FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Metody i techniki pomiarowe**
Name in English:	**Measurement methods and techniques**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	**Renewable Energy Systems**
Level and form of studies:	**2nd level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR053312**
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 for direct teacher-student contact (BK) classes:	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 transducers 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 LEARNING OUTCOMES

relating to knowledge:

PEU_W01	Has a knowledge of electrical signal processing in measurement systems.
PEU_W02	Identify measurement noises and knows methods of reduction in systems with data acquisition cards.
PEU_W03	Knows the design principles and construction of measurement 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		
Form of classes - 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**

Form of classes - 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 research 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 writing or oral answer form, report preparation, presentation and discussion of wrote program, office hours.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect 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
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