Zał. nr 5 do ZW 16/2020

FACULTY ELECTRONICS

SUBJECT CARD

Name of subject in Polish:	**Elementy elektroniczne**
Name of subject in English:	**Electronic Components and Sensors**
Main field of study (if applicable):	**Electronic and Computer Engineering**
Specialization (if applicable):	**……..**
Profile:	**academic**
Level and form of studies:	**1 st level/ full-time**
Kind of subject:	**obligatory**
Subject code:	**ECEA00016**
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 corresponding to classes that require direct participation of lecturers and other academics (BU)	1,5	0,5	1		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.

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:
PEU_W01 – describes principles of operation of basic electronic components
PEU_W02 – describes structure, characteristics and applications of basic electronic components
PEU_W03 – defines basic characteristics of sensors
PEU_W04 – characterises applications of sensors and interfaces in measurements of physical quantities

relating to skills:
PEU_U01 – calculates parameters of selected electronic components and their circuits
PEU_U02 – uses the LabVIEW programming environment for data acquisition, processing and presentation

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec1	Organizational matters, conditions of gaining credit.	1
Lec2	Passive electronic components - construction, types, principle of operation, basic parameters and characteristics.	3
Lec3	Physical principles of semiconductor and their energy band model. Types of semiconductor materials and their short characteristics.	2
Lec4	The physical structure of the p-n junction, polarization and static current-voltage characteristic.	2
Lec5	Types of semiconductor diodes: rectifier diodes, universal, Zener, Schottky etc. Parameters and characteristics.	2
Lec6	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
Lec7	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
Lec8	Junction Field Effect Transistors JFET - basic structures, characteristics, parameters, static work, dynamic work with small signals, the frequency characteristics.	2
Lec9	Field effect transistors with insulated gate MOSFET - structure, types, characteristics, parameters. HexFET, VDMOS and IGBT transistors – basic information.	2
Lec10	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
Lec11	Optoelectronics - basic concepts, LEDs, photoresistors, photodiode, phototransistor, silicon photomultiplier, construction, principle of operation, characteristics, parameters, examples of applications.	2
Lec12	Photovoltaic panels - construction, operation, characteristics, parameters	2
Lec13	Electronic elements for protection and suppression – properties, basic parameters and characteristics.	1
Lec14	Operational amplifiers - basic structures, characteristics, parameters, static work, dynamic work with small signals, the frequency characteristics.	1
Lec15	Batteries, accumulators and sources of energy used in electronics – basic parameters and characteristics.	2
Lec16	Photovoltaic cells - practical applications.	2

Lec17	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
Lec18	Metrological properties of sensors (sensitivity, selectivity, linearity, repeatability, accuracy). Classification of sensors.	2
Lec19	Fundamentals and electronic instruments for measurement of position, displacement, and tension	1
Lec20	Fundamentals and electronic instruments for measurement of temperature.	2
Lec21	Fundamentals and electronic instruments for measurement of pressure.	2
Lec22	Fundamentals and electronic instruments for measurement of flow.	1
Lec23	Smart sensors.	1
Lec24	Sensor networks and interfaces.	1
Lec25	Serial interfaces.	2
Lec26	IEEE488 standard. SCPI specification.	1
Lec27	Network protocols used in distributed instrumentation.	1
	Total hours	**45**

Classes		**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**

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 LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01 – PEU_W04	Final exam
F2	PEU_U01 – PEU_U02	Two tests, Graded assignments of laboratory tasks
P = 0.5*F1 + 0.5*F2 (positive grade under condition: F1≥3 & F2≥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)

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