Zał. nr 4 do ZW 64/2012

FACULTY: Electronics

SUBJECT CARD

Name in Polish: Elementy elektroniczne i czujniki
Name in English: Electronic Components and Sensors
Main field of study (if applicable): Electronic and Computer Engineering
Specialization (if applicable):
Level and form of studies: 1st level, full-time
Kind of subject: obligatory
Subject code: ECEA00005
Group of courses: YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	45	15	30		
Number of hours of total student workload (CNPS)	120	30	90		
Form of crediting	Examination	Crediting with grade	Crediting with grade		
For group of courses mark (X) final course	X				
Number of ECTS points	**8**				
including number of ECTS points for practical (P) classes		1	3		
including number of ECTS points for direct teacher-student contact (BK) classes	1,5	0,5	1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. K1ECE_W06
2. K1ECE _W11
3. K1ECE_W16

SUBJECT OBJECTIVES

C1 – Acquisition of basic knowledge on the design, operation and applications of semiconductor electronic components.
C2 – Acquiring basic knowledge on sensors and sensor systems
C3 – Acquisition of skills in determining parameters of selected electronic components
C4 – Acquisition of skills to design, create and implement applications for data collection, processing and presentation

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEK_W01 – describes principles of operation of basic electronic components
PEK_W02 – describes structure, characteristics and applications of basic electronic components
PEK_W03 – defines basic characteristics of sensors
PEK_W04 – characterises applications of sensors and interfaces in measurements of physical quantities

relating to skills:
PEK_U01 – calculates parameters of selected electronic components and their circuits
PEK_U02 – uses the LabVIEW programming environment for data acquisition, processing and presentation

PROGRAMME CONTENT		
Form of classes – lecture 1		**Number of hours**
Lec1.1	Organizational matters, conditions of gaining credit.	1
Lec1.2	Passive electronic components - construction, types, principle of operation, basic parameters and characteristics.	3
Lec1.3	Physical principles of semiconductor and their energy band model. Types of semiconductor materials and their short characteristics.	2
Lec1.4	The physical structure of the p-n junction, polarization and static current-voltage characteristic.	2
Lec1.5	Types of semiconductor diodes: rectifier diodes, universal, Zener, Schottky etc. Parameters and characteristics.	2
Lec1.6	Bipolar transistors. Construction and operation of PNP and NPN transistors principle of polarity. Configuration OB, OE, OC. Current gain. The characteristics and parameters - limiting the scope of usage.	2
Lec1.7	Bipolar junction transistors - graphical analysis, hybrid pi model, input resistance, frequency limit, the effect of temperature on the operation and performance of the transistor.	2
Lec1.8	Junction Field Effect Transistors JFET - basic structures, characteristics, parameters, static work, dynamic work with small signals, the frequency characteristics.	2
Lec1.9	Field effect transistors with insulated gate MOSFET - structure, types, characteristics, parameters. HexFET, VDMOS and IGBT transistors – basic information.	2
Lec1.10	Thyristor - construction, types, principle of operation, characteristics, two-transistor model and examples of applications to power control. Triac, Diac - construction, principle of operation, characteristics and applications.	2
Lec1.11	Optoelectronics - basic concepts, LEDs, photoresistors, photodiode, phototransistor, silicon photomultiplier, construction, principle of operation, characteristics, parameters, examples of applications.	2
Lec1.12	Photovoltaic panels - construction, operation, characteristics, parameters	2
Lec1.13	Electronic elements for protection and suppression – properties, basic parameters and characteristics.	1
Lec1.14	Operational amplifiers - basic structures, characteristics, parameters, static work, dynamic work with small signals, the frequency characteristics.	1

Lec1.15	Batteries, accumulators and sources of energy used in electronics – basic parameters and characteristics.	2
Lec1.16	Photovoltaic cells - practical applications.	2
	Total hours	**30**

Form of classes – class		**Number of hours**
Cl1	Organizational matters, conditions of gaining credit.	1
Cl2	Resistivity and resistance, calculation resistance of wirewound, carbon film, metal film and ceramic resistors, contacts, connections, cables etc. Capacitance and capacity – calculation of capacitance, charge/discharge curve and ESR coefficient. Calculation of air coils parameters, self-inductance and mutual.	2
Cl3	Ferrite core coil – properties, parameters calculation and design. Typical problems of impulse work. Transformer – properties, parameters and simple design calculations.	2
Cl4	Test I	1
Cl5	Semiconductor diodes – exercise in calculations of simple circuits. Power loss, thermal management and typical problems of impulse work.	1
Cl6	Bipolar junction transistor – small and large signal models, exercise in h-parameter calculation. Bipolar current sources and the current mirror. Bipolar transistor in amplifier and switching circuits. Calculation of switching and conduction losses of bipolar transistors.	2
Cl7	MOSFET transistor in amplifier and switching circuits. Calculation of switching and conduction losses of MOSFET transistors.	2
Cl8	Semiconductor switching elements – thyristor, triac, diac. Calculation of power loss in a switching and basic commutation circuit.	1
Cl9	Discrete optoelectronic components – photoresistor, photodiode, phototransistor. Calculation of its basic circuit and characteristic parameters.	1
Cl10	Test II	2
	Total hours	**15**

Form of classes – lecture 2		**Number of hours**
Lec2.1	Introduction, requirements and forms of crediting. Instrumentation components. Sensors, signal conditioning blocks, analog-to-digital converters, interface circuitry. Tools and programming environments used in the design of classical and virtual instruments.	1
Lec2.2	Metrological properties of sensors (sensitivity, selectivity, linearity, repeatability, accuracy). Classification of sensors.	2
Lec2.3	Fundamentals and electronic instruments for measurement of position, displacement, and tension	1
Lec2.4	Fundamentals and electronic instruments for measurement of temperature.	2
Lec2.5	Fundamentals and electronic instruments for measurement of pressure.	2
Lec2.6	Fundamentals and electronic instruments for measurement of flow.	1
Lec2.7	Smart sensors.	1
Lec2.8	Sensor networks and interfaces.	1

Lec2.9	Serial interfaces.	2
Lec2.10	IEEE488 standard. SCPI specification.	1
Lec2.11	Network protocols used in distributed instrumentation.	1
	Total hours	**15**

Form of classes – laboratory		**Number of hours**
Lab1	Organizational matters. Introduction to LabView. Characteristics of laboratory stands.	2
Lab2	Dataflow model. Navigating LabVIEW. Loop, conditional and sequential structures.	2
Lab3	Parts of Virtual Instrument program: front panel, block diagram, icon and connection pane. Subroutines (subvi).	2
Lab4	Simple application that illustrates the principles of creating and running programs in LabVIEW.	2
Lab5	How to change front panel objects properties during program execution? Property nodes.	2
Lab6	Implementation of the “state machine” design pattern.	4
Lab7	VISA library and rules for its use to remotely control measurement instruments.	2
Lab8	Establishment of project teams. Overview and discussion of requirements.	2
Lab9	Implementation of the measurement experiment using GPIB instruments (work in two-person teams).	10
Lab10	Results presentation.	2
	Total hours	**30**

TEACHING TOOLS USED
N1. Standard lectures with multimedia presentations N2. Discussions on problems being solved N3. Performing experimental and programming classes N4. Individual consultations

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	Lec1.1–Lec1.16 Lec2.1–Lec2.11	Final exam
F2	Cl1–Cl10	Two tests
F3	Lab1–Lab10	Graded assignments of laboratory tasks
P = 0.5*F1 + 0.2*F2 + 0.3*F3 (positive grade under condition: F1≥3 & F2≥3 & F3≥3)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] W. Gopel, J. Hesse, J.N. Zemel (Eds): Sensors. A Comrehensive Survey. VCH, Weinheim 1991.
[2] U.K. Mishra, J. Singh: Semiconductor Device Physics and Design, Springer-Verlag, Dordrecht 2008
[3] J.M. Pieper: Automatic Measurement Control: A Tutorial on SCPI and IEEE 488.2; Rohde & Schwarz GmbH, 2014.

SECONDARY LITERATURE:

[1] P. Hauptmann. Sensoren. Prinzipien und Anwendungen. Carl Hanser Verlag, Munchen1991.
[2] Hennel J., Podstawy elektroniki półprzewodnikowej, WNT, Warszawa 2003
[3] W. Tłaczała: Środowisko LabVIEW w eksperymencie wspomaganym komputerowo. Wydawnictwo Naukowo-Techniczne. Warszawa 2002.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Prof. Janusz Mroczka, Ph.D., D.Sc., janusz.mroczka@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT

Electronic Components and Sensors

AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY

Electronic and Computer 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	K1ECE_W17	C1	Lec1.1-Lec1.3	N1, N4
PEK_W02	K1ECE_W17	C1	Lec1.4-Lec1.16	N1, N4
PEK_W03	K1ECE_W17	C2	Lec2.1-Lec2.2	N1, N4
PEK_W04	K1ECE_W17	C2	Lec2.3-Lec2.11	N1, N4
PEK_U01	K1ECE _U17	C3	Cl1–Cl10	N2, N4
PEK_U02	K1ECE _U17	C3	Lab1–Lab10	N3, N4

** - enter symbols for main-field-of-study/specialization educational effects

*** - from table above