FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Zaawansowana technika wysokich napięć**
Name of subject in English:	**Advanced High Voltage Technology**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM1120
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		30		
Number of hours of total student workload (CNPS):	90		60		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	3		2		
including number of ECTS points for practical (P) classes :			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10		1.40		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basics of physics and electrostatics
2. Fundamentals of materials engineering

SUBJECT OBJECTIVES

C1. Getting to know the behavior of dielectric materials under the influence of a strong electric field

C2. Acquiring practical skills necessary for the proper assambly of testing and measuring devices, and proper implementation and development of measurement results.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Can describe and explain phenomena and processes responsible for the behavior of insulating materials under the influence of a strong electric field

PEU_W02 Is able to describe high-voltage insulation systems

relating to skills:

PEU_U01 Knows how to properly perform measurements in high-voltage systems and then develop and interpret results.

PEU_U02 Can use the knowledge gained earlier to describe the mechanism of phenomena.

relating to social competences:

PEU_K01 Awareness of teamwork and responsibility of all members of the team for the execution of the task

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Electrostatic fundamentals	2
Lec 2	Electrification of solid and liquid materials. Electrostatic hazards. Electrostatic charge elimination techniques	2
Lec 3	Electrostatic precipitation	2
Lec 4	Electrostatic atomization and spraying	2
Lec 5	Electrostatic printing technology and electrophotography	2
Lec 6	Application of electrostatic separation	2
Lec 7	Nonthermal plasma – fundamentals and applications	2
Lec 8	High voltage generation	2
Lec 9	Electric field. Air dielectric strength.	2
Lec 10	The strength of insulating liquids.	2
Lec 11	The strength of solid dielectrics	2
Lec 12	High voltage cables	2
Lec 13	Overvoltages and its reduction	2
Lec 14	Non-destructive diagnostic methods. Overhead high voltage insulation.	2
Lec 15	Test	2
	Total hours:	**30**

Laboratory		**Number of hours:**
Lab 1	Introduction, safety work regulations, subject area of the laboratory	3
Lab 2	Measurements of AC high voltage.	3
Lab 3	Test system of DC high voltage.	3
Lab 4	Surface electric strength of the post and bushing insulators under AC 50 Hz high voltage	3
Lab 5	Measurement of dielectric loss factor and partial discharges in the high voltage insulation systems	3
Lab 6	Voltage distribution on the string of disc insulators	3
Lab 7	Wave phenomena in the model long power line	3
Lab 8	Electric strength of insulation systems in the air at the AC high voltage	3
Lab 9	Generation and measurement of impulse high voltage	3
Lab 10	Last term, course acceptance	3
	Total hours:	**30**

TEACHING TOOLS USED
N1. traditional lecture
N2. Laboratory conducted in the traditional manner

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_K01	Test
P(W)	P=F1	
F1(L)	PEU_U02 PEU_K01	evaluation of preparation for laboratory classes
F2(L)	PEU_U01 PEU_U02 PEU_K01	Evaluation reports
P(L)	P=0.7*F1+0.3*F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Kuffel E., Zaengl W.S., Kuffel J., High Voltage Engineering Fundamentals. Newnes, Oxford, 2000
[2] Holtzhausen J.P., Vosloo W.L., High Voltage Engineering, Practice and Theory. Stellenbosch University 2008
[3] R. Arora, W. Mosch; High Voltage Insulation Engineering; New Age International (P) Limited Publischers 2008

SECONDARY LITERATURE:

[1] Ryan M.H., High Voltage Engineering and Testing. Institution of Electrical Engineers, London 2001
[2] IEEE standard 4-1995, IEEE Standard Techniques for High-Voltage Testing
[3] A. Haddad, D. Warne; Advances in High Voltage Engineering, The Institution of Engineering and Technology 2009

SUBJECT SUPERVISOR

Maciej Jaroszewski, maciej.jaroszewski@pwr.edu.pl

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Graficzne środowiska inżynierskie i języki programowania wizualnego**
Name of subject in English:	**Visual Engineering Environments and Graphical Languages**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM1230
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15		30		
Number of hours of total student workload (CNPS):	30		90		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	1		3		
including number of ECTS points for practical (P) classes :			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.70		2.10		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has the basic knowledge related to programming languages including data types and structures, operators, functions and procedures as well as objects.
2. Is computer-literate and has the high comfort level with using MS Windows operating system.
3. Is able to speak English and is familiar with English technical terminology at intermediate level required to comprehend and understand information and matters given during lectures and laboratory tutorials as well as well to communicate effectively and to discuss technical issues with lecturer as well as with other students.

SUBJECT OBJECTIVES

C1. To make a student acquainted with methodology and rules of graphical object-oriented programming language using selected development environment.

C2. To let a student acquire practical knowledge and skills required for writing computer applications using graphical programming language.

C3. Promotion of teamwork and team programming.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Being able to explain and describe the concept of object-oriented graphical programming.

PEU_W02 Being able to characterize basic and advanced objects and graphical functional blocks offered by a selected visual object-oriented programming language.

relating to skills:

PEU_U01 Being able to develop an algorithm to solve computational and remote-control-related problem taking into account specific requirements of visual object-oriented programming language.

PEU_U02 Being able to implement the develop algorithm in the form of a program prepared, run, tested and optimized in the selected visual object-oriented programming language.

relating to social competences:

PEU_K01 Is open to team work idea and is determined to co-operate in a team.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introductory information: basic requirements, rules and forms of credition. Review on the “visual” software packages: high-level languages, process visualization tools, integrated programming and development environments, graphical languages. Concept of object-oriented graphical programming. Objects and their mutual connections as the syntax of graphical programming. Rules of data flow, sequencing, multithreading.	2
Lec 2	Local and global variables, registers, containers, input and output terminals. Data types and structures. Data conversion and promotion/demotion rules. Functions and user objects, user objects nesting and dependency.	2
Lec 3	Basic objects and functional blocks: their classification, inputs and outputs, functionality and hints on their use.	2
Lec 4	Advanced mathematical, statistical and signal processing objects and functions. Text and binary file processing objects.	2
Lec 5	Data exchange and control of external programs: ActiveX automation, .NET compliancy, Matlab engine control, network solutions. Communication and control of external devices, control of digital communication interfaces.	2
Lec 6	Communication and device control using SCPI, VISA, ModBus. IVI device standards. Virtual instrument idea, instrument drivers. Graphical user interface and data visualization.	2
Lec 7	Principles, tips and tricks helpful in designing data processing and control programs. Efficiency and speed optimization issues. Special solutions for improving execution speed and numerical processing power, „embedded” and „real-time” applications.	2
Lec 8	Overview of selected practical applications and realizations (related e.g. to data manipulation, image processing and computer-controlled measurement and automation).	1
	Total hours:	**15**

Laboratory		**Number of hours:**
Lab 1	Basic operations within visual engineering environment package. Program editing (loading, linking and deleting objects, creation of new user objects and user functions), edition of terminals and definition of data types. Running a program, searching for and correction of errors, preview of container content and data flow.	2
Lab 2	Practical presentation of application and operation of basic objects and functional blocks offered by the visual programming environment – students are requested to fulfill mini-programming tasks (including puzzle game, reaction speed tester, primes generator, visualize computing results, create files documenting measurements, processing of data read from a file).	16
Lab 3	Presentation of the test tasks and their allocation for student groups. Preparation of test task application: elaboration of algorithms, implementation in the visual object-oriented programming environment.	10
Lab 4	Group presentation of the application implementing the allocated test tasks. An overview and discussion of the developed algorithms and programming solutions.	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Lectures given using traditional as well as modern audiovisual techniques (including multimedia presentations).
N2. Demonstration of device functionality and operation, demonstration of software package functionality, configuration and options.
N3. Hands-on computing experience with software package during laboratory tutorials supervised by the lecturer.
N4. Consultation (with the lecturer).
N5. Team work and working on one’s own using demo version of the visual software package made available to students.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F(W)	PEU_W01 PEU_W02	Oral examination.
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02	Assessment of the completed algorithm, its implementation in a selected graphical programming language and operation of the completed program.
F2(L)	PEU_K01	Assessment of the incurred workload into achievements of the student group.
P(L)	P=0,7F1+0,3F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] R. Helsel, Graphical programming-a tutorial for HP Vee, Prentice Hall PTR, London, 1995.
[2] W. Tłaczała, Środowisko LabView w eksperymencie wspomaganym komputerowo, WNT, Warszawa 2002.
[3] R. H. Bishop, LabView Student edition 6i, Upper Sadle River, Prentice-Hall 2001.

SECONDARY LITERATURE:

[1] W. Winiecki, Organizacja komputerowych systemów pomiarowych. WPW, Warszawa 1997.
[2] L. U. Wells, LabView for everyone: graphical programming made even easier, Upper Saddle River, Prentice Hall 1997.
[3] related information and services provided by Agilent (Keysight) and National Instruments companies available at their websites.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Metody numeryczne i metody optymalizacji**
Name of subject in English:	**Numerical and Optimization Methods**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM1330
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge about the properties of multivariable functions
2. Basic knowledge in the field of calculus
3. Basic knowledge in the field of matrix algebra

SUBJECT OBJECTIVES

C1. Transfer of the basic knowledge and skills needed for correct formulation of optimization problems
C2. Ordered presentation of various optimization methods
C3. Training the skills in practical use of software packages for solving optimization problems

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the rules of mathematical formulation of optimization problems
PEU_W02 knows basic methods and algorithms used to solve an optimization problem

relating to skills:

PEU_U01 is able to formulate an optimization problem in mathematical terms
PEU_U02 is able to solve an optimization problem correctly selecting the solving algorithm

relating to social competences:

PEU_K01 creativity in searching for the solution of a given problem

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction. Basic terms. Goal function, constrains, problem parameters. Formulation and classification of optimization tasks. Examples of problems	2
Lec 2	Elements of calculus and matrix algebra related to optimization problems. Convex sets and convex functions	2
Lec 3	Nonlinear optimization without constrains. Sufficient and necessary conditions for optimization of unconstrained problems	2
Lec 4	Algorithms for unconstrained problems used for minimum search. Steepest descent algorithm. Conjugate gradient algorithm. Newton algorithm and quasi Newton method	2
Lec 5	Minimum search of a one variable function. Golden section search algorithm	2
Lec 6	Nonlinear optimization with constrains. Kuhn-Tucker conditions. Lagrange function. Duality formulation	2
Lec 7	Penalty function methods. Linear optimization. Integer numbers optimization	2
Lec 8	Final test	1
	Total hours:	**15**

Laboratory		**Number of hours:**
Lab 1	H&S regulations. Laboratory working rules. Rules for working in a group. Rules for final crediting. Preliminary conditions. Presentation of subsequent labs contents	1
Lab 2	Constructing a mathematical model of an optimization problem. Analytical determination of the extremum of a function	4
Lab 3	Research on the effectiveness of numerical algorithms dedicated for problems without constrains	4
Lab 4	Solving problems with constrains	2
Lab 5	Applying the Optimization Toolbox of Matlab	4
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lecture with multimedia presentations
N2. Computer laboratory suitable for group working

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	Written final test
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02 PEU_K01	Grading the corectness of optimization problem solutions
P(L)	P=F1	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] .K.P. Chong, S.H. Żak: An Introduction to Optimization, 2nd edition, New York, John Wiley, 2001
[2] J.F. Bonnans: Numerical optimization: theoretical and practical aspects, Springer-Verlag, 2003
[3] M. Asghar Bhatti: Practical Optimization Methods, Berlin, Springer-Verlag 2000

SECONDARY LITERATURE:

[1] J. Nocedal, S. J. Wright, Numerical Optimization, Springer-Verlag, 2003

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Ocena jakości energii**
Name of subject in English:	**Power Quality Assessment**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM1331
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15		
Number of hours of total student workload (CNPS):	90		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	3		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows basic lows of electrical engineering and electrical quantity.
2. Is able to implement fundamental mathematical formulation in software environment as Matlab etc.
3. Understands the need and possibility of lifelong learning, achieving new skills professional as well as personal and social.

SUBJECT OBJECTIVES

C1. Getting the knowledge about different power quality disturbances, origin and impact of power quality disturbances
C2. Getting the knowledge about power quality indices as well as standards and regulations dedicated to limits and methods of power quality assessment
C3. Acquire practical skills of application of fundamental algorithms used in identification of power quality parameters as well as method of assessment and reporting

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Have general knowledge about power quality issues including relations to electromagnetic compatibility
PEU_W02	Know legislative formulation and regulation concerning limits in power quality
PEU_W03	Know the structure and range of power quality report

relating to skills:

PEU_U01	Decide and select limits of power quality disturbances for particular electrical equipments
PEU_U02	Implement fundamental algorithms used in calculation of parameters of the power quality disturbances
PEU_U03	Is able to join the origin of power quality disturbances with its potential influence on condition of work of electrical equipment

relating to social competences:

PEU_K01	Is responsible for entrusted task, exhibits creative attitude and cooperation in team

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Crucial issues and definitions of power quality, legislative documents, standards and regulations, review and classification of power quality disturbances, power quality disturbances linked to electromagnetic compatibility,	2
Lec 2	Power quality disturbances in relations to electromagnetic compatibility. Review and classification of power quality disturbances.	2
Lec 3	Methods of measurement and algorithms for disturbances of main frequency. Origin of power quality disturbances and potential impact on the operation of electrical power systems elements.	2
Lec 4	Methods of measurement and algorithms for disturbances of voltage. Origin of power quality disturbances and potential impact on the operation of electrical power systems elements. Example of emission and immunity test of the electrical equipments.	2
Lec 5	Methods of measurement and algorithms for disturbances of voltage and current waveform. Origin of power quality disturbances and potential impact on the operation of electrical power systems elements. Example of emission and immunity test of the electrical equipments.	2
Lec 6	Methods of measurement and algorithms for disturbances of symmetry and power balance. Origin of power quality disturbances and potential impact on the operation of electrical power systems elements.	2
Lec 7	Methods of measuring and assessment of the quality of electricity supply in low voltage and medium voltage power systems, the limits for the power quality disturbances, meaning of quality of the supply for distribution system operator.	2
Lec 8	Methods of measuring and assessment of the quality of electricity supply in high voltage power systems, the limits for the power quality disturbances, meaning of quality of the supply for transmission system operator.	2
Lec 9	Review of power quality recorders. Scope of the report of power quality, distribution of real measurements for the power quality report.	2
Lec 10	Discussion of exemplary power quality report. Examples of power quality disturbances finder.	2
Lec 11	Power quality monitoring systems, distributed measurement systems, time synchronization, on-line access.	2
Lec 12	Power quality monitoring systems, data based tools in the evaluation of the multipoint measurement data.	2
Lec 13	Selected methods of reducing or elimination of voltage disturbances.	2
Lec 14	Selected methods of reducing or elimination of voltage and current waveform disturbances.	2
Lec 15	Oral test, defence of power quality report	2
	Total hours:	**30**

Laboratory		**Number of hours:**
Lab 1	Information about the regulation of work in the laboratory, requirements for passing the course, distribution of the instructions and additional materials	1
Lab 2	Algorithms for voltage dips assessment. Part 1.	2
Lab 3	Algorithms for voltage dips assessment. Part 2.	2
Lab 4	Algorithms for harmonics assessment. Part 1.	2
Lab 5	Algorithms for harmonics assessment. Part 2.	2
Lab 6	Configuration of power quality recorder and assessment of the selected power quality parameters on the basis of real measurement at the laboratory setup. Part 1.	2
Lab 7	Configuration of power quality recorder and assessment of the selected power quality parameters on the basis of real measurement at the laboratory setup. Part 2.	2
Lab 8	Discussion the reports on particular laboratories, final marks, additional term of the laboratory.	2
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lectures with multimedia presentation
N2. Organization of the laboratory work in subgroup

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Oral test, assessment of power quality report
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Evaluation of preparing for laboratories
F2(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Evaluation of reports on particular laboratories
P(L)	P=0,2*F1+0,8*F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Arrillaga J. Watson N. R.: Power System Quality Assessment, John Wiley & Sons, New York, 2000.
[2] Bollen M. H. J.: Understanding Power Quality Problems Voltage Sags and Interruptions, IEEE Press, New York, USA, 2000.
[3] Dugan R. C., McGranaghan M. F., Beaty H. W.: Electrical Power Systems Quality, McGraw-Hill, New York, USA, 1986.

SECONDARY LITERATURE:

[1] Electrical Power Quality and Utilization - Journal
[2] Leonardo Energy – Power Quality Guide

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Obwody i układy**
Name of subject in English:	**Circuits and Systems**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM1332
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30	15			
Number of hours of total student workload (CNPS):	90	30			
Form of crediting:	examination	crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:	3	1			
including number of ECTS points for practical (P) classes :		1			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10	0.70			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows basic lows of electrical engineering and recognize electrical quantity.
2. Knows differential and integral calculus of one variable function, linear algebra and mathematic calculation in complex domain.
3. Can implement basic differential calculation, linear algebra and calculation on complex number.
4. Can recognize fundamental electrical problems and tools for its solution.

SUBJECT OBJECTIVES

C1. Getting the knowledge techniques used in synthesis of electrical circuits.
C2. Acquire skills of nonlinear circuit analysis.
C3. Getting the knowledge about state variable matrix application.
C4. Getting the knowledge about application of continuous representation of signals, transfer function in operator and frequency form.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Have knowledge about circuit synthesis
PEU_W02	nows elements of nonlinear circuits analysis including stability issues
PEU_W03	Formulate general theory of system description using state variable matrix. Formulate genera theory of system description using transfer function in operator and frequency form

relating to skills:

PEU_U01	Decide and select method of circuit synthesis on the basis of immittance function
PEU_U02	Knows elements of nonlinear circuits analysis including stability issues
PEU_U03	Formulate general theory of system description using state variable matrix. Formulate genera theory of system description using transfer function in operator and frequency form

relating to social competences:

PEU_K01	Is responsible for entrusted task, exhibits creative attitude in selection of calculation techniques

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction to circuits and electrical systems. Properties of circuits General problems description of the circuits according to the circuit components and operating state. General issues concerning signal transfer through the system.	2
Lec 2	Selected issues of circuits synthesis. positive rational functions, immittance function of driving point impedance.	2
Lec 3	Selected issues of circuits synthesis. Techniques for synthesis of passive RC, RL, LC circuits, Foster and Cauer synthesis. Part 1.	2
Lec 4	Selected issues of circuits synthesis. Techniques for synthesis of passive RC, RL, LC circuits, Foster and Cauer synthesis. Part 2.	2
Lec 5	Selected issues of nonlinear circuits analysis. Characteristics of driving point nonlinear elements.	2
Lec 6	Selected issues of nonlinear circuits analysis. Selected methods of nonlinear circuits analysis.	2
Lec 7	Selected issues of nonlinear circuits analysis. Stability of nonlinear circuits, phase plane.	2
Lec 8	Selected issues of nonlinear circuits analysis. Stability of nonlinear circuits, stability in Lapunov theory.	2
Lec 9	Selected issues of time series and matrix functions. differential and integral operation of matrix functions.	2
Lec 10	Selected issues of time series and matrix functions. State variable, transfer matrix, excitation matrix, output matrix.	2
Lec 11	Selected issues of time series and matrix functions. Application of engine values.	2
Lec 12	Selected issues of continuous representation of deterministic signals. Two-side Laplace transform, convergence area, inverse transformation.	2
Lec 13	Selected issues of continuous representation of deterministic signals. Fourier transform, relation of two-sides Laplace and Fourier transforms, signal parameters in time and frequency domain.	2
Lec 14	Selected issues of continuous representation of deterministic signals. Transfer function of LTI circuits, elements of filter synthesis. Hilbert compound.	2
Lec 15	Selected issues of continuous representation of deterministic signals. Elements of filter synthesis.	2
	Total hours:	**30**

Classes		**Number of hours:**
Cl 1	Information about the regulation of time schedule and requirements for passing the course. Application of synthesis of linear circuit - introduction	2
Cl 2	Application of synthesis of linear circuit	2
Cl 3	Application of methods of nonlinear circuits analysis. Part 1	2
Cl 4	Application of methods of nonlinear circuits analysis. Part 2	2
Cl 5	Application of state variable matrix in analysis of the circuits analysis. Part 1	2
Cl 6	Application of state variable matrix in analysis of the circuits analysis. Part 2	2
Cl 7	Application of transfer function of LTI circuits	2
Cl 8	Crediting test	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lectures with multimedia presentation
N2. Classes work in subgroup

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Examination
P(W)	P=F1	
F1(C)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Crediting test
P(C)	P=F1	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] A. Papoulis – Obwody i układy, WKiŁ, 1998 (PL) / A. Papoulis – Circuits and Systems: A modern approach, The Oxford Series in Electrical and Computer Engineering (EN)
[2] S. Haykin, B. Van Veen – Signals and systems, John Wiley & Sons, Inc., 1999.
[3] S T.H. Glisson – Introduction to system analysis, McGraw-Hill, Inc, 1985.
[4] G. E. Carlson – Signal and linear system analysis, John Wiley & Sons, Inc., 1998.
[5] Ch.T. Chen – System and signal analysis, Oxford University Press, 1994.

SECONDARY LITERATURE:

[1] A. D. Poularikas - The handbook of formulas and tables for signal processing, CRC Press, 2000
[2] Additional educational supplies http://eportal.eny.pwr.wroc.pl/

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Sygnały i Systemy**
Name of subject in English:	**Signal and Systems**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM1334
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30	15			
Number of hours of total student workload (CNPS):	90	30			
Form of crediting:	examination	crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:	3	1			
including number of ECTS points for practical (P) classes :		1			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10	0.70			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows basic lows of electrical engineering and recognize electrical quantity.
2. Knows differential and integral calculus of one variable function, linear algebra and mathematic calculation in complex domain.
3. Can implement basic differential calculation, linear algebra and calculation on complex number.
4. Can recognize fundamental electrical problems and tools for its solution. Competence
5. Understands the need and possibility of lifelong learning, achieving new skills professional as well as personal and social.

SUBJECT OBJECTIVES

C1. Getting the knowledge about using of delta Dirac function and step function in description of system
C2. Learn possible application of state variable matrix, system matrix and engine values.
C3. Getting the knowledge about graphical representation of circuit’s equations.
C4. Getting the knowledge about of stability formulation.
C5. Acquire skills of digital circuit description.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Have a knowledge in using of delta Dirac function and step function in description of system. Knows methods of system descriptions using state variable matrix.
PEU_W02	Knows methods of graphical representations of system equations Knows the methods of define system stability criterions
PEU_W03	Knows the techniques of digital systems description

relating to skills:

PEU_U01	Apply delta Dirac function and step function in description of system. Use the method of system description based on state variable matrix.
PEU_U02	Select the method of graphical system representation using graph and block scheme techniques. Is able to select stability criteria and conclude about the stability

relating to social competences:

PEU_K01	Is responsible for entrusted task, exhibits creative attitude in selection of calculation techniques

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Selected issues of system description. The basic properties of systems. The basic signals used in the system analysis. Elements of the theory of distribution. Step and Dirac impulse. Differentiation in terms of distribution theory.	2
Lec 2	Selected issues system description. Impulse and step response of linear time-invariant systems. Duhamel integral and convolution. Calculation of convolution of positive-time side signals.	2
Lec 3	Selected issues of description. Determination of impulse response, step response, and response for given excitation.	2
Lec 4	Selected issues of time series and matrix functions. Differential and integral operation of matrix functions.	2
Lec 5	Selected issues of time series and matrix functions. State variable, transfer matrix, excitation matrix, output matrix.	2
Lec 6	Selected issues of time series and matrix functions. Application of engine values.	2
Lec 7	Selected issues of graphical representation of circuit equations. flow graphs, block schemes, reduction of scheme blocks. Part 1.	2
Lec 8	Selected issues of graphical representation of circuit equations. flow graphs, block schemes, reduction of scheme blocks. Part 2.	2
Lec 9	Selected issues of graphical representation of circuit equations. flow graphs, block schemes, reduction of scheme blocks. Part 3.	2
Lec 10	Selected issues of system stability. Definition of stability of transmission element, stability conditions, Hurwitz polynomial.	2
Lec 11	Selected issues of system stability. Algebraic criteria, frequency criteria of linear stationary systems. Part 1.	2
Lec 12	Selected issues of system stability. Algebraic criteria, frequency criteria of linear stationary systems.Part 2.	2
Lec 13	Selected issues of digital system description. Impulse signal and his meaning in digitalization process, two-side ‘Z” transform, relation of ‘Z” transform with Laplace and Fourier technique.	2
Lec 14	Selected issues of digital system description. sampling theory, spectrum of digital signals, stationarity, causality, stability of digital systems.	2
Lec 15	Selected issues of digital system description. Frequency characteristic of digital systems.	2
	Total hours:	**30**

Classes		**Number of hours:**
Cl 1	Information about the regulation of time schedule and requirements for passing the course. Determination of impulse and step response of the systems.	2
Cl 2	Application of theory of distribution in determination of step, impulse response and response for given excitations.	2
Cl 3	Application of state variable matrix in determination of step and impulse response	2
Cl 4	Application of state variable matrix in determination of system response for given excitations. Application of engine values for stability criterion.	2
Cl 5	Application of graphical system representation using flow graphs	2
Cl 6	Application of graphical system representation using block schemes	2
Cl 7	Application of stability criterions	2
Cl 8	Crediting test	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lectures with multimedia presentation
N2. Classes work in subgroup

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Examination
P(W)	P=F1	
F1(C)	PEU_U01 PEU_U02 PEU_K01	Crediting test
P(C)	P=F1	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. Haykin, B. Van Veen – Signals and systems, John Wiley & Sons, Inc., 1999.
[2] S T.H. Glisson – Introduction to system analysis, McGraw-Hill, Inc, 1985.
[3] G. E. Carlson – Signal and linear system analysis, John Wiley & Sons, Inc., 1998.
[4] Ch.T. Chen – System and signal analysis, Oxford University Press, 1994.

SECONDARY LITERATURE:

[1] A. D. Poularikas - The .handbook of formulas and tables for signal processing, CRC Press, 2000.
[2] Additional educational supplies http://eportal.eny.pwr.wroc.pl/

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Zaawansowane metody przetwarzania sygnałów**
Name of subject in English:	**Advanced Signal Processing Methods**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM1335
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30	15			
Number of hours of total student workload (CNPS):	90	30			
Form of crediting:	examination	crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:	3	1			
including number of ECTS points for practical (P) classes :		1			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10	0.70			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge in the fields of calculus and linear algebra
2. Basic knowledge of the C language
3. Ability of systematic work and individual problem solving

SUBJECT OBJECTIVES

C1. Understanding and proper application of digital signal processing methods
C2. Presentation of tools for description and analysis of digital systems in time and frequency domain
C3. Ability to design and implement simple digital systems

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows mathematical methods for description and analysis of digital systems in time and frequency domain
PEU_W02 knows algorithms for digital filter design

relating to skills:

PEU_U01 is able to provide a spectral analysis of a signal
PEU_U02 is able to design a simple digital filter

relating to social competences:

PEU_K01 creativity in searching for the solution of a given problem

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Discrete signal and systems – examples, mathematical notation, sampling, aliasing. Part I.	2
Lec 2	Discrete signal and systems – examples, mathematical notation, sampling, aliasing. Part II.	2
Lec 3	Description and analysis of digital systems in time domain: difference equation, convolution, impulse response, block schemes, state space variables, system classification. Part I.	2
Lec 4	Description and analysis of digital systems in time domain: difference equation, convolution, impulse response, block schemes, state space variables, system classification. Part II.	2
Lec 5	Z transform: definition of Z transform, the correlation of Z transform to Laplace transform, basic properties of Z transform , inverse Z transform (methods and computational examples), the area of convergence and its meaning, computations. Part I.	2
Lec 6	Z transform: definition of Z transform, the correlation of Z transform to Laplace transform, basic properties of Z transform , inverse Z transform (methods and computational examples), the area of convergence and its meaning, computations. Part II.	2
Lec 7	Applications of the Z transform: solving of difference equations, the transfer function, casuality and stability of systems. Part I.	2
Lec 8	Applications of the Z transform: solving of difference equations, the transfer function, casuality and stability of systems. Part II.	2
Lec 9	Discrete Fourier transform: Definition of DFT (introduction, examples, properties), correlation of DFT to Z transform, inverse DFT, elimination of leakage with the window method, resolution of FFT. Part I.	2
Lec 10	Discrete Fourier transform: Definition of DFT (introduction, examples, properties), correlation of DFT to Z transform, inverse DFT, elimination of leakage with the window method, resolution of FFT. Part II.	2
Lec 11	Digital filters: introduction, methods of description, examples, classification. Finite impulse response filters -FIR. Design of FIR, window method. Part I.	2
Lec 12	Digital filters: introduction, methods of description, examples, classification. Finite impulse response filters -FIR. Design of FIR, window method. Part II.	2
Lec 13	Fast Fourier transform FFT. Correlation between FFT and DFT. Part I.	2
Lec 14	Fast Fourier transform FFT. Correlation between FFT and DFT. PartII.	2
Lec 15	Algorithm for FFT: computational scheme, implementation example, butterfly structures for FFT.	2
	Total hours:	**30**

Classes		**Number of hours:**
Cl 1	Mathematical description, generation and sampling for discrete signals. Part I.	2
Cl 2	Mathematical description, generation and sampling for discrete signals. Part II.	2
Cl 3	Z transform, Inverse Z transform. Part I.	2
Cl 4	Z transform, Inverse Z transform. Część II.	2
Cl 5	Transfer function, impulse response, difference equation, block scheme. Part I.	2
Cl 6	Transfer function, impulse response, difference equation, block scheme. Part II.	2
Cl 7	Fourier Transform - implementation. Part I.	2
Cl 8	Fourier Transform - implementation. Part II.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lecture with multimedia presentations
N2. Classes with problems for individual solving

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	exam
P(W)	P=F1	
F1(C)	PEU_U01 PEU_U02 PEU_K01	final test
P(C)	P=F1	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] S. Haykin, B. Van Veen – Signals and Systems, John Wiley & Sons, Inc., 1999
[2] D. F. Elliot – Handbook of Digital Signal Processing, Academic Press, Inc., 1987
[3] S. M. Kay – Modern Spectral Estimation, Prentice Hall, Signal Processing Series, Englewood Cliffs, 1988

SECONDARY LITERATURE:

[1] M. Vetterli, J. Kovacevic - Wavelets and Subband Coding, Englewood Cliffs, Prentice Hall, 1994

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Zwarcia w systemie elektroenergetycznym**
Name of subject in English:	**Power System Faults**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2131
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30				
Number of hours of total student workload (CNPS):	120				
Form of crediting:	examination				
For group of courses mark (X) final course:					
Number of ECTS points:	4				
including number of ECTS points for practical (P) classes:					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.80				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has basic knowledge on a power system operation.
2. Knowledge of complex number calculations.

SUBJECT OBJECTIVES

C1. Gaining knowledge on faults occurring in power systems.

C2. Familiarization with methods for analysis of fault waveforms and for fault identification.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Has knowledge on faults occurring in high voltage networks.

PEU_W02 Has knowledge on faults occurring in medium voltage networks.

PEU_W03 Has knowledge on analysis of fault waveforms and on fault identification.

relating to skills:

relating to social competences:

PEU_K01 Is able to independent thinking and to performing analysis of technical information.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction. Establishing conditions for passing and marking the lecture. Causes and consequences of faults, classifications of faults, aims of fault calculations.	2
Lec 2	Fault identification - digital algorithms for fault detection.	2
Lec 3	Fault identification - digital algorithms for fault direction discrimination and fault classification.	2
Lec 4	Fault calculations - application of per units, method of symmetrical components, calculations in phase co-ordinates.	2
Lec 5	Models of generators and power transformers in fault calculations.	2
Lec 6	Equivalent circuit diagrams of overhead and cable lines for symmetrical components. Modal transformation, calculations in phase co-ordinates.	2
Lec 7	Analysis of three-phase symmetrical faults. Analysis of single phase faults.	2
Lec 8	Analysis of phase-to-phase faults. Analysis of phase-to-phase-to-earth faults.	2
Lec 9	Analysis of broken conductor failure and broken conductor failure combined with phase-to-earth fault.	2
Lec 10	Requirements of international standards for fault calculations.	2
Lec 11	Earth faults in networks with isolated neutral point.	2
Lec 12	Earth faults in networks with neutral point earthed through compensating reactor and through resistor.	2
Lec 13	Microprocessor-based fault recorders and fault locators – application basics.	2
Lec 14	Fault location on power lines with use of local and two-end measurements.	2
Lec 15	Transformation of fault voltages and currents by instrument protective transformers.	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Informative lecture.
N2. Student's own work.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Presence at the lectures
F2(W)	PEU_W01 PEU_W02 PEU_W03 PEU_K01	Written or oral examination
P(W)	P=0,1F1+0,9F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Iżykowski J., Power system faults. PRINTPAP, 2011, p. 190.

SECONDARY LITERATURE:

[1] Glover J. D., Sarma M., Power system analysis and design. PWS Publishing Company Boston, second edition, 1994.
[2] Michalik M., Rosołowski E., Simulation and analysis of power system transients. PRINTPAP, 2011.
[3] Saha M.M., Iżykowski J., Rosołowski E., Fault location on power networks. Springer-Verlag London, Series: Power Systems, 2010, 425 p.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Cyfrowe Techniki Sterowania**
Name of subject in English:	**Digital Control Techniques**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2132
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basics of continuous control systems.
2. Knowledge of basics synthesis and analysis of digital systems.
3. Basic knowledge of MATLAB / Simulink software.
4. Practical skills of using MATLAB: writing programs.
5. Is capable of implementing digital algorithms based on difference equations.

SUBJECT OBJECTIVES

C1. Acquaintance of knowledge related to: function of analogue filtering in the context of proper operation of digital systems, digital signal processing, representation methods of discrete-time systems, appropriate sampling time selection, effect of pole location on system response.

C2. Practical skills to analyze and design of both finite and infinite impulse response filters.

C3. Practical skills to: PID digital controller tuning, design of digital controller dedicated to particular object, design of state variable feedback controller and state observer.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Possesses knowledge related to processing of continuous signals, their discretization and processing of digital signals.
PEU_W02	Has a basic knowledge of structure of digital control systems and their design methods.
PEU_W03	Possesses knowledge related to design of digital filters and various types of digital regulators.

relating to skills:

PEU_U01	Is able to select appropriate sampling time, represent continuous control system with use of transfer function and state space model, retrieve difference equation of digital model of continuous plant and implement this equation.
PEU_U02	Is able to design and perform analysis of digital filters.
PEU_U03	Is able to tune as well as design digital controller of a given output transient performance indices.

relating to social competences:

PEU_K01	Is able to carry out a complex engineering project in a competent way, unaided as well as to cooperate with a team if required

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction. Setting rules of course crediting. Tasks, structures and interface circuits of digital control system.	2
Lec 2	Classification of plants in digital control, basic notions used in analysis and design of real time control systems.	2
Lec 3	Classification of plants in digital control, basic notions used in analysis and design of real time control systems.	2
Lec 4	Digital models of continuous plants.	2
Lec 5	Processing of the plant output signals by interface circuits.	2
Lec 6	Processing of input digital signals – digital filtration, design of recursive digital filters based on analog lowpass filters transformation.	2
Lec 7	Processing of input digital signals – digital filtration, design of recursive digital filters based on analog lowpass filters transformation.	2
Lec 8	Processing of input digital signals – digital filtration, design of nonrecursive digital filters.	2
Lec 9	Design of nonrecursive digital filters using the Fourier transformation.	2
Lec 10	Digital PID regulators.	2
Lec 11	Design of the dedicated digital regulator for the determined plant and for predetermined transfer function of the closed-loop system K(z).	2
Lec 12	Robust digital regulators.	2
Lec 13	Design methods of state variable feedback controller.	2
Lec 14	Digital controller with a state observer.	2
Lec 15	Pass test.	2
	Total hours:	**30**

Laboratory		**Number of hours:**
Lab 1	Introduction. Setting rules of course crediting. Acquaintance with lab stands, safety rules and available software.	2
Lab 2	Design and analysis of recursive digital filters based on analog lowpass filters transformation.	2
Lab 3	Design and analysis of recursive digital filters based on analog lowpass filters transformation.	1
Lab 4	Design of nonrecursive digital filters using the inverse DFT.	2
Lab 5	Tuning of the digital PID regulator.	2
Lab 6	Design of dedicated and robust digital regulators.	2
Lab 7	Design of state variable feedback controller.	2
Lab 8	State variable feedback controller with a state observer.	2
	Total hours:	**15**

TEACHING TOOLS USED
N1. Project presentation.
N2. Informative lecture.
N3. Presentation of the reports.
N4. Matlab program.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Participation in the course
F2(W)	PEU_W01 PEU_W02 PEU_W03	Pass test
P(W)	P = 0,1F1+ 0,9F2	
F1(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Activity during the classes
F2(L)	PEU_U01 PEU_U02 PEU_U03	Presentation of the reports done
P(L)	P = 0.7F1+ 0.3F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Digital Control Systems – the lecture outline, provided by subject supervisor.

SECONDARY LITERATURE:

[1] Kuo B.C.: Digital Control Systems, Hold. Reinhard and Winston Inc. 1981.
[2] Bozic S. M.: Digital and Kalman Filtering, Edward Arnold Publishers, London 1984.
[3] Astrom K.J., Wittenmark B.: Computer Controlled Systems, Printice Hall, London 1989.
[4] Iserman R.: Digital Control Systems, Springers-Verlag, Berlin 1988.
[5] Vaccaro R.J.:Digital Control, A State Space Approach, McGrew-Hill, New York 1995.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Komputerowa analiza elektromagnetycznych stanów przejściowych**
Name of subject in English:	**Simulation and Analysis of Power System Transients**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2133
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15		30		
Number of hours of total student workload (CNPS):	30		60		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	1		2		
including number of ECTS points for practical (P) classes :			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.70		1.40		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student should have the basic knowledge of fundamentals of circuit theory and basics of differential calculus
2. Student should know how to formulate digital models of electrical circuits and to conduct analyses regarding accuracy, stability and frequency characteristics.
3. Student should know how to calculate the parameters of basic elements of the line

SUBJECT OBJECTIVES

C1. To provide knowledge of methods for solving differential equations describing electrical circuits.
C2. Learning how to formulate digital models of electrical circuits and to conduct analyses regarding accuracy, stability and frequency characteristics.
C3. To provide knowledge of modelling a power line with distributed parameters.
C4. Familiarization with methods of modelling and simulation of renewable energy sources.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student gets the knowledge on description of models for linear electrical circuits with use of differential equations and their numerical solution applying different numerical procedures of integration.

PEU_W02 Student gets the knowledge regarding evaluation of accuracy and stability of the solution of a differential equation in a numerical way.

relating to skills:

PEU_U01 Student is able to model linear elements and branches and also a power transmission line with distributed parameters, in particular, applying a graphical editor of this program, forms a structure of a simulative model, sets simulation parameters, conducts a simulation and analyses waveforms of signals from a modelled system.

PEU_U02 Student is able to apply results of computer simulation to analyse of dynamic electric circuits.

relating to social competences:

PEU_K01 Student can act independently and cooperate within a group working on a complex engineering project.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction, syllabus of the course, basic definitions. Computer programs for electromagnetic transients simulations - general description.	2
Lec 2	Digital models of linear elements (R, L, C) of an electric network	2
Lec 3	Basic concept of numerical solution of a dynamic network equations	2
Lec 4	Line model with distributed parameters.	2
Lec 5	Numerical oscillation and limitations of using the computer tools to simulation of electromagnetic transients.	2
Lec 6	Modelling of relays, measuring algorithms and instrument transformers	2
Lec 7	Modelling of power electronic converters	2
Lec 8	Qualified test	1
	Total hours:	**15**

Laboratory		**Number of hours:**
Lab 1	Presentation of health and safety rules, and general regulations of the laboratory. Establishing conditions for passing and marking the project course. General familiarization with the ATPEMTP program.	2
Lab 2	Simulation of a 3-phase network with line, load and a fault.	2
Lab 3	Simulation of 3-phase transformer with magnetizing characteristic. Test of the transformer energising.	2
Lab 4	Simulation of the instrument transformers with the relay input chain.	2
Lab 5	Modelling of faults in 3-phase network with transformer and instrument transformers.	2
Lab 6	Modelling of digital measuring algorithms applied in relay protection units.	2
Lab 7	Simulation of the induction motors. Test of start and load changing.	2
Lab 8	Testing of the synchronous generation with excitation control scheme.	2
Lab 9	Simulation of generation station with control scheme; fault analysis	2
Lab 10	Modelling of a power electronic converters	2
Lab 11	Modelling of DFIG generator and power control system.	2
Lab 12	Simulation of ride-through faults on the line connected wind generator.	2
Lab 13	Modelling of the photovoltaic source.	2
Lab 14	Simulation of the interconnection between the photovoltaic source with the utility network.	2
Lab 15	Additional term.	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Informative lecture.
N2. ATP-EMTP simulation program.
N3. Lab reports.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	Attendance on lectures
F2(W)	PEU_W01 PEU_W02	Qualified test
P(W)	P=0,1*F1+0,9*F2	
F1(L)	PEU_U01 PEU_U02	aktywność na zajęciach
F2(L)	PEU_U01 PEU_U02 PEU_K01	Project reports
P(L)	P=0,3*F1+0,7*F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] ROSOŁOWSKI E., Komputerowe metody analizy elektromagnetycznych stanów przejściowych. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2009.
[2] http://zas.ie.pwr.wroc.pl/ER/przyklady_D1/index.html - przykłady niektórych modeli wraz z plikami źródłowymi do programu ATP-EMTP.
[3] N. Watson, J. Arrillaga: Power systems electromagnetic transients simulation. The Institution of Electrical Engineers, London 2003.
[4] H.W. Dommel: Electromagnetic Transients Program. Reference Manual. BPA, Portland, 1986.

SECONDARY LITERATURE:

[1] Alternative Transients Program. Rule Book. K.U. Leuven, EMTP Center, 1987.
[2] P. Kacejko P., J. Machowski: Faults in power systems, WNT Warszawa 2002 (in polish).
[3] Materiały dostępne na stronie: http://www.rose.pwr.wroc.pl/

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Cyfrowe przetwarzanie sygnałów w układach automatyki elektroenergetycznej**
Name of subject in English:	**Digital Signal Processing for Protection and Control**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2134
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30			30	
Number of hours of total student workload (CNPS):	60			60	
Form of crediting:	examination			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	2			2	
including number of ECTS points for practical (P) classes :				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40			1.40	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basics of power system control, digital signal processing and numerical methods.
2. Practical skills of using MATLAB and ATP-EMTP software.

SUBJECT OBJECTIVES

C1. Acquaintance of knowledge related to digital power system protection and control systems including: digital filtration, measurement of criteria values and decision making.

C2. Practical skills to analyze and design of both hardware structure and software of digital control and protection for power systems, with special consideration to algorithms of digital filtration, measurement of criteria values and decision making.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Possesses knowledge related to structure of digital power system control and protection systems as well as knowledge related to processing of continuous signals, their discretization and processing of digital signals.
PEU_W02	Possesses knowledge related to digital filtering, algorithms of criteria values measurement, their accuracy and dynamics as well as possibilities of measurement errors elimination.
PEU_W03	Possesses knowledge related to deterministic and probabilistic decision processes, fundamentals of adaptive systems and structure of multi-criteria devices.

relating to skills:

PEU_U01	Is able to model and evaluate operation of the measurement path and A/D conversion units as well as to perform analysis and synthesis of digital recursive and non-recursive filters.
PEU_U02	Is able to model and evaluate operation of digital algorithms for protection criteria measurement.
PEU_U03	Is able to model and evaluate operation of the basic decision making algorithms for decision making in power system protection and control.

relating to social competences:

PEU_K01	Is able to carry out a complex engineering project in a competent way.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction. Setting rules of course crediting. Historical perspective, development of analog and digital power system control systems, reasons for and benefits of digital control, advantages of digital implementation.	2
Lec 2	Mathematical basis for control and protection algorithms: complex Fourier series, Fourier transform, Discrete Fourier transform, Z-transform, analog and discrete integration.	2
Lec 3	Analog filters: standard low-pass approximations, frequency and time response of the filter, analog filter design, frequency band transformation.	2
Lec 4	Analog to digital converters, multiplexer and analog memory, quantization time and errors, Shannon sampling theorem, practical sampling rates. Classification of digital filters.	2
Lec 5	Design of recursive filters using impulse invariant techniques. Design of recursive filters using frequency prewarping and the bilinear transformation, problems of quantization and round-off errors.	2
Lec 6	Design of non-recursive digital filters using a window function, commonly used FIR filter window functions and associated frequency responses.	2
Lec 7	Signal orthogonalization algorithms: single & double delay methods, FIR orthogonal filters, correlation, least squares estimation technique.	2
Lec 8	Signal magnitude estimation: digital integration methods, orthogonal components based methods, correlation, detailed algorithms.	2
Lec 9	Measurement of other power system quantities: algorithms of estimation of active and reactive power, impedance components, signal phase, digital estimation of power system frequency and frequency deviation.	2
Lec 10	Measurements in dynamic state of estimation, measurement error sources (signal distortion, harmonics, fundamental frequency deviation, ...).	2
Lec 11	Influence of current transformers on the quality of criteria values calculation. Methods od CT saturation detection and correction of distorted secondary current.	2
Lec 12	Special algorithms. Application of wavelet transform for detection of high impedance faults.	2
Lec 13	Decision making process, decision regions and borders, deterministic and probabilistic decision making methods.	2
Lec 14	Adaptive control and protection systems, multi-criteria systems, integrated measurement, control and protection systems.	2
Lec 15	Wide area measurements for power system protection and control.	2
	Total hours:	**30**

Project		**Number of hours:**
Proj 1	Introduction. Setting rules of course crediting. Acquaintance with lab stands and available software.	2
Proj 2	Design and evaluation of signal pre-processing and A/D conversion units.	4
Proj 3	Synthesis and analysis of digital IIR and FIR filters.	4
Proj 4	Quality evaluation of selected methods of digital estimation of signal magnitude.	4
Proj 5	Assessment of digital algorithms for power and impedance components measurement.	4
Proj 6	Evaluation of digital algorithms for frequency measurement.	2
Proj 7	Analysis of digital algorithms for symmetrical components extraction.	2
Proj 8	Design and evaluation of adaptive algorithms for measurement of selected protection criteria.	4
Proj 9	Evaluation of selected methods and algorithms of decision making.	2
Proj 10	Reserve date, accounting for the executed projects.	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Informative lecture.
N2. Matlab and ATP-EMTP programmes.
N3. Project presentation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Participation in the course.
F2(W)	PEU_W01 PEU_W02 PEU_W03	Final examination.
P(W)	P = 0,1F1 + 0,9F2	
F1(P)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Activity during the classes.
F2(P)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Presentation of the project done.
P(P)	P = 0,2F1 + 0,8F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Rebizant W., Szafran J., Wiszniewski A., Digital signal processing in power system protection and control, Springer, London 2011.
[2] Rebizant W., Wiszniewski A., Digital signal processing for protection and control, Skrypt PWr, Wrocław 2011
[3] Ungrad H., Winkler W., Wiszniewski A., Protection techniques in electrical energy systems, Marcel Dekker Inc. New York, Basel, Hong Kong 1995
[4] Jackson L.B., Digital filters and signal processing, Kluwer Academic Publishers, Boston 2002.

SECONDARY LITERATURE:

[1] Szafran J., Wiszniewski A., „Algorytmy pomiarowe i decyzyjne cyfrowej automatyki elektroenergetycznej”, WNT, Warszawa 2001
[2] Winkler W., Wiszniewski A, „Automatyka zabezpieczeniowa w systemach elektroenergetycznych”, WNT, Warszawa 2004
[3] Wiszniewski A., „Algorytmy pomiarów cyfrowych w automatyce elektroenergetycznej”, WNT, Warszawa 1990

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Techniki sztucznej inteligencji**
Name of subject in English:	**Artificial Intelligence Techniques**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2135
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30			15	
Number of hours of total student workload (CNPS):	60			30	
Form of crediting:	crediting with grade			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	2			1	
including number of ECTS points for practical (P) classes :				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40			0.70	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basics of power system control, digital signal processing and numerical methods
2. Practical skills of using MATLAB and ATP-EMTP software

SUBJECT OBJECTIVES

C1. Acquaintance of knowledge related artificial intelligence techniques application to digital power system protection and control systems

C2. Acquiring practical skills to design and analyze control and protection units for power systems, with application of artificial intelligence techniques

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Possesses knowledge related to expert systems: basic features, structure, inference methods, conflict resolution strategies, application fields.
PEU_W02	Possesses knowledge related to fuzzy logic systems: fuzzy signals, membership functions, fuzzy settings, fuzzyfication and defuzzyfication methods, realization of multi-criteria algorithms.
PEU_W03	Possesses knowledge related to artificial neural networks (features, neurone types, activation functions, neural network structures, learning methods, application fields) as well as genetic algorithms (evolutionary strategies, genetic modifications).

relating to skills:

PEU_U01	Is able to apply expert systems for power system control and protection purposes.
PEU_U02	Is able to apply fuzzy logic technique for power system control and protection purposes.
PEU_U03	Is able to apply artificial neural networks as well as genetic algorithms for power system control and protection purposes.

relating to social competences:

PEU_K01	Is able to carry out a complex engineering project in a competent way, unaided, undertaking multi-criterial analysis.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction. Setting rules of course crediting. Definition of artificial intelligence (AI), AI as a branch of science, AI techniques in power systems, statistics of AI application in power system protection and control.	2
Lec 2	AI approach to protection and control tasks – problems of contemporary digital protection systems, protection relay as a classifying unit, protection tasks as pattern recognition tasks.	2
Lec 3	Expert Systems (ES) – definitions, knowledge base, data base, inference mechanisms.	2
Lec 4	ES – semantic rules and structures, acquisition of rules, inference methods, conflict resolving strategies.	2
Lec 5	Expert Systems – application fields, examples.	2
Lec 6	Fuzzy Logic (FL) – basics of fuzzy sets theory, operations on fuzzy sets, fuzzy arithmetic. Linguistic variables, operators of aggregation, fuzzy reasoning.	2
Lec 7	Elements of FL in power system protection – fuzzy criteria signals, fuzzy settings, fuzzy comparison, amount of information, multi-criterial decision making.	2
Lec 8	Examples of FL technique application in power system protection.	2
Lec 9	Artificial Neural Networks (ANN) – neurone models, activation functions, multilayer perceptrons, feed-forward networks.	2
Lec 10	ANN architectures: feed-forward networks, ANNs with feedback connections, Hopfield networks, Kohonen networks.	2
Lec 11	ANN design problems – network structure selection, generation of training patterns, training algorithms with and without the teacher, learning process acceleration techniques, knowledge generalisation vs. overfitting.	2
Lec 12	Examples of ANN application in power system control.	2
Lec 13	Genetic algorithms – evolutionary strategies, genetic modification of individuals, genetic optimisation, application examples.	2
Lec 14	Comparison of described AI techniques, hybrid structures, examples.	2
Lec 15	Crediting test.	2
	Total hours:	**30**

Project		**Number of hours:**
Proj 1	Design and implementation of an expert system for chosen decision task.	4
Proj 2	Design and evaluation of the fuzzy logic based measurement/decision unit.	4
Proj 3	Design and evaluation of the neural network based measurement/decision unit.	4
Proj 4	Implementation of genetic optimization procedures for selected measurement/decision task.	2
Proj 5	Presentations of executed projects, crediting.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Informative lecture.
N2. Matlab and ATP-EMTP programmes.
N3. Project presentation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Participation in the course.
F2(W)	PEU_W01 PEU_W02 PEU_W03	Final colloquium/test.
P(W)	P = 0,1F1 + 0,9F2	
F1(P)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Activity during the classes.
F2(P)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Presentation of the projects done.
P(P)	P = 0,2F1 + 0,8F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Rebizant W., Szafran J., Wiszniewski A., Digital signal processing in power system protection and control, Springer, London 2011
[2] Russel S.J., Norvig P., Artificial intelligence: a modern approach, Prentice Hall, Pearson, 2010
[3] James J. Buckley, Esfandiar Eslami, An introduction to fuzzy logic and fuzzy sets, Heidelberg Physica-Verlag, 2002
[4] Dillon T.S. and Niebur D. (edited by), Neural Network Applications in Power Systems, CRL Publishing Ltd., London 1996
[5] Liebowitz J., The Handbook of applied expert systems, Boca Raton, CRC Press, 1998

SECONDARY LITERATURE:

[1] Gottlob G. And Nejdl W. (ed. by), Expert Systems in Engineering: Principles and Applications, Proceedings of the International Workshop, Vienna, Austria, Sept. 1990
[2] Cichocki A., Unbehauen R., Neural Networks for Optimization and Signal Processing, John Wiley & Sons, 1993
[3] Yager R.R. and Filev D.P., Essentials of Fuzzy Modelling and Control, J. Wiley & Sons, Inc., New York, USA, 1994
[4] Ringland G.A. and Duce D.A. (ed. By), Approaches to Knowledge Representation: An Introduction, Research Studies Press Ltd., Wiley & Sons, Chichester, England, 1988
[5] Pao Y.A., Adaptive Pattern Recognition and Neural Networks, Addison-Wesley, Reading, MA, 1989

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Projektowanie układów logicznych**
Name of subject in English:	**Design of logic circuits**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM2136
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. To be familiar with fundamentals of digital circuits.
2. To know how to practically interconnect simple digital circuits and verify their operation.
3. To be able to think and act in a creative way.
4. To be able to work in a team.

SUBJECT OBJECTIVES

C1. Gaining theoretical and practical knowledge on combinatorial logic circuits: canonical form, Karnaugh maps method, phenomenon of hazards.

C2. Gaining theoretical and practical knowledge on sequential logic circuits: the method of consecutive switching tables, Moore and Mealy type automata, races phenomenon.

C3. Familiarization with methods concerning: presenting a logic circuit operation, selecting of design methods, practical analysis/synthesis methods and ways of implementing logic circuits.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Has knowledge on operation, analysis and synthesis methods of combinatorial logic circuits.

PEU_W02 Has knowledge on operation, analysis and synthesis methods of sequential logic circuits.

relating to skills:

PEU_U01 Is able to conduct both analysis and synthesis, as well as to implement combinatorial logic circuits with use of the Karnaugh maps method, with eliminating a hazard phenomenon.

PEU_U02 Student is able to conduct both analysis and synthesis, as well as to implement asynchronous logic circuits with use of the method of consecutive switching tables, in particular Moore and Mealy types, with eliminating of races phenomenon.

PEU_U03 Student is able to conduct both analysis and synthesis, as well as to implement synchronous logic circuits.

relating to social competences:

PEU_K01 Student is able to act independently and cooperate within a group working on a complex engineering project.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction. Conditions for passing and marking the course. Basics of Boole algebra. Typical logic gates and circuits and their graphic symbols.	2
Lec 2	Design of combinatorial logic circuits.	2
Lec 3	Sequential automata – types, general characteristic, design principles.	2
Lec 4	Design of sequential automata with the method of consecutive switching tables.	2
Lec 5	Sequential automata – description of Moore and Mealy type automata.	2
Lec 6	Sequential automata – design steps.	2
Lec 7	Implementation of asynchronous sequential automata, elimination of races phenomenon and hazards.	2
Lec 8	Pass test.	1
	Total hours:	**15**

Laboratory		**Number of hours:**
Lab 1	Presentation of health and safety rules, and general regulations of the laboratory. Conditions for passing and marking the course. General familiarization with the laboratory stands and simulative software.	2
Lab 2	Design of asynchronous sequential logic circuits with use of the transition tables and output maps. Implementation of circuits with use of logic gates - part 1.	2
Lab 3	Design of asynchronous sequential logic circuits with use of the transition tables and output maps. Implementation of circuits with use of logic gates - part 2.	2
Lab 4	Design of asynchronous sequential logic circuits with use of the transition tables and output maps. Implementation of circuits with use of flip-flops.	2
Lab 5	Design of asynchronous sequential logic circuits with the method of consecutive switching tables.	2
Lab 6	Multiplexers, de-multiplexers and code conversion circuits, adders, subtractors, comparators, counters and memory registers - investigation of selected circuit.	2
Lab 7	Design of synchronous sequential logic circuits.	2
Lab 8	Summary of laboratory excercises.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Informative lecture.
N2. Didactic models of digital circuits.
N3. Programmme for simulating digital circuits.
N4. Report on performed laboratory excercise.
N5. Student's own work.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	Presence at the lectures
F2(W)	PEU_W01 PEU_W02	Crediting test
P(W)	P=0,1F1+0,9F2	
F1(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Activity at the laboratory
F2(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Reports from the laboratory assignements
P(L)	P=0,3F1+0,7F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Mano M. Morris, Digital design (second edition), Prentice-Hall Int., Inc., Englewood Cliffs, New Jersey, 1991.
[2] M. Morris Mano, C. R. Kime: Logic and computer design fundamentals, Pearson Prentice-hall Int., 2004, 3rd ed.
[3] Tocci R.J., Digital Systems. Principles and applications, Prentice-Hall Int., Inc., London, 1988.

SECONDARY LITERATURE:

[1] Układy logiczne. Ćwiczenia laboratoryjne. Skrypt Politechniki Wrocławskiej pod red. Mirosława Łukowicza. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2002
[2] Wilkinson B., Układy cyfrowe. WKŁ, Warszawa, 2000
[3] Skorupski A., Podstawy techniki cyfrowej. WKŁ, Warszawa, 2001
[4] Kamionka-Mikuła H., Małysiak H., Pochopień B., Układy cyfrowe. Teoria i przykłady. Wydawnictwo Pracowni Komputerowej Jacka Skalmierskiego. Wydanie III poszerzone. Gliwice 2001.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Elektroenergetyka-zajęcia terenowe**
Name of subject in English:	**Electrical Power Engineering – excursionary activities**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM2138
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15				15
Number of hours of total student workload (CNPS):	60				30
Form of crediting:	crediting with grade				crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:	2				1
including number of ECTS points for practical (P) classes :					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40				0.70

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student has ordered theoretical knowledge necessary to develop a detailed topic in the broadly understood power system and control systems area.
2. Can properly apply the knowledge learned to prepare an article and a multimedia presentation.
3. Can cooperate in an international group.

SUBJECT OBJECTIVES

C1. Extension and transplantation of knowledge in the field of electrical power engineering in the context of industrial practice.
C2. Expansion of skills to develop independently and present selected topics in power engineering.
C3. Acquisition of skills related to active participation in the discussion on presented of results.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 He knows about methods of control of RES systems, in particular those related to real industrial objects.

PEU_W02 He knows about algorithms of control of RES systems, in particular those related to real industrial objects.

relating to skills:

PEU_U01 He can independently characterize and evaluate the utility values of basic RES systems in relation to the problems of functioning in the electric power system.

PEU_U02 He can evaluate the importance of RES control systems for cooperation with the power network.

relating to social competences:

PEU_K01 He can translate general principles and values of academic community into practical attitudes and behaviours during the international educational trip.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction. Principles of work and credit. Papers characteristics.	2
Lec 2	Characteristics of RES objects - in relation to visited industrial objects (field activities) part.1.	2
Lec 3	Characteristics of RES objects - in relation to visited industrial objects (field activities) part.2.	2
Lec 4	Methods of control of RES objects - in relation to visited industrial objects (field activities) part 1.	2
Lec 5	Methods of control of RES objects - in relation to visited industrial objects (field activities) part 2.	2
Lec 6	Practical restrictions on the control of RES objects - in relation to visited industrial objects (field activities) part.1.	2
Lec 7	Practical restrictions on the control of RES objects - in relation to visited industrial objects (field activities) part.2.	2
Lec 8	Summary. Discussion of the results of written assignments.	1
	Total hours:	**15**

Seminar		Number of hours:
Sem 1	Requirements, individual subjects, nature of work, division into groups, conditions of credit.	2
Sem 2	Se2-8. Presentation of the performed analysis for a given problem in the field of power engineering.	13
	Total hours:	**15**

TEACHING TOOLS USED
N1. Field courses in industry, power plants, etc. and a seminar using multimedia presentations.
N2. Substantive discussion on the presented issues.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	Evaluation of the article / written report (distinguished works recommended to KNS)
P(W)	P=F1	
F1(S)	PEU_U01 PEU_U02 PEU_K01	Evaluation of multimedia presentation.
F2(S)	PEU_U01 PEU_U02 PEU_K01	Active participation in the didactic trip related to power engineering.
P(S)	P=0.7*F1+0.3*F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Ehrlich, Robert (1938-). Renewable energy : a first course / Boca Raton [etc.] : CRC Press/Taylor & Francis Group, cop. 2013
[2] Goodstal, Gary. Electrical theory for renewable energy Clifton Park : Delmar Cengage Learning, cop. 2013
[3] Thomashow, Mitchell. The nine elements of a sustainable campus / Cambridge, Mass. London, The MIT Press, cop. 2014

SECONDARY LITERATURE:

[1] Literature related directly to the individual subject of student work.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Obliczenia zwarciowe**
Name of subject in English:	**Fault Calculations**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2139
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):				30	
Number of hours of total student workload (CNPS):				60	
Form of crediting:				crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:				2	
including number of ECTS points for practical (P) classes :				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				1.40	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has basic knowledge on power system operation.
2. Has basic knowledge on programming in Matlab.
3. Is able to state and verify simple calculation algorithms.
4. Is able to think and act in a creative way.
5. Is able to work in a team.

SUBJECT OBJECTIVES

C1. Gaining knowledge on power system faults.
C2. Familiarization with methods for analysis of fault signals and fault identification.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 Is able to analyse fault signals obtained from computer simulation.

PEU_U02 Is able to conduct fault identification and to determine its characteristic features.

relating to social competences:

PEU_K01 Is able to act independently and cooperate within a group working on a complex engineering project.

PROGRAMME CONTENT		
Project		**Number of hours:**
Proj 1	Presentation of health and safety rules and general regulations of the laboratory. Establishing conditions for passing and marking the project course. Introduction - aim and contents of the projects to be performed.	2
Proj 2	Familiarization with loading the simulation data from ATP-EMTP simulation into the Matlab programme and visualisation of the signals.	2
Proj 3	Digital filtering of fault signals from ATP-EMTP simulation.	2
Proj 4	Digital algorithms for fault detection.	2
Proj 5	Digital algorithm for fault direction discrimination.	2
Proj 6	Digital algorithm for fault classification - part 1.	2
Proj 7	Digital algorithm for fault classification - part 2.	2
Proj 8	Distance protection - digital measurement of fault-loop impedance and reflection of MHO decision characteristic - part 1.	2
Proj 9	Distance protection - digital measurement of fault-loop impedance and reflection of MHO decision characteristic - part 2.	2
Proj 10	One-end fault location - the sample solution applied in modern protection terminal for power line - part 1.	2
Proj 11	One-end fault location - the sample solution applied in modern protection terminal for power line - part 2.	2
Proj 12	Fault location on power line with use of measurements of voltage and current from both line ends - part 1.	2
Proj 13	Fault location on power line with use of measurements of voltage and current from both line ends - part 2.	2
Proj 14	Calculation of fault currents in a given faulted network.	2
Proj 15	Summary and description of the performer projects.	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Matlab software.
N2. Report on performed project.
N3. Student's own work.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(P)	PEU_U01 PEU_U02 PEU_K01	Activity at the project classes
F1(P)	PEU_U01 PEU_U02 PEU_K01	Marks from reports on the completed projects
P(P)	P=0,3F1+0,7F2	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Iżykowski J., Power system faults. PRINTPAP, 2011, p. 190.
SECONDARY LITERATURE:
[1] Glover J. D., Sarma M., Power system analysis and design. PWS Publishing Company Boston, second edition, 1994. [2] Michalik M., Rosołowski E., Simulation and analysis of power system transients. PRINTPAP, 2011. [3] Saha M.M., Iżykowski J., Rosołowski E., Fault location on power networks. Springer-Verlag London, Series: Power Systems, 2010, 425 p.

SUBJECT SUPERVISOR
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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Czujniki i komunikacja światłowodowa**
Name of subject in English:	**Fiber Optics Communications and Sensors**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2140
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		30		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student has structured and theoretically formed knowledge necessary to understand phenomena related to fiber optics and communications
2. Student has a basics knowledge on electromagnetic field theory
3. Is able to select properly, to connect as well as to coordinable performance of elements and fiber sensors in measuring transmission networks
4. Is able to perform properly and effectively basic research on operation parameters of both active and passive optoelectronic elements
5. Is able to conduct work in a team and understands the need for continuous education

SUBJECT OBJECTIVES

C1. Acquaintance of student with basic knowledge necessary to understand physical phenomena related to optoelectronic transmission of signals

C2. Acquaintance of student with modern structures of optoelectronic elements as well as with ways of processing and data transmission in optical networks

C3. Creation of skills and ability to create modern technique methods and measuring tools to test and design fiber optics communication networks

C4. The acquisition of practical knowledge and skills to apply and to complete fiber optics circuits carrying out measurements and preparation of test protocols

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Knows structure and specifics of optical path work

PEU_W02 Has knowledge about optical phenomenon and optical elements dedicated for optical transmission

relating to skills:

PEU_U01 Is able to precise purpose and scope of research, project measurement circuit and select measurement equipment

PEU_U02 Is able to elaborate results and determine conclusions if about fiber guide condition

relating to social competences:

PEU_K01 Is conscious about responsibility for his own work and is willing to acknowledge teamwork rules

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Acquaintance with the subject, its program and the requirements of completion	2
Lec 2	Principles of wave theory of light propagation	2
Lec 3	Dielectric light guides, properties, basic parameters, fabrication	2
Lec 4	Problems of effective propagation of the light wave in fiber guides	2
Lec 5	Mechanisms of power losses in fiber guides: dispersion, refraction	2
Lec 6	Properties, classifications and operational parameters of the fiber guides	2
Lec 7	Light-emitting diodes (LED) as the light-wave source	2
Lec 8	Laser diodes (LD) as the light-wave source	2
Lec 9	Photodiodes, phototransistors and photoresistors in detection systems of the light-wave	2
Lec 10	Splices and optical connectors	2
Lec 11	Auxiliary, passive elements in fiber-optics networks and systems	2
Lec 12	Expanding optical system capacity by multiplexing	2
Lec 13	Digital and analog modulation of optical signals	2
Lec 14	Optical phenomena employed in fiber sensors	2
Lec 15	Completion quiz	2
	Total hours:	**30**

Laboratory		**Number of hours:**
Lab 1	Introduction to the rules of safety (BHP) and to internal regulations applicable in the lab. Determination of completion criteria. General learning in the lab. Stands and acquaintance with physical models of optical and optoelectronics elements as well as with performance criteria	2
Lab 2	Measurement of attentuation of a multisegment fiber optics transmission system	2
Lab 3	Attenuation measurement of optical fiber guides	2
Lab 4	Testing of optical polarizer	2
Lab 5	Investigation of radiation angular characteristics of semiconductor lasers	2
Lab 6	Investigation of output spectrum and light-current characteristics of optical light source	2
Lab 7	Investigation of matching efficiency of optical connectors	2
Lab 8	Communication in BPL smart meters model (TCP/IP)	2
Lab 9	Communication in PLC smart meters model (PRIME)	2
Lab 10	Communication between devices using the MODBUS protocol (RS485)	2
Lab 11	Local Power Protection Operator - local point of the Control and Supervision System (SCADA)	2
Lab 12	GOOSE communication - IEC61850 compliant communication - Part I	2
Lab 13	MMS communication - introduction to IEC61850 compliant communication - part II	2
Lab 14	Access Gateway - communication (using DNP3 protocol) with remote monitoring center	2
Lab 15	Completion and arrears exercises	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Lecture with the use audiovisual techniques multimedia presentations, transparencies
N2. Laboratory measurements on physical models of the fiber optic elements and using PSP devices, conducted in the traditional manual in the groups

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	Oral or written completion test
P(W)	P=F1	
F1(L)	PEU_U01	Checking and assessment of preparation for lab exercises
F2(L)	PEU_U02	Evaluation of reports of performed exercises
P(L)	P=0,3F1+0,7F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Chai Yeh, Hanbook of Fiber Optics – Theory and Applications, Academic Press. Inc, London 1990.
Hornet J.L., Optical Signal Processing, Academic Press, Inc. London 1990.
Winkler W., Wiszniewski A., Automatyka zabezpieczeniowa w systemach elektroenergetycznych, WNT, Warszawa 2004.
Handbook of Optics Volume I-V, Mc Graw Hill Companies Inc.,Third Edition, USA 2010

SECONDARY LITERATURE:

Gagliardi R.M., Karp S., Optical Communications, Willey-int.Pub.
CIGRE Working Group 35.04, optical Cable Selection fo Electricity Utilities, Febr. 2001

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Elektroenergetyczna Automatyka Zabezpieczeniowa**
Name of subject in English:	**Power System Protection**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2231
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		30		
Number of hours of total student workload (CNPS):	90		60		
Form of crediting:	examination		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	3		2		
including number of ECTS points for practical (P) classes :			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10		1.40		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student has structured and theoretically founded knowledge necessary to understand the purpose and tasks of modern power system protection
2. Student has a basic understanding of the criteria and methods of protection and automation solutions to the basic components of the power system
3. Is able to select setting as well as to connect and coordinate the work of one – and many inputs measuring relays in power protections
4. Is able to perform properly and effectively basic research as well as field tests of digital and analog measuring executive units of protection
5. Is able to conduct work in a team and understands the need for continuous education

SUBJECT OBJECTIVES

C1. Acquaintance of a student with modern solutions of power system protections
C2. The acquisition of practical knowledge and skills for setting the criteria quantities to protect electric machines, devices and power networks
C3. Creation of skills and ability to use modern methods, techniques and measurement tools for testing relays and protection systems
C4. The acquisition of practical knowledge and skills related to completion of circuits of power system automation, carrying out measurements and preparation of test protocols

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:	
PEU_W01	student has structured and theoretically founded knowledge necessary to understand the purpose and tasks of modern protection and restitution automation for low – and middle voltage power networks
PEU_W02	Has structured and theoretically founded knowledge necessary to selection of operation criteria of protection and restitution automation for low and middle voltage networks as well as to ways of solution for fundamental elements of electric power system (generators, transformers, motors, power lines)
relating to skills:	
PEU_U01	Can handle the protections tester. Is able to link protection with current and voltage measuring circuits as well as with these for ground faults and control in MV-line models
PEU_U02	Can select and perform setting of triping values for MV and LV protection
PEU_U03	Is able to evaluate the characteristics of basic criteria for operation of protection of electric power objects
relating to social competences:	
PEU_K01	He has a sense of responsibility for him own work and a willingness to comply with the principles of teamwork

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Acquaintance with the subject the requirements of completion, principles of power system protection and basic definitions	2
Lec 2	Relays and relaying systems, new generation of digital relays, the trend in progress	2
Lec 3	Converters of measuring quantities, measuring current and voltage transformers	2
Lec 4	Filters of symmetrical components	2
Lec 5	Fault detection criteria in machines and electrical equipment	2
Lec 6	Methodology for setting of input parameters for simple one-input relay systems	2
Lec 7	Fault detection criteria in electric power networks	2
Lec 8	Ways of setting of multi-input relay systems (directional, differential and distance protection)	2
Lec 9	Protection of synchronous and asynchronous generators	2
Lec 10	Protection of MV and LV power transformers	2
Lec 11	Protection of MV and LV electric motors of high power	2
Lec 12	Disturbances in transmission and distribution el. power networks	2
Lec 13	Distribution MV and LV power network protections	2
Lec 14	Protection of HV and MV transmission power networks	2
Lec 15	The objectives and operation principles of preventive and restitution automation	2
	Total hours:	**30**

Laboratory		**Number of hours:**
Lab 1	Introduction to the rules of safety and to internal procedure applicable in the lab. Determination of completion criteria. Presentation of the lab stands and acquaintance with physical models of protections as well as with performance criteria	3
Lab 2	Examinations of zero sequence current filters	3
Lab 3	Investigation of protection of inverse (dependent) time characteristics	3
Lab 4	Examination of AC motor protection	3
Lab 5	Examination of distance protection	3
Lab 6	Examination of automatic restoration system	3
Lab 7	Examination of auto-reclosing unit	3
Lab 8	Examination of differential protection of the power networks	3
Lab 9	Examination of generator protection	3
Lab 10	Completion and arrears exercises	3
	Total hours:	**30**

TEACHING TOOLS USED
N1. Lecture with the use of audiovisual techniques, multimedia presentations, transparencies
N2. Laboratory testing conducted in the traditional manner in students group
N3. A report of the measurements

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	Oral and written exam
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02 PEU_U03	Checking and assessment of preparation for lab exercises
F2(L)	PEU_U01 PEU_U02 PEU_U03	Evaluation of reports performer exercises
P(L)	P=0,4F1+0,6F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Horowitz S.H., Phadke A.G., Power System Relaying, RSP England, 1992.
Ungrad H., Winkler W., Wiszniewski A., Protection Techniques in Electrical Energy Systems, Marcel Dekker Inc., New York, 1995.
Winkler W., Wiszniewski A., Automatyka zabezpieczeniowa w systemach elektroenergetycznych, WNT, Warszawa 2004.
Synal B., Elektroenergetyczna automatyka zabezpieczeniowa : podstawy, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2003.
Praca zbiorowa por red. B. Synala, Automatyka Elektroenergetyczna, ćwiczenia laboratoryjne cz.I : Przetworniki sygnałów pomiarowych i przekaźniki automatyki zabezpieczeniowej, cz.II : Układy automatyki zabezpieczeniowej i regulacyjnej, Skrypt Politechniki Wrocławskiej, Wrocław 1991.

SECONDARY LITERATURE:

Wróblewski J., Zespoły elektroenergetycznej automatyki zabezpieczeniowej : zasady budowy, WNT, Warszawa 1993.
Wiszniewski A., Algorytmy pomiarów cyfrowych w automatyce elektroenergetycznej, WNT,Warszawa 1990

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Automatyka i bezpieczeństwo systemu elektroenergetycznego**
Name of subject in English:	**Power System Automation and Security**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2233
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30				15
Number of hours of total student workload (CNPS):	90				30
Form of crediting:	examination				crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:	3				1
including number of ECTS points for practical (P) classes :					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10				0.70

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. 1. Student has structured and theoretically founded knowledge necessary to understand phenomena associated with transient states under disturbances in networks and electrical machines
2. Has a basic knowledge on electric power protection
3. Is able to analyze properly selection joining and coordination of performance of elements and units of preventing and restitution automation
4. Is able to interpret the operation risk of electric power system and decide on selection of appropriate remedy
5. Is able to conduct work in a team and understands the need for continuous education

SUBJECT OBJECTIVES

C1. Acquaintance of a student with basic knowledge needed to understand physical phenomena associated with transient states under disturbances in networks and electric machinery

C2. Acquaintance with modern solutions of preventive and restitution automation with use of advanced digital techniques of data processing and transformation

C3. Creation of skills and ability to recognition and ability to recognition and interpretation of risks arising from transient states under disturbances

C4. The acquisition of a knowledge related to modern trends in control and safe management of supply and distribution of electric energy

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Has detailed knowledge on methods of solution of safe control of automated electric power systems

PEU_W02 Is able to decide on effective way to use elements of power restitution automation

relating to skills:

PEU_U01 Able to obtain information from the literature and database on selected problems in the field of reliability, safety and modern concept of solutions of power systems protection

PEU_U02 Able to formulate conclusion drawn from analysis of a selected power network concerning safe central and operation of automated electrical power systems

relating to social competences:

PEU_K01 He has a sense of responsibility for his work and a willingness to comply with the principles of teamwork

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Acquaintance with the subject its program	2
Lec 2	Switching and auxiliary as contact as well as contactless units in automation, classification, parameters and category of utilizations, electrical and mechanical endurance	2
Lec 3	Reed relays and sensors, structure principle of operation, switching properties and application considerations	2
Lec 4	Advanced current converters for digital protections (Hall sensor, Rogowski coils etc)	2
Lec 5	Security problems in MV network with no effective earthing under a single phase grounding	2
Lec 6	Overvoltage protection in power system, external and internal threats, resonance phenomena	2
Lec 7	Power line carrier system (PLC) for central, management and data distribution in electric power networks	2
Lec 8	Coordinated central: automatic restoration, auto reclosing and load shedding in electric power system	2
Lec 9	Wide Area Protection System – application fields, GPS synchronization of measurements	2
Lec 10	Substation automation and integration – cooperation with SCADA system	2
Lec 11	Modern trends in substation automation – application of intelligent electric devices, internet – based solutions	2
Lec 12	Blackouts – reasons of wide area developing faults	2
Lec 13	Voltage and angle stability monitoring – PMU	2
Lec 14	Adaptive protection system	2
Lec 15	Summary and discussion of the final examination	2
	Total hours:	**30**

Seminar		**Number of hours:**
Sem 1	Acquaintance with program, requirements and way of completion, selection of problems itself	1
Sem 2	Individual tasks and projects for presentation of selected problems related to reliability, safe operation and modern solutions and concepts of automated electric power systems	14
	Total hours:	**15**

TEACHING TOOLS USED

N1. Lecture with use of audiovisual techniques, multimedia presentation, transparences
N2. Seminar with use of audiovisual techniques, multimedia presentation, transparences
N3. Problem discussion, consultation

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	Oral or written exam
P(W)	P=F1	
F1(S)	PEU_U01 PEU_U02	Assessment of individual presentation and students ability
F2(S)	PEU_U01 PEU_U02	Assessment of student activities under seminar
P(S)	P = 0,7F1 + 0,3F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

KTV Grattan, Sensors technology, Systems and Applications, A.Hilger IOP Publishing Ltd.1991
Power System Protection Vol.4 : Digital Protection and Signaling, Short Run Press Ltd. Exeter 1997
Ungrad H., Winkler W., Wiszniewski A., Protection Techniques in Electrical Energy Systems, Marcel Dekker Inc., New York 19

SECONDARY LITERATURE:

Wybrane artykuły publikowane w renomowanych czasopismach światowych

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**PLC oraz bezprzewodowa komunikacja dla potrzeb monitoringu i pomiarów**
Name of subject in English:	**PLC and Wireless Communications for Monitoring and Metering**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM2234
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30				15
Number of hours of total student workload (CNPS):	90				30
Form of crediting:	examination				crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:	3				1
including number of ECTS points for practical (P) classes :					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10				0.70

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student has structured and theoretically founded knowledge necessary to understand phenomena related with as wire as well as wireless processing and transmission
2. Has a basic knowledge on electromagnetic field theory
3. Is able to apply properly knowledge of modern physics to analyze the efficiency of operation of communication systems employed in monitoring and metering
4. Is able to exploit properly common rules and laws of physics to the qualitative and quantitative analysis of an engineering issues
5. Able to conduct work in a team and understands the need for continuous education

SUBJECT OBJECTIVES

C1. Acquaintance with basic knowledge necessary to understand phenomena accompanying both wire and wireless transmission of analog and digital signals

C2. Acquaintance with opportunities to use PLC technique and wire communication in monitoring and metering

C3. Creation of skills and ability to use PLC and wireless communication for monitoring and metering in automated electric power systems

C4. The acquisition of a knowledge related on current trends in signal transmission technology for industrial applications

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Has knowledge on physical basis of operation, implementation and use of PLC technology
PEU_W02	Has knowledge on physical basis of operation, implementation and use of both wire and wireless telecommunication technology

relating to skills:

PEU_U01	Able to extract information from literature and database on selected problem in field of reliability of PLC technology and/or wireless telecommunication for selected monitoring and metering systems
PEU_U02	Has the ability of analyzing the results and formulating conclusions, as well as preparation and delivering presentation

relating to social competences:

PEU_K01	Has a sense of responsibility for his own work and willingness to comply with the principles of teamwork

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Acquaintance with the subject and requirements of completion	2
Lec 2	PLC and wireless telecommunication tasks, basic functions	2
Lec 3	Standardization of PLC technology – advantages and disadvantages	2
Lec 4	Architecture of electric network, modeling of electric devices, layered architecture OSI	2
Lec 5	Transmission channel functionality, synchronization, frame control, management, frame priorities	2
Lec 6	Overview of network security issues	2
Lec 7	Network mode functionality, master-slave, peer-to-peer, centralized	2
Lec 8	Areas of application, voice, video, multimedia, equipment for different modems, PLC modems	2
Lec 9	Coupling problems; transformers and metering devices	2
Lec 10	Choice of transmission cabling	2
Lec 11	Application problems of selected sensors	2
Lec 12	Control of environment conditions and automated meter reading	2
Lec 13	Architecture of LAN and WAN wireless networks, advantages and disadvantages	2
Lec 14	Architecture of LAN and WAN wire networks, advantages and disadvantages	2
Lec 15	Repetition and discussion of exam issues	2
	Total hours:	**30**

Seminar		**Number of hours:**
Sem 1	Acquaintance with program, requirements and way of completion	1
Sem 2	Individual projects and presentations (with use of audiovisual techniques) on application of PLC and telecommunication networks	14
	Total hours:	**15**

TEACHING TOOLS USED

N1. Lecture with use of audiovisual techniques, multimedia presentation, transparences.
N2. Seminar with use of audiovisual techniques, multimedia presentation, transparences
N3. Discussion on presented material

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_K01	Written exam
P(W)	P=F1	
F1(S)	PEU_U01 PEU_U02 PEU_K01	Individual performance evaluation
F2(S)	PEU_U01 PEU_U02 PEU_K01	Assesment of student activities during seminar
P(S)	P=0,8F1+0,2F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Xavier Carcelle, Power Line Communication in Practice, Artec House, Boston London 2006
[2] Yang Xiao, Yi Pan, Emerging Wireless LANs, Wireless PANs, Wireless MANs, Willey&Sons, Inc. Pub. 2009

SECONDARY LITERATURE:

[1] Selected papers published in recognized international journals and/or presented in internet

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Odnawialne Źródła Energii**
Name of subject in English:	**Renewable Energy Sources**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2331
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30				15
Number of hours of total student workload (CNPS):	60				30
Form of crediting:	examination				crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:	2				1
including number of ECTS points for practical (P) classes :					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40				0.70

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a basic knowledge in the field of the theory of electric circuits.
2. Has a basic knowledge of power system operation and electricity generation and transmission techniques.
3. Has sufficient range of language means at his/her disposal to relatively flawlessly speak out (orally and written), formulate and justify opinions, explain his/her position, show advantages and disadvantages of different solutions, participate in discussion and present general, scientific and technical subject matter.
4. Can use basic hardware and software, create and edit a text on basic level, create computer presentations.
5. Understands a need and knows possibilities of continuous education, increasing of professional, personal and social competences.
6. Has awareness of responsibility for own work.

SUBJECT OBJECTIVES

C1. Getting to know principles of electric energy generation from renewable energy sources.
C2. Possession a knowledge from range of technical, economic and environmental aspects of renewable energy sources utilization for electric energy generation.
C3. Getting to know applicable technologies and real solutions for electric energy generation with utilization of renewable energy sources.
C4. Identification disadvantages and advantages of different renewable energy sources.
C5. Acquisition of abilities to solve problems connected with renewable energy sources.
C6. Interpreting processes of electric energy generation with utilization of renewable energy sources.
C7. Acquisition of abilities to analyze technical, economical and environmental aspects of renewable energy sources utilization for electric energy generation.
C8. Acquisition of abilities to design systems for electric energy generation with utilization of renewable energy source.

SUBJECT EDUCATIONAL EFFECTS	
relating to knowledge:	
PEU_W01	Knows principles of electric energy generation from renewable energy sources.
PEU_W02	Possesses a knowledge from range of technical, economic and environmental aspects of renewable energy sources utilization for electric energy generation.
PEU_W03	Knows applicable technologies and real solutions for electric energy generation with utilization of renewable energy sources.
relating to skills:	
PEU_U01	Can solve problems connected with renewable energy sources.
PEU_U02	Can interpret processes of electric energy generation with utilization of renewable energy sources.
PEU_U03	Can analyze technical, economical and environmental aspects of renewable energy sources utilization for electric energy generation.
relating to social competences:	
PEU_K01	Can think and act in creative and enterprising way. He/she is able to rank appropriately the priorities needed for realizing the respective task.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Renewable energy sources – introduction, the fundamentals, definitions, glossary, classifications, the potential of renewable energy, development of renewable energy, scientific principles of renewable energy, technical implications.	2
Lec 2	Wind energy – introduction, the potential and energy of wind, parameters of wind, measurements of wind, mathematical models of wind, analysis of wind conditions.	2
Lec 3	Wind energy - wind turbines (construction, operation principle, basic technical parameters, example calculations, review of solutions), optimising wind farm, connection of wind power plant to the electric power grid.	2
Lec 4	Wind energy – assessment of wind power plant impact on the Environment, economic aspects of wind energy, account of costs, tariffs, example economical calculations.	2
Lec 5	Wind energy – design of wind plant, examples of solutions of small and medium wind power plant, medium wind power plant, examples of wind farm in Poland and Germany, wind energy market, future of wind energy.	2
Lec 6	Solar Energy – introduction, current PV technology, principles of PV cells work; PV cells, modules and arrays; PV systems (classifications, construction, operation principles, production).	2
Lec 7	Solar Energy – PV systems (installation, exploitation, standards, review of solutions), connection of PV systems to the electric power grid.	2
Lec 8	Solar Energy – solar house, solar energy collectors, systems of solar energy collectors (construction, review of solar energy collectors use, design).	2
Lec 9	Hydro energy – introduction, definitions, hydro electric power plants (construction, classifications, operation principles), advantages and disadvantages of hydropower, hydropower resource potential in Poland.	2
Lec 10	Biogas energy – introduction, definitions, biogas (kinds, sources, the potential), converting biogas to energy, biogas technologies.	2
Lec 11	Biogas energy - applications, review of solutions, environmental aspects, economical aspects of biogas utilization, advantages and disadvantages, future of biogas.	2
Lec 12	Biomass energy – introduction, definitions, biomass (kinds, sources, the potential), converting biomass to energy, biomass technologies.	2
Lec 13	Biomass energy – applications, review of solutions, environmental aspects, economical aspects of biomass utilization, advantages and disadvantages, future of biomass.	2
Lec 14	Geothermal energy – introduction, the potential, kinds of geothermal energy sources, review of geothermal sources utilization to electric energy production, examples of real solutions, economical aspects of geothermal energy utilization.	2
Lec 15	Wave energy – introduction, principles of wave energy conversion, advantages and disadvantages, market barriers, impact on the Environment, technology, review of real solutions of sea waves utilization to electric energy production.	2
	Total hours:	**30**

Seminar		**Number of hours:**
Sem 1	Analysis of wind, geographical, technical, economical and legal conditions for wind power plant. Perspectives of development of wind energy and other renewable energy sources.	2
Sem 2	Review of applied wind turbines in Europe. Analysis of possibility of wind farm connection to the electric power grid.	2
Sem 3	Analysis of costs for wind power plant. Some aspects of wind farm project. Schedule of investor's procedure at build wind power plant.	2
Sem 4	Design of photovoltaic systems. Review of current solutions od photovoltaic systems.	2
Sem 5	Review of solar heating systems. Selected aspects of solar house project.	2
Sem 6	Analysis of small-scale and large hydro electric power plant. Review of solutions of sea waves energy utilization.	2
Sem 7	Review of current solutions in range of biomass energy utilization to electric energy production. Case study of biomass utilization in energy project.	2
Sem 8	Analysis of costs for geothermal power solutions Review of projects of geothermal energy utilization.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lecture with the use of audiovisual techniques, multimedia presentations. N2. Multimedia presentation. N3. Problem discussion. N4. Case study.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03 PEU_K01	Test.
P(W)	P=F1	
F1(S)	PEU_U01 PEU_U02 PEU_U03	Activity on seminar classes.
F2(S)	PEU_U01 PEU_U02 PEU_U03	Preparing and presenting a presentation.
P(S)	P=0.2*F1+0.8*F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Boyle G., Renewable Energy – Power for a sustainable future, Second Edition, Oxford University Press Inc. New York, 2004.
[2] Twidell J., Weir T., Renewable Energy Resources, Seventh Edition, Spon Press, London, 2005.
[3] Burton T., Sharpe D., Jenkins N., Bossanyi E., Wind Energy Handbook, John Wiley and Sons Ltd. Chichester, England, 2001.
[4] Luque A., Hegedus S., Handbook of photovoltaic science and engineering, John Wiley and Sons Ltd. Chichester, England, 2003.

SECONDARY LITERATURE:

[1] Manwell J.F., McGowan J.G., Rogers A.L., Wind Energy Explained: Theory, Design and Application, John Wiley and Sons Ltd. Chichester, England, 2002.
[2] Markvart T.: Solar electricity, Second Edition, UNESCO, John Wiley and Sons Ltd. New York, 2000.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Zaawansowane stacje i urządzenia elektroenergetyczne**
Name of subject in English:	**Advanced Substations and Electrical Equipment**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM2335
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30			15	
Number of hours of total student workload (CNPS):	90			30	
Form of crediting:	examination			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	3			1	
including number of ECTS points for practical (P) classes :				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10			0.70	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows physical phenomena occurred in electrical devices.
2. Has a basic knowledge in the field of the theory of electric circuits.
3. Can correctly and effectively apply a knowledge of linear algebra and analytical geometry to qualitative and quantitative analysis of mathematical issues connected with studied engineering branch.
4. Can apply a mathematical apparatus to analysis of linear electric circuits with sinusoidal AC force.
5. Can apply a mathematical apparatus to analysis of temporary states in linear electrical circuits.
6. Understands a need and knows possibilities of continuous education, increasing of professional, personal and social competences.
7. Has awareness of responsibility for own work.

SUBJECT OBJECTIVES

C1. Possession a knowledge of physical phenomena occurred in electrical devices.
C2. Possession a knowledge of important parameters of electrical devices in aspect of their designing.
C3. Getting to know of principles of electrical devices designing.
C4. Getting to know of relations between construction, correct exploitation, reliability and effectiveness of use of electrical devices in power network.
C5. Possession a knowledge of function of power substations.
C6. Acquisition of abilities to design low voltage electrical installation for supply of different electricity receivers in objects with varied character of use.
C7. Acquisition of abilities to design MV electrical installation for supply of object with varied character of use.
C8. Acquisition of abilities to selection of LV and MV switchgears and MV/LV container transformer substations for required work conditions.

SUBJECT EDUCATIONAL EFFECTS	
relating to knowledge:	
PEU_W01	Knows physical phenomena occurred in electrical devices.
PEU_W02	Knows of principles of electrical devices designing.
PEU_W03	Possesses a knowledge of function of power substations.
relating to skills:	
PEU_U01	Can design low voltage electrical installation for supply of different electricity receivers in objects with varied character of use.
PEU_U02	Can design MV electrical installation for supply of object with varied character of use.
PEU_U03	Can select LV and MV switchgears and MV/LV container transformer substations for required work conditions.
relating to social competences:	
PEU_K01	Can think and act in creative and enterprising way. He/she is able to rank appropriately the priorities needed for realizing the respective task.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Short circuit currents in power electric systems, characteristic values and parameters, ways of their calculation.	2
Lec 2	Thermal effects of normal and short circuit currents.	2
Lec 3	Electro-dynamical effects of short circuit currents.	2
Lec 4	Electric arc – physical properties, extinguishing methods of arc.	2
Lec 5	Switching apparatus - basic terminology and functions in power electrical networks. Low voltage switching apparatus.	2
Lec 6	High voltage switching apparatus – classification, construction, main parameters.	2
Lec 7	Power transformers in power substations.	2
Lec 8	Current and voltage transformers in electrical power substations.	2
Lec 9	Over-voltages and over-voltage protection.	2
Lec 10	Limitation of fault currents. Short-circuit reactors.	2
Lec 11	Structures of main circuits in high-voltage electrical power substations. Supplying of industrial and residential load.	2
Lec 12	Constructional solutions of air and SF6 insulated indoor power substations.	2
Lec 13	Earthing systems in power substations.	2
Lec 14	Auxiliary devices in high-voltage power substations. Protection against electric shock in power substations.	2
Lec 15	Principles of correct operation in power substations.	2
	Total hours:	**30**

Project		**Number of hours:**
Proj 1	Description of the project task. Planning of the supply of object with varied character of use and structure of the installation.	2
Proj 2	Project of general lighting in the object.	2
Proj 3	Calculation of the power demand for the object. Calculation of reactive power compensation. Selection of capacitor bank. Selection of power transformers.	2
Proj 4	Selection of main cable supplied the object with varied character of use.	2
Proj 5	Calculation of selected circuits of power installation.	2
Proj 6	Selection of LV switchgears in the object with varied character of use.	2
Proj 7	Selection of MV/LV container power substations.	2
Proj 8	Project documentation.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lecture with the use of audiovisual techniques, multimedia presentations.
N2. Multimedia presentation.
N3. Problem discussion.
N4. Presentation of the project.
N5. Consultations.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03 PEU_K01	Exam in written form.
P(W)	P=F1	
F1(P)	PEU_U01 PEU_U02 PEU_U03	Assessment of project preparing.
F2(P)	PEU_U01 PEU_U02 PEU_U03	Defence of the project.
P(P)	P=0.6*F1+0.4*F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Dołęga W., Advanced substations and electrical equipment. Wrocław University of Technology, Wrocław, 2011.
[2] McDonald J.D., Electric Power Substations Engineering, Wiley, 2003.
[3] Seip G., Electrical Installations Handbook, Springer Verlag, 2001.
[4] ABB Switchgear Manual, 10th edition, Düasseldorf, Cornelsen Verlag, 1999.

SECONDARY LITERATURE:

[1] Garzon R.D., High Voltage Circuit Breakers, Wiley, 2002.
[2] Switching, Protection and Distribution in Low-Voltage Networks, Siemens handbook, 1994.

SUBJECT SUPERVISOR

Waldemar Dołęga, waldemar.dolega@pwr.edu.pl

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Kierowanie i sterowanie systemem elektroenergetycznym**
Name of subject in English:	**Electric Power System Operation and Control**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2531
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30				15
Number of hours of total student workload (CNPS):	60				30
Form of crediting:	crediting with grade				crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:	2				1
including number of ECTS points for practical (P) classes :					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40				0.70

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basics of power system control and three-phase and single-phase electric circuits analysis
2. Practical skills of using MATLAB
3. The student can build on Ohm's low and Kirchhoff's lows and matrix calculus for the steady-state and transient short circuit linear analysis

SUBJECT OBJECTIVES

C1. Acquaintance of knowledge related to transmission and distribution of electricity
C2. Practical skills to analyze and design of modeling of a power system under normal and abnormal states

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Knows the rules of the functioning of the power system
PEU_W02	The student has a thorough knowledge of power system calculations performed under normal, abnormal states and short-circuits

relating to skills:

PEU_U01	Is able to develop the equivalent circuit of power systems in the steady state, short-circuit and transient states and calculate equivalent circuit parameters
PEU_U02	Student is able to apply results of computer simulation to analyse of static electric circuits

relating to social competences:

PEU_K01	Student can act independently and cooperate within a group working on a complex engineering project.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction. Setting rules of course crediting. Historical perspective, development of electrical power systems	2
Lec 2	Models of basic elements of electrical power systems	2
Lec 3	Mathematical background of load flow analysis	2
Lec 4	Iterative solution of active and reactive power flows using Matlab	2
Lec 5	Example of hand and computer calculations of load flow	2
Lec 6	Voltage and reactive power regulation	2
Lec 7	Voltage stability of power system using Matlab - detailed algorithms	2
Lec 8	Symmetrical short-circuit in electrical power systems	2
Lec 9	Analysis of unbalanced faults using the symmetrical component transformation	2
Lec 10	IEC method of short-circuit analysis. Example of short-circuit analysis	2
Lec 11	Short-circuit analysis using Matlab	2
Lec 12	Synchronous generator models in stability analysis	2
Lec 13	Transient stability of a synchronous generator connected to a large power system. Differential equations of generator and voltage and speed regulators	2
Lec 14	Design of small disturbance stability of a synchronous generator connected to a large electric power system	2
Lec 15	Final test	2
	Total hours:	**30**

Seminar		**Number of hours:**
Sem 1	Acquaintance with program, requirements and way of completion, selection of problems itself	1
Sem 2	Indiwidual tasks and projects for presentation of selected problems related to steady-state analysis, voltage stability, local and transient stability of the power system using MATLAB	2
Sem 3	Project ideas presentations related to the steady-state analysis, voltage stability, local and transient stability of the power system using.	10
Sem 4	Summary of seminar and classification	2
	Total hours:	**15**

TEACHING TOOLS USED

N1. General lecture
N2. Seminar with use of audiovisual techniques, multimedia presentation
N3. Problem discussion, consultation

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F(W)	PEU_W01 PEU_W02	Oral or written test
P(W)	P=F1	
F1(S)	PEU_U01 PEU_U02	Evaluation of individual presentation and students ability
F2(S)	PEU_U01	Assessment of student activities under seminar
P(S)	P = 0,7F1 + 0,3F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Sobierajski M, Łabuzek M., Lis R, Electric Power System Analysis in Matlab.. Wrocław, Wyd. PWr, 2007
[2] Machowski J., Białek J.,Bumby J., Power System Dynamics and Stability, Wiley, 2005.
[3] Kremens Z., Sobierajski M., Analiza systemów elektroenergetycznych. Warszawa. WNT 1996.

SECONDARY LITERATURE:

[1] Selected articles published in refereed or reputable academic journals

SUBJECT SUPERVISOR

Robert Lis, robert.lis@pwr.edu.pl

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Zarządzanie w elektroenergetyce**
Name of subject in English:	**Electrical Power Systems Management**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM2532
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15				15
Number of hours of total student workload (CNPS):	30				30
Form of crediting:	crediting with grade				crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:	1				1
including number of ECTS points for practical (P) classes :					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.70				0.70

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student should has a basic knowledge of linear electrical circuit theory
2. The student should has a basic knowledge of the power system operation and electricity generating technologies and electric power transmission.
3. The student should has a basic knowledge of the steady-state and transient short circuit linear analysis applied in modern power systems.
4. It has sufficient range of language tools to correct pronouncement and write, formulate and motivate opinions, to explain his point of view, to present disadvantages and advantages of various solutions, to participate in discussion and to present general, scientific and technical problems.
5. Can use basic hardware and software, create, edit texts and create computer presentations.
6. He has an awareness of responsibility for his work.

SUBJECT OBJECTIVES

C1. Getting to know the problems of organization and management of the electricity sector and energy company.

C2. The student should demonstrate the ability to analyze the key strategies of deregulation and restructuring of the electricity sector and the development of electricity markets.

C3. The student should learn the basic problems of power system control applications.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Student has knowledge on the scope of organizing and management power sector companies.
PEU_W02	Knows the market mechanisms for electricity trading.
PEU_W03	Has a knowledge of power system operation risk assessment.

relating to skills:

PEU_U01	Student can identify, analyze and evaluate complex management problems under different operating conditions of the power system.
PEU_U02	He can make a strategic analysis of the organization and its environment. He can performs the audit functioning of the organization.

relating to social competences:

PEU_K01	Student show the readiness to identify, critical analyze and decide the appearing problems in the site of work. Student be able to evaluate of effect of taking up decisions.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Structure of power sector, components of this structure, definition and their function.	1
Lec 2	Electrical power system management, what is management. Define of the term management, planning, organizing, directing and controlling.	1
Lec 3	Electricity reform, main steps in this reform - restructuring, deregulation, competition and markets, ownership.	1
Lec 4	Management of the power system in normal operation condition.	2
Lec 5	Legal regulations concerning the operation of the power sector.	1
Lec 6	Crisis management of the power system - in pre-fault, fault states.	1
Lec 7	The development of electricity markets, examples of the markets models.	2
Lec 8	Crisis management of the power system - post-fault states.	2
Lec 9	The role of independent system operators and energy regulators	1
Lec 10	System planning under competition, integrated resources planning, demand side management.	2
Lec 11	Final test	1
	Total hours:	**15**

Seminar		Number of hours:
Sem 1	Acquainted with the program of the seminar, requirements and formative assessment. Seminar topic selection.	1
Sem 2	Project ideas presentations related to the organization of the electricity power sector - part 1.	2
Sem 3	Project ideas presentations related to the organization of the electricity power sector - part 2.	2
Sem 4	Project ideas presentations related to the organization of the electricity power sector - part 3.	2
Sem 5	Project ideas presentations related to the organization of the electricity power sector - part 4.	2
Sem 6	Project ideas presentations related to the organization of the electricity power sector - part 5.	2
Sem 7	Project ideas presentations related to the organization of the electricity power sector - part 6.	2
Sem 8	Repetition and summing up.	2
	Total hours:	**15**

TEACHING TOOLS USED

N1. Lecture with the use of audiovisual techniques, multimedia presentations.
N2. Case study.
N3. Problem discussion.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03 PEU_K01	Final test
P(W)	P=F1	
F1(S)	PEU_U01 PEU_U02	Activity on seminar classes.
F1(S)	PEU_U01 PEU_U02	Preparing and presenting a presentation.
P(S)	P=0.2F1+0.8F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Malko J., Wilczyński A., Rynki energii – działania marketingowe. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2006.
[2] S. Hunt, G. Shuttleworth: Competition and choice in electricity, John Wiley & Sons, Chichester - New York - Weinheim - Brisbane - Singapore - Toronto, 1997.
[3] M. Ilic, F. Galiana, L. Fink: Power systems restructuring, engineering and economics, KLUWER Academic Publishers, Boston - Dordrecht - London, 1998.
[4] Directive 2003/54/EC of the European Parliament and of the Council, of 26 June 2003, concerning common rules for the internal market in electricity and repealing Directive 96/92/EC.
[5] Philipson L., Willis H. L.: Understanding Electric Utilities and De-Regulation. Marcel Dekker, Inc., New York 1999.

SECONDARY LITERATURE:

[1] Chochowski A, Krawiec Fr., Zarządzanie w energetyce. Difin, Warszawa 2008.
[2] Czasopisma: Rynek Energii, IEEE Power & Energy, Power Engineering

SUBJECT SUPERVISOR
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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Modelowanie systemu elektroenergetycznego**
Name of subject in English:	**Power System Modelling**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM2534
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30			15	
Number of hours of total student workload (CNPS):	90			30	
Form of crediting:	examination			crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	3			1	
including number of ECTS points for practical (P) classes :				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10			0.70	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basics of mathematical analysis and linear algebra.
2. Knowledge of basics of power systems.
3. Abilities of developing computer programs and performing calculation in the Matlab environment.

SUBJECT OBJECTIVES

C1. Acquiring knowledge in the scope of modern concepts of power system modelling.
C2. Acquiring competence in solving the problems of the power system state estimation and estimation of loads in distribution system.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 The student has knowledge on models for different states of power systems.
PEU_W02 The student knows principles of power system model reduction.
PEU_W03 The student knows principles of real-time modelling of power system.

relating to skills:

PEU_U01 The student is able to choose models of power system elements for given case of calculations.
PEU_U02 The student is able to determine required power-system-model reduction for given case of calculations.
PEU_U03 The student is able to evaluate a process of real-time power-system modeling.

relating to social competences:

PEU_K01 The student is able to think and act creatively

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	An introduction to the lecture, program of the lecture, requirements. General principles of modelling.	2
Lec 2	Models for steady states analyses scope of utilisation.	2
Lec 3	Models for transient analyses scope of utilisation.	2
Lec 4	Power system model reduction: types of equivalents. Network transformation.	2
Lec 5	Power system model reduction: aggregation of generating units, equivalent model of the external subsystem.	2
Lec 6	Real-time modelling of power system: need of real-time modelling, main problems, general approaches.	2
Lec 7	Summation of modelling for different power system analyses. Test.	2
Lec 8	Weighted least squares (WLS) power system state estimation. Alternative formulations of the power system state estimation.	2
Lec 9	Network observability analysis.	2
Lec 10	Bad data detection and identification.	2
Lec 11	Network parameter estimation. Topology error processing.	2
Lec 12	State estimation using ampere measurements.	2
Lec 13	State estimation of distribution system specific problems.	2
Lec 14	Estimation of loads in distribution system.	2
Lec 15	Summation of estimation problems for power system. Test	2
	Total hours:	**30**

Project		**Number of hours:**
Proj 1	Power system model reduction	2
Proj 2	Weighted least squares power system state estimation in the polar coordinate system.	4
Proj 3	Weighted least squares power system state estimation in the rectangular coordinate system	4
Proj 4	Network observability analysis	2
Proj 5	Bad data identification.	1
Proj 6	Topology verification.	2
	Total hours:	**15**

TEACHING TOOLS USED
N1. Multimedia presentation.
N2. Information lecture.
N3. Preparation in the form of reports.
N4. The Matlab programs.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	activity at the classes
F2(W)	PEU_W01 PEU_W02 PEU_W03	tests
F3(W)	PEU_W01 PEU_W02 PEU_W03	exam
P(W)	P=0.1 F1 + 0.2 F2 + 0.7 F3	
F1(P)	PEU_U01 PEU_U02 PEU_U03	activity at the classes
F2(P)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	reports from the classes
P(P)	P=0.3 F1 + 0.7 F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Łukomski R., Okoń T., Wilkosz K., Power system modelling. Wrocław University of Technology, 2011.
[2] Abur A., Exposito A. G., Power system state estimation. New York, Marcel Dekker, Inc. 2004.
[3] Machowski J., Białek J.W.,Bumby J. R., Power system dynamics and stability, New York, John Willey & Sons 1997.

SECONDARY LITERATURE:

Publikacje w czasopismach z zakresu elektroenergetyki

SUBJECT SUPERVISOR

Kazimierz Wilkosz, kazimierz.wilkosz@pwr.edu.pl

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Sterowanie komputerowe systemami elektroenergetycznymi**
Name of subject in English:	**Computer Control of Power System**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM2535
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30				15
Number of hours of total student workload (CNPS):	90				30
Form of crediting:	examination				crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:	3				1
including number of ECTS points for practical (P) classes :					1
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10				0.70

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basic problems of computer science.
2. Knowledge of basics of power systems.

SUBJECT OBJECTIVES

C1. Knowing problems of computer control of modern power system.
C2. Familiarizing with modern computer control of power system.
C3. Familiarizing with modern techniques used in computer control of power system.
C4. Enhancing practical skills in preparing presentation.
C5. Enhancing practical skills in participating in discussion.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 student knows problems of power system control.
PEU_W02 The student knows solutions of problems of power system control.

relating to skills:

PEU_U01 The student is able to perform analyses of power systems from the view-point of their control.
PEU_U02 The student is able to evaluate different solutions of problems of computer control of power system.

relating to social competences:

PEU_K01 The student is able to prepare presentation in a problem manner.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	An introduction to the lecture, program of the lecture, requirements. Basic notions.	2
Lec 2	Open-system standard. Formulation of the problem of power system control.	2
Lec 3	Characteristics of system of power system control.	2
Lec 4	Problems of dispatcher power system control.	2
Lec 5	Characteristics of real-time power system modelling. The power system monitoring - generating topology model.	2
Lec 6	The power system monitoring - intelligent validation of measurement data and topology model.	2
Lec 7	Summation of problems of control and managing of a power system. Test.	2
Lec 8	Power system state estimation.	2
Lec 9	Utilization of current and voltage phasors for monitoring and controlling power system.	2
Lec 10	Utilization of artificial intelligence in computer systems for power system control: artificial neural network, expert systems.	2
Lec 11	Utilization of artificial intelligence in computer systems for power system control: fuzzy sets, genetic algorithms.	2
Lec 12	Elements of structural analysis of computer systems for power system control.	2
Lec 13	Elements of structural design of computer systems for power system control.	2
Lec 14	Cybersecurity of computer systems for power system control.	2
Lec 15	Summation of problems of utilizing of computers for monitoring and control of a power system. Test.	2
	Total hours:	**30**

Seminar		**Number of hours:**
Sem 1	Modern dispatcher centers of power system control.	2
Sem 2	Implementation of EMS systems.	2
Sem 3	Implementation of SCADA and MINISCADA systems.	2
Sem 4	Implementation of computer control of a substation.	2
Sem 5	Computer control in a power station.	2
Sem 6	Control of active power and frequency in a power system.	2
Sem 7	Control of voltage and reactive power in a power system.	2
Sem 8	Utilization of artificial intelligence in computer systems of power systems control.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Multimedia presentation. N2. Information lecture.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	activity at the classes
F2(W)	PEU_W01 PEU_W02	tests
F3(W)	PEU_W01 PEU_W02	exam
P(W)	P=0.1 F1 + 0.2 F2 + 0.7 F3	
F1(S)	PEU_U01 PEU_U02	activity at the classes
F2(S)	PEU_U01 PEU_U02 PEU_K01	preparing seminar presentation
P(S)	P=0.3 F1 + 0.7 F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Murty P.S.R., Operation and Control in Power Systems, CRC Press, 2011.
[2] Milano F., Advances in power system modelling control and stability analysis, IET, London 2016.
[3] Strauss C., Practical electrical network automation and communication systems, Elsevier 2003.
[4] Waha J. P. (Ed.), Control of power plants and power systems, Elsevier 2000.
[5] Wood A.J., Wollenberg B.F., Sheblé G.B., Power Generation, Operation, and Control, John Wiley & Sons, Inc., Hoboken, New Jersey 2013

SECONDARY LITERATURE:

[1] Donald G. Fink, Standard Handbook for Electrical Engineers. Section 10: Power-System Components/SCADA. McGraw-Hill Professional 1999.
[2] Flynn D. (Ed.), Thermal Power Plant Simulation and Control, The Institution of Engineering and Technology 2003.
[3] Artykuły w czasopismach technicznych takich jak np.: Energetyka, Biuletyn Miesięczny PSE itd.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Dynamika i sterowanie napędami prądu stałego i przemiennego**
Name of subject in English:	**Dynamics and Control of AC and DC Drives**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM3225
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15	15	
Number of hours of total student workload (CNPS):	120		30	30	
Form of crediting:	examination		crediting with grade	crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:	4		1	1	
including number of ECTS points for practical (P) classes :			1	1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.80		0.70	0.70	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has knowledge in the control theory (basics), informatics and fundamentals of electrical drives.

SUBJECT OBJECTIVES

C1. Consolidate knowledge and/or filling the knowledge gap in the field of torque and speed control of the DC and AC (induction motors and PMSM) motor drives.

C2. Familiarizing students with the extended knowledge on the application of advanced control theory methods in controlled converter-fed motor drives, including adaptive and sensorless control.

C3. The acquisition of practical knowledge and skills for design, testing and analysis of advanced control structures for DC and AC motor drives, including sensorless drives.

C4. Perfecting skills for the understanding, analysis and interpretation of steady-state and transient processes in chosen controlled DC and AC drive systems.

C5. Acquisition and fixing the social competences related to work in teams, solving engineering problems together; responsibility, honesty and fairness, observance of manners which are obligatory for academia and society.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Has matured knowledge on the torque and speed control methods of the converter-fed DC motor drives], including adaptive systems.

PEU_W02 Has matured and in-depth knowledge on modern control methods of converter-fed induction motor drives (including scalar and vector methods, sensorless control).

PEU_W03 Has matured and in-depth knowledge on modern control methods of converter-fed brushless DC and AC motors drives (including vector methods and sensorless control).

relating to skills:

PEU_U01 Can realize the simulation tests of chosen controlled electrical drive in Matlab/Simulink environment using delivered software and can make analysis of the obtained results.

PEU_U02 Can realize the experimental tests of chosen controlled electrical drive in laboratory set-up and can make analysis of the obtained results.

PEU_U03 Can design and test in simulation a chosen structure of speed or position control of electrical drive.

relating to social competences:

PEU_K01 Student can act independently and cooperate within a group working on a complex engineering project.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction. Basics of control system synthesis problems for electrical drives; control quality indexes for electrical drives.	2
Lec 2	Static and dynamical optimization for electric motor drives. Torque control structures of electrical drives: classification, characteristic features, performance.	2
Lec 3	Adjustment criteria for linear controllers, integral criteria, modulus and symmetry criteria, pole-placement method.	2
Lec 4	Static optimization conditions for DC motor; constant and variable flux control, dynamical properties for constant and variable excitation flux.	2
Lec 5	Speed control methods of converter-fed DC motor drives: series and parallel speed control structure; dynamical performance comparison.	2
Lec 6	Influence of static rectifier to the DC motor drive dynamical performance; adaptive control structures.	2
Lec 7	Induction motor – mathematical model using vector representation, state equations.	2
Lec 8	Frequency controlled induction motor drives – conditions of static optimization. Torque control methods of the induction motor.	2
Lec 9	Influence of the control method to the static mechanical characteristic of the induction motor drive. Influence of the control orientation to dynamical performance of the induction motor drive.	2
Lec 10	Scalar control methods for induction motor drives; constant flux and constant slip frequency methods.	2
Lec 11	Field-oriented control methods and structures for the induction motor drive - part 1.	2
Lec 12	Field-oriented control methods and structures for the induction motor drive - part 2.	2
Lec 13	Direct torque control methods and structures for the induction motor drive.	2
Lec 14	Control methods of brushless DC and AC permanent magnet motors. Field-oriented and direct torque control methods.	2
Lec 15	Sensorless drives, state variables estimation methods and structures for AC motor drives.	2
	Total hours:	**30**

Laboratory		**Number of hours:**
Lab 1	Introduction. Modeling of basic drive system elements using Matlab/Simulink - repetition.	1
Lab 2	Simulation tests of the cascade control structure for chosen dynamical object. Application of different design methods for the PI/PID controllers. Anti-windup systems.	2
Lab 3	Testing of the cascade control structure of DC motor drive; simulation and experimental tests.	2
Lab 4	Testing of the scalar control method for the induction motor.	2
Lab 5	Testing of the vector control methods for the induction motor - the FOC metod. Part 1 - simulation tests.	2
Lab 6	Testing of the vector control methods for the induction motor - the FOC metod. Part 2 - experimental tests.	2
Lab 7	Testing of the direct torque control method for the induction motor drive.	2
Lab 8	Testing of the chosen sensorless control structure of the induction motor drive. Crediting with grade.	2
	Total hours:	**15**

Project		**Number of hours:**
Proj 1	Introduction, basic requirements for course assessment. Methodology for project realization. Description of the project topics and distribution the project between student groups.	1
Proj 2	Description of the modeling methodology of chosen elements of the drive systems in Matlab/Simulink. Implementation of basic mathematical and simulation models (DC motor, induction motor. AC/DC and DC/AC converter, modulator for DC/AC converter).	2
Proj 3	Realization of the projects in students groups. Presentation and continuous consultations on project results.	10
Proj 4	Project presentation. Crediting with grade.	2
	Total hours:	**15**

TEACHING TOOLS USED	
N1.	Lecture with multimedia tools combined with classical lecture (problem oriented).
N2.	Consultations.
N3.	Laboratory exercises in student groups; testing of student knowledge with short test before laboratory exercises.
N4.	Assessment of the laboratory exercises by reports.
N5.	Project presentation and its evaluation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Participation in lectrures.
F2(W)	PEU_W01 PEU_W02 PEU_W03	Exam.
P(W)	P=0,1F1+0,9F2	
F1(L)	PEU_U01 PEU_U02 PEU_K01	Activity during laboratory exercises (including short written test).
F2(L)	PEU_U01 PEU_U02 PEU_K01	Preparationn of the reports.
P(L)	P=0,3F1+0,7F2	
F1(P)	PEU_U03 PEU_K01	Evaluation of the activity during classes.
F2(P)	PEU_U03 PEU_K01	Evaluation of the project and the form of its presentation.
P(P)	P=0,3F1+0,7F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M.P. Kazmierkowski, F. Blaabjerg, R. Krishnan, Control in Power Electronics - Selected Problems, Academic Press, USA, 2002
[2] P. Vas, Sensorless Vector and Direct Torque Control, Oxford University Press, 1998
[3J M.D. Murphy, F.G.Turnbull, Power Electronic Control of AC Drives, Pergamon Press, Oxford, 1988
[4] W. Leonhard, Control of Electrical Drives, Springer Verlag, 1990
[5] K. Ogata, Modern Control Engineering

SECONDARY LITERATURE:

[1] Kaźmierkowski M.P., Tunia H., Automatyka napędu przekształtnikowego. PWN, 1987
[2] Orlowska-Kowalska T., Bezczujnikowe układy napędowe z silnikami indukcyjnymi. Oficyna Wydawnicza P.Wr., Wrocław, 2003
[3] Orlowska-Kowalska T., Automatyka napędu elektrycznego - podstawy. Oficyna Wydawnicza P.Wr., Wrocław, w druku
[4] Zawirski K., Deskur J., Kaczmarek T., Automatyka napędu elektrycznego, Wyd. Polit. Poznańskiej, 2012
[5] T. Kaczorek, A. Dzieliński, W Dobrowolski, R. Łopatka. Podstawy teorii sterowania, WNT, 2005

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Sterowanie rozmyte**
Name of subject in English:	**Fuzzy Logic Control**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM3226
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has basic knowledge in automation, informatics and modeling.

SUBJECT OBJECTIVES

C1. The acquisition of knowledge in the field of fuzzy sets, fuzzy controllers structures of different types and aspects of industrial applications of fuzzy systems.

C2. Acquire skills in the design and testing of various types of fuzzy systems.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 He has knowledge of fuzzy sets, different types of fuzzy controllers.

PEU_W02 has knowledge of adaptive fuzzy system.

relating to skills:

PEU_U01 Can design different types of the fuzzy controllers, define operations in fuzzyfication, interference and defuzzyfication parts as well as define the base rules.

PEU_U02 can test the control system with fuzzy controller.

relating to social competences:

PEU_K01 Can solve different problem in creative way.

PROGRAMME CONTENT

	Lecture	Number of hours:
Lec 1	Introduction to fuzzy logic.	2
Lec 2	Classical and fuzzy controllers.	2
Lec 3	Mamdani fuzzy system type, blocks, blurring, sharpening, and inference.	2
Lec 4	Significant features of the rules, and the rule base fuzzy system.	2
Lec 5	TSK-type fuzzy systems, Tsukamoto and others.	2
Lec 6	Adaptive fuzzy system.	2
Lec 7	Industrial applications of fuzzy systems.	2
Lec 8	Summary.	1
	Total hours:	**15**

Laboratory		Number of hours:
Lab 1	Organizational matters. Introduction to the software.	2
Lab 2	Design of selected classical controllers.	2
Lab 3	Design of Mamdani type fuzzy controller, design and tests of the fuzzy controller working with the selected types of the plant, the selection of the control parameters.	4
Lab 4	Designing a TSK fuzzy system for the selected plant.	2
Lab 5	Deign of adaptive fuzzy system.	4
Lab 6	Summary.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Multimedia Lecture with elements of traditional and problematic lectures
N2. Written tests
N3. Raports

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	written and/or oral tests
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02 PEU_K01	raports
P(L)	P=F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Michels K., Klawonn F., Kruse R., Nurnberger A., Fuzzy Control: Fundamentals, Stability and Design of Fuzzy Controllers (Studies in Fuzziness and Soft Computing), Springer 2006. [2] Piegat A., Fuzzy Modeling and Control (Studies in Fuzziness and Soft Computing), Physica-Verlag HD, 2010.
SECONDARY LITERATURE:
[1] J Yager R.R., Filev D.P., Essential of Fuzzy Modelling and Control, John Wiley & Sons, Inc., 1994 [2] Driankov D, Hellendoorn H., Reinfrank M, An Introduction to fuzzy control. Springer 2010.

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Sterowanie przekształtnikami energoelektronicznymi**
Name of subject in English:	**Control of Power Electronic Converters**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM3227
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. It has a basic knowledge of analysis and synthesis of linear and nonlinear circuits.
2. It has a basic knowledge of the construction and operation electronic systems and power electronics basics.
3. It has a basic knowledge of electrical machines and electromechanical drive systems.
4. It has a basic knowledge of theory automatic control systems.
5. Able to perform basic measurements of electrical devices using analog and digital oscilloscope.
6. He can verify the results of laboratory measurements with theoretical knowledge.

SUBJECT OBJECTIVES

C1. Familiarize students with the basic control systems and control of power converters.
C2. Familiarize students with basic mathematical models and how to analyze the response of the converter control.
C3. Familiarize students with the basic characteristics of practical power electronic converters control systems.
C4. Acquiring the ability to develop research results, their interpretation and the interpretation and critical evaluation

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	It has an knowledge of the control of power semiconductor devices.
PEU_W02	He knows the basics of control systems and automatic control power electronic converters.
PEU_W03	He knows the basic methods of mathematical description of control systems of power converters.

relating to skills:

PEU_U01	Able to organize test of industrial power electronic systems.
PEU_U02	It can determine the basic characteristics of the power converters working as part of the control system.
PEU_U03	It can present the results in numerical and graphical form and to interpret them. He can draw conclusions from the measurements.

relating to social competences:

PEU_K01	He can think and act in a creative and enterprising.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Optimization of SCR thyristor triggering.	2
Lec 2	SCR thyristor drivers, TRIAC drivers, GTO drivers.	2
Lec 3	Optimization of BJ transistor control.	2
Lec 4	BJ power transistor drivers, MOSFET power transistor drivers, IGBTO transistor drivers.	2
Lec 5	Control systems of controlled rectifiers, AC controllers, cycloconverters.	2
Lec 6	Control systems of DC AC converters.	2
Lec 7	Control systems of DC-DC converters.	2
Lec 8	Course credit.	1
	Total hours:	**15**

Laboratory		**Number of hours:**
Lab 1	Introduction. The organization of classes. Conditions of gaining credit.	2
Lab 2	Testing of triggering and phase control systems of thyristor.	2
Lab 3	Testing of control systems of thyristor rectifiers and cycloconverters.	2
Lab 4	Testing of control systems of AC- voltage controllers.	2
Lab 5	Testing of control systems of three phase thyristor inverter.	2
Lab 6	Testing of control systems of three phase transistor PWM inverter.	2
Lab 7	Test of inverter control system of cooperates with the network of alternating current.	2
Lab 8	Course credit.	1
	Total hours:	**15**

TEACHING TOOLS USED

N1. Informative lecture using presentation slides.
N2. Job self, self-preparation of the laboratory.
N3. Consultation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03 PEU_K01	Final test.
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02 PEU_U03	Check preparation for classes.
F2(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Activity in the conduct of laboratory measurements.
F3(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Appraisal reports made
P(L)	P=0,25*F1+0,25*F2+0,5*F3	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Yuriy Rozanov: Power Electronics Basics: Operating Principles, Design, Formulas, and Applications, ORC, 2015
[2] Branko L. Dokic: Power Electronics: Converters and Regulators, Springer, 2015.
[3] Bogdan M. Wilamowski, J. David Irwin: Power Electronics and Motor Drives (The Industrial Electronics Handbook) CRC Press 2011
[4] A. Trzynadlowski: Introduction to Modern Power Electronics, CRC, 2002

SECONDARY LITERATURE:

[1] Adrian Ioinovici: Power Electronics and Energy Conversion Systems: Fundamentals and Hard-switching Converters, Volume 1, Wiley 2013.
[2] Mukund R. Patel: Introduction to Electrical Power and Power Electronics, CRC Press, 2012
[3] Muhammad Rashid: POWER ELECTRONICS HANDBOOK, ORC, 2010
[4] Euzeli dos Santos: Advanced Power Electronics Converters: PWM Converters Processing AC Voltages (IEEE Press Series on Power Engineering), 2014
[5] Marian P. Kazmierkowski, Ramu Krishnan: Control in Power Electronics: Selected Problems. 2004

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Kompatybilność elektromagnetyczna**
Name of subject in English:	**Electromagnetic Compatibility**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM3311
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15		
Number of hours of total student workload (CNPS):	60		30		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		1		
including number of ECTS points for practical (P) classes :			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. He has basic knowledge in the field of linear circuits with sinusoidal waveforms. He knows the rules for creating circuit models and their mathematical description.
2. He or she has knowledge in the analysis of transients in linear electric circuits. He has knowledge of the macroscopic electromagnetic field approach
3. He has a basic knowledge of metrology and measurement units, knows basic metrological characteristics of measuring instruments, are knowledgeable about the design of measurement known calculation methods used in developing the measurement results, a knowledge of the latest measurement technology
4. He or she is able to do basic measurements of electrical devices using analog and digital oscilloscope. Can set on the basis of measurements of nonlinear characteristics of the elements. Able to present the results in the form of numerical tables and graphics to make their interpretations and draw conclusions.

SUBJECT OBJECTIVES

C1. Understanding the concepts of electromagnetic compatibility

C2. Understanding the principles of interaction between the elements of the power system

C3. Knowledge of voltage quality parameters, evaluation of the impact of power quality on loads and the impact on the quality of the loads

C4. Knowing regulations and standardization of components which improve power quality

C5. Getting the practical skills in the assessment of power quality and surge protection

C6. Acquisition and consolidation of social skills including emotional intelligence skills involving the cooperation of a group of students with a view to effective problem solving. Responsibility, honesty and fairness in the procedure observance force in academia and society

SUBJECT EDUCATIONAL EFFECTS	
relating to knowledge:	
PEU_W01	He or she knows the key concepts in the field of electromagnetic compatibility. He has extensive knowledge in the field of power quality
PEU_W02	He knows the power requirements of the law and regulations relating to electromagnetic compatibility standards - in particular the power quality
PEU_W03	He or she has knowledge of the location and control the interference sources and their affect on the device. Know the methods of overvoltage protection.He or she knows methods to improve the power quality and ways to reduce disturbances
relating to skills:	
PEU_U01	He can determine and evaluate the power quality parameters
PEU_U02	He knows the procedure for carrying out the immunity tests of the loads (equipment) on power system disturbances.
PEU_U03	He has the skills to assess the disturbances emissions from loads
relating to social competences:	
PEU_K01	He or she is aware of their own responsibility for their work and a willingness to comply with the principles of teamwork. He searches information and its critical analysis, properly identifies and resolves the dilemmas of working in the profession

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Electromagnetic Compatibility. Power quality parameters	2
Lec 2	Definitions of parameters determining the power quality - the conditions of measurement, presentation the impact of the distortion on electric loads	2
Lec 3	Power quality standards	2
Lec 4	Sources and external parameters of electromagnetic interference. Lightning as a source of interference, Elements lightning protection, the basic parameters of the varistor, varistor assembly rules	2
Lec 5	Design rules for hybrid security systems, information transmission systems.	2
Lec 6	Voltage variation. Long and short term flicker.	2
Lec 7	Methods of reducing the voltage distortion - examples	2
Lec 8	Measurement methods of harmonics and interharmonics.	2
Lec 9	Shielding. The effectiveness of shielding against electromagnetic interference and electrical. Shielding low-frequency magnetic fields, the materials for the construction of the shield	2
Lec 10	Harmonic filters. Examples of calculating analysis of the effectiveness of filters.	2
Lec 11	Electric energy losses due to voltage distortion.	2
Lec 12	EMC issues in control systems	2
Lec 13	Methods of immunity test of electric loads. Measurement of disturbances emmision	2
Lec 14	Electromagnetic Compatibility i radio frequency range. Electrostatic discharge (ESD) Fast transients (BURST) and high – energy surges (SURGE)	2
Lec 15	test knowledge gained	2
	Total hours:	**30**

Laboratory		**Number of hours:**
Lab 1	Presentation of the safety rules and principles of assessment laboratory. Presentation of laboratory	1
Lab 2	Voltage quality – measurement of voltage variation, frequency, unbalance, dips, and short interruption, harmonics and interharmonics, mains signalling voltage	2
Lab 3	Current and voltage waveforms analysis – determining of harmonics and interharmonics contents	2
Lab 4	Testing of nonlinear loads influence on waveform distortion	2
Lab 5	Voltage variation, dips and short interruption immunity tests	2
Lab 6	Measurement of harmonics emission of electric equipments	2
Lab 7	Harmonic analysis of active, reactive and apparent power in circuits with non-sinusoidal voltage and current waveforms	2
Lab 8	Spectrum Analyzer	2
	Total hours:	**15**

TEACHING TOOLS USED	
N1.	Traditional Lecture with audio-visual techniques
N2.	Laboratory run in the traditional manner of exercises + student groups, a report

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	test
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Average assessment of laboratory reports
P(L)	P=F1	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Hasse P.: Overvoltage protection of low voltage systems, TJ International, Padstown, 2000
[2] Pradas Kodali V.: Engineering Electromagnetic Compatibility Principles, Measurments and Technology, IEEE Press, New York, 1996
[3] Baggini A., Handbook of Power Quality, John Wiley&Sons, Ltd, 2008
[4] PN-EN 50160:2010, Voltage Characteristics in Public Distribution Systems
[5] Henry W. Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons, Inc., Hoboken, New Jersey 2009

SECONDARY LITERATURE:

[1] IEEE Std 1159-2009: IEEE Recommended Practice for Monitoring Electric Power Quality
[2] Dugan R.C., Mc Gramaghan M.F., Beaty H. W., Santoso S: Electrical Power System Quality, Wyd 2. MC Graw-Hill 2002
[3] Standler R. B.: Protection of electronic circuits from overvoltages John Wiley & Sons, New York, 1989
[4] Clayton R. P.: Introduction to electromagnetic compatibility John Wiley & Sons, New York, 1992
[5] Arrillaga J. Watson N. R.: Power System Quality Assessment, John Wiley & Sons, New York, 2000

SUBJECT SUPERVISOR

Grzegorz Kosobudzki, grzegorz.kosobudzki@pwr.edu.pl

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Metody i techniki pomiarowe**
Name of subject in English:	**Measurement methods and techniques**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W05ETK-SM3312
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		30		
Number of hours of total student workload (CNPS):	60		60		
Form of crediting:	crediting with grade		crediting with grade		
For group of courses mark (X) final course:					
Number of ECTS points:	2		2		
including number of ECTS points for practical (P) classes :			2		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40		1.40		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a knowledge of electrical circuits theory.
2. Has a basic knowledge of measurement technique and basis of electronic .
3. Is able to do measurements of electrical quantities using analogue and digital instruments or oscilloscope.
4. Is able to designate nonlinear elements characteristics, present given results in numerical, tabular and graphical form. Can calculate results using uncertainty theory, correctly interpret the result and draw the right conclusions.

SUBJECT OBJECTIVES

C1. Familiarize student with knowledge of measurement systems architecture and design principles.
C2. Understanding the properties of selected converters and measuring circuits
C3. Practical skills to: transducers tests, measuring circuit components, analysis the tests results and draw the correct conclusions.
C4. Acquisition practical skills of measurement systems use containing transducers, AD converters, data acquisition cards, autonomous instruments connected via standard measuring interfaces in order to perform a specific measurement task.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Has a knowledge of electrical signal processing in measurement systems
PEU_W02	Can identify measurement ditortions and knows it minimalization methods in systems with data acquisition cards.
PEU_W03	Knows the principles of design and construction of measuring systems.

relating to skills:

PEU_U01	Can do tests of measuring line properties consist of transducers, sensors and instruments
PEU_U02	Can write basic programs in LabView, can do virtual instrument visualization. Can design automatic measurement stand to tests parameters and characteristics of chosen elements consist of autonomic instruments and data acquisition cards.

relating to social competences:

PEU_K01	Understands the need to work in a team, is aware of the responsibility for the work.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Basic terms of metrology. Error theory and uncertainty theory. Uncertainty propagation law.	2
Lec 2	Measurement systems architecture. Signal processing in measuring systems.	2
Lec 3	Linear normalize converters. Properties of inverting, non-inverting, differential amplifiers and voltage follower. Common mode rejection ratio CMRR.	2
Lec 4	Instrumental amplifiers.	2
Lec 5	Insulation amplifiers, parameters and applications. Transimpedance amplifiers. Rail-to-rail amplifiers.	2
Lec 6	Inductive methos of power line frequency current and voltage processing.	2
Lec 7	Active and reactive power measurements. High-voltage power measurements. Geometrical interpretation of power.	2
Lec 8	Non-linear operational converters. Multi-functional operational analogue converter.	2
Lec 9	TDM multiplier. RMS value converters. Chosen converters of electrical quantities .	2
Lec 10	Classification, structure and organization of Digital Measurement Systems. Universal data acquisition card construction.	2
Lec 11	Introduction to LabView environment. Front panel and diagram of virtual instrument. Programming structures. Autonomic instruments control. Designing methodology of virtual instruments.	2
Lec 12	Chosen A/D and D/A converters.	2
Lec 13	Methods of measurement noise reduction in DAQ systems.	2
Lec 14	Smart sensors. Stray measurement systems.	2
Lec 15	Test.	2
	Total hours:	**30**

Laboratory		**Number of hours:**
Lab 1	Presentation the Procedure Health and Safety Rules and Laboratory Rules. Establish rules for passing. Presentation of measuring stands.	2
Lab 2	Test of measurement circuit with transducer XTR-103.	2
Lab 3	Properties tests of mean and RMS value integrated converters.	2
Lab 4	Amplifier with carrier-wave generator tests.	2
Lab 5	Geometrical interpretation of power.	2
Lab 6	Properties of current inductive transducers with homogoneous magnetic circuit.	2
Lab 7	Virtual Instrument application to measure of distorted signals.	2
Lab 8	Introduction to LabView. The program implements a predetermined mathematical operation.. Basis programming structures.	2
Lab 9	Type A virtual instrument. Instrument control with GPIB or USB interface program realization with uses given driver. Programming structures.	2
Lab 10	System realization with uses of autonomic instruments connected via standard interfaces. Table operations, reading and writing data from or to file.	2
Lab 11	Automatic measurement system to determine characteristics of chosen electronic elements.	2
Lab 12	Tybe B Virtual Instrument. DAQ cards application in measeurement system.	2
Lab 13	Application with DAQ card.	2
Lab 14	Stray measurement system.	2
Lab 15	Assessment and complement laboratory arreas.	2
	Total hours:	**30**

TEACHING TOOLS USED
N1. Traditional lecture, multimedia presentations.
N2. Laboratory – check knowledge in oral answer form, report preparation, presentation wrote program and discussion, office hours.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Test
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02	Check preparation to laboratory.
F2(L)	PEU_U01 PEU_U02	Activity on laboratory
F3(L)	PEU_U01 PEU_U02	Report preparation
P(L)	P=0,3F1+0,1F2+0,6F3	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Nawrocki Z., Dusza D., Analogue and digital measurement systems, Wrocław, 2011
[2] Tumański S., Principles of electrical measurements, New York ; London : Taylor & Francis, 2006
[3] Lyons R.G., Understanding Digital Signal Processing, Pearson Education; 1996.
[4] Morris A.S., Measurement and Instrumentation Principles, Butterworth-Heinemann, 2001.
[5] Van de Plassche R., CMOS integrated analog to digital and digital to analog converters, Kluwer Academic Publishers, 2003
[6] Lyons R.G., Understanding Digital Signal Processing, Pearson Education; 1996.
[7] J.Mc.Ghee, I.A. Henderson, M.J. Korczyński, W.Kulesza: Scientific metrology, Technical University of Lodz, Lodz, 1998.

SECONDARY LITERATURE:

[1] Clayton G., Winder S.: Operational amplifiers, Newnes, Oxford, 2003.
[2] Kester W., Jung W., Op AMP structures, Op AMP applications, Analog Devices, Norwood, 2002.
[3] Kester W., Analog to Digital Conversion, Analog Devices, 2004.
[4] Nawrocki Z., Dusza D., Kosobudzki G, Metrological analysis of integrated analog RMS converters described by explicit and implicit functions, Measurement (London). 2009, vol. 42, nr 2, s. 308-313
[5] Mc.Ghee, I.A. Henderson, M.J. Korczyński, W.Kulesza: Measurement data handling, vol. 1 and vol.2 , Technical University of Lodz, Lodz, 2001

SUBJECT SUPERVISOR

Daniel Dusza, daniel.dusza@pwr.edu.pl

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Praktyka dyplomowa (4-tygodniowa)**
Name of subject in English:	**Diploma placement 4 weeks**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM5105
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):				160	
Number of hours of total student workload (CNPS):				120	
Form of crediting:				crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:				4	
including number of ECTS points for practical (P) classes :				4	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				2.80	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Allow for the implementation of placement by the Commissioner for practice.

SUBJECT OBJECTIVES

C1. Acquisition of knowledge useful for the implementation of a Master's thesis.
C2. Gaining industrial experience, learning of basic technical equipment and technology of companies, knowledge of the manager specific work and higher technical personel.
C3. Expanding the knowledge gained during education and developing the skills to use it.
C4. Getting to know the specifics of the professional and development of specific skills directly related to the place of performance of the practice.
C5. Getting to know the organizational structure of company, principles of work organization and distribution of competences, procedures, work planning and work control.
C6. Improving the organization of individual and team work, effective time management, conscientiousness and responsibility for assigned tasks.
C7. Improving skills in using foreign languages in professional situations.
C8. Professionalization of professional behavior, compliance with the rules of professional conduct and respect for technical and cultural diversity.
C9. Establish professional contacts, particularly useful when looking for work.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 He has an ability to use the gained knowledge to creatively analyze and solving various engineering problems.
PEU_U02 Skills in estimation of the time needed to carry out the ordered task or project.

relating to social competences:

PEU_K01 Getting the skills of behavior in a professional manner, compliance with the rules of professional conduct and respect for technical and cultural diversity.

PROGRAMME CONTENT		
Project		**Number of hours:**
Proj 1	Individual program practices, adapted to the specific implemented thesis.	160
	Total hours:	**160**

TEACHING TOOLS USED
N1. Keynote presentation at the company's operations.
N2. Consultation.
N3. Specialized equipment and measuring technology used in the company.
N4. Specialized computer programs to support the company.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(P)	PEU_U01 PEU_U02 PEU_K01	Individual rating (2.0....5.5) on the basis of a written report just completed practice and requirements contained in the "Rules of Practice".
P(P)	P=F1	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Nawrocki Z., Dusza D., Analogue and digital measurement systems, Wrocław, 2011
[2] Tumański S., Principles of electrical measurements, New York ; London : Taylor & Francis, 2006
[3] Lyons R.G., Understanding Digital Signal Processing, Pearson Education; 1996.
[4] Morris A.S., Measurement and Instrumentation Principles, Butterworth-Heinemann, 2001.
[5] Van de Plassche R., CMOS integrated analog to digital and digital to analog converters, Kluwer Academic Publishers, 2003
[6] Lyons R.G., Understanding Digital Signal Processing, Pearson Education; 1996.
[7] J.Mc.Ghee, I.A. Henderson, M.J. Korczyński, W.Kulesza: Scientific metrology, Technical University of Lodz, Lodz, 1998.

SECONDARY LITERATURE:

[1] Clayton G., Winder S.: Operational amplifiers, Newnes, Oxford, 2003.
[2] Kester W., Jung W., Op AMP structures, Op AMP applications, Analog Devices, Norwood, 2002.
[3] Kester W., Analog to Digital Conversion, Analog Devices, 2004.
[4] Nawrocki Z., Dusza D., Kosobudzki G, Metrological analysis of integrated analog RMS converters described by explicit and implicit functions, Measurement (London). 2009, vol. 42, nr 2, s. 308-313
[5] Mc.Ghee, I.A. Henderson, M.J. Korczyński, W.Kulesza: Measurement data handling, vol. 1 and vol.2 , Technical University of Lodz, Lodz, 2001

SUBJECT SUPERVISOR

Piotr Serkies, piotr.serkies@pwr.edu.pl

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Seminarium dyplomowe**
Name of subject in English:	**Diploma seminar**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM5108
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):					30
Number of hours of total student workload (CNPS):					90
Form of crediting:					crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:					3
including number of ECTS points for practical (P) classes :					3
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					2.10

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Student has the well-ordered theoretical knowledge to meet requirements of MSc work in the specialization of Control in Electrical Power Engineering.
2. Student is capable of using the learned knowledge for the realization of MSc work in the specialization of Control in Electrical Power Engineering
3. Student can work in a team and understand the need to improve one's skill all the time.

SUBJECT OBJECTIVES

C1. To assimilate ability to present the results of computations, experiments and analysis made in the frame of MSc work.
C2. To become skillful at the critical assessment of the results of computations, experiments and analysis made in the frame of MSc work.
C3. To be able to take part in group discussion on the problems considered in MSc works.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01	Student can acquire information from literature and data base concerning the theme associated with the realization of the MSc work.
PEU_U02	Has the ability of synthetic and effective presentation of research results and their interpretation, drawing conclusions, and preparing and delivering presentations on the realized thesis.
PEU_U03	Student can reliably evaluate the results of the other student, formulate questions and take active participation in discussion on the subjects related to the completed master’s theses.

relating to social competences:

PEU_K01	Student has a sense of responsilibity of their own work and is open to the exchange of ideas and new challenges.

PROGRAMME CONTENT

	Seminar	Number of hours:
Sem 1	To make oneself acquainted with program, requirements and way of receiving a credit for a class.	2
Sem 2	Presentation of investigation results related to MSc works.	28
	Total hours:	**30**

TEACHING TOOLS USED

N1. Seminar with using the audio-video technique and multimedia presentation.
N2. Relevant problem's discussion of presented materials.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(S)	PEU_U01 PEU_U02 PEU_K01	Mark for individual presentation.
F2(S)	PEU_U03 PEU_K01	Mark for class activity
P(S)	P=0,7F1+0,3F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Literature recommended by MSc thesis supervisor.

SECONDARY LITERATURE:

MSc related literature collected by student.

SUBJECT SUPERVISOR

Robert Lis, robert.lis@pwr.edu.pl

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Projekt dyplomowy**
Name of subject in English:	**Diploma Project**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM5117
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):				120	
Number of hours of total student workload (CNPS):				240	
Form of crediting:				crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:				8	
including number of ECTS points for practical (P) classes :				8	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				5.60	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 xx

PEU_U02 xx

relating to social competences:

PEU_K01 xx

PROGRAMME CONTENT

Project		Number of hours:
Proj 1	xx	120
	Total hours:	**120**

TEACHING TOOLS USED

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Literature recommended by MSc thesis supervisor.

SECONDARY LITERATURE:

MSc related literature collected by student.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Praca dyplomowa magisterska**
Name of subject in English:	**Master's thesis**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM5119
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):				180	
Number of hours of total student workload (CNPS):				540	
Form of crediting:				crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:				18	
including number of ECTS points for practical (P) classes :				18	
including number of ECTS points for direct teacher-student contact (BK) classes:				12.60	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 xx

PEU_U02 xx

relating to social competences:

PEU_K01 xx

PROGRAMME CONTENT

Project		Number of hours:
Proj 1	xx	180
	Total hours:	**180**

TEACHING TOOLS USED

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Literature recommended by MSc thesis supervisor.

SECONDARY LITERATURE:

MSc related literature collected by student.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Projekt dyplomowy**
Name of subject in English:	**Diploma Project**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM5127
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):				120	
Number of hours of total student workload (CNPS):				240	
Form of crediting:				crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:				8	
including number of ECTS points for practical (P) classes :				8	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				5.60	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 xx

PEU_U02 xx

relating to social competences:

PEU_K01 xx

PROGRAMME CONTENT

Project		Number of hours:
Proj 1	xx	120
	Total hours:	**120**

TEACHING TOOLS USED

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Literature recommended by MSc thesis supervisor.

SECONDARY LITERATURE:

MSc related literature collected by student.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Praca dyplomowa magisterska**
Name of subject in English:	**Master's thesis**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM5129
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):				180	
Number of hours of total student workload (CNPS):				540	
Form of crediting:				crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:				18	
including number of ECTS points for practical (P) classes :				18	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				12.60	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 xx

PEU_U02 xx

relating to social competences:

PEU_K01 xx

PROGRAMME CONTENT

Project		Number of hours:
Proj 1	xx	180
	Total hours:	**180**

TEACHING TOOLS USED

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Literature recommended by MSc thesis supervisor.

SECONDARY LITERATURE:

MSc related literature collected by student.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Projekt dyplomowy**
Name of subject in English:	**Diploma Project**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM5137
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):				120	
Number of hours of total student workload (CNPS):				240	
Form of crediting:				crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:				8	
including number of ECTS points for practical (P) classes :				8	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				5.60	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 xx

PEU_U02 xx

relating to social competences:

PEU_K01 xx

PROGRAMME CONTENT

Project		Number of hours:
Proj 1	xx	120
	Total hours:	**120**

TEACHING TOOLS USED

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Literature recommended by MSc thesis supervisor.

SECONDARY LITERATURE:

MSc related literature collected by student.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Praca dyplomowa magisterska**
Name of subject in English:	**Master's thesis**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional**
Subject code:	W05ETK-SM5139
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):				180	
Number of hours of total student workload (CNPS):				540	
Form of crediting:				crediting with grade	
For group of courses mark (X) final course:					
Number of ECTS points:				18	
including number of ECTS points for practical (P) classes :				18	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)				12.60	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 xx

PEU_U02 xx

relating to social competences:

PEU_K01 xx

PROGRAMME CONTENT

Project		Number of hours:
Proj 1	xx	180
	Total hours:	**180**

TEACHING TOOLS USED

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

Literature recommended by MSc thesis supervisor.

SECONDARY LITERATURE:

MSc related literature collected by student.

SUBJECT SUPERVISOR

,

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Zaawansowane technologie produkcji energii elektrycznej**
Name of subject in English:	**Advanced Technology in Electrical Power Generation**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	W09ETK-SM1501
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30	15			
Number of hours of total student workload (CNPS):	90	30			
Form of crediting:	crediting with grade	crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:	3	1			
including number of ECTS points for practical (P) classes :		1			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2.10	0.70			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows basic laws of physics, chemistry, has the knowledge of the description of processes and properties for ideal gases including thermodynamic processes for water vapor and basic knowledge in the field of fuel
2. Is able apply the knowledge of differential and integral calculus of functions of one variable and use mass and energy balance

SUBJECT OBJECTIVES

C1. Getting the knowledge the fundamental processes describing the generation of electricity and methods for assessing the energy balance of energy production systems

C2. Acquire practical skills of efficiency and energy balance determination for advanced energy production system from conventional and renewable energy sources.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Have knowledge of fundamental principles of different power production systems at high efficiency.

PEU_W02 Knows principles of power production systems configurations including conventional unit depending on primary energy carrier

relating to skills:

PEU_U01 Is able to perform critical analysis of advanced concept of power systems especially near zero emission technology using different types of primary Energy sources.

PEU_U02 Is able to perform of thermodynamics efficiency calculation for thermal, cogeneration and combined power unit.

relating to social competences:

PEU_K01 Assess the energy needs of countries depending on local resources.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Energy in the future Challenges for the 21st Century	2
Lec 2	Impact of climate changes on progress low emission power production technology.	2
Lec 3	Physical and Chemical fundamentals of power production.	2
Lec 4	Combustion and Gasification of fuels	2
Lec 5	Thermodynamical fundamentals of power production	2
Lec 6	Vapor Power Cycle – improvement of efficiency	2
Lec 7	Super critical boilers in advanced power unit	2
Lec 8	Cogeneration system of energy production	2
Lec 9	Fundamental of combined power plant.	2
Lec 10	IGCC – Integrated gasification coal combined plants - fundamentals.	2
Lec 11	Advanced power unit integrated with SOFC- fuel cel.	2
Lec 12	Fundamentals of CCS technology – carbon capture and storage	2
Lec 13	Nuclear Power Plants	2
Lec 14	Hybrid power unit , polygeneration with RES	2
Lec 15	Test (crediting with grade)	2
	Total hours:	**30**

Classes		**Number of hours:**
Cl 1	Calculation of combustion air and the quantities and composition of exhaust gases from fuel combustion in thermal power plants	2
Cl 2	Calculation of cycle efficiency thermal power plant for sub-critical parameters	2
Cl 3	Calculation of cycle efficiency thermal power plant for sub-critical parameters with reheated of steam system.	2
Cl 4	Calculation of cycle efficiency thermal power plant for sub-critical parameters with reheated of steam system and regeneration system.	2
Cl 5	Calculation of cogeneration cycle efficiency.	2
Cl 6	Calculation of cycle efficiency of combined power unit.	2
Cl 7	The calculation of the balance of coal-fired thermal power plant with CO2 capture by amine absorption.	2
Cl 8	Test (crediting with grade)	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lectures with multimedia presentation
N2. Students own work
N3. Classes
N4. Discussion of results
N5. Colloquium

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02	test
P(W)	P=F1	
F1(C)	PEU_U01 PEU_U02 PEU_K01	Evaluation of home works
F2(C)	PEU_U01 PEU_U02 PEU_K01	Test
P(C)	P=0,3F1+0,7F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Advanced Power Genertion technology, RES, H. Pawlak-Kruczek, 2011
[2] Yunus A. Cengel, Michael A. Boles , Thermodynamics, An Engineering Approach. McGraw –Hill Higher Education ,2009
[3] Theory And Problems Of Thermodynamics For Engineers, Merle C. Potter, Craig W,Somerton, Ph,D.,Associate Professor Of Mechanical Engineering,Michigan State University, Schaum's Outline Series, Mcgraw-Hill, 2008
[4] Prabir Basu , Cen Kefa, Louis Jestin, Boilers and Burners , Design and Theory , Springer, 2013

SECONDARY LITERATURE:

[1] Steam/its generation and use - 42nd Edition, Copyright © 2015 by The Babcock & Wilcox Company Forty-second edition
[2]J.M. Beer, High efficiency electric power generation: The environmental role; Progress in Energy and Combustion Science 33 (2007), 107–134

SUBJECT SUPERVISOR

Halina Pawlak-Kruczek, halina.kruczek@pwr.edu.pl

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Etyka w biznesie**
Name of subject in English:	**Ethics in bussiness**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W08ETK-SM1721
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):					15
Number of hours of total student workload (CNPS):					50
Form of crediting:					crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:					2
including number of ECTS points for practical (P) classes :					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1.40

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Text interpretation ability
2. Basic abilities in performing analysis and synthesis

SUBJECT OBJECTIVES

C1. Analysis of the significance and role of ethics in modern business
C2. Resolve problems relating to social responsibility to the surroundings
C3. The appearance and analysis of the situation in which ethical problems may arise
C4. Sensitize students to the ethical problems

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 Student has the ability to understand social, economic, legal and others non technical conditions of engineering activities.

PEU_U02 The student is able to formulate and thoroughly justify opinions, prepare and make presentations related to the problems from the scope of topics of the studied discipline as well as to the topics related to the environment of work. Is also able to take part in scientific and professional discussions.

relating to social competences:

PEU_K01 The student is able to think critically and to argue their position, allowing it properly determine the priorities for implementing specified by himself or other tasks, taking into account issues of social responsibility.

PROGRAMME CONTENT		
Seminar		**Number of hours:**
Sem 1	Introduction to business ethics	1
Sem 2	Ethics in economic activity	1
Sem 3	Protection of intellectual property versus ethics	1
Sem 4	Economic crises as a source of change in moral values	2
Sem 5	Ethical trade	1
Sem 6	Corporate Social Responsibility	2
Sem 7	Ecoethic	2
Sem 8	Ethics in Marketing	2
Sem 9	Areas of of modern ethical finance	1
Sem 10	Manipulation, corruption, lies and abuses in business	2
	Total hours:	**15**

TEACHING TOOLS USED
N1. Information lecture
N2. Interactive lecture
N3. Multimedia presentation
N4. Discussion

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(S)	PEU_U01 PEU_U02 PEU_K01	Presentation
F2(S)	PEU_U01 PEU_U02 PEU_K01	Activity on the lectures
P(S)	P=0,8F1+0,2F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] B. Klimczak, Etyka gospodarcza, Wrocław 1996.
[2] P. M. Minus, Etyka w biznesie, Warszawa 1995.
[3] E. Sternberg, Czysty biznes. Etyka biznesu w działaniu, Warszawa 1998.

SECONDARY LITERATURE:

[1] G. D. Chrissides, J. H. Kaler, Wprowadzenie do etyki biznesu, Warszawa 1999.
[2] A. Chaufen, Kradzież a rozwój gospodarczy, Warszawa 2006.
[3] C. Porębski, Czy etyka się opłaca, Kraków 1997.
[4] Podstawy marketingu, pod red. J. Altkorna, Kraków 2004.
[5] M. Bąk, P. Kulawczuk, A. Szcześniak, Strategia polskiego biznesu wobec korupcji, Warszawa 2001.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish	**Język obcy B2+ lub C1+**
Name of subject in English:	**Foreign language B2+ or C1+**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	SJO000-SM00
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):		15			
Number of hours of total student workload (CNPS):		30			
Form of crediting:		crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:		1			
including number of ECTS points for practical (P) classes :		1			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)		0.70			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 xx

PEU_U02 xx

relating to social competences:

PEU_K01 xx

PROGRAMME CONTENT

Classes		Number of hours:
Cl 1	xx	15
	Total hours:	**15**

TEACHING TOOLS USED

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] B. Klimczak, Etyka gospodarcza, Wrocław 1996.
[2] P. M. Minus, Etyka w biznesie, Warszawa 1995.
[3] E. Sternberg, Czysty biznes. Etyka biznesu w działaniu, Warszawa 1998.

SECONDARY LITERATURE:

[1] G. D. Chrissides, J. H. Kaler, Wprowadzenie do etyki biznesu, Warszawa 1999.
[2] A. Chaufen, Kradzież a rozwój gospodarczy, Warszawa 2006.
[3] C. Porębski, Czy etyka się opłaca, Kraków 1997.
[4] Podstawy marketingu, pod red. J. Altkorna, Kraków 2004.
[5] M. Bąk, P. Kulawczuk, A. Szcześniak, Strategia polskiego biznesu wobec korupcji, Warszawa 2001.

SUBJECT SUPERVISOR

,

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Język obcy A1lub A2**
Name of subject in English:	**Foreign language A1 or A2**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	SJO000-SM00
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):		45			
Number of hours of total student workload (CNPS):		60			
Form of crediting:		crediting with grade			
For group of courses mark (X) final course:					
Number of ECTS points:		2			
including number of ECTS points for practical (P) classes :		2			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)		1.40			

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

SUBJECT OBJECTIVES

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 xx

PEU_U02 xx

relating to social competences:

PEU_K01 xx

PROGRAMME CONTENT

Classes		Number of hours:
Cl 1	xx	45
	Total hours:	**45**

TEACHING TOOLS USED

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation *F – forming (during semester) P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] B. Klimczak, Etyka gospodarcza, Wrocław 1996.
[2] P. M. Minus, Etyka w biznesie, Warszawa 1995.
[3] E. Sternberg, Czysty biznes. Etyka biznesu w działaniu, Warszawa 1998.

SECONDARY LITERATURE:

[1] G. D. Chrissides, J. H. Kaler, Wprowadzenie do etyki biznesu, Warszawa 1999.
[2] A. Chaufen, Kradzież a rozwój gospodarczy, Warszawa 2006.
[3] C. Porębski, Czy etyka się opłaca, Kraków 1997.
[4] Podstawy marketingu, pod red. J. Altkorna, Kraków 2004.
[5] M. Bąk, P. Kulawczuk, A. Szcześniak, Strategia polskiego biznesu wobec korupcji, Warszawa 2001.

SUBJECT SUPERVISOR

,

FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Sztuka wystąpień publicznych**
Name of subject in English:	**The art of public speaking**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W08ETK-SM3721
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):					15
Number of hours of total student workload (CNPS):					50
Form of crediting:					crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:					2
including number of ECTS points for practical (P) classes :					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1.40

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge from the area of Humanities and Social Sciences area

SUBJECT OBJECTIVES

C1. Student acquires basic knowledge of the functioning in the society
C2. Student acquires skills in interpersonal communication and social interaction
C3. Student acquires basic competence in critical thinking and positive argumentation.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01 The student has the ability to understand social, economic, legal, and other non technical conditions of engineering activities.

PEU_U02 The student is able to formulate and thoroughly justify opinions, prepare and make presentations related to the problems from the scope of topics of the studied discipline as well as to the topics related to the environment of work. Is also able to take part in scientific and professional discussions.

relating to social competences:

PEU_K01 The student is able to think critically and to argue their position, allowing it properly determine the priorities for implementing specified by himself or other tasks, taking into account issues of social responsibility.

PROGRAMME CONTENT

	Seminar	Number of hours:
Sem 1	Introduction to social communication	2
Sem 2	Visual communication	2
Sem 3	Nonverbal communication – authority, trust and faith	2
Sem 4	Nonverbal communication – technical ascpects	4
Sem 5	Stage, space and technical support	2
Sem 6	Auditory – strategies of group dynamic	2
Sem 7	Mass communication	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Informational lecture N2. Multimedia presentation N3. Interactive lecture

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(S)	PEU_U01 PEU_U02 PEU_K01	Presentation
F2(S)	PEU_U01 PEU_U02 PEU_K01	Active participation
P(S)	P=0,8F1+0,2F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Lucas S., The art of public speaking, (2012), McGraw-Hill, New York.
[2] Parrish A. C., Adaptive Rhetoric. Evolution, Culture, and the Art of Persuasion, (2014), Routledge, New York.
[3] Sobczak B., Zgółkowa H. (red.), Dydaktyka retoryki, (2011), Wydawnictwo Poznańskie, Poznań.
[4] Arystoteles, Retoryka. Poetyka. (1988), Przeł. H. Podbielski, Wydawnictwo Naukowe PWN, Warszawa.

SECONDARY LITERATURE:

[1] Esenwein J. B., Carnegey D., (1915), The art. of public speaking, The Home Correspondence School, Springfield, Mass..
[2] Dąbrowski Ł., (2012), 101 porad dla prezenterów, Helion, Warszawa.
[3] Bugajski M. (2007), Język w komunikowaniu, Wydawnictwo Naukowe PWN, Warszawa.
Kuziak M., (2008), Jak mówić, rozmawiać, przemawiać? Wydawnictwo Szkolne PWN, Warszawa.

SUBJECT SUPERVISOR

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Komunikacja społeczna**
Name of subject in English:	**Social communication**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W08ETK-SM3821
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):					15
Number of hours of total student workload (CNPS):					50
Form of crediting:					crediting with grade
For group of courses mark (X) final course:					
Number of ECTS points:					2
including number of ECTS points for practical (P) classes :					2
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)					1.40

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge from the area of Humanities and social sciences area
2. Basic knowledge from the area of Humanities and social sciences area

SUBJECT OBJECTIVES

C1. Student acquires basic knowledge of the functioning in the society.
C1. Student acquires basic knowledge of the functioning in the society
C2. Student acquires skills in interpersonal communication and social interaction
C2. Student acquires skills in interpersonal communication and social interaction
C3. Tthe student acquires basic social competences in interpersonal communication.
C3. Student acquires basic competence in critical thinking and positive argumentation

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

relating to skills:

PEU_U01	The student has the abillity to understand social, economic, legal and others non technical conditions of engineering activities
PEU_U01	The student has the abillity to understand social, economic, legal and others non technical conditions of engineering activities
PEU_U02	The student is able to formulate and thoroughly justify opinions, prepare and make presentations related to the problems from the scope of topics of the studied discipline as well as to the topics related to the environment of work. Is also able to take part in scientific and professional discussions.
PEU_U02	The student is able to formulate and thoroughly justify opinions, prepare and make presentations related to the problems from the scope of topics of the studied discipline as well as to the topics related to the environment of work. Is also able to take part in scientific and professional discussions.

relating to social competences:

PEU_K01	The student is able to think critically and to argue their position, allowing it properly determine the priorities for implementing specified by himself or other tasks, taking into account issues of social responsibility.
PEU_K01	The student is able to think critically and to argue their position, allowing it properly determine the priorities for implementing specified by himself or other tasks, taking into account issues of social responsibility.

PROGRAMME CONTENT		
Seminar		**Number of hours:**
Sem 1	Introduction to the social communication.	1
Sem 1	Introduction to the social communication.	1
Sem 2	Verbal communication	2
Sem 2	Verbal communication	2
Sem 3	Nonverbal communication.	2
Sem 3	Nonverbal communication.	2
Sem 4	Visual communication	2
Sem 4	Visual communication	2
Sem 5	Audial communication	3
Sem 5	Audial communication	3
Sem 6	Mediated communication	2
Sem 6	Mediated communication	2
Sem 7	Mass communication - advertising	1
Sem 7	Mass communication – advertising	1
Sem 8	Praxis of communication and PR	1
Sem 8	Praxis of communication and PR	1
Sem 9	Netiquette electronic communication	1
Sem 9	Netiquette electronic communication	1
	Total hours:	**30**

TEACHING TOOLS USED
N1. Multimedia presentation
N1. Multimedia presentation
N2. Informational lecture
N2. Informational lecture
N3. Interactive lecture
N3. Interactive lecture

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(S)	PEU_U01 PEU_U02 PEU_K01	Presentation
F1(S)	PEU_U01 PEU_U02 PEU_K01	Presentation
F2(S)	PEU_U01 PEU_U02 PEU_K01	Active participation
F2(S)	PEU_U01 PEU_U02 PEU_K01	Active participation
P(S)	P=0,8F1+0,2F2	
P(S)	P=0,8F1+0,2F2	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Goban-Klas T. (2009) Media i komunikowanie masowe: Teorie i analizy radia, prasy, telewizji i internetu, Wydawnictwo Naukowe PWN, Warszawa.
[2] Hopfinger M. (red.) (2002) Nowe media w komunikacji społecznej XX wieku, Oficyna Naukowa, Warszawa.
[3] Kluszczyński R. W. (2001) Społeczeństwo informacyjne. Cyberkultura. Sztuka multimediów, Rabid, Kraków.
[4] Leathers D. G. (2007) Komunikacja niewerbalna, Wydawnictwo Naukowe PWN, Warszawa.

SECONDARY LITERATURE:

[1] van Dijk J., (2010) Społeczne aspekty nowych mediów, Wydawnictwo Naukowe PWN, Warszawa.
[2] McLuhan M. (2001) Wybór tekstów, Zysk i Spółka, Poznań.
[3] Rothert A. (2003) Technopolis. Wirtualne sieci polityczne, Elipsa, Warszawa.
[4] Sieńko M. (2002) Człowiek w pajęczynie: Internet jako zjawisko kulturowe, Atut, Wrocław.
[5] Bugajski M. (2007) Język w komunikowaniu, Wydawnictwo Naukowe PWN, Warszaw

SUBJECT SUPERVISOR
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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Prawo własności intelektualnej na świecie**
Name of subject in English:	**Intellectual property rights in the world**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W05ETK-SM1231
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15				
Number of hours of total student workload (CNPS):	25				
Form of crediting:	crediting with grade				
For group of courses mark (X) final course:					
Number of ECTS points:	1				
including number of ECTS points for practical (P) classes :					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.70				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of legal concepts.
2. The ability to thinking independely, searching and analyzing information.
3. The understanding of self-education need and continuous improvement of the knowledge.

SUBJECT OBJECTIVES

C1. Gaining knowledge of the legal protection of intellectual property in the field of industrial property and copyright.
C2. Understanding the rules of intellectual property protection within international procedures.
C3. Awareness of the importance of intellectual property protection in the world.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Student is able to define the concept of industrial property rights, its types, scope of protection and limitations.
PEU_W02	The student is able to characterize the concept of copyright, its types and scope of protection, the methods copyright management (licenses).
PEU_W03	Student knows the rules of intellectual property protection within the international procedures.

relating to skills:

relating to social competences:

PEU_K01	He understands the importance of intellectual property protection in the contemporary world.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Introduction to the law. The concept of intellectual property. Sources of industrial property rights and copyright in the world. International agreements.	2
Lec 2	Patents, utility models, industrial designs, know-how- definitions, scope of protection, duration, limitations of rights.	2
Lec 3	Granting a patent in the regional and international procedures.	2
Lec 4	Trademarks. Trademark protection systems in the EU, the U.S.A., Latin America and Asia.	2
Lec 5	Subject and object of copyright law in international law. Categories and types of works protected by copyright. Exclusions from copyright protection of certain categories of work. The obtaining of copyright protection.	2
Lec 6	Economic copyrights - the content, disposal of the work. Management of copyright property rights (licenses). Limitations of copyright - fair use.	2
Lec 7	The rules of intellectual property protection within regional and international procedures.	2
Lec 8	Written test.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Traditional lecture.
N2. Multi-media presentation.
N3. Consultations.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03 PEU_K01	Written test.
P(W)	P=F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Kotarba W., Ochrona własności intelektualnej", Oficyna Wydawnicza Politechniki warszawskiej, Warszawa 2012 [2] Sieńczyło-Chlabicz, Prawo własności intelektualnej, Wydawnictwo prawnicze LexisNexis, Warszawa 2013 [3] Nowińska E., Promińska U. de Vall M., Prawo własności przemysłowej, Wydawnictwo prawnicze LexisNexis, Warszawa 2008 [4] Grzywińska A., Okoń S., Marki, wynalazki, wzory użytkowe: ochrona własności przemysłowej, Wydawnictwo Helion, Gliwice 2010 [5] Poradnik wynalazcy. Zasady sporządzania dokumentacji zgłoszeń wynalazków i wzorów użytkowych. Urząd Patentowy R.P. www.uprp.gov.pl [6] Ustawa z dn. 30.06.2000 r. Prawo własności przemysłowej. Dz. U. z 2001 r. nr 49, poz. 508 z późniejszymi zmianami
SECONDARY LITERATURE:
[1] Żakowska-Henzler H., Wynalazek biotechnologiczny. Przedmiot patentu., Wydawnictwo Naukowe Scholar, Warszawa 2006 [2] de Vall M, Prawo patentowe, Wolters Kluwer, Warszawa 2008 [3] Adamczak A., du Vall M., Ochrona własności intelektualnej, UOTT, Warszawa 2010.

SUBJECT SUPERVISOR
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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Wynalazki i patenty**
Name of subject in English:	**Inventions and patents**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W05ETK-SM1232
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15				
Number of hours of total student workload (CNPS):	25				
Form of crediting:	crediting with grade				
For group of courses mark (X) final course:					
Number of ECTS points:	1				
including number of ECTS points for practical (P) classes :					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.70				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of legal concepts.
2. The ability to thinking independely, searching and analyzing information.
3. The understanding of self-education need and continuous improvement of the knowledge.

SUBJECT OBJECTIVES

C1. Understanding the concepts of inventions, their classification and characteristics.
C2. Understanding the principles of patent protection.
C3. Gaining knowledge about the process of obtaining a patent in the national, regional and international procedure.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 He is able to define the concept of the invention, describe its features and types.
PEU_W02 He is able to determine what is a patent, characterize its content. scope, duration and limitations.
PEU_W03 He has knowledge how to grant a patent in the national, regional and international procedures.

relating to skills:

relating to social competences:

PEU_K01 He is able to think creatively.

PROGRAMME CONTENT

	Lecture	Number of hours:
Lec 1	Introduction.The most important theories of patent protection and the basic sources of patent law at international, EU and national level.	2
Lec 2	The concept of the invention and its features (terms of patentability). Inventions excluded from protection.	2
Lec 3	Types of inventions. The specificity of a biotechnological invention.	2
Lec 4	Patent - content, scope of protection, duration, limitations.	2
Lec 5	The concept of patent author and his rights. License agreements.	2
Lec 6	Patent application in the national, European and international procedure.	2
Lec 7	Patent databases as a source of information. Terms of use of patent databases.	2
Lec 8	Written test.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Traditional lecture. N2. Multi-media presentation. N3. Consultations.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Written test.
P(W)	P=F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Kotarba W., Ochrona własności intelektualnej", Oficyna Wydawnicza Politechniki warszawskiej, Warszawa 2012 [2] „Prawo własności przemysłowej", Wydawnictwo C.H. Beck 2010 [3[3] Nowińska E., Promińska U. de Vall M., Prawo własności przemysłowej, Wydawnictwo prawnicze LexisNexis, Warszawa 2008 [4] Grzywińska A., Okoń S., Marki, wynalazki, wzory użytkowe: ochrona własności przemysłowej, Wydawnictwo Helion, Gliwice 2010 [5] Poradnik wynalazcy. Zasady sporządzania dokumentacji zgłoszeń wynalazków i wzorów użytkowych. Urząd Patentowy R.P. www.uprp.gov.pl [6] Ustawa z dn. 30.06.2000 r. Prawo własności przemysłowej. Dz. U. z 2001 r. nr 49, poz. 508 z późniejszymi zmianami **SECONDARY LITERATURE:** [1] Nowicka A., Wynalazek, Prawo własności przemysłowej, Wyd. Difin, Warszawa 2005 [2] Żakowska-Henzler H., Wynalazek biotechnologiczny. Przedmiot patentu., Wydawnictwo Naukowe Scholar, Warszawa 2006 [3] de Vall M, Prawo patentowe, Wolters Kluwer, Warszawa 2008 [4] Adamczak A., du Vall M., Ochrona własności intelektualnej, UOTT, Warszawa 2010.

SUBJECT SUPERVISOR
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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Prawo własności przemysłowej i prawo autorskie dla inżynierów**
Name of subject in English:	**Industrial property and copyright for engineers**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W05ETK-SM1233
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15				
Number of hours of total student workload (CNPS):	25				
Form of crediting:	crediting with grade				
For group of courses mark (X) final course:					
Number of ECTS points:	1				
including number of ECTS points for practical (P) classes :					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.70				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of legal concepts
2. The ability to thinking independely, searching and analyzing information.
3. The understanding of self-education need and continuous improvement of the knowledge.

SUBJECT OBJECTIVES

C1. Gaining knowledge of the legal protection of intellectual property in the field of industrial property and copyright.
C2. Gaining knowledge about the protection of inventions, utility models and industrial designs.
C3. Awareness of the importance of protection of intellectual property in engineering activities.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Student is able to define the concept of industrial property rights, its types, scope of protection and limitations.

PEU_W02 Student is able to characterize the concept of copyright, its types and scope of protection, the methods of copyright management (licenses).

relating to skills:

relating to social competences:

PEU_K01 He is able to think creatively.

PROGRAMME CONTENT

	Lecture	Number of hours:
Lec 1	The concept of intellectual property. Sources of industrial property law. Industral property - its types and scope.	2
Lec 2	The concept of the invention and its features (terms of patentability). The specificity of a biotechnological invention. Inventions excluded from protection.	2
Lec 3	Patents, utility models, industrial designs - the content, the scope of protection, duration, limitations. Principles of preparation of patent specification and the use of patent databases.	2
Lec 4	Subject of copyright law - the concept of copyright work, its categories and types. Exclusions from the copyright protection.	2
Lec 5	The copyright subject - the concept of the creator, co-creator and others copyright holders. Moral and economic copyrights- the content and infringement of protection.	2
Lec 6	The limitatios of economic copyrights – time duration and fair use. Managament of economic copyrights (licenses).	2
Lec 7	Copyright protection of databases. Copyright and the Internet. Copyright infringement on the Internet.	2
Lec 8	Written test.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Traditional lecture. N2. Multi-media presentation. N3. Consultations.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_K01	Written test.
P(W)	P=F1	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Kotarba W., Ochrona własności intelektualnej", Oficyna Wydawnicza Politechniki warszawskiej, Warszawa 2012
[2] Sieńczyło-Chlabicz, Prawo własności intelektualnej, Wydawnictwo prawnicze LexisNexis, Warszawa 2013
[3] Nowińska E., Promińska U. de Vall M., Prawo własności przemysłowej, Wydawnictwo prawnicze LexisNexis, Warszawa 2008
[4] Grzywińska A., Okoń S., Marki, wynalazki, wzory użytkowe: ochrona własności przemysłowej, Wydawnictwo Helion, Gliwice 2010
[5] Poradnik wynalazcy. Zasady sporządzania dokumentacji zgłoszeń wynalazków i wzorów użytkowych. Urząd Patentowy R.P. www.uprp.gov.pl
[6] Ustawa z dn. 30.06.2000 r. Prawo własności przemysłowej. Dz. U. z 2001 r. nr 49, poz. 508 z późniejszymi zmianami

SECONDARY LITERATURE:

[1] Żakowska-Henzler H., Wynalazek biotechnologiczny. Przedmiot patentu., Wydawnictwo Naukowe Scholar, Warszawa 2006
[2] de Vall M, Prawo patentowe, Wolters Kluwer, Warszawa 2008
[3] Adamczak A., du Vall M., Ochrona własności intelektualnej, UOTT, Warszawa 2010.

SUBJECT SUPERVISOR
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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Ochrona własności intelektualnej**
Name of subject in English:	**Protection of Intellectual Property**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W05ETK-SM1007
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15				
Number of hours of total student workload (CNPS):	25				
Form of crediting:	crediting with grade				
For group of courses mark (X) final course:					
Number of ECTS points:	1				
including number of ECTS points for practical (P) classes :					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.70				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a basic knowledge about legislative issues.

SUBJECT OBJECTIVES

C1. Getting the knowledge in the field of intellectual property protection.
C2. Skills of determination of patent procedures, introduction of utility models, industrial, trade marks.
C3. Forming of attitudes of the respect for the law of the intellectual property.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Has a basic knowledge about elements of patent protection, trademarks, utility models, industrial designs.
PEU_W02 Has a basic knowledge about copyright .

relating to skills:

relating to social competences:

PEU_K01 He understands the need of protection of the copyright and following them.

PROGRAMME CONTENT

	Lecture	Number of hours:
Lec 1	The notion and meaning of the intellectual property in the activity of companies and the everyday life. Protection systems of the intellectual property and types of protective laws.	2
Lec 2	Industrial property law - kinds of the knowledge of PWP being protected, comprehending the invention, the patent and the patent ability, procedures of the patent protection (PL, EU, international), costs of the procedures patent, world trends in the patent protection.	2
Lec 3	Utility models, industrial designs definitions and procedures of the protection.	2
Lec 4	Trademarks and service - definitions and procedures of the protection	2
Lec 5	The copyright and related rights: protection of scientific, literary, artistic works, computer programs and databases. The object and the subject of laws, duration of the protection	2
Lec 6	The access and ways of using information bases about the protected intellectual property - cells and examples of using patent information	2
Lec 7	The transfer of knowledge and agreements in trading with laws of the intellectual property	2
Lec 8	Test	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lectures with multimedia presentation supplemented by traditional form N2. Individual work of students N3. Consultation

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_K01	Test
P(W)	P=F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Bently L., B. Sherman Intellectual property law. Oxford, New York , Oxford University Press, cop. 2009. [2] Lewis J.A. Intellectual property protection: promoting innovation in a global information economy, Washington: Center for Strategic and International Studies, 2008. [3] C. Junghans, A. Levy, Intellectual Property Management: A Guide for scientists, engineers, financiers and managers, Wiley-VCH 2006. **SECONDARY LITERATURE:** [1] Internet portals dedicated to intellectual property: www.uprp.pl, www.epo.org, www.uspto.gov, www.wipo.org, OHIM etc

SUBJECT SUPERVISOR
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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Prawo międzynarodowe**
Name of subject in English:	**International Law**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W05ETK-SM1008
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15				
Number of hours of total student workload (CNPS):	25				
Form of crediting:	crediting with grade				
For group of courses mark (X) final course:					
Number of ECTS points:	1				
including number of ECTS points for practical (P) classes :					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0.70				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a basic knowledge about legislative issues.

SUBJECT OBJECTIVES

C1. Getting of basic knowledge in the field of international law.
C2. Skills for understanding and interpretation of the existing provisions in the area of international law
C3. Acquisition and persisting social competence in respecting the provisions of international law.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 He knows the basic functioning of the international community and the international legal order.
PEU_W02 He knows the principles of cooperation through international organizations.

relating to skills:

relating to social competences:

PEU_K01 He understands the need of the development of the activity of an engineer in technical and legal and control aspects

PROGRAMME CONTENT

	Lecture	Number of hours:
Lec 1	The international law and his sources. Principles shaping contemporary international relations. Processes and international structures.	2
Lec 2	International agreements and their meaning for integration processes international and of globalization.	2
Lec 3	Legal subjectivity of international organizations.	2
Lec 4	Sources and principles of the international protection of human rights	2
Lec 5	Foreign economic relations - characteristics of regulations being in force. Legal bases of international funds. International economic transactions.	2
Lec 6	Civil law and commercial in the international exchange.	2
Lec 7	Legal grounds of international marketing.	2
Lec 8	Test	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lectures with multimedia presentation supplemented by traditional form N2. Individual work of students N3. Consultation

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_K01	Test
P(W)	P=F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] "Polish Yearbook of International Law, Wydawnictwo Instytutu nauk Prawnych Warszawa 2010. [2] I. Brownlie, Principles of Public International Law, (OUP 2008). [3] I. Slomanson, W. William, Fundamental Perspectives on Internationa Law, Boston 2011. [4] The Free Dictionary Definition of Human Rights", The American Heritage® Dictionary of the English Language, Fourth Edition copyright ©2000 by Houghton Mifflin Company. Updated in 2009.. Retrieved 13 September 2011. [5] R. Filipek, Protection of Human Rights in the EU – Meeting the Standards of a European Human Rights System?, A. Bodnar et al. (red.) The Emerging Constitutional Law of the European Union. German and Polish Perspectives, Heidelberg 2003. **SECONDARY LITERATURE:** [1] L. Antonowicz, Podręcznik prawa międzynarodowego, Wydawnictwo LexisNexis Warszawa 2003. [2] W. Czapliński, A. Wyrozumska, Prawo międzynarodowe publiczne, Warszawa 2010. [3] „ Przegląd prawa europejskiego i międzynarodowego" , Wydawnictwo Wolters Kluwer Polska – ABC, Warszawa 2011. [4] A. Przyborowska-Klimczak, D. Pyć, Leksykon prawa międzynarodowego publicznego, Wydawnictwo C.H. Beck Warszawa 2012 [5] J. Ciszewski, Obrót prawny z zagranicą w sprawach cywilnych i karnych, Wydawnictwo LexisNexis Warszawa 2012.

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Mechanizmy rynkowe w energetyce o strukturze rozproszonej**
Name of subject in English:	**Market Mechanisms in Power Systems with Distributed Energy Sources**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W05ETK-SM2538
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15				
Number of hours of total student workload (CNPS):	50				
Form of crediting:	crediting with grade				
For group of courses mark (X) final course:					
Number of ECTS points:	2				
including number of ECTS points for practical (P) classes :					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knows the principles a power system operation and control, is familiar with electricity generation and transmission techniques.
2. Has a basic knowledge in the field of renewable energy sources.
3. Understands a need and knows possibilities of continuous education, increasing of professional, personal and social competences.

SUBJECT OBJECTIVES

C1. Possession a knowledge of function of electric energy sector including renewable energy sources.
C2. Getting to know market and regulatory mechanisms in power sector.
C3. Possession a knowledge of electric energy market.
C4. Possession a knowledge of goals of national and union energy policy.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01	Knows function of electric energy sector including renewable energy sources.
PEU_W02	Knows market and regulatory mechanisms in power sector.
PEU_W03	Possesses a knowledge of electric energy market.

relating to skills:

relating to social competences:

PEU_K01	Can think and act in creative and enterprising way. He/she is able to rank appropriately the priorities needed for realizing the respective task.

PROGRAMME CONTENT		
Lecture		**Number of hours:**
Lec 1	Specific features of energy supply sector. Evolution of structural forms - from vertical integration to restructuring and liberalization.	2
Lec 2	Mechanisms of energy market.	2
Lec 3	Regulation of energy market.	2
Lec 4	State' interventionism and market rules. Regulatory mechanisms on energy market.	2
Lec 5	Infrastructural multi-energy utilities.	2
Lec 6	Financial relations between market entities.	2
Lec 7	Realization of the European energy policy goals: effectiveness, use of renewable energy sources, counteraction of climate changes.	2
Lec 8	Test.	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Lecture with the use of audiovisual techniques, multimedia presentations.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03 PEU_K01	Test.
P(W)	P=F1	

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE:
[1] Kowalska A., Wilczyński A., Źródła rozproszone w systemie elektroenergetycznym. Wydawnictwo Kaprint, Lublin, 2007. [2] Malko J. Wilczyński A., Rynki energii – działania marketingowe. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2006. [3] W.Joerss, M. Uyterlinde, P. Loeffler, P.E. Morthost, Decentralised Power Generation in the Liberalised EU Energy Markets, Springer-Verlag Berlin Heidelberg, 2003. [4] B. Murray, Power Markets and Economics: Energy Costs, Trading, Emissions, John Wiley and Sons Ltd. Chichester, England, 2009.
SECONDARY LITERATURE:
[1] M. Shahidehpour, H. Yamin, Zuyi Li, Market Operations in Electric Power Systems: Forecasting, Scheduling, and Risk Management, John Wiley and Sons Ltd. New York, 2002. [2] Czasopisma: Rynek Energii, IEEE Power & Energy, Power Engineering, Renewable Energy World.

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FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name of subject in Polish:	**Podstawy Zarządzania**
Name of subject in English:	**Fundamentals of Management**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Control in Electrical Power Engineering**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**optional / university-wide**
Subject code:	W05ETK-SM1499
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	15				
Number of hours of total student workload (CNPS):	50				
Form of crediting:	crediting with grade				
For group of courses mark (X) final course:					
Number of ECTS points:	2				
including number of ECTS points for practical (P) classes :					
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1.40				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a basic knowledge about management processes, functions, principles and tools and identifies the basic management issues.

SUBJECT OBJECTIVES

C1. To ensure fundamental knowledge (including application aspects) about: setting up the business
C2. To ensure fundamental knowledge (including application aspects) about: organization as a system
C3. To ensure fundamental knowledge (including application aspects) about: organizational development dynamics and characteristics of the organization in various development phases
C4. To ensure fundamental knowledge (including application aspects) about: change and project management

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Has a basic knowledge about setting up and running the business.
PEU_W02 Has a basic knowledge about managing organization as a system.
PEU_W03 Has a basic knowledge about introducing changes in organizations

relating to skills:

relating to social competences:

PEU_K01 aware how important is the cooperation in completing complex tasks.

PROGRAMME CONTENT

	Lecture	Number of hours:
Lec 1	Scope of lecture, conditions of crediting and literature Introduction: challenges of contemporary management	2
Lec 2	How to set up the business? The essence of entrepreneurship.	2
Lec 3	Organization as a system of functions, processes and operations.	2
Lec 4	Managing organizational environment.	2
Lec 5	Organizational transformations: birth, growth, decline, and death. Change management	2
Lec 6	Project management	2
Lec 7	Effective teams building	2
Lec 8	Final assessment	1
	Total hours:	**15**

TEACHING TOOLS USED
N1. Traditional lecture with multimedia presentations N2. Case studies presented during lecture N3. Self-study: final assessment preparation

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Learning outcomes code**	**Way of evaluating learning outcomes achievement**
F1(W)	PEU_W01 PEU_W02 PEU_W03	Final assessment
F2(W)	PEU_K01	Scoring students' involvement during lecture
P(W)	P=F1	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] McKee A.: Management: a focus on leaders, Pearson , Boston 2012.

SECONDARY LITERATURE:

[1] Griffin R.W.: Management, Houghton Mifflin Company, New York 2008.
[2] Jones G.R., George J.M., Essentials of contemporary management, McGraw-Hill Irwin, Boston 2007 (2006).
[3] Osterwalder A., Pigneur Y., Business model generation: a handbook for visionaries, game changers, and challengers, John Wiley & Sons, 2010.
[4] Robbins S.P., DeCenzo D.: Fundamentals of management: essential concepts and applications, Pearson/Prentice Hall, 2008.

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