FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Analogowe i cyfrowe systemy pomiarowe**
Name in English:	**Analog and Digital Measurement Systems**
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:	**ELR033313**
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 for direct teacher-student contact (BK) classes:	1.40		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a basic knowledge of the basic of electrical circuits.
2. Has a basic knowledge of the measurement technique.
3. Has a basic knowledge of the electronic components, describes it operation by peripheral model, distinguishes and characterizes basic analogue and digital circuits.
4. Is able to apply theoretical basis to analyze linear steady-state electrical circuits for sinusoidal input signals. Knows the time and frequency methods to solve electrical circuits.
5. Is able to do measurements of electrical quantities using analogue and digital instruments or oscilloscope. 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. Introduction student with knowledge of the architecture, design principles of analog and digital measurement systems.

C2. Awareness of the possibility of using measurement systems containing in the measurement circuit: normalizing transducers, analog-to-digital converters, data acquisition cards,

C3. Acquisition of practical skills to transducers tests, measuring circuit components, analysis the research results and to draw the correct conclusions.

C4. Skills sophistication of using autonomous instruments and data acquisition cards with the LabVIEW graphical programming environment.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01	Has a knowledge of electrical signal processing in measurement systems.
PEK_W02	Identify measurement noises and knows methods of reduction in systems with data acquisition cards.
PEK_W03	Knows the design principles and construction of analogue and digital measurement systems

relating to skills:

PEK_U01	Can do tests of measurement circuit properties with resistance temperature sensor, integrated mean and RMS value converters.
PEK_U02	Can do measurements of amplifier with carrier-wave generator and interprate results..
PEK_U03	Can write basic programs in LabView, can do virtual instrument visualization. Can design automatic measurement stand consist of autonomic instruments to determine the parameters and characteristics of chosen elements

relating to social competences:

PEK_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	Analogue measurement systems architecture. Signal processing in analogue measurement systems. Sensors and transducers with current 4..20 mA input signals.	2
Lec 2	Linear normalize converters. Properties of inverting, non-inverting, differential amplifiers and voltage follower. Common mode rejection ratio.	2
Lec 3	Instrumental amplifiers. Differential input and differential output structure and structure with additional differential amplifier.	2
Lec 4	Insulation amplifiers, parameters and applications. Transimpedance amplifiers – basic scheme and circuit analysis. Rail-to-Rail amplifiers.	2
Lec 5	Instrumental amplifiers application in renewable energy systems.	2
Lec 6	Non-linear operational converters. Principle of operations and realization of logarithmic and exponential circuit. Multiplier-divider circuit. Multi-functional analogue operational converter.	2
Lec 7	TDM multiplier – principle of operations basic structure and with feed-back. RMS value converters described by explicite and implicite function. Chosen electrical quantities converters.	2
Lec 8	Classification, structure and organization of Digital Measurement Systems. Functional blocks: controllers, communication with user, data acquisition, signal processing, signal generation.	2
Lec 9	Sampling-hold circuit parameters. A/D and D/A processing uses analogue and digital filters.	2
Lec 10	Chosen A/D and D/A converters. Flash, uniform rate compensation, sigma-delta, binary-weighted and R-2R ladder. Parameters of converters.	2
Lec 11	Digital measurement errors. Methods of measurement noise reduction in DAQ systems.	2
Lec 12	Introduction to LabView environment. Front panel and diagram of virtual instrument. Programming structures. Autonomic instruments control. Designing methodology of virtual instruments.	2
Lec 13	Inductive current transducers and their application in Digital measurement systems. Smart sensors.	2
Lec 14	Stray measurement systems. Wireless measurement systems Bluetooth, ZigBee, GSM, UMTS, Wi-Fi.	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.	1
Lab 2	Test of measurement circuit with transducer XTR-103.	2
Lab 3	Properties research of mean and RMS value integrated converters. Standarization and errors calculations of tested converters.	2
Lab 4	Amplifier with carrier-wave generator tests. Determination of static and dynamic characteristics of the amplifier.	2
Lab 5	Introduction to LabView. Program realization which can calculate the result on basis input data and known relation with visualization. Basic programming structure.	2
Lab 6	Type A virtual instrument. Instrument control with GPIB or USB interface program realization with uses given driver. Programming structures.	2
Lab 7	System realization with uses autonomic instruments connected via standard interfaces. Table operations, reading and writing data from or to file.	2
Lab 8	Autonomic measurement system to determine characteristics of chosen elements. Credit laboratory.	2
	Total hours:	**15**

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 EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation *F – forming (during semester)* *P – concluding (at semester end)*	**Educational effect number**	**Way of evaluating educational effect achievement**
F1(W)	PEK_W01 PEK_W02 PEK_W03	Test
P(W)	P=F1	
F1(L)	PEK_U01 PEK_U02	Check preparation to laboratory.
F2(L)	PEK_U01 PEK_U02 PEK_U03	Activity on laboratory
F3(L)	PEK_U01 PEK_U02 PEK_U03	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.

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., Wzmacniacze operacyjne i przetworniki pomiarowe, Oficyna Wyd. Pol. Wrocławskiej, Wrocław, 2008
[5] Van de Plassche R., CMOS integrated analog to digital and digital to analog converters, Kluwer Academic Publishers, 2003.
[6] 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, p. 308-313
[7] Nawrocki W., Komputerowe systemy pomiarowe, WKŁ, Warszawa, 2006
[8] Nawrocki W., Rozproszone systemy pomiarowe, WKŁ, Warszawa, 2006
[9] Świsulski D., Komputerowa Technika Pomiarowa, Oprogramwanie wirtualnych przyrządów pomiarowych w LabView, PAK, 2005

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR033313 - Analog and Digital Measurement Systems
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**
AND SPECIALIZATION **Renewable Energy Systems**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)	Subject objectives	Programme content	Teaching tool number
PEK_W01	K2ETK_W05	C.1 C.2	Lec2 Lec3 Lec4 Lec6 Lec7 Lec9 Lec12 Lec13	N.1
PEK_W02	K2ETK_W05	C.2	Lec10 Lec11	N.1
PEK_W03	K2ETK_W05	C.1 C.2	Lec1 Lec5 Lec8 Lec14	N.1
PEK_U01	K2ETK_U04	C.3	Lab2 Lab3	N.2
PEK_U02	K2ETK_U04	C.3	Lab4	N.2
PEK_U03	K2ETK_U04	C.4	Lab5 Lab6 Lab7 Lab8	N.2
PEK_K01	S2RES_K02	C.1 C.2 C.3 C.4	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2