FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Analogowe i cyfrowe systemy pomiarowe**
Name in English:	**Analogue and Digital Measurement Systems**
Main field of study (if applicable):	**Industrial Control Engineering**
Specialization (if applicable):	
Level and form of studies:	**1st level, full-time**
Kind of subject:	**optional**
Subject code:	**APR013306**
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		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 for direct teacher-student contact (BK) classes:	0.70		0.70		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Has a basic knowledge of the electrical circuits theory.
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 and design principles of analog and digital systems.

C2. Awareness of the possibility of using measurement systems containing in the measurement circuit: normalizing transducers, analog-to-digital converters, data acquisition cards, autonomous devices connected via standard interfaces for realization specific measuring task.

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

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

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.

relating to skills:

PEU_U01	Can do tests of measurement circuit properties with resistance temperature sensor, mean and RMS value integrated circuits, squar-rooter, multiplier and divider converters, interprat power.
PEU_U02	has an abilities to run and determination the properties of PLL circuits, can do measurements of amplifier with carrier-wave generator.
PEU_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:

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	Analogue measurement systems architecture. Signal processing in analogue measurement systems. Sensors and transducers with 4..20 mA current 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	Classification, structure and organization of Digital Measurement Systems. Functional blocks: controllers, communication with user, data acquisition, signal processing, signal generation.	2
Lec 5	Chosen A/D and D/A converters. Flash, uniform rate compensation, sigma-delta, binary-weighted and R-2R ladder. Converters parameters.	2
Lec 6	Digital measurement errors. Methods of measurement noise reduction in DAQ systems. reject DC, AC common-mode voltage, break ground loops, use 4-20mA current loops, using digital circuits with higher voltage level.	2
Lec 7	Stray measurement systems. Wireless measurement systems division: Bluetooth, ZigBee, GSM, UMTS, Wi-Fi. Virtual instruments. Categories, configurations of virtual instruments. Uncertainty calculations.	2
Lec 8	Test	1
	Total hours:	**15**

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	Geometrical interpretation of power. Measurement circuit test.	2
Lab 3	Test of measurement circuit with transducer XTR-103. Drawing characteristics: natural, with correction and linearized transducer and measurement circuit with using the temperature simulator.	2
Lab 4	Determination of phase locked loop properties. Knowing the possibility of electrical signals reproduction frequency and ensure the stability of phase-locked loop.	2
Lab 5	Properties research of mean and RMS value integrated converters. Standarization and errors calculations of tested converters.	2
Lab 6	Amplifier with carrier-wave generator tests. Determination the static and dynamic characteristics of the amplifier.	2
Lab 7	Tests of square-rooter, multiplier and divider converters. Determination of converters errors.	2
Lab 8	Introduction to LabView. Program realization which can calculate the result on basis input data and known relation, make visualization. Basic programming structure.	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 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 elements.	2
Lab 12	Type B virtual instrument. Measurement data acquisition with using DAQ boards	2
Lab 13	Measurement of chosen electrical quantities with DAQ boards.	2
Lab 14	Stray measurement system. Test of stray measurement system based on autonomic instruments which transmit measure signals via Ethernet interface	2
Lab 15	Assessment and complement arrears.	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	Test
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02 PEU_U03	Check preparation to laboratory
F2(L)	PEU_U01 PEU_U02 PEU_U03 PEU_K01	Activity in laboratory
F3(L)	PEU_U01 PEU_U02 PEU_U03	Report
P(L)	P=0,3F1+0,1F2+0,6F3	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Nawrocki Z., Wzmacniacze operacyjne i przetworniki pomiarowe, Oficyna Wyd. Pol. Wrocławskiej, Wrocław, 2008
[2] Winiecki W., Organizacja komputerowych systemów pomiarowych, Of.Wyd. Pol. Warszawskiej, Wa-a, 1997
[3] Tumański S., Technika pomiarowa, WNT, Warszawa, 2007
[4] Nadachowski M., Kulka Z., Analogowe układy scalone, WKiŁ, Warszawa, 1983
[5] Lyons R.G., Wprowadzenie do cyfrowego przetwarzania sygnałów, WKŁ, Warszawa, 2006
[6] Rudy van de Plassche, Scalone przetworniki analogowo-cyfrowe i cyfrowo-analogowe

SECONDARY LITERATURE:

[1] Nawrocki W., Komputerowe systemy pomiarowe, WKŁ, Warszawa, 2006
[2] Nawrocki W., Rozproszone systemy pomiarowe, WKŁ, Warszawa, 2006
[3] Nawrocki Z., Dusza D., Analogue and digital measurement systems, Wrocław, 2011
[4] Świsulski D., Komputerowa Technika Pomiarowa, Oprogramwanie wirtualnych przyrządów pomiarowych w LabView, PAK, 2005
[5] Soclof S.: Zastosowania analogowych układów scalonych, WKiŁ, Warszwa, 1991.

SUBJECT SUPERVISOR

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