FACULTY OF CHEMISTRY

SUBJECT CARD

Name in Polish: Pomiary w aparaturze procesowej
Name in English: Measurements in chemical equipment
Main field of study (if applicable):
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level – supplementary semester, full-time
Kind of subject: obligatory
Subject code: ICR024024
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)	60		60		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BK) classes	1		1		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Competences in the field of mathematics and physics confirmed by positive assessments on the certificate of upper secondary school graduation.

SUBJECT OBJECTIVES

C1. Basic knowledge about metrology terms, error theory and measurement uncertainty theory, instruments to measure mean and RMS value currents and voltages..
C2. Make students aware of the possibility of using measuring circuits realizing different measurement methods for measuring basic electrical and non-electrical quantities.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEK_W01 Students knows basic terms of metrology. Student has knowledge in the field of measurement errors: systematical, random and mistakes with measuring errors interpretation on the base of instrument class knowledge..
PEK_W02 Student has knowledge about using and calculating uncertainty type A, B, total and extended.
PEK_W03 Students knows the construction, operation principle and processing characteristics of the most common measuring transducers. He knows the rules of physical quantities processing into electrical quantities.
PEK_W04 Students have basic knowledge of the dynamic characteristics of sensors and transducers. He knows the mathematical models of sensors and transducers.

relating to skills:

PEK_U01 Student is able to make quantity measurements with analog and digital instruments and can calculate measurement result using the uncertainty theory.
PEK_U02 Student has the ability in oscilloscope measurements for sinusoidal and distorted signals for high frequencies.
PEK_U03 Student is able to correctly select an instrument to measuring non-electrical quantities.
PEK_U04 Student is able to use the tool to temperature, pressure, stress, vibration, moisture content, chemical composition, flow rates of gases and liquids measure.

PEK_U05 Student has the skills to assess the impact of external factors on the result. He can estimate the measurement method error and make a correction.

relating to social competences:

PEK_K01 Student is aware of their own responsibility for their work and a willingness to comply with the principles of teamwork.

PEK_K02 Student searches information and can subject them to critical analysis.

PROGRAMME CONTENT

Lectures		**Number of hours**
Lec 1	Basic terms of metrology. Measurement errors of analogue and digital instruments. Instruments errors and classes. Systematical and random errors, mistakes.	2
Lec 2	Measurement uncertainty. Uncertainty type A, type B. Total uncertainty. Statistical distributions: Normal and Student.	2
Lec 3	Uncertainty of direct measurements. Uncertainty of indirect measurements. Calculation examples.	2
Lec 4	Processing of non-electrical quantities into electrical signals - general issues. Analogue to digital transducers of non-electrical quantities. Measurements of linear and angular displacement, measurements of vibration.	2
Lec 5	Strain gauge transducers, torque measurement, force measurements. Measurement of gas and liquid flow rates. Pressure measurements	2
Lec 6	Phametric and conductometric measurements, Measurements of chemical composition. Humidity measurements.	2
Lec 7	. Temperature measurement, temperature measurement methods, resistance and thermoelectric thermometers. Measuring methods for the temperature of solids, gases and liquids. Temperature measurements in industrial equipment.	2
Lec 8	Summary and credit of the subject	1
	Total hours	**15**
Laboratory		**Number of hours**
Lab1	Presentation of safety regulations and laboratory rules. Establish complete the course rules. Write of the measurement result learning.	2
Lab2	Analog instruments uses to measure voltages and currents. Determination of relative and absolute errors. Determination of the measurement result uncertainty.	2
Lab3	Digital instruments uses to measure voltages and currents. Determination of relative and absolute errors. Determination of the measurement result uncertainty.	2
Lab4	Measurements of sine and distorted waves by using an oscilloscope.	2
Lab5	Understanding the basic concepts of statistics and probability theory used in the assessment of the measurement accuracy with random errors.	2
Lab6	Power measurements.	2
Lab7	Frequency and phase shift measurements.	2
Lab8	Temperature measurements - determining characteristics of temperature sensors.	2
Lab9	Strain gauge measurements – sensor properties, force sensors tests.	2
Lab10	Pressure measurements.	2
Lab11	Liquid pH and conductivity measurements.	2
Lab12	Gas flow measurements	2
Lab13	Humidity measurements	2

Lab14	Determination of proximity (distance) sensor characteristics and linear and angular displacement sensors.	2
Lab15	Grading	2
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture with multimedia presentation.
N2. Laboratory: knowledge check in writing or oral form, report preparation, 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)	PEK_W01, PEK_W02, PEK_W03, PEK_W04	Exam
P (W) = F1 (W)		
F1 (L)	PEK_U01, PEK_U02, PEK_U03, PEK_U04, PEK_U05	Laboratory preparation
F2 (L)	PEK_U01, PEK_U02, PEK_U03, PEK_U04, PEK_U05	Laboratory activity
F3 (L)	PEK_U01, PEK_U02, PEK_U03, PEK_U04, PEK_U05	Reports
P=0,2F1+0,2F2+0,6F3		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Nawrocki Z., Dusza D., Analogue and digital measurement systems, Wrocław, 2011

[2] Tumański S., Principles of electrical measurements, New York ; London : Taylor & Francis, 2006

[3] Morris A.S., Measurement and Instrumentation Principles, Butterworth-Heinemann, 2001.

[4] J.Mc.Ghee, I.A. Henderson, M.J. Korczyński, W.Kulesza: Scientific metrology, Technical University of Lodz, Lodz, 1998.

SECONDARY LITERATURE:

[1] Mc.Ghee, I.A. Henderson, M.J. Korczyński, W.Kulesza: Measurement data handling, vol. 1 and vol.2 , Technical University of Lodz, Lodz,200

[2] Editors: Erika Kress-Rogers and Christopher J. B. Brimelow - Instrumentation and sensors for the food industry, second edition, CRC Press 2001

[3] Nestor 0. Shpak, Vadim P. Deynega Nikolay V. Kirianaki and Sergey Y. Yurish - Data Acquisition And Signal Processing For Smart Sensors, John Wiley & Sons 2002

[4]Tumański S.: *Technika pomiarowa*, WNT, Warszawa, 2007

[5] Kalus-Jęcek B., *Wzorce wielkości elektrycznych i ocena niepewności pomiarów*, Wyd. Pol. Łódzkiej, Łódź, 2000

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

Daniel Dusza, daniel.dusza@pwr.wroc.pl