

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): **Control Engineering and Robotics**
 Specialization (if applicable):
 Level and form of studies: **1st level, full-time**
 Kind of subject: **optional**
 Subject code: **ARR043306**
 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 its 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.
Is able to do measurements of electrical quantities using analogue and digital instruments or oscilloscope. Is able to
5. 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 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.

relating to skills:

- PEK_U01 Can do tests of electronic transformers, measurement circuit properties with resistance temperature sensor, mean and RMS value integrated circuits, square-rooter, multiplier and divider converters.
- PEK_U02 has an abilities to run and determination the properties of PLL circuits, can do measurements of amplifier with carrier-wave generator.
- 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 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	Metrological properties tests of electronic voltage instrument transformers. Determination of voltage transformer errors, drawing errors characteristics.	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 EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation <i>F – forming (during semester) P – concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(W)	PEK_W01 PEK_W02	Test
P(W)	P=F1	
F1(L)	PEK_U01 PEK_U02 PEK_U03	Check preparation to laboratory
F2(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Activity in 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., 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, Scalane 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, Oprogramowanie wirtualnych przyrządów pomiarowych w LabView, PAK, 2005 [5] Soclof S.: Zastosowania analogowych układów scalonych, WKiŁ, Warszawa, 1991.

SUBJECT SUPERVISOR
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ARR043306 - Analogue and Digital Measurement Systems
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Control Engineering and Robotics**

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	K1AiR_AMPU_W02	C.1	Lec1 Lec2 Lec3 Lec4 Lec5	N.1
PEK_W02	K1AiR_AMPU_W02	C.1	Lec6 Lec7	N.1
PEK_U01	K1AIR_AMPU_U02	C.2 C.3	Lab2 Lab3 Lab5 Lab7	N.2
PEK_U02	K1AIR_AMPU_U02	C.2 C.3	Lab4 Lab6	N.2
PEK_U03	K1AIR_AMPU_U02	C.4	Lab8 Lab9 Lab10 Lab11 Lab12 Lab13 Lab14	N.2
PEK_K01	K1AiR_K09	C.1 C.2 C.3 C.4	Lec8 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8 Lab9 Lab10 Lab11 Lab12 Lab13 Lab14 Lab15	N.1 N.2