*, Wydawnictwo Politechniki Poznańskiej, Poznań, 1994.

[2] Łuba T., Zbierzchowski B.: *Komputerowe projektowanie układów cyfrowych*, WKiŁ, Warszawa, 2000.

[3] Majewski W.: *Układy logiczne*, WNT, Warszawa, 1992.

[4] Pieńkos J., Turczyński J.: *Układy scalone TTL w systemach cyfrowych*, WKiŁ, Warszawa, 1986.

OPTIONAL READING:

[1] –

COMPUTER SCIENCE II

Course code: 11.3-WE-E-I2-PP20_S1S
Type of course: Compulsory
Entry requirements: Computer science I
Language of instruction: Polish
Director of studies: Dr inż. Marcin Mrugalski
Name of lecturer: Dr inż. Marcin Mrugalski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					3
Lecture	15	1	II	Grade	
Laboratory	30	2		Grade	

COURSE CONTENTS:

Introduction to the computer networks. Fundaments of the computer networks. ISO OSI model. Architectures of the computer networks: physical topologies of the local area networks and the media access control methods. Devices in the computer networks: network interfaces controllers, hubs, bridges, routers, switches.
Standards of the computer networks. Standards of the local area networks: Ethernet, Token-Ring, FDDI. Standards of the metropolitan and wide area networks: Gigabit Ethernet, ATM, FrameRelay, SONET.
Physical media applied in the computer networks. Wireless, concentric cable, multi and single fiber optic cables, radio and satellite channels. The categories of the physical media and quality standards of the network connections. The standards of the wireless networks.
Technologies applied in the local computer networks. Fundaments of the Ethernet technology. Technologies applied in the Ethernet technology. Switching in the Ethernet. The construction and functions of the switches. Configuration and diagnostic of the switches. Directions of development of the Ethernet technology.
TCP/IP standard. Functions of the media access, network and internet layers.
IP addressing. Addressing with constant and variable length subnet mask (VLSM). Fundaments of the static and dynamic routing. Transport and applications' layers of the TCP/IP standard.
Introduction to the routers. Functions of the routers in the LAN and WAN. The structure, configuration and diagnostic of the routers. Internetwork operation system and user shell. Static and dynamic routing configuration.
Designing of the local and wide area networks. Strategies and rules in design of the computers networks. Routes and distributions of IDF and MDF. Choosing and configuration of the computer network devices. The rules of the power supply in the computer networks. An analysis of exemplary implementations of the computer networks.

LEARNING OUTCOMES:

Skills and competence: designing and building of the Local Area Network (LAN) and Wide Area Network (WAN); application of tools for building and testing of the network Ethernet cabling; explaining fundaments of the static and dynamic routing and IP addressing; configuration of the routing protocols, administering of the switches and routers; diagnosis of the hardware and software network layer of the LAN, MAN and WAN.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Breyer R., Riley S., *Switched, Fast I Gigabit Ethernet*, Helion, Gliwice, 2003

[2] Forouzan B.A., Fegan S.C., *Data Communications Networking*, McGraw-Hill Professional, New York, 2003

[3] Lewis W., *LAN Switching and Wireless, CCNA Exploration Companion Guide*, , Cisco Press, *Jacksonville*, 2008

[4] Reid A., Lorenz J., Schmidt C. A., Introducing Routing and Switching in the Enterprise, CCNA Discovery Learning Guide, Cisco Press, Jacksonville, 2008

[5] Stewart K., Adams A., Reid A., Lorenz J., Designing and Supporting Computer Networks, CCNA Discovery Learning Guide, Cisco Press, Jacksonville, 2008

OPTIONAL READING:

[1] –

MATERIALS ENGINEERING

Course code: 06.7-WE-E-IM-PP21_S1S

Type of course: Compulsory

Entry requirements: -

Language of instruction: Polish

Director of studies: Dr hab. inż. Adam Kempski, prof UZ.

Name of lecturer: Dr hab. inż. Adam Kempski, prof UZ.

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					3
Lecture	30	2	II	Grade	
Laboratory	15	1		Grade	
Part-time studies					
Lecture	18	2	II	Grade	
Laboratory	9	1		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Introduction to structure of materials and material classification. Molecular bonds. Amorphous and crystalline solids. Classification of solids on the basis of band theory. Material constants (permittivity, permeability, conductivity) in classical electrodynamics equations. Electrotechnical materials classification

Conducting materials. Electrical conduction in metals. Thermal processing of materials. Alloys and their properties. Overview of common conducting materials. Resistance materials. Contact and thermoelectric materials. Filler metals and solder materials.

Dielectrics. Electrical conduction and polarization phenomena in dielectrics. Dielectric aging effects. Classification of insulating materials. Gas and liquid insulating materials. Glasses and ceramics. Polymer insulating materials overview. Heat shrink plastics materials.

Magnetism and magnetic materials. Magnetic polarization. Classification of magnetic materials. Magnetic sheets. Ferrites. Magnetic alloys. Magnetodielectrics. materials for memory storage devices

Material tests and examination of electronic elements properties. Test methods for electrical and magnetic properties of materials. Examination methods for mechanical and thermal properties. Parasitic parameters and equivalent circuit diagram of electronic components.

Special issues. Current trends in material science and engineering. Micro- and nanotechnology. Superconductivity. High temperature super conductivity. Materials for optoelectronics. Electrostatic discharge protection.

LEARNING OUTCOMES:

Skills and competence in: understanding physical phenomena in materials; practical applications of knowledge about material properties and structure in modern electrical and electronic devices.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Celiński Z., *Electrotechnical materials science*, Oficyna PW, Warszawa, 2005 (in Polish)

[2] Jones I, Jones I. P., *Materials Science For Electrical And Electronic Engineers*, Oxford University Press, 2000

[3] Soiński M., *Magnetic materials in technique*, COSiW SEP, Warszawa, 2001 (In Polish)

[4] Charles P., Poole Jr., *Introduction to Nanotechnology*, Wiley, 2003

OPTIONAL READING:

[1] –

CIRCIUT THEORY I

Course code: 06.2-WE-E-TO1-PK25_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Dr inż. Radosław Kłosiński
Name of lecturer: Dr inż. Radosław Kłosiński

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					8
Lecture	30	2	III	Exam	
Class	30	2		Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	III	Exam	
Class	18	2		Grade	
Laboratory	18	2		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Circuits analysis methods. Superposition theorem. Reciprocity principle. Kirchhoff's laws. Equivalent network methods. Node-voltage method. Loop analysis method. Y Δ transformations.
Circuits supplied with sinusoidal sources. Phasor technique, phasor impedance, phasor diagrams, complex power, resonance. Frequency-response characteristics of *RLC* networks, quality factor, half-power bandwidth.
Circuits with non-sinusoidal signals. Non-sinusoidal, periodic, non-periodic and quasi-periodic signals. Fourier series. Linear time invariant circuits supplied with non-sinusoidal sources. Power definitions. Perceval theorem.
Three-phase networks. Three-phase sources and loads, three and four-wire Y network, ΔΔ network. Method of symmetrical components and its application. Power.

Two-ports. Terminal equations, calculation of coefficients, two-ports connections. Two-port as signal and energy transfer channel. Differential equations and characteristic equations of two-ports.

LEARNING OUTCOMES:

Basic knowledge and understanding of circuit theory issues, i.e. three-phase networks, two-ports and n-ports. Ability to create circuits models and their mathematical description, i.e. differential equations, transfer function, frequency response.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Blackwell WA. Grigsby LL.: *Introductory Network Theory*, PWS Publishers, Boston 1985.

[2] Bolkowski S.: *Electrical engineering, circuit theory*. T1, WNT, Warszawa 1982. (in Polish)

[3] Cichowska Z., Pasko M.: *Theoretical electrical engineering problems*. Printed series of course lectures of Silesian Technical University Gliwice 1994 (in Polish)

[4] Cichowska Z., Pasko M.: *Theoretical Electrical Engineering Lectures. Part I Basic sections, Part. II Sinusoidal currents*, Printed series of course lectures of Silesian Technical University Gliwice 1998 (in Polish)

[5] Mikołajuk K., Trzaska Z.: *Collection of problems of theoretical electrical engineering*. PWN Warszawa 1976. (in Polish)

[6] Osiowski J., Szabatin J.: *Circuit theory principles*, WNT Warszawa 1998. (in Polish)

[7] Papoulis A.: *Circuits and Systems. A modern Approach*. Holt, Rinehart and Winston, Inc. 1980.

[8] Siwczyński M.: *Circuits and signals theory, part I Linear electric circuits*, RWNT, Zielona Góra 2002.

[9] Kłosiński R., Chełchowska L., Chojnacki D., Siwczyńska Z., Rożnowski E, *Collection of laboratory exercises instructions*, Zielona Góra 1988 – 2004. (not published, in Polish)

OPTIONAL READING:

[1] –

ELECTROMAGNETIC FIELD THEORY

Course code: 06.2-WE-E-TPE-PK26_S1S

Type of course: Compulsory

Entry requirements: -

Language of instruction: Polish

Director of studies: Dr hab. inż. Adam Kempski, prof UZ.

Name of lecturer: Dr hab. inż. Adam Kempski, prof UZ.

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					3
Lecture	30	2	IV	Exam	
Part-time studies					
Lecture	18	2	III	Exam	
Project	9	1		Grade	

COURSE CONTENTS:

Basics of vector analysis. Vector algebra. Coordinate systems. Divergence and curl operators and their interpretation. Gauss' law. Divergence theorem. Stokes' theorem. Basic vector identities. Laplace's equation. Field classification.
Electromagnetic fields. Electromagnetic field vectors. Maxwell's equations and their interpretation. Material constants in Maxwell's equations. Electromagnetic field energy. Poynting vector.
Electrostatic field. Work in electrostatic field. Conservative property of the electrostatic field. Scalar potential and its gradient. Energy in static electric fields. Calculation of electrostatic fields. Boundary conditions across interface of two dielectrics.
Quasi-static electric fields.
Magnetostatic field. Biot-Savart law. Ampere's law. Magnetic flux. Vector magnetic potential. Stokes' theorem in magnetic field. Forces and torques in magnetic fields. Energy in magnetic field.
Electromagnetic induction. Faraday;s law. Self- and mutual magnetic inductance. Induced electromagnetic force.
Magnetic circuits. Amper's law in magnetic circuits. Nonlinearity of magnetic circuits.
Electromagnetic waves. Wave propagation. Wave equations. Delayed potentials. Hertzian dipole. Near- and far fields. Electromagnetic wave with sinusoidal excitation Electromagnetic plane wave. Electromagnetic waves in dielectrics and conducting media. Skin effect.
Transmission lines. Distributed parameters of transmission lines. Wave equations. Pulse and sinusoidal steady-state excitations. Reflection of electromagnetic waves. Smith Chart. Impedance matching.
Numerical techniques for solving electromagnetic problems.

LEARNING OUTCOMES:

Skills and competences in: description of basic problems in the field of electomagnetism; formulation of field equations; calculation of electromagnetic field distribution.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Edminister J. A., *Theory and problems of Electromagnetics*, Schaums Outline Series, McGraw-Hill, 1993

[2] Jackson J. D., *Classical electrodynamics*, John Wiley&Sons, 1998

[3] Hiziroglu H. R., Guru B. S., *Electromagnetic Field Theory Fundamentals*. Cambridge University Press, 2004

[4] Moon P., Spencer D. E., *Field theory*, PWN, Warszawa, 1990 (in Polish)

[5] Zahn M., *Electromagnetic Field Theory,* Krieger Publishing. Co, 2003

OPTIONAL READING:

[1] –

FUNDAMENTALS OF METROLOGY

Course code: 06.0-WE-E-PM-PK27_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Dr hab. inż. Ryszard Rybski
Name of lecturer: Dr hab. inż. Ryszard Rybski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					6
Lecture	30	2	III	Grade	
Class	15	1		Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	III	Grade	
Class	9	1		Grade	
Laboratory	18	2		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Basic concepts in metrology. Measurement scales and measurement units. Selected quantity standards.
Measurement methods and their accuracy. Indirect and direct comparison method. Transposition and substitution method. Differential and zero method. Compensating and deflection method.
Determination of measurement result inaccuracies. Systematic, random and excessive errors. Measurement method errors. Basic and additional measuring instrument errors. Dynamic errors. The calculation of boundary errors in direct and indirect measurements.
Measurement uncertainty. Type A, type B and type A and B uncertainty. Standard and extended uncertainty. The determination of uncertainties in direct and indirect method.
General information on mathematical object and phenomena modelling. Parametric and non-parametric identification. Static and dynamic models. Point and field models. Concepts of inadequacy and inaccuracy. The determination of model parameters by the least squares method. Tabular and graphic model representation.
Measurement signals. Classification and mathematical models of selected measurement signals.

Characteristics of measuring signals. Classification of measuring signals. Metrologic structure of a measuring instrument. Basic metrological properties of measuring instruments. *Analogue, analogue-digital an digital analogue measurement signal processing*. Principle of operation and metrological properties of basic analogue functional operators. Sampling and quantisation. Sample and store converters, analog-to-digital and digital-to-analog converters.

LEARNING OUTCOMES:

Skills and competences in: Using measurement units; SI measurement systems; basic measurable unit standards; developing measurement units, assessing measurement errors and uncertainties, basics in analogue, analogue-digital and digital-analogue measuring signal processing.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester).

RECOMMENDED READING:

[1] Barzykowski J. (red): Modern metrology. WNT, Warszawa, 2004 (in Polish)

[2] Chwaleba A, Poniński M., Siedlecki A.: *Elctrical metrology*, WNT, Warszawa, 1998 (in Polish)

[3] *Guide to the Expression of Uncertainty in Measurement*, BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 1995

[4] Skubis T.: *Fundamentals of measurement results metrological interpretation.* Wydawnictwo Politechniki Śląskiej, Gliwice, 2004 (in Polish) *Fundamentals of measurement results metrological interpretation.* Wydawnictwo Politechniki Śląskiej, Gliwice, 2004 (in Polish)

[5] Tumański S.: *Measurement engineering*. WNT, Warszawa, 2007 (in Polish) *Measurement engineering*. WNT, Warszawa, 2007 (in Polish)

OPTIONAL READING:

[1] –

FUNDAMENTALS OF ELECTRICAL POWER ENGINEERING

Course code: 06.2-WE-E-PE-PK28_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Dr hab. inż. Grzegorz Benysek, prof UZ.
Name of lecturer: Dr hab. inż. Grzegorz Benysek, prof UZ.

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					5
Lecture	30	2	III	Exam	
Laboratory	15	1		Grade	
Part-time studies					
Lecture	18	2	IV	Exam	
Laboratory	9	1		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Energy significance in present times. Energetic raw materials and energy carriers. Energetic characteristics, economy energy-consumption, energy balances.
Electrical energy production. Operation principles and types of the conventional steam power stations, water as well as nuclear. Distributed energy production. Unconventional energy sources – wind energy.
Power networks. Construction and types of the energy networks: industry networks, transmission networks, distribution networks. Overhead and cable networks. Influence of the distributed generation on power system behavior.
Power stations: connection types, construction solutions. Distribution and measurement devices: types, principle of operation, destination. Operation of the star-point in energy networks.

LEARNING OUTCOMES:

Skills and competences in: understanding problems related to electrical energy production in power stations; electrical energy market functions; requirements to the power system users.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Mielczarski W., *Electrical energy market – selected technical and economical aspects*, ARE & EP-C, Warszawa, 2000 (in Polish)

[2] Polskie Sieci Elektroenergetyczne, *Balance market regulations*, Warszawa, 2001 (In Polish)

[3] Arrillaga J., Watson N., *Power system harmonics*, John Wiley & Sons, 2003

[4] Machowski J. et all., *Power system dynamics and stability*, John Wiley & Sons, 1997

OPTIONAL READING:

[1] –

PRINCIPLES OF ELECTRONICS AND POWER ELECTRONICS I

Course code: 06.2-WE-E-PEE1-PK29_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Dr hab. inż. Andrzej Olencki, prof UZ.
Name of lecturer: Prof. Dr hab. inż. Edward Greczko

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					5
Lecture	30	2	III	Exam	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	IV	Grade	
Laboratory	18	2		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Electronic components. Voltage and current in electronic circuits, principles applied to voltage and current. Resistors, capacitors, inductors, diodes, optoelectronic components, transistors – absolute maximum ratings and electrical characteristics.
Applications of electronic components. Voltage dividers and filters. State signalization of devices and a galvanic isolation of signals with using of optoelectronic components. Transistor amplifiers for control of output components.
Operational amplifiers. Op Amps Basics and its applications. Op Amps specifications. Basic circuits with Op Amps. Op Amp applications in control engineering and measuring techniques.
Specialty integrated circuits. Voltage regulators, reference voltage sources, electronic switches and multiplexers, multipliers, RMS/DC converters.
Digital to analog converters. Types, structures, specifications, applications.
Analog to digital converters. Types, structures, specifications, applications.

LEARNING OUTCOMES:

Skills and qualifications in range: applications of electronic components and integrated circuits to design of analog and mixed (analog/digital) electronic circuits, understanding, analysis and designing of simple electronic circuits for using in measuring and automatics.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Horowitz P., Hill W., *The Art of Electronics*, Cambridge University Press, New York, USA, 1993

[2] Walter G. Jung (Eds)., *Op Amp Applications* , Analog Devices, USA, 2002

[3] Data sheets and other information can be downloaded from www pages of electronics components distributors and producers

OPTIONAL READING:

[1] –

CONTROL ENGINEERING

Course code: 06.2-WE-E-TS-PK31_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Dr hab. inż. Andrzej Janczak, prof UZ.
Name of lecturer: Dr hab. inż. Andrzej Janczak, prof UZ.

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					5
Lecture	30	2	IV	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	IV	Grade	
Laboratory	9	1		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Introduction. Control loop basics. Open-loop control, closed-loop control, disturbance compensation. Control tasks, classification of control systems.
Linear continuous control systems. Characterization of systems dynamics in the time and frequency domains. State space representation of system dynamics. Equilibrium points, state trajectories, phase portraits. Basic dynamic elements. Interconnection of subsystems.
Analysis of linear continuous control systems. Stability of linear continuous system. Stability definitions. Stability criteria. Control specifications. Measures of control system performance. Methods of improving system performance. PID controllers. Choice of controller type. Tuning PID control systems. Controllability and observability. State observers. State feedback control systems.
Discrete-time control systems. Computer control systems. Digital control. Signal sampling and quantization. Discrete-time models of continuous-time systems. Characterization of discrete-time systems dynamics in the time and frequency domains. State space representation of discrete-time system. Stability of discrete-time systems. Discrete PID controllers.
Nonlinear control systems. Basic nonlinear elements. Linearization. Describing function method. Phase plane method. Stability of nonlinear continuous control systems. First Lyapunov method. Second Lyapunov method. Nonlinear controllers. On-off control.
Computer-aided analysis and synthesis of control systems. Control System Toolbox. Simulink. Fuzzy Logic Toolbox.

LEARNING OUTCOMES:

Basic knowledge of analysis and synthesis of continuous and discrete control systems in the time and frequency domains, engineering skills in designing linear control systems, choice of controller type, tuning a control loop, analysis and synthesis of nonlinear control systems.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Kaczorek T., Dzieliński A., Dąbrowski W., Łopatka R., *Fundamentals of control theory*, WNT, Warsaw, 2005 (in Polish)

[2] Kaczorek T., *Theory of control systems*, WNT, Warsaw, 1977 (in Polish)

[3] Nise N. S., *Control Systems Engineering*, John Wiley & Sons, Holboken, 2003

[4] Ogata K., *Modern Control Engineering*, Prentice Hall, Upper Saddle River, 2002

[5] Sontag E. D., *Mathematical Control Theory*, Springer, Berlin, 1998

OPTIONAL READING:

[1] –

ELECTRIC MACHINES AND DRIVES I

Course code: 06.2-WE-E-MNE1-PK32_S1S

Type of course: Compulsory

Entry requirements: -

Language of instruction: Polish

Director of studies: Dr hab. inż. Grzegorz Benysek, prof UZ.
Dr inż. Robert Smoleński

Name of lecturer: Dr inż. Robert Smoleński

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					6
Lecture	30	2	IV	Grade	
Laboratory	30	2		Grade	

COURSE CONTENTS:

Basic electrodynamics' laws in electric machines theory. Induced voltage. Conditions of electromagnetic torque formation. Electromagnetic torque asynchronous, synchronous (excited and reluctance) and electromagnetic torque of commutator motors.
Construction elements of electric machines.
Transformers. One-phase-transformer, three-phase-transformer, winding connections, transformer ratio, voltage, hour indication of vector group, parallel work of three-phase-transformers. Power balance, efficiency.
Induction motors (asynchronous). Mathematical model of three-phase induction motor. Steady state of induction motor. Equivalent circuit. No load and short-circuit condition, power balance, currents and torque in steady state. Mechanical characteristic, Kloss formula, electrodynamics and electromagnetic transients of induction motors. Typical waveforms of currents, speed and torque. Two-phase induction motors. Power balance, efficiency.
Synchronous motors. Construction, basis of work of three-phase synchronous motor. Mathematical model of three-phase synchronous motor. Synchronization, field forcing, field suppression. Synchronous motor start-up, steady state of synchronous motor. Equivalent circuit, vector diagram for motor and generator state. Load, no-load and shorting condition. Electric grid and single generator work. Reluctance motors. Permanent magnet motors. Synchronous motor fed-by current source inverter. Power balance, efficiency.
Direct current motors. Mathematical model of DC motor. Separately excited DC motor, series connected DC motor. Start-up, speed control, braking of DC motors. Printed circuit DC motors, brushless DC motors. Power balance, efficiency.

LEARNING OUTCOMES:

Skills and competences in: understanding of the matters of electromechanical energy conversion; application of the basic electric motors and transformers as elements of energy and drive systems.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Boldea I., Nasar S. A, *Electric Drives*, CRC Press, 1999

[2] Sen P.C., *Principles of Electrical Machines and Power Electronics*, John Willey and Sons, Inc., New York, USA. 1997

[3] Kaźmierkowski M. P., Tunia H., *Automatic Control of Converter-Fed Drives*, Warsaw - Amsterdam - New York - Tokyo: PWN-ELSEVIER SCIENCE PUBLISHERS, 1994

[4] Kaźmierkowski M. P., Blaabjerg F., Krishnan R., *Control in Power Electronics, Selected Problems*, Elsevier, 2002

[5] Kaźmierkowski M. P. and Orłowska-Kowalska T., *Neural Network estimation and neuro-fuzzy control in converter-fed induction motor drives, Chapter in Soft Computing in Industrial Electronics*, Springer-Verlag, Heidelberg, 2002

[6] Leonhard W., *Control of Electrical Drives*, Springer, Berlin, New York, 2001

[7] Miller T. J. E., *Brushless Permanent-Magnet and Reluctance Motor Drives*, Oxford University Press, Oxford, England, 1989

OPTIONAL READING:

[1] –

HIGH VOLTAGE ENGINEERING

Course code: 06.2-WE-E-TWN-PK33_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Dr hab. inż. Adam Kempski, prof UZ.
Name of lecturer: Dr hab. inż. Adam Kempski, prof UZ.

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					6
Lecture	30	2	V	Exam	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	V	Exam	
Laboratory	18	2		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

IIntroduction. Subject and range of discipline. Electric field distributions. Electric field non-uniformity coefficient. Ionization and deionization processes.
Electric breakdown strength of materials and composite insulation. Electrical breakdown in gases. Townsend's mechanism. Paschen's law. Streamer mechanism of spark. Breakdown under impulse voltage. Insulating properties of high-pressure gas. Processes of electrical breakdown in liquids. Effect of oil contamination on the electrical strength. Breakdown processes in solid dielectrics. Partial discharges. Dielectric aging. Breakdown in composite insulation. Forms of surface discharge.
Overvoltages. Types of overvoltages. External and internal overvoltages. Wave phenomena in electrical power transmission power lines. Travelling waves in real conditions.
Lightning protection and transit overvoltage protection. Lightning overvoltages. Lightning protection. Overvoltage protection. Coordination of overvoltage protection.
Electrical insulation systems. Principles of insulation coordination. Outdoor and indoor high voltage insulators. Rotating machines, transformers and cables insulation.
High voltage testing techniques. High voltage measurements. Safety of high voltage measurements.

LEARNING OUTCOMES:

Skills in understanding high voltage phenomena; designing and exploitation of high voltage systems; designing and exploitation of lightning and transit overvoltage protection.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Flisowski Z.: *High voltage technique*, WNT W-wa, 2005 (in Polish)

[2] Naidu M.S., Karamaju V. *High voltage engineering*, McGraw-Hill, 1995

[3] Gacek Z.: *High voltage insulation technique*, Wydawnictwo Politechniki Śląskiej, 1996 (In Polish)

[4] Kufel J., Kufel E., Zaengl W.S.: *High voltage engineering Fundamentals*, Elsevier 2000

OPTIONAL READING:

[1] –

METROLOGY

Course code: 06.2-WE-E-M-PD35_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Dr hab. inż. Ryszard Rybski
Name of lecturer: Dr hab. inż. Ryszard Rybski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					3
Lecture	30	2	IV	Exam	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	V	Exam	
Laboratory	18	2		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Measuring voltages and currents. Measurements by means of the deflection method: electronic voltmeters and digital voltmeters. Measurements by means of zero methods: Compensatory measurement of voltage and current. Comparison methods.
Methods and systems for measuring resistance and impedance. Voltmeter-ammeter methods. Measurements by DC and AC bridge methods. Transformer bridges. Unbalanced bridges.
Measurements of frequency, period, time and phase shift angle. Analogue and digital methods for measuring period and frequency. Electronic digital and analogue phase meters.
Measuring power and energy of alternating and direct current in single- and three-phase systems. Rules of power and energy measurements. Electrodynamic wattmeter. Electronic instruments for power measurements. Measurements of active and passive power in three-phase systems. Electronic meters of electric energy.
Recording electric signals. Analogue and digital oscilloscope. Measuring signal recorders.
Investigations of electrotechnical materials, semi-conductors and dielectrics. Measuring properties of magnetic materials.
Measurement systems. A general characteristic of measurement systems. Types of measurement systems. Basic functional blocks of measurement systems.

LEARNING OUTCOMES:

Skills and competences in: measuring basic electric quantities by means of analogue and digital measuring instruments; general knowledge in measurement systems.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Chwaleba A, Poniński M., Siedlecki A., *Elctrical metrology*, WNT, Warszawa, 1998 (in Polish)

[2] Marcyniuk A., Pasecki E., Pluciński M., Szadkowski B., *Basic of electrical metrology*. WNT, Warszawa, 1984 (in Polish)

[3] Piotrowski J., *Basic of measurements.* WNT, Warszawa, 2002 (in Polish)

[4] Stabrowski M., *Digital measurement instruments.* PWN, Warszawa, 2002 (in Polish)

[5] Tumański S., *Measurement engineering*. WNT, Warszawa, 2007 (in Polish)

OPTIONAL READING:

[1] –

METHODS OF DATA ANALYSIS

Course code: 11.9-WE-E-MAD-PD36_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: Prof. dr hab. inż. Dariusz Uciński
Name of lecturer: Prof. dr hab. inż. Dariusz Uciński

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	II	Grade	
Class	15	1		Grade	
Part-time studies					
Lecture	18	2	V	Grade	
Class	18	2		Grade	

COURSE CONTENTS:

Measurement uncertainty. Propagation of uncertainty. Random and systematic errors. Statistical sampling study. Frequency distribution. Histogram. Summary statistical measures of location, variability, asymmetry and concentration. Rejection of outliers.
Probability. Sample space. Basic definitions of probability: classical, frequency and modern. Fundamental properties of probability. Conditional probability. Independence. Total probability theorem. Bayes' Theorem.
Discrete and continuous random variables. Discrete random variables. Distributions: binomial, Bernoulli, Poisson and geometric. Functions of random variables. Expected value and variance. Joint probabilisty distributions of many random variables. Independence of random variables. Continuous random variables. Uniform distribution. Exponential distribution. Cumulative distribution function of a random variable. Normal distribution.
Fundamentals of statistical inference. Types of random samples. Simple random sample. Distributions: chi-square, t-Student and Fisher-Snedecor. Point and interval estimation. Unbiasedness, consistency, efficiency and sufficiency. Parameter and non-parameter estimation. Confidence intervals for the mean. Limit theorems. Interval estimates of the proportion, variance, standard deviation, differences between proprtions and means. Determining the required sample size.
Hypothesis testing. One- and two-sided tests of the mean. Testing the proportion. Testing the variance. Selecting the test procedure.
Regression and correlation analysis. Linear regression using least squares. Correlation and regression. Statistical regression using the regression line. Correlation analysis. Curvilinear regression. Multiple regression and correlation.

LEARNING OUTCOMES:

Basic knowledge and competence in practical application of probability theory to construct probabilistic models of phenomena, as well as practical use of statistical methods and techniques to solve various problems encountered in electrical engineering and other areas of engineering.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Class – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Bertsekas D. P.,Tsitsiklis J. N., *Introduction to probability, 2nd Ed.,* Athena Scientific, Belmont, MA, 2008

[2] Sobczyk M., *Statistics*, PWN, Warsaw, 2002 (in Polish)

[3] Koronacki J., Mielniczuk J., *Statistics for students of engineering and natural sciences*, WNT, Warsaw, 2001 (in Polish)

[4] Starzyńska W., *Practical statistics*, PWN, Warsaw, 2000 (in Polish)

[5] Gajek L., Kałuszka M., *Statistical inference. Models and methods*, WNT, Warsaw, 2000 (in Polish)

[6] Kukuła K., *Elements of statistics in exercises,* PWN, Warsaw, 1998 (in Polish)

OPTIONAL READING:

[1] –

PRINCIPLES OFELECTRONICS AND POWER ELECTRONICS II

Course code: 06.2-WE-E-PEE2-PD37_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: dr hab. inż. Zbigniew Fedyczak, prof. UZ.
Name of lecturer: dr hab. inż. Zbigniew Fedyczak, prof. UZ.

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					3
Lecture	30	2	IV	Exam	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	VI	Exam	
Laboratory	9	1		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Basic power electronics circuits (general description). Power electronics historical outline. Application area. Types of power electronic converters (PEC), their classification and basic functions. A semiconductor device as a power electronics switch and its thermal model.
Basic parameters and conversion quality evaluation of the PEC. Coefficients or factors: efficiency, total harmonics distortion, power, deformations, displacement, non-symmetry at non-sinusoidal current circumstances.
Non-controlled and controlled rectifiers (AC/DC converters). Topologies and properties of single-, two- and six-pulsed non-controlled rectifiers. Single- and three-phase thyristor rectifiers with phase control. Influence of the rectifiers on supplying source. Examples of applications.
DC/DC PWM voltage and current stabilizators (DC/DC converters). Topologies and properties of the impulse DC stabilizators types buck, boost, buck-boost and H-bridge with PWM control. Examples of applications.
Single-phase AC choppers (AC/AC converters, $f_1 = f_2$). Solid state relay and thyristor choppers. Phase-angle and integral control. Operation and static characteristics at R and RL load, power factor. Examples of applications.
Inverters (DC/AC converters). Single-phase voltage source inverters. Functioning and properties of the transistorized inverters at different load. The PWM control strategy in the inverters. Output voltage and frequency control. Operation general description of three-phase voltage source inverter with square-wave modulation and sinus PWM. Examples of applications.
Problems and development trends of the PEC. Intelligent power module, multilevel converters, resonance converters. Future trends.

LEARNING OUTCOMES:

Skills and competence in the frame: operation understanding of basic power electronic semiconductor devices and circuits, knowledge deals with their properties and application fields.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Tunia H., Smirnow A., Nowak M., Barlik R., *Power electronic circuits*, WNT Warsaw, 1990 (in Polish)
[2] Tunia H., Barlik R., *Theory of power electronic converters*, Warsaw University of Technology Publishing House, Warsaw 1992 (In Polish)
[3] Piróg S., *Power electronics*, AGH Publishing House, Cracow, 1998 (in Polish)
[4] Mohan N., *Power Electronics: Converters, Application and Design,* John Wiley & Sons, 1998
[5] Trzynadlowski A., *Introduction to modern power electronics*, John Wiley & Sons, 1998
[6] Mikołajuk K., *Fundamentals of power electronic circuits analysis*, PWN, Warsaw, 1998 (in Polish)
[7] Frąckowiak L., *Power electronics*, Poznan University of Technology Publishing House, Poznan, 2000

OPTIONAL READING:

[1] –

ELECTRICAL DEVICE

Course code: 06.2-WE-E-UE-PD38_S1S

Type of course: Compulsory

Entry requirements: -

Language of instruction: Polish

Director of studies: dr hab. inż. Grzegorz Benysek, prof. UZ.
dr hab. inż. Adam Kempski, prof. UZ.

Name of lecturer: dr hab. inż. Grzegorz Benysek, prof. UZ.
dr hab. inż. Adam Kempski, prof. UZ.

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	VI	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	VII	Grade	
Laboratory	18	2		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Medium power engine generator sets. Sets driven by internal combustion engines: construction, operation conditions, protection, control and alarm systems. Autonomous energy sources on the base of wind and hydro sources: wind and hydro power plants – construction and operation conditions, generators for small wind and hydro power plants.
Electromagnetic, dynamic and thermal phenomenon. Switching processes in electrical devices. Short-circuits in power system devices. Current thermal and dynamic issues. Overvoltages in electrical devices. Switchings proceeds in electrical circuits. Arc discharge and extinguishing methods.
Power stations. Transformers, bus-bars, shunt transformers and anti-fault coils. Switches – classification and construction. Low voltage circuit breakers – structure and selection. Medium and high voltage circuit breakers – minimum and bulk oil circuit breakers, air-blasts, with SF_6, vacuum. Isolating switch – structure and selection, lightning protector – structure and selection.
Utilization of the electrical energy. Power quality influence on behavior of the loads. Investigations of the electrical devices.
Electromagnetic compatibility (EMC). Basic terms. EMC terminology. Immunity and emissions of electric equipment. Basic mechanisms of electromagnetic interferences couplings and propagations. Methods of electromagnetic emission measurement. Immunity measurements. EMC for systems and installations. Parameters of power quality. EMC Directive and EMC standardization.
Electrical devices and systems reliability.

LEARNING OUTCOMES:

Basic knowledge, design, planning, and control of electrical devices. Competences in understanding problems related to electrical devices utilization in power system.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Markiewicz H., *Power engineering devices*, WNT, Warszawa, 2001 (in Polish)

[2] Bełdowski T., Markiewicz H.: *Stations and power engineering devices*, WNT, Warszawa, 1992 (in Polish)

[3] Kamińska A., *Stations and power engineering devices*, Wydawnictwo Politechniki Poznańskiej, Poznań, 2000 (in Polish)

[4] Williams T., Armstrong K., *EMC for systems and installations*, Newness, 2000

OPTIONAL READING:

[1] –

PROGRAMMING LANGUAGES I

Course code: 11.3-WE-E-JP1-PD39_S1S
Type of course: Compulsory
Entry requirements: -
Language of instruction: Polish
Director of studies: dr inż. Grzegorz Łabiak
Name of lecturer: dr inż. Wojciech Zając

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					3
Lecture	15	1	II	Grade	
Laboratory	30	2		Grade	

COURSE CONTENTS:

Programming environment. Source files. Compilation. Fundamental building of computer program. Main function. Functions and procedures.

Simple types. Variables. Input and output operations. Operators.

Iterative loops: for, while, do-while (repeat-until).

Control statement.

Creation own functions.

Tables and chains of characters.

Pointers

Sorting Algorithms: bobble sort, selection sort, quick sort.

List structures: creation, adding, removing, sorting, printing

Tree structure: tree creations, inserting, searching, printing.

Graphs in computer memory and their algorithms. Adjacency Matrix, Adjacency list.

LEARNING OUTCOMES:

After completion of this course students will posses skills in implementing of fundamental algorithms in procedural computer programming language.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Aho A. V., Hopcroft J. E., *The Design and Analysis of Computer Algorithms*. Addison-Wesley, 1974

[2] Corman T. H., Leiserson Ch. E., Rivest R., *Introduction to Algorithms*, McGraw-Hill, 1990

[3] Kernighan B., W., Ritchie D. M., *C Programming Language*, Prentice Hall, 1988

[4] Wirth N., *Algorithms + Data Structures = Programs*, Prentice-Hall, 1974

[5] Banachowski L., Diks K., Rytter W., *Algorithm and data structures*, WNT Warszawa, 2001 (in Polish)

[6] Roszkowski J., *Analysis and structural design*, Helion, Gliwice, 2002 (in Polish)

[7] Sielicki A., *Programming laboratory in Pascal computer programming language*, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 1994 (in Polish)

OPTIONAL READING:

[1] –

ELECTRIC MACHINES AND DRIVES II

Course code: 06.2-WE-E-MNE2-PK41_S1S

Type of course: Compulsory

Entry requirements: -

Language of instruction: Polish

Director of studies: dr hab inż. Grzegorz Benysek, prof. UZ
dr inż. Robert Smoleński

Name of lecturer: dr hab inż. Grzegorz Benysek, prof. UZ
dr inż. Robert Smoleński

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	15	1	VI	Exam	
Laboratory	15	1		Grade	

COURSE CONTENTS:

Selected electromechanical elements of automatic control systems. Tachogenerators (DC, induction, synchronous), selsyns, selsyn systems, transmitters and indicators.

Step motors. Reluctance, permanent magnet, hybrid.

Basis of electric drives. Star-up methods, speed control and braking of described motors. Motion equation of drive. Inertia of the drive systems on motor shaft.

Electric drives. Drive system and its elements. Electric drive classification. Motion equation of drives. Proprieties of second and higher order systems. Modeling of steady state and transients of electric drives.

Power converter drives. Two-quadrant asynchronous drives. Direct current and asynchronous power converter drives.

Automatic control of electric drive. Control methods of electric drives. Scalar control. Automatic control of speed, torque and position. Servo drives.

LEARNING OUTCOMES:

Skills and competences in: application of basic electric machines and transformers as elements of energy and drive systems, understanding of the matters of electromechanical energy conversion.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Boldea I., Nasar S.A, *Electric Drives*, CRC Press, 1999

[2] Sen P. C., *Principles of Electrical Machines and Power Electronics*, John Willey and Sons Inc., USA, New York, 1997

[3] Kaźmierkowski M. P., Tunia H., *Automatic Control of Converter-Fed Drives*, Warsaw - Amsterdam - New York - Tokyo: PWN-ELSEVIER SCIENCE PUBLISHERS, 1994

[4] Kaźmierkowski M. P., Blaabjerg F., Krishnan R., *Control in Power Electronics, Selected Problems*, Elsevier, 2002

[5] Kaźmierkowski M. P., Orłowska-Kowalska T., *Neural Network estimation and neuro-fuzzy control in converter-fed induction motor drives, Chapter in Soft Computing in Industrial Electronics*, Springer-Verlag, Heidelberg, 2002

[6] Lonhard W., *Control of Electrical Drives*, Springer, Berlin, New York, 2001

[7] Miller T. J .E., Brushless Permanent-Magnet and Reluctance Motor Drives, Oxford University Press, Oxford, England, 1989

[8] Rutkowska D., Intelligent computing systems, Genetic algorithms and neural networks in fuzzy systems, Akademicka Oficyna Wydawnicza, Warsaw, 1997 (in Polish)

OPTIONAL READING:

[1] –

COMPUTER-AIDED DESIGN

Course code: 06.2-WE-E-KWP-PSW_B42_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr inż. Janusz Kaczmarek
Name of lecturer: dr inż. Janusz Kaczmarek

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					6
Lecture	30	2	V	Grade	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	VI	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Basic knowledge of the virtual instruments. Basic definitions. Characteristic of integrated software environments to designing the software for virtual instruments and measurement systems.
Introduction to programming in LabWindows. LabWindows overview. Basics of creating the Graphical User Interface. Generating the source code. Methods of designing programs: callback functions and event loops. Properties and programming control of GUI objects. Characteristic of library functions for analysis and processing of measurement signals. Debugging techniques. Creating and distributing executable program.
Advanced programming techniques in LabWindows. Multithreading programming techniques. Using ActiveX automation: server and controller applications. Using internet programming technology. Creating measurement instrument drivers. Methods of creating reports from measurements.
Introduction to programming in LabVIEW. Concept of the graphical programming language G. Building a front panel and block diagram. Basic and composite data types. Controlling program execution with loops and structures: for, while, shift-register mechanism, case, sequence, formula node. Operations on arrays and strings. Hierarchical programming. Global and local variables. Polling and event-driven programming models. Characteristic of library functions for analysis and processing of measurement signals. Express technology.
Methodology of designing an electronic circuit using EDA system. Basic concepts on capturing a circuit as a schematic diagram: netlist, wires and buses. Component library structure: part, symbol, package and padstack. Creating schematic diagrams with hierarchical and multipage techniques. Printed Circuit Board designing using layout editor. Methods of placing components and routing traces. Designing one, two and multilayer PCB. Automatic routing of PCB traces with an autorouter tool. Design rule check in EDA systems.

Computer simulation of electronic circuits. SPICE simulation fundamentals. Types of simulation analysis: nonlinear dc, small signal ac, transient, sensitivity and distortion. Models of electronic devices. Schematic-level simulation of embedded microprocessor systems. Analysis of simulation results.
Computer simulation of thermal and electromagnetic properties of printed circuit boards.
Producing design documentation and CAM files in EDA systems.

LEARNING OUTCOMES:

Skills and competences in the field of designing and creating the software for measurement systems with the use of specialized integrated software environments – LabVIEW and LabWindows. Skills and competences in the field of applying Electronic Design Automation software supporting the process of designing electronic circuits with emphasis on embedded microprocessor systems.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Winiecki W., Nowak J., Stanik S., *Integrated graphical programming environments for designing and creating the computer measurement and control systems,* MIKOM, Warszawa, 2001 (in Polish).

[2] Khalid S.F., *LabWindows/CVI Programming for Beginners.* Prentice Hall PTR, 2000

[3] Świsulski D., *Computer measurement technique. LabVIEW programming of virtual instruments*, Agenda Wydawnicza PAK, Warszawa, 2005 (in Polish)

[4] Johnson G.W, Jennings R., *LabVIEW Graphical Programming.* McGraw-Hill Professional, 2006.

[5] Rymarski Z., *Materials technology and construction of electronic circuits. Designing and production of electronic circuits*, Wydawnictwo Politechniki Śląskiej, Gliwice, 2000 (in Polish)

[6] Williams T., *The Circuit Designer's Companion,* Newnes*,* 2005

[7] Dobrowolski A., *Under the mask of SPICE*, BTC, Warszawa, 2004 (in Polish)

OPTIONAL READING:

[1] –

MEASUREMENT TRANSDUCERS

Course code: 06.2-WE-E-PP-PSW_C43_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr hab. inż. Ryszard Rybski
Name of lecturer: dr hab. inż. Ryszard Rybski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					5
Lecture	30	2	V	Exam	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	VI	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

General characteristic of measuring converters and signals. Basic definitions, measuring signal and converter classification. Structures of measuring converters.
Static and dynamic properties of measuring converters. Definitions of basic static parameters. Description methods for dynamic properties of measuring converters in the domain of time and frequency. Models of ideal dynamic transformations. Models and dynamic properties of real converters.
Scale converters. Impedance and transformer converters of current and voltage.
Analogue measuring converters for selected electric quantities. Power, voltage and alternating current converters. Converter structures. Input steps of converters. Impedance and transformer scale converters. Analogue functional blocks. Absolute value converters, logarithmic and alogarithmic systems, multiplying systems, RMS systems.
Analogue-digital and digital-analogue processing. General characteristics of A/D and D/A processing: sampling, quantisation, coding. Classification and basic functions of A/D and D/A converters.
Structure and properties of selected D/A converter types. Converters: with a resistor network, with switching capacities, sigma – delta, multiplying D/A converters. Application examples.
Structure and properties of selected A/D converters. Dual-slope, successive approximation, parallel and sigma-delta A/D converters. Application examples.
Static and dynamic parameters of A/D and D/A converters. Definitions and examples of interpretation of basic static and dynamic parameters of A/D and D/A converters..

LEARNING OUTCOMES:

Skills and competences in: using methods of description and assessment of static and dynamic measuring converters; methods for analogue processing of selected electric

quantities, analog-to-digital and digital-to-analog processing, assessing properties of A/D and D/A converters on the basis of their catalogue parameters, elements of line designing for measurement signal processing.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Baranowski J., Kalinowski B., Nosal Z., *Electronic circuits, Vol. III.* WNT, Warszawa, 1998 (in Polish)

[2] Gajda J., Szyper M., *Modeling and simulation of measurement systems.* Jartek s.c., Kraków, 1998 (in Polish)

[3] Hagel R., Zakrzewski J., *Dynamic measurements.* WNT, Warszawa, 1984 (in Polish)

[4] Kulka Z., Libura M., Nadachowski M., *Analog-to-digital and digital-to-analog converters.* WKiŁ, Warszawa, 1987 (in Polish)

[5] Van de Plassche R.*, Integrated analog-to-digital and digital-to-analog converters.* Kluver Academic Publishers, 1994

[6] Zakrzewski J., *Sensors and measurement transducers.* Wydawnictwo Politechniki Śląskiej, Gliwice, 2004 (in Polish)

OPTIONAL READING:

[1] –

MICROPROCESSOR SYSTEMS

Course code: 06.5-WE-E-SM-PSW_D44_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr inż. Janusz Kaczmarek
Name of lecturer: dr inż. Janusz Kaczmarek

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	V	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	VI	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Introduction to microprocessor systems. Basic architectures of microprocessors – Von Neumann, Harvard, Modified Harvard, RISC, CISC. Microprocessors with one, two and three buses. Microprocessor system structure and basic functional blocks.
Practical interfacing techniques for microprocessor systems. Bus structure: address, data, control, non-multiplexed and multiplexed. Methods of connecting the functional blocks to the central unit of microprocessor systems. Bus buffering and latching. Control signals. Addressing methods of peripheral devices: uniform and distributed. Address decoders. Timing considerations of memory devices.
Programmable peripheral devices: general purpose parallel interface, interval timer/counter, interrupts controller, DMA controller, serial asynchronous interface.
User interface in microprocessor systems. Simple and matrix structures of keyboards. Interfacing keyboards. Techniques for mitigating the effects of switch bounce. LED, LCD and OLED displays in microprocessor embedded systems. Numeric, alpha-character and graphic displays. Multiplexed LED displays. Specialized integrated circuits to interfacing displays.
Design microprocessor embedded systems using microcontrollers. Microprocessor via microcontroller. Microcontroller functional structure. Internal peripheral devices. Circuits for generating clock and reset signals. Communication methods with peripherals. Rozwiązania układowe praktycznych problemów konstrukcyjnych.
Local serial interfaces in microprocessor systems: SPI, I2C, 1-Wire, SMBus. Microwire.
Designing microprocessor circuits using EDA system. Creating schematic diagrams with buses. Schematic-level simulation of microprocessor systems. Analysis of simulation results. Printed Circuit Board designing layout with Signal Integrity requirements.
Software and hardware methods for debugging microprocessor embedded systems: simulators, burn-and-learn method, in-circuit simulators and run-time monitors, in-circuit debuggers, in-circuit emulators.

LEARNING OUTCOMES:

Skills and competencies in the field of designing and building microprocessor devices.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Badźmirowski K., Pieńkos J., Myzik I., Piotrowski A., *Microprocessor circuits and systems, part 1 i 2*, WNT, Warszawa, 1990 (in Polish)

[2] Stallings W., *Computer organization and architecture*, Prentice Hall, 2002

[3] Coffron J.W., Long W.E., *Practical interfacing techniques for microprocessor systems*, Prentice Hall, 1983

[4] Hadam P., *Designing microprocessor systems*, Wydawnictwo BTC, Warszawa, 2004 (in Polish)

[5] Daca W., *Microcontrollers form 8- to 32-bits*, Wydawnictwo MIKOM, Warszwa, 2000 (in Polish)

[6] Mazidi M.A., Mazidi J., *The 8051 Microcontroller and Embedded Systems*, Prentice Hall, 1999

[7] Bogusz J., *Local serial interfaces in digital systems*, Wydawnictwo BTC, Warszawa, 2004 (in Polish)

OPTIONAL READING:

[1] –

INTELLIGENT MEASUREMENT TRANSDUCERS

Course code: 06.5-WE-E-IPP-PSW_E45_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr hab. inż. Wiesław Miczulski, prof. UZ
Name of lecturer: dr hab. inż. Wiesław Miczulski, prof. UZ

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					5
Lecture	30	2	V	Exam	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	VII	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

General characteristic of intelligent measurement transducers. Definition and classification of intelligent measurement transducers. The structure, basic function blocks ale algorithms of work. Primary features of intelligent measurement transducers.
Metrological features of selected function transducer blocks. Mathematical models and features of input circuits of electrical quantities transducers, selected measurement sensors and conditioners, function operators (mean circuits, analogue filters, multipliers, RMS transducers, switches and analogue multiplexers, sample and hold circuits and other).
Error correction methods. Factors influencing on value of measurement error. Methods of correction of zero error, sensitivity and non linearity. Methods of adaptation of measurement transducers to parameters of processed signals. Classical (program based) and neural realisation of reconstruction process.
Selected examples of sensors and intelligent transducers.

LEARNING OUTCOMES:

Skills and competences in: designing and simulation research of metrological features of intelligent measurement transducers.

ASSESSMENT CRITERIA:

Lecture – full-time study obtaining a positive grade in written or oral exam; part-time study the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Baranowski J., Czajkowski G., *Electronics circuits part. II. Analogue circuits nonlinear and pulse*, WNT, Warszawa, 1998 (in Polish)
[2] Barzykowski J. (Ed.), *Contemporary metrology. Selected subjects*, WNT, Warszawa, 2004 (in Polish)
[3] Bolikowski J. (Ed.), Essentials of designing of intelligent measurement transducers of electrical quantities, Monograph Nr 68, WSI, Zielona Góra, 1993 (in Polish)
[4] Gajda J., Szyper M., *Modelling and simulation research of measurement systems*, Jartek s.c.. Kraków, 1998 (in Polish)
[5] Jakubiec J., Roj J., *Measurement sample transducers*, Wydawnictwo Politechniki Śląskiej, Gliwice, 2000 (in Polish)

OPTIONAL READING:

[1] –

DIGITAL MEASUREMENT SYSTEM

Course code: 06.5-WE-E-CSP-PSW_F46_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr inż. Leszek Furmankiewicz
Name of lecturer: dr inż. Leszek Furmankiewicz

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	VI	Exam	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	VII	Exam	
Laboratory	18	2		Grade	
Project	9	1		Grade	

COURSE CONTENTS:

Measuring systems - introduction. Definition, classification, basic tasks, basic configurations, kinds of transmission, methods of transmission coordination, functional blocks of measuring and control systems. Errors of measurements and dynamic of measuring system.
Data acquisition systems. Destination of data acquisition systems, configurations, basic functional blocks: conditioning system, multiplexer, measuring amplifier, isolating amplifier, filters. Data acquisition cards, basic functional blocks of the cards. Programming of data acquisition cards .
Interfaces of measuring systems: Definition of interface, classification of interfaces, interfaces used in measuring systems. Serial interfaces: RS -232, RS -422, RS -485, serial interfaces programming. Parallel interface IEEE 488: principal tags of IEEE 488 standard, bus of the interface, types of devices, word of status, serial control of devices, parallel control of devices. Widening of IEEE -488 standard: enlargement of speed, enlargement of range, enlargement of number of devices. IEEE 488.2 standard. Requirement relating to controller requirements relating to devices, word of status, synchronization of devices. Controller and devices software. VXI standard. Principal tags of VXI, card chassis, bus of VXI. LAN in measuring systems.
SCPI standard. SCPI device model, structure of commands, trigger system, status system. Profile of commands for example devices.
Digital industrial nets. Net: MODBUS, PROFIBUS, PROFInet, CAN, LONWORKS, INTERBUS - S. Net MikroLAN. Communication properties of industrial nets.
Internet technologies in measuring systems. Embedded WWW servers. Profiles of hardware structure and software of embedded WWW servers.
Wireless measuring systems. GSM technology in measuring systems. Radiomodems. BlueTooth and ZigBee standards.

Virtual measurement instruments. Definition, structure and basic tags of virtual instruments. Programming of virtual instruments. Metrological and computer characteristics of virtual instruments.
Measuring systems programming. Programming of measuring systems using classic languages and software development environments. Characteristics of integrated environments: LabWindows, LabView, Agillent Vee. Software of interfaces and chosen DSP software. VISA library. Software drivers for measuring instruments. IVI drivers. *Visualization systems*. Structure of company computer system, functions of SCADA, measuring and control instruments in SCADA, design of visualization systems. Examples of SCADA applications.
Design and starting of measuring systems. General principles of design. Task analysis, consolidation of requirements, stages of design. Starting of hardware and starting of software. Failure of measuring systems..

LEARNING OUTCOMES:

Skills and competences in the range of the: understanding of functioning of measuring and control systems, using laboratory and industrial measuring systems with wired and wireless communication technique, design hardware of measuring and control systems, creating application software for measuring system and control systems.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Sydenham P., Thorn R. (Eds.), *Handbook of Measuring System Design.* John Wiley & Sons, London, 2005

[2] Caristi A. J., *IEEE-488 General Purpose Instrumentation Bus Manual,* Academic Press, INC., San Diego, California, 1992

[3] Winiecki W., *The Organization of Computer Measuring Systems*. Warsaw University of Technology Press, Warsaw, 1997 (in Polish)

[4] Mielczarek W., *Measuring Instruments and Systems with SCPI Compatibility*, Helion, Gliwice 1999 (in Polish)

[5] Lesiak P., Świsulski D., *Computer Measuring Technique in Examples*, PAK, Warsaw, 2002 (in Polish)

[6] Rak R. J., *Virtual Measuring Instrument - Real Tool of Present Metrology,* Warsaw University of Technology Press, Warsaw, 2003 (in Polish)

[7] Nawrocki W., *Distributed Measuring Systems*, WKŁ, Warsaw 2006 (in Polish)

OPTIONAL READING:

[1] –

WIRELESS SENSOR NETWORKS

Course code: 06.5-WE-E-BSS-PSW_G47_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: doc dr inż. Emil Michta
Name of lecturer: doc dr inż. Emil Michta

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	VI	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	VII	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Introduction to sensor networks. Evolution of WPAN wireless networks. Wireless networks IEEE 802.15.x. Processors for wireless network nodes. Supply issues of wireless sensor networks. Application areas of sensor networks.
Sensor networks. Sensor networks topology. Physical layer and data layer of wireless sensor networks – IEEE 802.15.4. Network layer and application layer – ZigBee standard.
ZigBee. Architecture of ZigBee protocol. ZigBee network functioning. Kinds and functioning of ZigBee nodes. Central managing and routing. Domens, clusters and profiles in ZigBee networks. Configuration of ZigBee networks. Implementation of security solution on MAC layer, network layer and application layer. Addressing and binding of variables. Application areas and application profiles.
Bluetooth. Architecture of Bluetooth protocol. Functioning of Bluetooth networks. Implementation of measurement – control functions.
Nodes of WPAN. Types and functions of ZigBee and Bluetooth network nodes. Design of ZigBee and Bluetooth network nodes.
Design and analysis of communication features in sensor networks. Choose of designed network topology. Coordinator and network configuration. Calculation of communication parameters for designed network. ZigBee sensor network simulation. Examples of applications.

LEARNING OUTCOMES:

Skills and competence within: design and configuration ZigBee wireless sensor networks. Writing of application programs in C or Java for ZigBee nodes. Creating of application profiles for ZigBee. Use of security solutions for data transmission protection in ZigBee networks.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Miller A.B., Bisdikian Ch., *Bluetooth,* Helion. Gliwice, 2004

[2] Nawrocki W., *Komputerowe systemy pomiarowe*, WKŁ, Warszawa, 2004

[3] Raghavendra C.S., Sivalingam K.M., Znati T., *Wireless Sensor Networks*, Kluver Academic Publisher, 2005

[4] Zieliński B., *Bezprzewodowe sieci komputerowe*, Helion, Gliwice, 2003.

[5] ZigBee Alliance. *ZigBee Specification v.1.0,* 2005

[6] ZigBee Alliance. *ZigBee Specification v.1.1*, 2007

[7] Zhao F., Gibas L., *Wireless Sensor Networks. An Information Processing Approach*, Elsevier, 2004

OPTIONAL READING:

[1] –

ELECTRONIC MEASUREMENT INSTRUMENTS

Course code: 06.5-WE-E-EPP-PSW_H48_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr hab. inż. Ryszard Rybski
Name of lecturer: dr hab. inż. Ryszard Rybski

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					6
Lecture	30	2	VI	Exam	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					
Lecture	9	1	VII	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Development tendencies of contemporary measuring instruments. Microprocessor instruments, microprocessor measuring blocks, PI class measuring modules, measuring cards and modules of „plug-in" types, virtual instruments.
Digital multimeter. Characteristics of basic functional blocks of digital multimeters. Presentation of possibilities of using procedures for digital improvement of metrological properties of microprocessor measuring instruments on the basis of selected solutions of digital multimeters.
Electric interference in voltage measurements and methods of elimination. Types of interference and their types. Attenuation of serial and parallel interference. Rules for relating measurement signal sources to measuring instruments.
Voltage measurements in the range of very high frequencies. Sources of errors in voltage measurements in the range of very high frequencies. Instrument stalks. Measurements by voltmeters with high-impedance input and measurements with impedance matching.
Instruments for narrow-band measurements of alternating voltages. Selective voltmeters. Lock-in voltmeter. Vector voltmeters.
Digital oscilloscopes. Classification of electronic oscilloscopes. Construction and rules of operation of a digital oscilloscope. Characteristics of modes of operation. Comparison characteristics of selected types of modern digital oscilloscopes. Measurements with digital oscilloscopes.
Spectrum analysers and THD meters. Analogue spectrum analysers. Digital spectrum analysers: analysers with digital filters, analysers based on the fast Fourier transform. Methods for THD measurement.
Measurement signal recorders. Analogue and digital methods for recording measurement signals. Compensatory recorder. Digital recorders.

Instruments for measuring of impedance. Automatic RLC meters, impedance analysers, Q-metres, transformer bridges.
Electronic instruments for measuring electric power and energy. Basic functional blocks: voltage and current input circuits, multiplier systems. Specialized integrated circuits for measuring electric power and energy. Electronic electric energy meters.
Measurement signal sources.. Methods of generation of sinusoidal voltages used in the range of very low and high frequencies. Generators with direct digital synthesis. Voltage and current calibrators.

LEARNING OUTCOMES:

Skills and competences in: using electronic measurement instruments designed for measuring basic electric properties; assessing accuracy of conducted measurements and specifications of metrological properties made available by instrument manufacturers; designing selected measuring instruments and systems accounting for basic algorithms of digital signal processing and a skilful use of possibilities resulting from the use of microprocessor technology.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Piotrowski J., Kostyrko K.: Apparatus calibration. PWN, Warszawa, 2000 (in Polish)

[2] Stabrowski M.: *Digital measurement instruments.* PWN, Warszawa, 2002 (in Polish)

[3] Tumański S.: *Measurement engineering.* WNT, Warszawa, 2007 (in Polish)

[4] Application notes, technical documentation, data sheets of Agilent, Fluke, Keithley, Rohde & Schwarz, Signal Recovery, Tektronix et al.

OPTIONAL READING:

[1] –

CONSTRUCTION OF ELECTRONIC APPARATUS

Course code: 06.0-WE-E-KAE-PSW_I49_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr inż. Włodzimierz Kujanek
Name of lecturer: dr inż. Włodzimierz Kujanek

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	VI	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	9	1	VII	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Course and rules of process of constructing. Constructional foundations. Initial project. Pattern. Technical project. Prototype. Production. Constructional working plans. Application of computers in process of constructing.
Methods of research of new constructional solutions. General bases. Brainstorming. Delphive method. Method 635. Sinectics. Intuitive methods: Deductive methods. Speculative methods. Analysis of value.
Normalization. Historic outline. Legal basics. Review of connected norms from constructing electronic apparatus.
Constructional materials in build of electronic apparatus. Proprieties electric and of magnetical materials. Bases of selection of materials. Description of technical materials practical in construction of electronic apparatus.
Select elements and components practical in electronic apparatus. Resistors, condensers, inductive elements. Integrated circiuts. Transformers. Displays. Helping oneself with catalogues.
Basic problems relating reliabiliy. Coefficients characterizing reliability. Prognosis of exploitation reliability of electronic elements. Applique recommendations. Research reliability.
Ergonomics in construction of electronic apparatus. Basic dategiven anthropometric. Virtual reception of information. Construction of frontal plates of devices.
Activity of exposure factors on elecrtonic apparatus. Climatical factors. Corrosive atmospheres. Biotic factors. Vibrations and shocks. Manners protections before exposure factors. Bases of constructing safe apparatus.
Thermal circumstances of work of electronic apparatus. Basic messages about exchange of warmth in electronic apparatus. Utilization of airs to accompanying warmth. Intensive accompanying warmth from electronic elements and devices . Bases of selection of radiators. Selection of ventilator.
Factors disturbing work of electronic apparatus. Methods of diminishing of influence of disturbances on electronic apparatus. Screening.

Printed circuits. Laminates. Methods of production of printed circuits. Bases of projecting of printed circuits. Stages of production of printed plates. Estimation of quality of printed plates.
Technology of electronic apparatus. Technology of plastics. Technology of tooling with machine cutting. Tooling of thermal metals. Covers galvanic.
Solutions constructional of select blocks of electronic apparatus. Solutions of input circuits {districts},of block of power supply, of amplifiers, of displays, of keyboard. Joints. Construction of mechanical units of electronic apparatus.
Solutions constructional of select electronic apparatus. Solutions of electronic volt-meters, of multimeter, of power unit, of generators, of bridges, calibrators, of measuring transducer.

LEARNING OUTCOMES:

Arts and competences in range of constructing, components and blocks of elecrtonic apparatus and of projecting of electronic apparatus in accordance with requirements of norms and ergonomics.

ASSESSMENT CRITERIA:

Lecture – he main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Collective Work under drafting Stepien S., *Guide of constructor of electronic equipment,* WKiL, Warsaw, 1981 (in Polish)

[2] Kisiel. R., Bajera A., *Basics of constructing of electronic devices*, Publishers Warsaw University of Technology, Warsaw, 1988 (in Polish)

[3] Winkler T., *Computer recording of construction,* WNT, Warsaw, 1989 (in Polish)

[4] Dobies R., *Methodics of constructing of electronic equipment*, WKiL, Warszawa, 1987 (in Polish)

[5] Oleksiuk W., Paprocki K., *Construction of mechanical teams of electronic equipment*, WKiL, Warsaw, 1989 (in Polish)

[6] Mika M., *Printed Circuits*, WKiL, Warsaw,1983 (in Polish)

[7] Baldwin-Ramult A. et all., *Montage of electronic elements on printed plates,* WKiŁ, Warsaw, 1984 (in Polish)

[8] Collective Work under drafting. Prazewska M., *Reliability of electronic devices*, WKiL, Warsaw, 1987 (in Polish)

[9] Hasse L. et al.., *Disturbances in electronic apparatus,* Publishers Radioelektronik, Warsaw, 1995 (in Polish)

[10] Charoy A., *Disturbances in electronic devices*, WNT, Warsaw, 2000 (in Polish)

OPTIONAL READING:

[1] –

DIGITAL SIGNAL PROCESSING USING DIGITAL SIGNAL PROCESSOR

Course code: 06.0-WE-E-PSZP-PSW_B42_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr inż. Krzysztof Sozański
Name of lecturer: dr inż. Krzysztof Sozański

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					6
Lecture	30	2	V	Grade	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					
Lecture	9	1	VI	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Analog and digital signal processing. Properties of signals. Analog (continuous-time) signals, discrete-time signals. Signal parameters.
Analog signal processing. Analog circuits, linear two-port network. Continuous-time filters. Filter parameters. Introduction to analog filter design.
Signal Discretization. Uniform and nonuniform signal sampling. Analog-to-digital (A/D) and digital-to-analog (D/A) signal conversion. A/D and D/A signal converters. Examples of multimedia and measurements data signal conversions.
Linear time-invariant (LTI) circuit. Discrete Fourier transform (DFT). Leakage effects. Widows. Properties of DFT. Fast Fourier transform (FFT). *Z* transform. Properties of *Z* transform.
Multirate digital signal processing. Decimation and interpolation. Implementation of multirate digital signal processing algorithms. Applications of multirate signal processing: noise shaping technique in delta-sigma modulator (DSM) used in A/D and D/A converters.
Digital modulations: pulse width modulation (PWM), pulse density modulation PDM, pulse code modulation PCM, differential pulse code modulation.
Digital filters: linear and nonlinear filters, multirate filters, filter banks, multidimensional filters. Properties of digital filters: finite impulse response filter (FIR), infinite response filter (IIR). Design of digital filters. Round off effects in digital filters. Implementation of digital filters using digital signal processors.
Switched Capacitor (SC) filters.
Signal processing of random processes. Adaptive systems.
Subband coding. Design of filter banks. Wavelet transform.

Signal compression: lossless and losy. Multimedia compression algorithms.
Very large-scale integration integrated circuits (VLSI) used for implementation of digital signal processing algorithms: microprocessors, microcontrollers, digital signal processors, programmable digital logic circuits.
Introduction. Historical outline of DSPs and microcontrollers.
Digital signal processors. Main architectures of DSP: modified Harvard architecture, hardware multiplier with long accumulator, supporting saturation, barrel shifter, address generators: hardware modulo addressing, allowing circular buffers, advanced program sequencer: delayed braches, instruction parallelism, parallel branch and compute, zero-overhead do until loops, instruction cache, cache memory. Direct memory access (DMA). Comparison between microcontrollers and DSPs.
Implementation of digital signal processing circuit using DSPs. Realization of: digital filters FIR and IIR, filter banks, DFT, interpolation and decimation, signal generators.
DSPs for *video and audio* signal processing.
Specialized DSPs for power electronics control circuits: TMS320F24x, TMS320F28x, ADSP2199x.
Matlab - tool for designing and simulation of digital signal processing algorithms.

LEARNING OUTCOMES:

Basic knowledge of: designing of digital signal processing, applied: in power electronics, multimedia, control technique, measurements. Implementation of digital signal processing methods and digital control algorithms using DSPs and microcontrollers.

ASSESSMENT CRITERIA:

Lecture – he main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester

RECOMMENDED READING:

[1] Proakis J. G., Manolakis D. M., *Digital Signal processing, Principles, Algorithms, and Applications*, Third Edition, Prentice Hall Inc., Engelwood Cliffs, New Jersey 1996
[2] Stallings W., *Computer Organization and Architecture*, Prentice Hall Inc., 1996
[3] Chassaing R., *Digital Signal Processing with C and the TMS320C30*, John Wiley & Sons, 1992
[4] Vaidyanathan P. P., *Multirate Systems and Filter Banks*, Prentice Hall Inc., Engelwood Cliffs, New Jersey 1992
[5] Wanhammar L., *Digital Filters*, Linkoping University, 1996
[6] McFarland G., *Microprocessor Design (Professional Engineering)*, McGraw-Hill Professional, 2006
[7] Embree P. M., Kimble B., *C Language Algorithms for Digital Signal Processing*, Prentice Hall, 1991

OPTIONAL READING:

[1] –

MODELLING AND COMPUTER AIDED DESIGN

Course code: 06.2-WE-E-MKWP-PSW_C43_S1S

Type of course: Optional

Entry requirements: -

Language of instruction: Polish

Director of studies: prof. dr hab. inż. Igor Korotyeyev
dr inż. Grzegorz Kobyłecki

Name of lecturer: prof. dr hab. inż. Igor Korotyeyev
dr inż. Grzegorz Kobyłecki

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					6
Lecture	30	2	V	Exam	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	VI	Exam	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Introduction. Basic concepts. Systems. Dynamics of systems. State and output equations. Equilibrium and stability. Similarity and analogy of dynamical systems.
Mathematical models. Continues and discrete models. Static and dynamical models. Control models.
Component models. Key models. Static and dynamic characteristics of keys. Passive component models. Models of magnetic coupling components. DC inductor motor model.
Topological description of converter systems. Incidence matrix. Loop matrix. Cutset matrix.
Nonlinear system modelling. Method of small parameter, averaged method, state space averaged method.
Close loop system modelling. PWM systems. System stability. Notion of chaos.
Mathematical methods. Solution of differential equations for a continuous lineał system. Solution of differential equations by Laplace transform. Multistep methods. Methods stability. Notion of stiffness of differentia equations. Random methods.
Programs characteristic: Pspice, Matlab, Mathcad, Mathematica, Maple, Tcad. Compare of precision, possibility and using area. Topologycal description of systems. Convergence and precision of calculations.
Symulation of electronic systems. Numerical solution of differential equations with MATLAB. Using of MATLAB – Simulink and Blocksets programs for system symulation. System simulation using OrCAD program.

LEARNING OUTCOMES:

Basic knowledge of modeling and computer aided design of electronic circuits.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester

RECOMMENDED READING:

[1] Fortuna Z., Macukow B., Wąsowski J., *Numerical methods*, WNT, Warsaw, 1993 (in Polish)

[2] Kudrewicz J., *Nonlinear electrical networks*, WNT, Warsaw, 1996 (in Polish)

[3] Szczęsny R., *Computer symulation of power electronic systems*, Gdansk University of Technology Publishing House, Gdańsk, 1999 (in Polish)

[4] Król A., Moczko J., *Pspice Symulation and optimization of electronic systems*, Nakom, Poznań,1998 (in Polish)

[5] Zachara Z., Wojtuszkiewicz K., *Pspice practical example*, MIKOM, Warszawa, 2000 (in Polish)

[6] Zalewski A., Cegieła R., *MATLAB – numerical calculations and there using*, Nakom, Poznań, 1996 (in Polish)

[7] Brzózka J., Dorobczyński L., *Programming in Matlabie*, MIKOM, Warsaw, 1998 (in Polish)

OPTIONAL READING:

[1] –

TRANSMISSION AND DISTRIBUTION OF THE ELECTRICAL ENEGRY

Course code: 06.2-WE-E-PREE-PSW_D44_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr hab. inż. Grzegorz Benysek, prof. UZ
Name of lecturer: dr hab. inż. Grzegorz Benysek, prof. UZ

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	V	Grade	
Class	15	1		Grade	
Laboratory	15	1		Grade	
Part-time studies					
Lecture	18	2	VI	Grade	
Class	9	1		Grade	
Laboratory	9	1		Grade	

COURSE CONTENTS:

General information about electrical power system. Network structure. Construction of the power network elements. Overhead power line, construction of the conductors, mechanics of the conductors, insulators and equipment, supporting constructions, groundings. Cable lines, basic information, construction of the cable power lines.
Power stations. Significance of the power stations in electrical power system. Single, double and triple busses systems, switchgears, systems with more than one circuit breaker, overhead switchgears.
Basic calculations in electrical power engineering. Voltage drops, power and energy losses, symmetrical short circuits.
Electrical energy consumption prediction. Characteristics of the electrical loads. Power and energy demands. Methods of power and electrical energy prediction. Qualitative and quantitative predictions methods.

LEARNING OUTCOMES:

Skills and competences in: understanding problems related to the organization of the electrical power systems; calculations in radial and closed power networks.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Class – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester

RECOMMENDED READING:

[1] Kahl T., *Power networks*, WNT, Warszawa, 1981 (in Polish)

[2] Popczyk J., Żmuda K., *Power networks*, Politechnika Śląska, Gliwice, 1991 (In Polish)

[3] Arrillaga J., Watson N., *Power system harmonics*, John Wiley & Sons, 2003

[4] Machowski J. et all., *Power system dynamics and stability*, John Wiley & Sons, 1997)

OPTIONAL READING:

[1] –

POWER ELECTRONIC CIRCUITS

Course code: 06.2-WE-E-UE-PSW_E45_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr hab. inż. Zbigniew Fedyczak, prof. UZ
Name of lecturer: dr hab. inż. Zbigniew Fedyczak, prof. UZ

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					5
Lecture	30	2	V	Exam	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	VII	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Introduction. General description (outline) of the preceded course deals with Fundamentals of power electronics (basic power electronics semiconductor devices, basic power electronic converters, standards and conversion quality evaluation, basic control techniques, application field).
AC/DC and AC/AC with phase-angle control. Topologies review, operation description and properties of non-controlled and controlled (thyristorized) six- and multipulse rectifiers, three-phase AC choppers and cycloconverters. Application examples of such converters.
Conversion quality of the AC/DC and AC/AC converters using phase-angle control. Influence of such converters on a voltage supplying source (displacement factor, deformation factor and power factor).
PWM DC/DC converters II. Operation descriptions and properties of the DC/DC converters with ideal switch circuit models: non-isolated higher level (types Ćuk, ZETA), isolated (types flyback and forward). Application examples of such converters.
PWM DC/AC converters II. Topologies, operation descriptions and properties of single- and three-phase voltage source and current source inverters (VSI, CSI) with sinus PWM (SPWM) control. PWM control techniques review. Properties of the VSI with space vector PWM (SVPWM) control.
PWM AC/DC converters. Topologies, operation description and properties of single- and three-phase rectifiers with sinusoidal input current as well as buck and boost type. Suppliers with power factor correction (PFC). The impulse stabilizators control techniques in the suppliers with unity power factor. Integrated monolithic control circuit in the impulse stabilizators.
Indirect PWM AC/AC converters. Topologies, operation description and properties of PWM AC/DC/AC converters (frequency converters). Output and input current shaping methods in PWM AC/DC/AC converters. Application examples of the AC/AC frequency converters.
Conversion quality of the circuits with PWM AC/DC and AC/AC converters. Influence of such converters on supplying source (displacement factor, deformation factor and power factor).

Future trends of the power electronic circuits (general description). A new semiconductor power electronic switches and intelligent power modul. Conversion quality improvement as well as new application areas of the power electronic converters.

LEARNING OUTCOMES:

Skills and competence in the frame: operation understanding and design of basic power electronic converters, knowledge deals with their properties and application fields.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester and pass of the final exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester

RECOMMENDED READING:

[1] Tunia H., Smirnow A., Nowak M., Barlik R., *Power electronic circuits*, WNT Warsaw, 1990 (in Polish).
[2] Tunia H., Barlik R., *Theory of power electronic converters*, Warsaw University of Technology Publishing House, Warsaw, 1992 (in Polish)
[3] Piróg S., *Power electronics*, AGH Publishing House. Cracow, 1998 (in Polish)
[4] Mohan N., *Power Electronics: Converters, Applications, and Design.* John Wiley & Sons, 1998
[5] Trzynadlowski A., *Introduction to modern power electronics*, John Wiley & Sons, 1998
[6] Mikołajuk K., *Fundamentals of Power electronic circuits analysis*, PWN, Warsaw, 1998 (in Polish)
[7] Frąckowiak L., *Power electronics*, Poznan University of Technology Publishing House, Poznan, 2000
[8] Holms D. G.., Lipo T. A., *Pulse width modulation for power converters. Principle and practice*, IEEE Press, New York, 2003

OPTIONAL READING:

[1] –

AUTOMATIC CONTROL OF CONVERTER DRIVES

Course code: 06.2-WE-E-ANP-PSW_F46_S1S

Type of course: Optional

Entry requirements: -

Language of instruction: Polish

Director of studies: dr hab. inż. Grzegorz Benysek, prof. UZ
dr inż. Robert Smoleński

Name of lecturer: dr inż. Robert Smoleński

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	VI	Exam	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	VII	Exam	
Laboratory	18	2		Grade	
Project	18	2		Grade	

COURSE CONTENTS:

Drive control basics. Control method classifications according to control rules and control devices (internal and external control, analog and digital, follow-up and adjusting). Application of informatics and power electronics in electric drive.
Electric drives. Dynamics of electric drives. Dynamic equations of drive systems. Models of electric motors and systems for speed and torque control.
Power converter drives. Two- and four quadrant asynchronous drives. DC converter drives, permanent magnet and reluctance converter drives. Brushless DC motors.
Control methods of converter drives. Scalar control. Field oriented control. Direct torque control. Sensorless control. Automatic control systems for speed, torque and position. Dynamics of closed loop drive systems. Follow-up and position servo drives.

LEARNING OUTCOMES:

Skills and competences in: understanding of the matters of electromechanical energy conversion; selection of converter drives according to mechanical requirements of driven machine; understanding control matters of converter drives and selection of control parameters.

ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written or oral exam.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Project – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester

RECOMMENDED READING:

[1] Boldea I., Nasar S.A., *Electric Drives*, CRC Press, 1999

[2] Sen P. C., *Principles of Electrical Machines and Power Electronics*, John Willey and Sons, Inc., New York, USA. 1997

[3] Kaźmierkowski M. P., Tunia H., *Automatic Control of Converter-Fed Drives*, Warsaw - Amsterdam - New York - Tokyo: PWN-ELSEVIER SCIENCE PUBLISHERS, 1994

[4] Kaźmierkowski M. P., Blaabjerg F., Krishnan R., *Control in Power Electronics, Selected Problems*, Elsevier, 2002

[5] Kaźmierkowski M. P., Orłowska-Kowalska T., *Neural Network estimation and neuro-fuzzy control in converter-fed induction motor drives, Chapter in Soft Computing in Industrial Electronics*, Springer-Verlag, Heidelberg, 2002

[6] Leonhard W., *Control of Electrical Drives*, Springer, Berlin, New York, 2001

[7] Miller T. J .E., *Brushless Permanent-Magnet and Reluctance Motor Drives*, Oxford University Press, Oxford, England, 1989

OPTIONAL READING:

[1] –

FILTRATION AND SEPARATION IN ELECTRIC CIRCUIT

Course code: 06.2-WE-E-FSUE-PSW_G47_S1S

Type of course: Optional

Entry requirements: -

Language of instruction: Polish

Director of studies: dr hab. inż. Grzegorz Benysek, prof. UZ
dr inż. Krzysztof Sozański

Name of lecturer: dr hab. inż. Grzegorz Benysek, prof. UZ
dr inż. Krzysztof Sozański

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	VI	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	VII	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Analog signal processing. Analog circuits, linear two-port network. Continuous-time filters. Filter parameters. Introduction to analog filter design.
Properties of electrical filters. Continuous-time (analog) filters. Active and passive circuits. Designing of passive RLC filters: Butterworth, Chebyshev, Bessel, elliptic (Cauer). Sensitivity to filter parts tolerance. Active analog filters.
Digital filters: linear and nonlinear filters. Properties of digital filters: finite impulse response filter (FIR), infinite response filter (IIR). Design of digital filters. Round off effects in digital filters. Implementation of digital filters using digital signal processors.
Switched Capacitor (SC) filters.
Design of analog filters for power electronics circuit. Model of passive parts used in power electronics circuits. Capacitors for high pulse stressing value and high currents. Capacitor models. Resistors. Magnetic materials: ferrite, amorphous alloy, powder, classical iron, air. Properties of winding and magnetic core. Eddy current losses in magnetic core. Inductor and transformer design. Eddy currents in conductors.
Signal separation in power electronics circuits. Voltage and current measurements. Parameters: input-output momentary withstand voltage, common mode transient immunity, input-output capacitance, isolation class. Galvanic isolation: magnetic, capacitance, optic, piezoelectric. Galvanic isolation of analog and digital signals. Review of specialized integrated circuit used for galvanic isolation.
Coupling power parts with control circuit. High common mode transient immunity. Galvanic isolated power supply sources.
Design and simulation of analog filters using program *Matlab*.
Energy measurements integrated circuits. Parameters. Single-phase and tree-phase circuits. Review of integrated circuits.

LEARNING OUTCOMES:

Basic knowledge of: analog passive filters and active analog filters understanding and designing. Understanding and designing of galvanic isolation in power electronics circuits.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Proakis J. G., Manolakis D. M., *Digital Signal processing, Principles, Algorithms, and Applications*, Third Edition, Prentice Hall Inc., Engelwood Cliffs, New Jersey 1996

[2] Kazmierkowski M. P., Kishnan R., Blaabjerg F., *Control in Power Electronics*, Academic Press, 2002

[3] Mohan N., Undeland, T. M., Robbins W. P., *Power electronics*, John Wiley & Sons, Inc., 1995

[4] Van den Bossche A., Valchev V. C., *Inductors and Transformers for Power Electronics*, CRC Press, Taylor & Francis Group, 2005

[5] Attia J. O., *Electronics and Circuit Analysis using Matlab*, CRC Press, 1999

[6] Paarmann L. D., *Design and Analysis of Analog filters, a Signal Processing Perspective, with Matlab Examples*, Kluwer Academic Publishers, 2001

OPTIONAL READING:

[1] –

POWER SYSTEM PROTECTION

Course code: 06.2-WE-E-EAZ-PSW_I49_S1S
Type of course: Optional
Entry requirements: -
Language of instruction: Polish
Director of studies: dr hab. inż. Adam Kempski, prof. UZ
Name of lecturer: dr hab. inż. Adam Kempski, prof. UZ

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Part-time studies					4
Lecture	30	2	VI	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	VII	Grade	
Laboratory	18	2		Grade	

COURSE CONTENTS:

Power system faults. Electrical power system faults classification. Faults within the scope of power protection system
Role and functions of protection system in electrical power system. General structure. Functional scheme. Basic requirements. Reliability and redundancy.
Data collecting and processing. Current and voltage signals in fault states. Measurement circuits in relay protection system. Converters of measuring quantities in protection system.
Signal processing in relays and relay protection system. Single- and multi-input relays. Phase and amplitude comparators. Two-state input circuits. Digital techniques in measurement and data processing protection structures.
Basic power system protection criteria and circuit realization. Overcurrent criterion. Instantaneous and delayed over-current protection. Over- and undervoltage criteria. Differential current protection. Impedance criterion. Distance protection. Power direction. Directional overcurrent protection. Decision-making methods and algorithms.
Relay protection of basic power system units. Principles of a selection and arrangements of the protection for basic units of electrical power system (distribution and transmission lines, generators, transformers, motors)
Restoring and preventing automatics. Automatic reclosing. Automatic reserve switching (ARS). Automatic under-frequency load shedding (UFLS).

LEARNING OUTCOMES:

Skills and competences in: understanding needs of using power system protection devices and criteria of their work; understanding of the functioning principles and application of power system protection devices.

ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

RECOMMENDED READING:

[1] Ungrad H., Winkler W. Wiszniewski, *Protection Techniques in Electrical energy Systems*, Marcel Dekker Inc., 1995

[2] Blackburn J. L., *Protective Relaying. Principles and Applications*, Marcel Dekker, 1998

[3] Anderson P.M., *Power System Protection*, McGraw-Hill, 1999

[4] Synal B., *Power system protection – fundamentals*, Oficyna wydawnicza Politechniki Wrocławskiej, Wrocław, 2000 (in Polish)

OPTIONAL READING:

[1] –