FACULTY OF ELECTRICAL ENGINEERING

SUBJECT CARD

Name in Polish:	**Miernictwo elektryczne 2**
Name in English:	**Electrical Metrology 2**
Main field of study (if applicable):	**Electrical Engineering**
Specialization (if applicable):	
Level and form of studies:	**1st level, full-time**
Kind of subject:	**obligatory**
Subject code:	**ELR053315**
Group of courses:	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU):	30		15		
Number of hours of total student workload (CNPS):	60		30		
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 a basic knowledge of basic mathematical operations, functions properties (trigonometric, exponential, logarithmic, and inverse to them), indefinite integral calculus of one variable functions.
2. Has a basic knowledge of the electrical metrology and measurement units. Knows measurement properties of basic metrological tools, bridge circuits. Has a knowledge of calculation methods used to measurement result calculations.

SUBJECT OBJECTIVES

C1. Familiarize student with a knowledge of: analogue instruments to measure mean nad RMS value of currents and voltages, bridge measurement circuits, measure active and reactive power three-phase lines alternating current, using intrument transformers and standard transducers in high-voltage power lines, reactive power measurements.

C2. Awareness student possibilities of using measurement circuits realizing different measurement methods to measure basic electrical quantities.

C3. Skills sophistication of correctly writing measurement results in used measurement systems in range of basic electrical quantities measures.

C4. Skills sophistication of electric circuits connection, current, voltage and power measurements using analogue and digital instruments and oscilloscopes.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01	Has knowledge of moving coil meters, moving iron meters, electrodynamic meters and knows measurement circuits using these instruments.
PEU_W02	Has a knowledge of the resistance and impedance measurements and its components using the deflection and zero method.
PEU_W03	Has knowledge of measurement systems to measure active and reactive power single-phase and three-phase lines alternating current. Knows basis methods of current and voltage processing and knows measurement circuits to measure active power in high-voltage lines.

relating to skills:

PEU_U01	Be able to measure current and voltage using analog and digital instruments and oscilloscope. Knows how to develop a measurement result using uncertainty theory.
PEU_U02	Be able to choose the correct measurement circuit to measure quantities by technical method. Can measure the resistance using digital ohmmeters.

relating to social competences:

PEU_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	Resistance measurement using technical method, method error.	2
Lec 2	Moving-iron meters. Electrodynamic meters. Power measurement implementation – the scalar product.	2
Lec 3	Properties of ferrodymamic and electrostatic instruments.	2
Lec 4	Resistance measurements using analog and digital meters and bridges. Wheatstone and Thomson bridge.	2
Lec 5	Impedance measurements using AC bridges. Wien, Maxwell-Wien, Schering and transformer bridge.	2
Lec 6	Voltage standards, DC voltage compensators.	2
Lec 7	Analogue and digital measurement technique. Sampling, quantization and coding signals. Digital voltmeter with dual slope integral converter.	2
Lec 8	One-phase circuit power measurement – elimination of method error.	2
Lec 9	Three-phase power measurement using one or three wattmeters.	2
Lec 10	Three-phase power measurement using two wattmeters.	2
Lec 11	Reactive power definitions. One-phase reactive power measurements. Three-phase reactive power measurements.	2
Lec 12	Voltage and current instrument transformers. Current and voltage transducers with inductive and Hall effect sensors zero detectors.	2
Lec 13	Single-phase high voltage power measurements. Three-phase high voltage power measurements.	2
Lec 14	AC voltage and current RMS value converters.	2
Lec 15	Test.	2
	Total hours:	**30**

Form of classes - laboratory		**Number of hours:**
Lab 1	Presentation the Procedure Health and Safety Rules and Laboratory Rules. Establish rules for passing. Rounding of the measurement results rules presentation. Learning writing the measurement results.	1
Lab 2	Voltage and current measurements using analogue meters. Absolute and relative errors determination. Measurement result uncertainty calculation.	2
Lab 3	Voltage and current measurements using digital meters. Absolute and relative errors determination. Measurement result uncertainty calculation.	2
Lab 4	Sinusoidal and distorted signals measures generated from function generator using oscilloscope.	2
Lab 5	Resistance measurements using multimeter and circuits realizing technical methods. Correct measurement circuit selection, assessing method errors and measurement result uncertainty calculation.	2
Lab 6	Indirect measurement inductive elements substitute parameters using measuring circuit realizing technical method. Correct measurement circuit selection, assessing method errors and measurement result uncertainty calculation.	2
Lab 7	Understanding the basic terms of statistics and probability, used in assessing measure accuracy with random errors.	2
Lab 8	Assessment and complement arreas.	2
	Total hours:	**15**

TEACHING TOOLS USED
N1. Traditional lecture, multimedia presentations.
N2. Check knowledge in oral and writing answer 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)	PEU_W01 PEU_W02 PEU_W03	Test.
P(W)	P=F1	
F1(L)	PEU_U01 PEU_U02	Check preparation to laboratory.
F2(L)	PEU_U01 PEU_U02 PEU_K01	Activity.
F3(L)	PEU_U01 PEU_U02	Report.
P(L)	P=0,3F1+0,1F2+0,6F3	

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Chwaleba A., Poniński M., Siedlecki A.: Metrologia elektryczna, WNT, Warszawa 2010.
[2] Miernictwo elektryczne – Ćwiczenia laboratoryjne, praca zbiorowa pod redakcją D. Koczeli, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2001
[3] Tumański S.: Technika pomiarowa, WNT, Warszawa, 2007
[4] Derlecki S., Metrologia elektryczna i elektroniczna, Podręczniki Akademickie- Pol. Łódzka, 2010
[5] Kalus-Jęcek B., Wzorce wielkości elektrycznych i ocena niepewności pomiarów, Wyd. Pol. Łódzkiej, Łódź, 2000
[6] www.imnipe.pwr.edu.pl

SECONDARY LITERATURE:

[1] Kwiatkowski W.: Miernictwo elektryczne. Analogowa technika pomiarowa, OW Pol. Warszawskiej, Warszawa, 1998
[2] Lisowski M., Podstawy metrologii, Of. Wyd. Pol. Wrocławskiej, Wrocław, 2011
[3] Marcyniuk A., Pasecki E., Pluciński M., Szadkowski B., Podstawy Metrologii Elektrycznej, Warszawa, WNT, 1984.
[4] Orzeszkowski Z.: Podstawy metrologii elektrycznej, Wyd. Pol. Wrocławskiej, Wrocław 1981.
[5] Czajewski J., Podstawy metrologii elektrycznej, OW Pol. Warszawskiej, Warszawa, 2008
[6] Piotrowski J., Podstawy miernictwa, WNT, 2003

SUBJECT SUPERVISOR

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