FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Czujniki i przetworniki**
Name in English:	**Sensors and Transducers**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	
Level and form of studies:	**1st level, part-time**
Kind of subject:	**optional**
Subject code:	**ELR041268**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	20		10		
Number of hours of total student workload (CNPS):	54		27		
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 knowledge of basics of physics and electronics.
2. Knows basic of electrical metrology.
3. Ability to use basic electrical measurement devices

SUBJECT OBJECTIVES

C1. Learn physical basics of sensors and converters.
C2. Learn most important parameters of sensors and converters, which influence their work.
C3. Ability to use sensors and converters. in measurement systems.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Is able to describe basic lows, construction, and properties of sensors and converters.
PEK_W02 Is able to describe application of sensors and converters in various physical quantities measurements and measurement systems.
PEK_W03 Is able to select sensors and converters for certain applications.

relating to skills:

PEK_U01 Has ability to perform measurements with sensors and converters.
PEK_U02 Has ability to determine usefulness of sensor and converters in measurement system based on their parameters.
PEK_U03 Is able to design and make measurement system with sensors and converters and evaluate processing errors.

relating to social competences:

PEK_K01 Is aware of responsibility for own work and is ready to subordinate the rules of team work.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours:**
Lec 1	Information about the subject, requirements educational effects and grading system. Classification of sensors and converters and their role in measurement chain.	2
Lec 2	Static and dynamic parameters of sensors and converters.	2
Lec 3	Temperature sensors: resistive, diodes, capacitive. Thermoelectric temperature sensors, optical fiber and pyrometric sensors, thermographic cameras.	2
Lec 4	Mechanical quantities sensors: inductive, tensometric and other.	2
Lec 5	Gas sensors. Humidity and pH sensors.	2
Lec 6	Analogue converters, and their tasks in measurement systems. Measurement amplifiers, I/V and V/I converters. Standardizing, differential, integrative converters. Mean, RMS, peak, sample and hold converters, phase-sensitive rectifiers.	2
Lec 7	Multiplying converters, halotrones, power converters. A/D converters, types and properties.	2
Lec 8	A/D converters in measurement devices. D/A converters, digital generation of analogue signals.	2
Lec 9	Sensors integrated with A/D converter and interface and their application in industrial measurement systems, diagnostics, monitoring, medicine, car industry, home appliances etc.	2
Lec 10	Test.	2
	Total hours:	**20**

Form of classes - laboratory		**Number of hours:**
Lab 1	Introduction.	1
Lab 2	Investigation of measurement amplifiers properties.	3
Lab 3	Sensors in measurements of mechanical strain and pressure and their signal processing. Investigation of temperature sensors properties.	3
Lab 4	Sensors in measurements of displacement and fluid level and their signal processing. Investigation of A/D converters properties.	3
	Total hours:	**10**

TEACHING TOOLS USED
N1. Lecture of problem.
N2. Lecture with use of audio-visual technique and multimedia presentation.
N3. Measurement laboratory realized in traditional students groups.

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 PEK_K01	Written test.
P(W)	P=F1	
F1(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Preparation to the classes
F2(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Activity during classes.
F3(L)	PEK_U01 PEK_U02 PEK_U03 PEK_K01	Reports from classes.
P(L)	P=0,4*F1+0,3F2+0,3*F3	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Walt Kester, Przetworniki A/C i C/A: teoria i praktyka, Wydawnictwo BTC, Legionowo 2012.
[2] Lisowski Michał Podstawy metrologii, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2011.
[3] Nawrocki Zdzisław, Wzmacniacze operacyjne i przetworniki pomiarowe, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2008.
[4] Sławomir Tumański, Technika pomiarowa, Warszawa WNT 2007,
[5] Nawrocki, Waldemar, Sensory i systemy pomiarowe, Wyd. Politechniki Poznańskiej, Poznań 2001
[6] Miłek Marian, Metrologia elektryczna wielkości nieelektrycznych, Oficyna wydawnicza Uniwersytetu Zielonogórskiego, Zielona Góra 2006
[7] Gajek Andrzej, Juda Zdzisław, Czujniki, WKŁ, Warszawa 2011
[8] Kaczmarek Zdzisław, Światłowodowe czujniki i przetworniki pomiarowe, Agenda wydawnicza PAK, Warszawa 2006

SECONDARY LITERATURE:

[1] Patrick F. Dunn, Fundamentals of sensors for engineering and science, Boca Raton CRC/Taylor & Francis, 2011
[2] Gardner J. W.: Microsensors. Principles and applications. John Wiley and Sons. Chichester, 1995.
[3] Wagner E. i inni: Sensors. A comprehensive survey. Vol. 6. Optical sensors. VCH Weinheim 1992.
[4] Ohba R. i inni: Inteligent sensor technology. John Wilej and sos, Chichester 1992.
Fraden J.: AIP hadbook of modern sensors. Physics, designs and applications. AIP, New York 1993.
[5] Rylski A.: Sensory i przetworniki wielkości nieelektrycznych. Skrypt Pol. Rzeszowskiej, 1994
[6] Vetelino J., Reghu A., Introduction to sensors, Boca Raton : CRC Press/Taylor and Francis Group, 2011.
[7] Fraden J., Handbook of modern sensors: physics, designs, and applications, New York [etc.] Springer, 2010.

SUBJECT SUPERVISOR

Jan Ziaja, jan.ziaja@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR041268 - Sensors and Transducers
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**

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	K1ETK_ETP_W08	C.1 C.2	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9	N.1 N.2
PEK_W02	K1ETK_ETP_W08	C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec9	N.1 N.2
PEK_W03	K1ETK_ETP_W08	C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9	N.1 N.2
PEK_U01	K1ETK_ETP_U05	C.2 C.3	Lab2 Lab3 Lab4	N.3
PEK_U02	K1ETK_ETP_U05	C.2 C.3	Lab2 Lab3 Lab4	N.3
PEK_U03	K1ETK_ETP_U05	C.2 C.3	Lab2 Lab3 Lab4	N.3
PEK_K01	K1ETK_K09	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lab1 Lab2 Lab3 Lab4	N.1 N.2 N.3