FACULTY OF ELECTRICAL ENGINEERING, COMPUTER SCIENCE AND TELECOMMUNICATIONS

ERASMUS PROGRAMME

FIELDS OF STUDY:

ELECTRICAL ENGINEERING

SUPPLEMENTARY MASTER PROGRAMME

Collected and prepared for printing by
RADOSŁAW KŁOSIŃSKI

SELECTED ISSUES OF CIRCUIT THEORY I

Course code: 06.2-WE-E-WZT1-PK2_S2S
Type of course: compulsory
Language of instruction: Polish
Director of studies: Dr hab. inż. Radosław Kłosiński
Name of lecturer: Dr hab. 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
Full-time studies					6
Lecture	30	2	1	Exam	
Laboratory	30	2		Grade	
Part-time studies					6
Lecture	18	2	1	Exam	
Laboratory	18	2		Grade	

COURSE OBJECTIVE:

- to familiarize students with basic concepts, methods, description and analysis of linear time-invariant analog and discrete systems;
- to familiarize with methods of description and analysis of circuits and signals in the time and frequency domains;
- to mastery by students ability to apply theory of linear time-invariant systems for the analysis of transient and steady states in electrical circuits;
- introduction to theory and mastery of the basic methods of discrete simulation of analog circuits;
- to give basic skills of observation of the behavior and take of characteristics of electric circuits;
- to give basic skills in the design of simple passive filters;

ENTRY REQUIREMENTS:

Mathematical analysis, Linear algebra, Electrical engineering principles, Circuit theory.

COURSE CONTENTS:

Flow diagrams of circuits. Mason's signal flow diagrams. Flow diagram for electrical circuit construction. Flow diagram transformations. Mason's rules.

Continuous linear time-invariant systems. Circuit treated as an input output system. Differential equations of circuit. Linearity, causality, time-invariance. Transfer function, circuit operator. Impulse response, convolution. Stability. Periodic excitation, circular convolution, circular impulse response.

Discrete time signals and systems. Sampling of continuous signals. Z transformation. Digital signals filtering, Recursive and nonrecursive filters (IIR and FIR filters). Discrete systems impulse response and linear convolution. Digital filters stability. Periodic steady state of digital filters, circular convolution. Discrete simulation of continuous systems. Introductory discrete linear time-varying systems theory.

Spectral analysis. Continuous Fourier transformation. Time and frequency domain sampling. Other versions of Fourier transformation: Fourier series, discrete Fourier transformation. Frequency response of linear time-invariant continuous and digital filters.

TEACHING METHODS:

Lecture, laboratory exercises.

LEARNING OUTCOMES:

Code	Effects of the course
K2E_W02, K2E_U04	Knows basic concepts in description and analysis of time independent linear systems of continuous and discrete time.
K2E_W01, K2E_W02, K2E_U04	Formulates equations and operator description of linear time-independent circuits.
K2E_W01, K2E_U04	Creates discrete circuit models and performs their discrete simulation
K2E_W08, K2E_U09	Uses equipment to measure signals, parameters and characteristics of electrical circuits.
K2E_U09	Is able to design simple passive filters.

LEARNING OUTCOMES VERIFICATION AND 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.

Calculation of the final grade: lecture 60% + laboratory 40%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
60	Class participation	2,0
24	Preparation for classes	0,80
20	Reading of supplementary texts	0,67
30	Preparation of reports	1,00
10	Execution of tasks assigned by the lecturer	0,33
30	Assignment completion	1,00
6	Personal and on-line consultations	0,20
180	**Total**	**6**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
36	Class participation	1,20
24	Preparation for classes	0,80
30	Reading of supplementary texts	1,00

30	Preparation of reports	1,00
24	Execution of tasks assigned by the lecturer	0,80
30	Assignment completion	1,00
6	Personal and on-line consultations	0,20
180	**Total**	**6**

RECOMMENDED READING:

1. Zieliński T.P.: „From theory to digital signal processing". Dep. EAIiE AGH, Kraków 2002. (in Polish)

2. Oppenheim A.V., Willsky A.S., Nawab S.H.: „Signal & Systems". Prentice Hall 1997.

3. Papoulis A.: Circuits and Systems. A modern Approach. Holt, Rinehart and Winston, Inc. 1980.

4. Lyons R.G.: „Understanding Digital Signal Processing". Addison Wesley Longan, Inc. 2004.

5. Dąbrowski A.: Signal processing by means of signal processors. WPP, Poznań, 2000 (in Polish)

6. Krakowski M.: Theoretical electrical engineering, Vol. I, Linear and non-linear circuits. PWN, Warszawa, 1983. (in Polish)

7. Osiowski J., Szabatin J.: Circuit theory principles, WNT Warszawa 1998. (in Polish).

OPTIONAL READING:

1. Siwczyński M.: Circuits and signals theory, part I Linear electric circuits, RWNT, Zielona Góra 2002. (in Polish)

2. Siwczyński M.: Issues and problems of circuits and systems theory, functional approach. Vol.1. Linear lumped-parameter systems. Printed series of course lectures of WSI in Zielona Góra, 1986. (in Polish)

REMARKS:

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SELECTED ISSUES OF CIRCUIT THEORY II

Course code: 06.2-WE-E-WZT2-PK3_S2S
Type of course: compulsory
Language of instruction: Polish
Director of studies: Prof dr hab inż.Igor Korotyeyev
Name of lecturer: Prof dr hab inż.Igor Korotyeyev

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	30	2	2	Exam	
Part-time studies					4
Lecture	18	2	2	Exam	

COURSE OBJECTIVE:

To provide skills and competence: problem comprehension in electrical systems; circuit synthesis and its circuit realization; linear circuit analyses in the view of their sensitivity for parameters; problem comprehension of nonlinear circuits.

ENTRY REQUIREMENTS:

Mathematical analysis, Linear algebra, Electrical engineering principles, Circuit theory.

COURSE CONTENTS:

Description methods for 3 - phase systems. State description problems of multiphase systems with non-sinus processes. Fortescue's conception. Modal analysis. Clarke - Parka's transform.
Linear system synthesis. Frequency characteristics and their approximation. Two - terminal and four - terminal networks.
Analog Butterworth's and Chebyshev's filters. Examples of circuit realization of analog active filters.
Numerical filter designing by analog prototype. SOI filter designing with linear phase.
Sensitivity analysis. Nonlinear circuit theory. Bases of description methods and nonlinear system analyses.
Linearization method, Newton's method, homotopy method, stable point method.
Consecutive and parallel ferroresonance, Introduction in numerical solution of nonlinear differential equations. Numerical simulation of time – dependent nonlinear systems by time series approximation.
Stability of nonlinear system.

TEACHING METHODS:

Lecture.

LEARNING OUTCOMES:

Code	Effects of the course
K2E_W01, 2E_W03, K2E_U05, K2E_U08	*can analyze simple nonlinear systems*
K2E_U05, K2E_U08	*can run the analysis of three-phase systems*
K2E_U05, K2E_U08	*can use the methods of interpolation and approximation of functions*
K2E_U05	*can use numerical methods for solving differential equations*

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

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

Calculation of the final grade: lecture 100%

student workload:**Full-time studies**		
No. of hours	**Type of workload**	**ECTS**
30	Class participation	1,0
15	Preparation for classes	0,50
15	Reading of supplementary texts	0,50
15	Preparation of reports	0,50
15	Execution of tasks assigned by the lecturer	0,50
15	Assignment completion	0,50
15	Preparation for exam	0,50
120	**Total**	**4**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
18	Class participation	0,60
17	Preparation for classes	0,57
17	Reading of supplementary texts	0,57
17	Preparation of reports	0,56
17	Execution of tasks assigned by the lecturer	0,57
17	Assignment completion	0,56
17	Preparation for exam	0,57
120	**Total**	**4**

RECOMMENDED READING:

1. Williams, Arthur B.; Taylors, Fred J. *Electronic Filter Design Handbook*. New York: McGraw-Hill, 1988.
2. D. Stevenson, Jr., *Elements of Power System Analysis*, 3rd ed., New York: McGraw–Hill, New York, 1975.
3. Leon O. Chua, Charles A. Desoer, Ernest S. Kuh. Linear and Nonlinear Circuits. Mcgraw-Hill College, 1987

OPTIONAL READING:

1. Hartman, M.T., "The application of Fortescue's transformation to describe power states in multi-phase circuits with non-sinusoidal voltage and currents," *Electrical Power Quality and Utilisation, 2007. EPQU 2007. 9th International Conference on* , vol., no., pp.1,6, 9-11 Oct. 2007

REMARKS:

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ELECTROMECHANICAL DRIVE SYSTEMS

Course code: 06.2-WE-E-ESN-PK4_S2S

Type of course: compulsory

Language of instruction: Polish

Director of studies: D.Sc. Robert Smoleński

Name of lecturer: D.Sc. Robert Smoleński, M.Sc. Piotr Leżyński

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					6
Lecture	30	2	1	Grade	
Laboratory	30	2		Grade	
Part-time studies					
Lecture	18	2	1	Grade	
Laboratory	18	2		Grade	

COURSE OBJECTIVE:

- familiarize students with the principles of construction and control of electromechanical drive systems
- acquiring skills in the selection of the parameters of converter drives working in drive systems;

ENTRY REQUIREMENTS:

Physics, Fundamentals of Electrical Engineering, Fundamentals of electronics and power electronics

COURSE CONTENTS:

Drive systems. Dynamics of electric drives. Equation describing dynamics of drives. Dynamics equation of electromechanical systems.

Modeling of steady and dynamic state of electric drive. General properties of nonlinear systems. Mathematical models of electric machines and drive systems. Identification of parameters of equivalent circuits of drive systems. Dynamic state in electric drives. Influence of drive dynamic state on power grid.

Power converter multi-drives. Selection of parameters of power converter drives in drive systems. Regenerative breaking in multi-drive systems.

Analysis of energetic and mechanical properties of power converter drives. Two- and four quadrant asynchronous drives. DC converter drives, permanent magnet and reluctance converter drives. Brushless DC motors.

TEACHING METHODS:

Lecture, laboratory exercises.

LEARNING OUTCOMES:

Code	Effects of the course
K2E_W11, T2A_W09, T2A_W11	*Analyses energy and mechanical properties of: two- and four-quadrant asynchronous drives, converter drives with DC motors, synchronous and reluctance motors, brushless DC motors*
K2E_W04, K2E_W07, T2A_W02, T2A_W04, T2A_W07, T2A_W08, T2A_W05	*Is aware of the effects of dynamic states of drives on the electric power network*
K2E_U06, T2A_U09, T2A_U12	*Can choose the parameters of converter drives in drive systems*
K2E_U06, T2A_U09, T2A_U12	*Can formulate equations describing simple drive systems*
K2E_U07, K2E_K04, T2A_U14, T2A_U16, T2A_K03	*Can apply analysis methods for numerical electro-mechanical systems*

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Lecture – in order to get a credit it is necessary to pass all of the required tests (oral or written)

Laboratory - in order to get a credit it is necessary to earn positive grades for all laboratory works defined by tutor

Calculation of the final grade: lecture 50% + laboratory 50%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
60	Class participation	2
27	Preparation for classes	0,9
24	Reading of supplementary texts	0,8
27	Preparation of reports	0,9
24	Execution of tasks assigned by the lecturer	0,8
18	Personal and on-line consultations	0,6
180	**Total**	**6**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
36	Class participation	1,2
30	Preparation for classes	1
30	Reading of supplementary texts	1
30	Preparation of reports	1
30	Execution of tasks assigned by the lecturer	1
24	Personal and on-line consultations	0,8
180	**Total**	**6**

RECOMMENDED READING:

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

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

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

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

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.

Leonhard W.: *Control of Electrical Drives*, Springer, Berlin, New York, 2001.

Miller T.J.E.: *Brushless Permanent-Magnet and Reluctance Motor Drives*, Oxford University Press, Oxford, England, 1989. Pamiętaj o kolejności: autor, tytuł, wydawnictwo, miejsce, rok wydania!

OPTIONAL READING:

REMARKS:

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DIGITAL INDUSTRIAL NETWORKS

Course code: 06.0-WE-E-PSP-PSW_A7_CSP_S2S
Type of course: Optional
Language of instruction: Polish
Director of studies: Dr inż. Adam Markowski
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
Full-time studies					6
Lecture	30	2	2	Exam	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					6
Lecture	18	2	2	Exam	
Laboratory	18	2		Grade	
Project	9	1		Grade	

COURSE OBJECTIVE:

To familiarize students with the basic solutions used in the field of industrial computer networks.

To shape basic skills in programming using digital serial interfaces used in industrial automation.

To shape basic skills in the design and characterization of communication properties of distributed systems – control.

ENTRY REQUIREMENTS:

Fundamentals of microprocessor systems, Programming Languages I and II, Fundamentals of metrology

COURSE CONTENTS:

The evolution of measuring – controlling systems. The architecture of computer industrial networks. Topology of industrial networks. Transmission media.

Access methods to a medium in industrial networks: Master-Slave, Token-Passing, CSMA and TDMA.

Standard communication protocols. Characteristics of standard communication protocols: PROFIBUS, MODBUS, CAN, LonWorks, INTERBUS-S, ASI and HART.

Industrial Ethernet. Characteristics of selected solutions: PROFINET, EtherCAT and Powerlink. Internet technologies in computer industrial networks. Dedicated WWW servers.

Analysis of communication efficiency and time parameters of selected protocols. Time determination in industrial networks.

Industrial network components. Converters, amplifiers, concentrators, nodes, routers, bridges and gates. Integration of industrial networks with local computer networks.

Utility programs for creating intelligent devices operating in industrial network nodes. Software of serial digital interfaces for data exchange with industrial automation devices.

Integration and management of industrial networks. Methods of industrial network integration.

Industrial network analysers and testers. Properties of industrial networks analysers and testers.

Standards engineering of industrial network environments. Specifics of application areas for particular standards. Elements of industrial network designing.

TEACHING METHODS:

Lecture, laboratory exercises, project.

LEARNING OUTCOMES:

Code	Effects of the course
K2E_U13	Can choose the devices to create a distributed measurement and control system for the given simple object
K2E_U13	Can run the analysis of communication properties of the presented measuring and control system
K2E_W12	Understands aim of application of digital industrial networks
K2E_W12	Can characterize basic solutions in the area of digital industrial networks
K2E_U13	Can configure and use basic serial digital interfaces for programming data exchange with automation devices

LEARNING OUTCOMES VERIFICATION AND 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 is acquiring sufficient marks for all project tasks as scheduled

Calculation of the final grade: lecture 40% + laboratory 30% + project 30%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
75	Class participation	2,5
18	Preparation for classes	0,60
18	Reading of supplementary texts	0,60
18	Preparation of reports	0,60
17	Execution of tasks assigned by the lecturer	0,56
17	Personal and on-line consultations	0,56
17	Preparation for exam	0,56

180	Total	6
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
45	Class participation	1,50
23	Preparation for classes	0,77
23	Reading of supplementary texts	0,77
22	Preparation of reports	0,77
22	Execution of tasks assigned by the lecturer	0,73
22	Personal and on-line consultations	0,73
22	Preparation for exam	0,73
180	**Total**	**6**

RECOMMENDED READING:

1. Mielczarek Wojciech: *Serial digital interfaces*, Helion, Gliwice, 1999. (in Polish)
2. Nawrocki W.: *Computer measuring systems*. WKŁ, Warszawa 2002. (in Polish)
3. Sacha K.: *Local Profibus networks.* MIKOM, Warszawa 1998. (in Polish)
4. Winiecki W.: *The organisation of computer measuring systems.* Oficyna Wydawnicza Politechniki Warszawskiej WPW, Warszawa 1997. (in Polish)
5. Lesiak P., Świsulski D.: *Examples of computer measuring methods*, Agenda Wydawnicza PAK, Warszawa, 2002. (in Polish)
6. Nawrocki W.: *Distributed measuring systems*, WKŁ, Warszawa 2006. (in Polish)
7. Kwiecień R.: *Computer systems for industrial automation*, Helion, Gliwice 2012. (in Polish)
8. Mackay S., Wright E., Reynders D., Park J.: *Practical Industrial Data Networks: Design, Installation and Troubleshooting,* Newnes.
9. Reynders D., Mackay S., Wright E.: *Practical Industrial Data Communications: Best Practice Techniques,* Butterworth-Heinemann, 2004

OPTIONAL READING:

REMARKS:

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EMBEDDED MEASUREMENT SYSTEMS

Course code: 06.0-WE-E-PSW-PSW_B8_CSP_S2S
Type of course: compulsory
Language of instruction: Polish
Director of studies: Dr Janusz Kaczmarek
Name of lecturer: Dr 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
Full-time studies					5
Lecture	30	2	2	Grade	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					**5**
Lecture	**18**	**2**	**2**	Grade	
Laboratory	**18**	**2**		Grade	
Project	**9**	**1**		Grade	

COURSE OBJECTIVE:

Skills and competences in the field of designing the hardware and the software of embedded systems with emphasis on measurement equipment.

ENTRY REQUIREMENTS:

Electronics principles, Metrology, Foundations of digital and microprocessor engineering, Programming languages

COURSE CONTENTS:

Fundamentals terms and definition. Architecture microprocessor measurement devices. Methodology of designing embedded systems: division of project tasks on software and hardware, creating technical documentation. Some elements of microprocessor technique. Microprocessors and microcontrollers. Microcontroller architecture.

Overview of some microcontroller families. Architecture of DSP floating-point processors. Problems of power-saving in embedded systems. Microprocessor power-saving modes. Interfacing of analog-to-digital and digital- to-analog converters.

Introduction to programming for embedded systems. Integrated programming environments. Low-level and high-level programming languages. Hybrid programming technique. Methods of code optimization.

Applying real-time operating system (RTOS) to design the software for embedded systems with low resources. Basic terms. Principles and aims of applying RTOS systems. Mechanisms of RTOS kernel. Services of peripheral devices. Scalability of RTOS. Examples of commercial and non-commercial RTOS. Advantages of applying RTOS in measurement equipment.

Processing of measurement data in digital systems. Arithmetic and numerical representations for measurement data. Effective fixed-point arithmetic on fractional numbers. Transformations of numbers and conversions of codes. Scaling and calibrating. Display of measurement results.

Implementation of some measurement and control algorithms. Software control procedures for analog-to-digital and digital-to-analog converters. Acquisition and generation signals using interrupts. Sampling methods of RMS and frequency measurement. Real-time signals processing with DSP processors.

TEACHING METHODS:

Lecture, laboratory exercises, project.

LEARNING OUTCOMES:

Code	Effects of the course
K2E_W12	Can design microprocessor measuring devices
K2E_U13	Can realize in a team the tasks related to microprocessor programming of measurement devices
K2E_W12, K2E_U13	Knows specifics of embedded systems including microprocessor architecture of measurement devices
K2E_W12, K2E_U13	Can program microprocessor measuring devices in low- and high- level languages and carry out the startup process.

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Lecture – the passing condition is to obtain a positive mark from the final test.

Laboratory – the passing condition is to obtain positive marks from all laboratory exercises to be planned during the semester.

Project - the project documentation and oral presentation

Calculation of the final grade: lecture 30% + laboratory 40% + project 30%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
75	Class participation	2,5
15	Reading of supplementary texts	0,5
25	Preparation for classes	0,83
20	Preparation of reports	0,67
5	Assignment completion	0,17
10	Personal and on-line consultations	0,33
150	**Total**	**5**
Part-time studies		

No. of hours	Type of workload	ECTS
45	Class participation	1,5
30	Reading of supplementary texts	1
30	Preparation for classes	1
20	Preparation of reports	0,67
10	Assignment completion	0,33
15	Personal and on-line consultations	0,5
150	**Total**	**5**

RECOMMENDED READING:

1. Barney G.C.: Intelligent Instrumentation. Microprocessor Applications in Measurement and Control , Prentice Hall, 1988
2. Tumański S.: Measuring Technique, WNT, Warszawa, 2007 (n Polish)
3. Labrosse J.J.: Embedded System Building Blocks, CMP Books, 2000
4. Dąbrowski A.: Processing of signals with DSP processors, Wydawnictwo Politechniki Poznańskiej, Poznań, 1998 (in Polish)

OPTIONAL READING:

REMARKS:

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COMPUTER-AIDED DESIGN

Course code: 06.5-WE-E-KWP-PSW_C9_CSP_S2S
Type of course: compulsory
Language of instruction: Polish
Director of studies: Dr Janusz Kaczmarek
Name of lecturer: Dr 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
Full-time studies					5
Lecture	30	2	2	Exam	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					**5**
Lecture	**18**	**2**	**2**	Exam	
Laboratory	**18**	**2**		Grade	
Project	**9**	**1**		Grade	

COURSE OBJECTIVE:

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

ENTRY REQUIREMENTS:

Digital systems design , microprocessor systems, principles of programming

COURSE CONTENTS:

Advanced design techniques for electronic devices. Creating a hierarchical and multipages schemes. Defining and automatic verification of complex design rules. Project version control. Advanced PCB design techniques. Automating the process of deploying electronic components and connection paths.

Printed Circuit Board designing for EMC requirements. Basic knowledge of RF emissions and susceptibility of electronic circuits. PCB EMC techniques: circuit zoning, suppressing interfaces

between circuit zones, ground system, power routing and decoupling, signal routing and line termination. Signal integrity and transmission lines on PCB.

Schematic-level simulation of embedded microprocessor systems. Analysis of simulation results.

Computer simulation of thermal and electromagnetic properties of printed circuit boards.

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.

TEACHING METHODS:

Lecture, laboratory exercises, project.

LEARNING OUTCOMES:

Code	Effects of the course
K2E_W12	Can design and study microprocessor systems using EDA program
K2E_W12	Can design printed circuit boards with manual and automatic routing
K2E_W12, K2E_U13	Knows the specifics of PCB design taking into account the requirements of the EMC.
K2E_W12, K2E_U13	Can program in LabVIEW environments

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Lecture – obtaining a positive grade in written exam.

Laboratory – the passing condition is to obtain positive marks from all laboratory exercises to be planned during the semester.

Project - the project documentation and oral presentation

Calculation of the final grade: lecture 30% + laboratory 40% + project 30%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
75	Class participation	2,5
15	Reading of supplementary texts	0,5
25	Preparation for classes	0,83
20	Preparation of reports	0,67
5	Assignment completion	0,17
10	Personal and on-line consultations	0,33
150	**Total**	**5**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
45	Class participation	1,5
30	Reading of supplementary texts	1
30	Preparation for classes	1
20	Preparation of reports	0,67

10	Assignment completion	0,33
15	Personal and on-line consultations	0,5
150	**Total**	**5**

RECOMMENDED READING:

5. Williams T., The Circuit Designer's Companion, Newnes, 2005.
6. Archambeault B. R., Drewniak J.: PCB Design for Real-World EMI Control, Kluwer Academic Publishers, 2004
7. Essick J.: Hands-On Introduction to LabVIEW for Scientists and Engineers, Oxford University Press, 2012.
8. Winiecki W.: Organization of computer measurement systems, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 1997 (in Polish)

OPTIONAL READING:

REMARKS:

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MODELING OF MEASUREMENT TRANSDUCERS

Course code: 06.0-WE-E-MPP-PSW_F12_CSP_S2S
Type of course: Optional
Language of instruction: Polish, English
Director of studies: Professor Wiesław Miczulski
Name of lecturer: Ph.D. Mariusz Krajewski

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					6
Lecture	30	2	3	grade	
Laboratory	30	2		grade	
Part-time studies					
Lecture	18	2	3	grade	
Laboratory	18	2		grade	

COURSE OBJECTIVE:

acquaint students with the basic principles of construction of mathematical models of measurement transducers,
Shaping of basic skills in analyzing of sources error primary function blocks measuring transducers.
Shaping of basic skills for conducting simulation research and experimental research measuring transducers.

ENTRY REQUIREMENTS:

Measurement transducers.

COURSE CONTENTS:

General characteristic of smart measurement transducers. Characteristic of basic functional smart measurement transducers blocks. Features distinguishing smart measurement transducers from previous generation transducers.

General notes about designing and role of mathematical model. The aim and stages of the design process. Sequential-iteration design algorithm. Limitations in the process of designing. Essence and scope of the mathematical modeling.

Fundamentals of models building. Stages of mathematical modeling. Analogies between physical phenomena. Methods of creation of mathematical models. Examples of building models of sensor and hardware analog-to-digital.

Basic elements of transducers and their mathematical models. Mathematical models of input circuits, analogue function modules, S/H and A/D converters.

Designing rules of measurement transducers with analogue function operators. Transducer of active power and root mean square voltage.

Designing rules of measurement transducers with S/H transducers. Active power transducer.

Selected methods of measurement transducers error correction. General notes about methods of error correction. Selected correction procedures. Iterative methods. Method of reference sources. Test methods. Adaptation of measurement circuit parameters to parameters of processed signals and work conditions. Multiparameter methods. Selected examples of smart sensors and transducers.

TEACHING METHODS:

Lecture, laboratory exercises.

LEARNING OUTCOMES:

Code	Effects of the course
K2E_W12	Can formulate mathematical models of basic function blocks of measurement converters on the basis of metrological properties.
K2E_U13	Can work individually and in a team.
K2E_U13	Can carry out research on metrological characteristics of measurement transducers.
K2E_W12	Can characterize metrological characteristics of basic function blocks of measuring transducers.
K2E_U13	Can apply selected correction methods for measurement converters

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once a semester.
Laboratory – the main condition to get a pass are sufficient marks for all exercises and tests conducted during the semester.

Calculation of the final grade: lecture 50% + laboratory 50%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
60	Class participation	2,0
21	Preparation for classes	0,7
21	Reading of supplementary texts	0,7
30	Preparation of reports	1,0
21	Execution of tasks assigned by the lecturer	0,7
21	Assignment completion	0,7
6	Personal and on-line consultations	0,2
180	**Total**	**6**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
36	Class participation	1,2
36	Preparation for classes	1,2
36	Reading of supplementary texts	1,2
30	Preparation of reports	1,0
21	Execution of tasks assigned by the lecturer	0,7
12	Assignment completion	0,4
9	Personal and on-line consultations	0,3
180	**Total**	**6**

RECOMMENDED READING:

1. Bolikowski J. (red): *Essentials of designing of smart measurement transducers of electrical quantities*, Monograph Nr 68, WSI, Zielona Gora 1993 (in Polish).
2. Gajda J., Szyper M.: *Modeling and simulation research of measurement syste*ms, Jartek s.c. Krakow 1998 (in Polish).
3. Jakubiec J., Roj J.: *Measurement sample transducers*, Wydawnictwo Politechniki Śląskiej, Gliwice, 2000 (in Polish).
4. Kesler W.: *The Data Conversion Handbook*, Analog Devices Inc., Newnes, 2004.
5. Proakis J.G, Manolakis D.G.: *Digital Signal Processing. Principles, Algorithms and Aplications*, Prentice Hall, 2007.

OPTIONAL READING:

1. Rudy van de Plassche: *Integrated Analog-to-Digital and Digital-to-Analog Converters*, Kluwer Academic Publishers, Boston,1994.
2. Smith S.W.: *Digital Signal Processing: A Practical Guide for Engineers and Scientists*, Newnes,2002.
3. www.sensirion.com.
4. www.analog.com.

REMARKS:

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DESIGN AND SYSTEM ANALYSIS

Course code: 06.2-WE-E-PASP-PSW_B8_EE_S2S

Type of course: compulsory

Language of instruction: Polish, English

Director of studies: Dr Zbigniew Fedyczak, prof. of UZ

Name of lecturer: Dr Zbigniew Fedyczak, prof. of 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
Full-time studies					6
Lecture	30	2	2	1. exam	
Laboratory	30	2		2. grade	
Project	15	1		3. grade	
Part-time studies					
Lecture	18	2	2	4. exam	
Laboratory	18	2		5. grade	
Project	9	1		6. grade	

COURSE OBJECTIVE:

- familiarize students with the basic issues and tools associated with the process of meeting the technical needs;
- formation among the students understand the need for appropriate sequence of actions in the technical preparation of production (TPP) of an electrical device.

ENTRY REQUIREMENTS:

Computer aided design.

COURSE CONTENTS:

Introduction. Techno-sphere and their relationship with eco-sphere. General description of the stages leads to satisfy the needs and the designing system analysis of the electrical devices.
Technical needs identification. Original and secondary needs. Awareness of needs. Design and constructing as the needs of technical problem solutions. Criteria of needs.

Object of the technical work and technical means and systems. Composition and product. Attributes and properties of technical systems. A technical mean in process of the needs satisfy. General characteristic of the technical systems. Relation in the technical systems.
Fundamentals of design methodology. Designing methods. Heuristic methods, algorithmic methods. Model idea.
Technical preparation of production. Manufacture conception, design assumption data. Construction documentation. Technology documentation. System analysis and examples of the construction documentation of electrical device. The aims and stages of the technology documentation.
Computer aided of the technical preparation of production. Tools and the computer programs used for accomplishing of construction and technology documentations. Normalization and patent computer data bases.
Management of the production quality. A production as a final acting stage lead to needs satisfy. Production time table and production control in manufacture systems. General description of the production quality systems and computer tools and programs for management aids of production quality.

TEACHING METHODS:

Lecture, laboratory exercises, project.

LEARNING OUTCOMES:

Code		Effects of the course
K2E_W12 K2E_U33	T2A_W04 T2A_U17 T2A_U19	Can describe the stages of technical preparation of production (TPP)
		Understands the need for application of procedures related to production quality management
		Knows basic definitions and has general knowledge on design methodology as a process of satisfying technical needs

LEARNING OUTCOMES VERIFICATION AND 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.

Calculation of the final grade: lecture 60% + laboratory 20% + project 20%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
60	Class participation	2.0
24	Preparation for classes	0.80
20	Reading of supplementary texts	0.66
30	Preparation of reports	1.00
10	Execution of tasks assigned by the lecturer	0.34
30	Assignment completion	1.00
6	Personal and on-line consultations	0.20
180	**Total**	**6**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
36	Class participation	2.0
24	Preparation for classes	0.80
30	Reading of supplementary texts	0.66
30	Preparation of reports	1.00
24	Execution of tasks assigned by the lecturer	0.34

30	Assignment completion	1.00
6	Personal and on-line consultations	0.20
180	**Total**	**6**

RECOMMENDED READING:

[1] Klir G.: General systems theory. Development trends. WNT, Warsaw, 1975 and next editions, (in Polish).
[2] Ditrich J.: System and construction. System i konstrukcja. WNT, Warsaw, 1985 and next editions, (in Polish).
[3] Witkowski T.: Decision In enterprise management. WNT, Warsaw, 2004, (in Polish).
[4] Pająk E.: Production management. PWN, Warsaw, 2007, (in Polish).

OPTIONAL READING:

[1] Jaskolski A.: AutoCAD 2007/LT+. PWN, Warsaw 2007 (in Polish).
[2] Jaskolski A.: Autodesk Inventor 10PL/10+. PWN, Warszawa 2007, (in Polish).

REMARKS:

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ELECTROMAGNETIC COMPATIBILITY

Course code: 06.2-WE-E-KE-PSW_D10_EE_S2S

Type of course: compulsory

Language of instruction: Polish

Director of studies: D.Sc. Adam Kempski, prof. UZ, D.Sc. Robert Smoleński

Name of lecturer: D.Sc. Adam Kempski, prof. UZ, D.Sc. Robert Smoleński, M.Sc. Piotr Leżyński

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					6
Lecture	30	2	2	Exam	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	2	Exam	
Laboratory	18	2		Grade	
Project	9	1			

COURSE OBJECTIVE:

- provide fundamental knowledge of electromagnetic compatibility (EMC) in the electrical, electronic and automation systems,
- familiarize students with the principles of EMC standardization and procedures for CE mark obtaining,
- developing basic skills in EMC measurements and methods of electromagnetic compatibility assurance;

ENTRY REQUIREMENTS:

Physics, Fundamentals of electrical engineering, Fundamentals of Electronics,

COURSE CONTENTS:

Introduction to electromagnetic compatibility (EMC). Basic terms. EMC terminology. Immunity and emissions of electric equipment. Interference sources – intentional and non-intentional.

Electromagnetic fields and coupling mechanisms. Near and far field terms. Conducted and radiated interferences. Basic mechanisms of electromagnetic interferences couplings and propagations: galvanic, by means of near and far fields. Propagation of EMI in transmission lines. Basics of EMI signal analysis.

EMC measurement and investigations. Methods of electromagnetic emission measurement. Immunity measurements. Measurements at the development stage.

Electromagnetic compatibility in the electronic equipment. Characteristics of real elements in the interference frequency range. Electromagnetic compatibility of PCB. Signal integrity. EMC of control and transmission systems. EMC of telecommunication systems. EMC and functional safety of electronic equipment.

EMC strategy. EMC analyses and simulations. Techniques of EMI effects reduction – earthing and bonding, shielding, topology and structure of circuits, EMI filters. development of devices according to EMC requirements. Internal and external EMC. EMC for systems and installations.

EMC standardization. International Standardization Organization. Directives of New Approach and Global Approach. EMC Directive. EMC standards. EMC standards classification – generic, basic and product standards. Standards for electromagnetic environments. Safety related EMC standards. Present stage of EMC standardization. Routes to declaring compliance and CE marking and legal responsibility of manufacturer.

Electric power quality. Definitions of power quality. Voltage characteristics of electricity supplied by public distribution systems. Voltage sags or dips, short interruptions, asymmetry and distortions. Methods of improvement of electric power quality. Influence of loads on electric power quality. Measurements of characteristics of electric power quality.

TEACHING METHODS:

Lecture, laboratory exercises.

LEARNING OUTCOMES:

Code	Effects of the course
K2E_W12, T2A_W04	*Can identify and analyze the situations of the absence of electromagnetic compatibilityin electrical and electronic systems.*
K2E_U13, T2A_U17, T2A_U19	*Can use measurement techniques used to measure electromagnetic emission and device resistance to disturbance.*
K2E_U13, T2A_U17, T2A_U19	*Knows and can apply measures decreasing effects of electromagnetic interferences*
K2E_W12, T2A_W04	*Knows and understands basic coupling and propagation mechanisms of electromagnetic interferences and emissivity and resistance of devices concepts.*
K2E_W12 T2A_W04	*Knows and understands principles of technical law operation in the field of EMC (electro magnetic compatibility)*

LEARNING OUTCOMES VERIFICATION AND 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.

Calculation of the final grade: lecture 40% + laboratory 30% + project 30%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
75	Class participation	2,5
21	Preparation for classes	0,7
18	Reading of supplementary texts	0,6
18	Preparation of reports	0,6
15	Execution of tasks assigned by the lecturer	0,5
21	Preparation for exam	0,7

12	Personal and on-line consultations	0,4
180	**Total**	**6**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
45	Class participation	1,5
24	Preparation for classes	0,8
21	Reading of supplementary texts	0,7
24	Preparation of reports	0,8
21	Execution of tasks assigned by the lecturer	0,7
24	Preparation for exam	0,8
21	Personal and on-line consultations	0,7
180	**Total**	**6**

RECOMMENDED READING:

Weston D.A.: Electromagnetic Compatibility. Principles and Applications. Marcel Dekker Inc., 1991

Williams T., Armstrong K.: EMC for systems and Installations, Newness, 2000

Tichanyi L.: Electromagnetic Compatibility in Power Electronic. J.K.Eckert & Company, 1995

Magnusson P.C. et al.: Transmission lines and wave propagation, CRC Press, 2001

Charoy A.: Interferences In electronic devices, WNT W-wa, 1999 (in Polish).

OPTIONAL READING:

REMARKS:

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ENERGY CONVERSIONS AND ALTERNATIVE ENERGY SOURCES

Course code: 06.2-WE-E-PEAŹ-PSW_E11_S2S

Type of course: compulsory

Language of instruction: English

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
Full-time studies					6
Lecture	30	2	3	grade	
Laboratory	30	2		grade	
Part-time studies					
Lecture	18	2	3	grade	
Laboratory	18	2		grade	

COURSE OBJECTIVE:

To provide fundamental knowledge in subject of energy conversions and renewable energy sources.

ENTRY REQUIREMENTS:

Circuit theory, Fundamentals of electrical power engineering

COURSE CONTENTS:

Energy resources and energy demands. Conversion of the thermal energy into mechanical and electrical. Conversion of the wind and water energy. Conversion of the nuclear energy into thermal and electrical energy. Energy conversions and influence onto environment.

Nuclear energy. Nuclear reactor – principle of operation. Advantages and disadvantages of the nuclear power stations.

Wind energy. Wind conditions In Poland and Europe. Wind conversion system. Ecological, scenery and environmental results of the wind installations utilization.

Solar energy. Insolation in Poland. Types and construction of the solar systems. Principle of operation.

Examples of the industrial installations with photovoltaic.

Water energy. Turbine construction. Influence of the large water power stations onto environmental changes. Principles of constructions as well as cooperation of the small water power stations with the energy network.

Geothermal energy. Methods and examples of utilization of the geothermal energy. Geothermal energy resources in Poland. Principle of operation of the heat pumps, heat sources utilized In heat pumps.

Biogas, biomass and waste heat. Fermentation as source of the biogas. Straw and brushwood utilization.

Electrical arrangements In alternative energy sources. Methods of solar energy conversion into electrical energy. Arrangements to cooperation with AC networks.

Novel sources of the alternative energies. Electrolysis and hydrogen utilization.

Thermonuclear fusion. Financial aspects of the alternative energy installations.

TEACHING METHODS:

Lecture, laboratory exercises

LEARNING OUTCOMES:

Code	Effects of the course
K2E_W12	Characterizes the sources of renewable energy and energy storage
K2E_U13	Can select installation elements, estimate design cost and investment payback time for alternative energy sources
K2E_W12	Knows about energy conversion
K2E_W12	Knows properties of renewable energy sources and electric energy deposits

LEARNING OUTCOMES VERIFICATION AND ASSESSSMENT 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 is acquiring sufficient marks for all laboratory exercises as scheduled.

Calculation of the final grade: lecture 50% + laboratory 50%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
60	Class participation	2
30	Preparation for classes	1
30	Reading of supplementary texts	1
45	Preparation of reports	1,5
0	Assignment completion	0
15	Personal and on-line consultations	0,5
0	Preparation for exam	0
180	**Total**	**6**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
36	Class participation	1,2
30	Reading of supplementary texts	1
42	Preparation of reports	1,4
42	Preparation for classes	1,4
0	Assignment completion	0

30	Personal and on-line consultations	1
0	Preparation for exam	0
180	**Total**	**6**

RECOMMENDED READING:

1. Klugmann E., Klugmann-Radziemska E.: Alternative energy sources. Photovoltaics power systems, Wydawnictwo Ekonomia i Środowisko, Białystok, 1999. (in Polish)
2. Heier S., Waddington R.: Grid integration of wind energy conversion systems, John Wiley & Sons, 2006.
3. Luque A.: Handbook of photovoltaic science and engineering, John Wiley & Sons, 2003.
4. Lewandowski W.: Ecological friendly renewable energy sources, WNT, Warszawa, 2001. (in Polish)
5. Marecki J.: Basic of energy transformations, WNT, Warszawa, 1995. (in Polish).

OPTIONAL READING:

1. O'Hayre R.: Fuel cell fundamentals, John Wiley & Sons, 2006.
2. Mielczarski W., Electrical energy market – selected technical and economical aspects, ARE & EP-C, Warszawa, 2000 (in Polish)

REMARKS:

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ADVVANCED SYSTEMS FOR POWER FLOW CONTROL

Course code: 06.2-WE-E-ZSPE-PSW_F12_S2S

Type of course: compulsory

Language of instruction: English

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
Full-time studies					6
Lecture	30	2	3	grade	
Laboratory	30	2		grade	
Part-time studies					
Lecture	18	2	3	grade	
Laboratory	18	2		grade	

COURSE OBJECTIVE:

To provide fundamental knowledge in subject of power flow control.

ENTRY REQUIREMENTS:

Circuit theory, Fundamentals of electrical power engineering, Power electronics circuits

COURSE CONTENTS:

Distributed generation. Power quality in distributed electrical power system. Limitations of the transmission and distributed power lines.

Control of the parameters of the electrical power system. Series, parallel and series-parallel compensation. Power electronics arrangements for compensation.

Electrical power system - stability. Transient and dynamic stability. Methods of improvement of the stability margin. Influence of the series, parallel and series-parallel compensation on transient and dynamic stability.

Conventional FACTS. Knowledge of TCR, TSC, SVC, TCSC, FC. Influence of the above mentioned on system stability.

FACTS on the base of synchronous sources. Knowledge of SSSC, STATCOM, UPFC, IPFC. Influence of the above mentioned on system stability.

Energy storage arrangements. Batteries. Super-capacitors. Compressed air. Fly wheels. Fuel cells. SMES. FACTS with energy storage – influence on voltage conditions and stability.

UPS arrangements. UPS Standby. UPS Line-interactive. Delta conversion UPS.

Methods for identification of the unneeded components. Basic component identification method. Integral methods. Instantaneous power theory. Kalman filters. Neural networks. DTF.

Power electronics arrangements for power quality improvement. Series and parallel active filters. Hybrid filters. Series-parallel arrangements for power quality improvement – UPQC. UPLC arrangements.

TEACHING METHODS:

Lecture, laboratory exercises

LEARNING OUTCOMES:

Code	Effects of the course
K2E_U13	Can examine the properties of FACTS and UPS systems
K2E_U13	Can indicate the system eliminating the specific constraints of transmission networks
K2E_W12	Knows functionality limitation mechanisms of power grids
K2E_W12	Knows theoretical fundamentals of FACTS and UPS systems operation
K2E_W12	Knows serial and concurrent compensation

LEARNING OUTCOMES VERIFICATION AND ASSESSSMENT 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 is acquiring sufficient marks for all laboratory exercises as scheduled.

Calculation of the final grade: lecture 50% + laboratory 50%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
60	Class participation	2
30	Preparation for classes	1
30	Reading of supplementary texts	1
45	Preparation of reports	1,5
0	Assignment completion	0
15	Personal and on-line consultations	0,5
0	Preparation for exam	0
180	**Total**	**6**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
36	Class participation	1,2
30	Reading of supplementary texts	1
42	Preparation of reports	1,4
42	Preparation for classes	1,4
0	Assignment completion	0
30	Personal and on-line consultations	1
0	Preparation for exam	0
180	**Total**	**6**

RECOMMENDED READING:

1. Strzelecki R., Supronowicz H.: Power factor in alternating currents systems and improvement methods, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa, 2000. (in Polish)
2. Hingorani N., Gyugyi L.: Understanding FACTS. Concepts and technology of flexible AC transmission systems, IEEE Press, New York, 2000.
3. Song Y., Johns A.: Flexible AC transmission systems (FACTS), IEE Power and Energy Series 30, TJ International Ltd, Padstow, Cornwall, 1999.
4. Benysek G.: Improvement in the quality of delivery of electrical energy using power electronics systems, Springer-Verlag Ltd, London, 2007.

OPTIONAL READING:

1. Arrillaga J., Watson N., Power system harmonics, John Wiley & Sons, 2003
2. Machowski J. et all., Power system dynamics and stability, John Wiley & Sons, 1997

REMARKS:

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FAULTS IN POWER SYSTEMS

Course code: 06.2-WE-E-ZUE-PK6_S2S
Type of course: compulsory
Language of instruction: Polish
Director of studies: Dr hab. inż. Adam Kempski
Name of lecturer: Dr hab. inż. Grzegorz Benysek
Dr hab. inż. Adam Kempski

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					6
Lecture	30	2	1	Grade	
Laboratory	30	2		Grade	
Part-time studies					6
Lecture	18	2	1	Grade	
Laboratory	18	2		Grade	

COURSE OBJECTIVE:

Understanding problems related to reasons and effects of transients states in the electrical power systems; developing skills in the implementation of system protection.

ENTRY REQUIREMENTS:

Circuit theory, High voltage engineering , Fundamentals of electrical power engineering.

COURSE CONTENTS:

Transients and electromagnetic distortions in electrical power engineering systems. Classification of distortions.Influences of transients on electrical power system and its elements behavior. Voltage dips and supply interruptions

Overvoltages in electrical power system. Reasons, effects and overvoltages classification. External and internal overvoltages in high voltage electric al Power system. Lightning overvoltages. Wave phenomena in electrical power transmission power lines. Lightning protection and transit overvoltage protection. Coordination of overvoltage protection.

Short-circuits in electrical power system. Reasons, effects and short-circuits classification. Transients caused by shortcircuits and switchings in high voltage level arrangements. Influences of the short-circuit currents. Short-circuit calculations. Electro-mechanical transients and power system stability.

Power system protection. Methods of fault detection in power system. Relay protection system in electrical power system. Power system co-ordination in fault conditions.

TEACHING METHODS:

Lecture, laboratory exercises.

LEARNING OUTCOMES:

Code	Effects of the course
K2E_W06, K2E_U11	Knows and understands interferences causes and course in electric systems
K2E_W06, K2E_U11	Knows about the effects of interferences impact on operation of electric power system and its elements
K2E_U12	Knows and can apply principles of security realization for electromagnetic system elements
K2E_U12	Can choose system and security settings in simple systems of protection automation

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Lecture – the passing condition is to obtain a positive mark from the final test.

Laboratory – the passing condition is to obtain positive marks from all laboratory exercises to be planned during the semester.

Calculation of the final grade: lecture 60% + laboratory 40%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
60	Class participation	2,0
24	Preparation for classes	0,80
20	Reading of supplementary texts	0,67
30	Preparation of reports	1,00
10	Execution of tasks assigned by the lecturer	0,33
30	Assignment completion	1,00
6	Personal and on-line consultations	0,20
180	**Total**	**6**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
36	Class participation	1,20
24	Preparation for classes	0,80
30	Reading of supplementary texts	1,00
30	Preparation of reports	1,00
24	Execution of tasks assigned by the lecturer	0,80
30	Assignment completion	1,00
6	Personal and on-line consultations	0,20
180	**Total**	**6**

RECOMMENDED READING:

1. Machowski J., et all: Power system dynamics and stability, John Wiley & Sons, 1997.

2. Song Y., Johns A.: Flexible AC transmission systems (FACTS), IEE Power and Energy Series 30, TJ International Ltd, Padstow, Cornwall, 1999.

3. Flisowski Z.: High voltage technique, WNT W-wa, 2005 (in Polish).

4. Ungrad H., Winkler W. Wiszniewski: Protection Techniques in Electrical energy systems. Marcel Dekker Inc. 1995.

OPTIONAL READING:

1 Kufel J., Kufel E., Zaengl W.S.: High voltage engineering Fundamentals, Elsevier 2000.

REMARKS:

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SELECTED PROBLEMS OF POWER ELECTRONICS

Course code: 06.2-WE-E-WZE-PSW_C9_S2S

Type of course: compulsory

Language of instruction: Polish, English

Director of studies: Dr Zbigniew Fedyczak, prof. of UZ

Name of lecturer: Dr Zbigniew Fedyczak, prof. of 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
Full-time studies					5
Lecture	30	2	2	Exam	
Laboratory	30	2		Grade	
Project	15	1		Grade	
Part-time studies					
Lecture	18	2	2	Exam	
Laboratory	18	2		Grade	
Project	9	1		Grade	

COURSE OBJECTIVE:

- familiarize students with modeling, analysis, properties and characteristics of PWM AC choppers and frequency converters without DC energy storage;
- formation among the students understanding of the need to develop of the multilevel and resonant converter solutions particular in power systems.

ENTRY REQUIREMENTS:

Mathematical analysis, Circuit theory, Power electronics circuits.

COURSE CONTENTS:

Introduction. General description of the problems in the frame of power electronic circuits and new solutions of semiconductor power electronic devices. Analysis methods of the power electronic circuit properties.
PWM AC choppers. Topologies, operation description and properties of single- and three-phase matrix choppers (MC) and matrix-reactance choppers (MRC). Application examples of such converters.

Matrix converters. Properties of the matrix converters: with low frequency transfer matrix control strategy (Venturini and scalar control methods): with space vector and fictitious DC link control strategy. Application examples of such converters.
Matrix-reactance frequency converters. Description of conception of the frequency converters with buck-boost voltage transformation based on matrix-reactance PWM AC choppers. Topologies, operation description and properties of selected solutions.
Multilevel power electronic converters. Concept of multilevel converters. Topologies, operation description and properties of the voltage source inverters. Selected solutions of other multilevel converters and their applications.
Resonance converters. Converters with resonance switch types ZVS, ZCS, quasi- and multiresonance. Converters with resonance load and resonance DC link. Example of selected solutions and their applications.
Galvanic separation in power electronic converters. Galvanic isolation of the signals connected with electrical energy transfer by means of the electromagnetic or piezoelectric couple. Impulse transformer solution. Example of selected solutions and their applications.
Future trends of the power electronic circuits. A new semiconductor power electronic switches and intelligent power modul. Conversion quality improvement as well as new application areas of the power electronic converters.

TEACHING METHODS:

Lecture, laboratory exercises, project.

LEARNING OUTCOMES:

Code		Effects of the course
K2E_W12 K2E_U13	T2A_W04 T2A_U17 T2A_U19	Has knowledge on circuit and mathematical models of PWM AC choppers and frequency converters without DC energy storage
		Can build the models of PWM AC converters using vector representations
		Can justify the need for multilevel and resonant power electronic circuits

LEARNING OUTCOMES VERIFICATION AND 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.

Calculation of the final grade: lecture 60% + laboratory 20% + project 20%

STUDENT WORKLOAD:

Full-time studies		
No. of hours	**Type of workload**	**ECTS**
60	Class participation	2
24	Preparation for classes	0.80
20	Reading of supplementary texts	0,67
15	Preparation of reports	0.50
10	Execution of tasks assigned by the lecturer	0.33
15	Assignment completion	0.50
6	Personal and on-line consultations	0.20
150	**Total**	**5**
Part-time studies		
No. of hours	**Type of workload**	**ECTS**
36	Class participation	1.20
24	Preparation for classes	0.80
30	Reading of supplementary texts	1
15	Preparation of reports	0.50
24	Execution of tasks assigned by the lecturer	0.80

15	Assignment completion	0.50
6	Personal and on-line consultations	0.20
150	**Total**	**5**

RECOMMENDED READING:

[1] Pirog S*., Power electronics*, AGH Publishing House, Cracow, 2006 (in Polish)
[2] Mohan N., *Power Electronics: Converters, Application and Design*, John Wiley & Sons, 1998
[3] Trzynadlowski A., *Introduction to modern power electronics*, John Wiley & Sons, 1998
[4] Erickson R., W., Maksimowić D.: *Fundamentals of power electronics.* Kluver Academic Publishers, 1999.

OPTIONAL READING:

[1] Mikołajuk K., *Fundamentals of power electronic circuits analysis*, PWN, Warsaw, 1998 (in Polish)
[2] Holms D., G., Lipo T., A.: *Pulse width modulation for power converters. Principles and practice.* John Wiley & Sons Inc., 2003.
[3] Fedyczak Z.: Impulse alternating voltage transforming circuits. University of Zielona Gora Publishing House. Zielona Gora 2003 (in Polish).

REMARKS:

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