

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: **ELR043315**  
 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**

- Has a basic knowledge of basic mathematical operations, functions properties (trigonometric, exponential, logarithmic, and inverse to them), indefinite integral calculus of one variable functions.
- 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 and RMS value of currents and voltages, bridge measurement circuits, measure active and reactive power three-phase lines alternating current, using instrument 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 EDUCATIONAL EFFECTS***relating to knowledge:*

- PEK\_W01 Has knowledge of moving coil meters, moving iron meters, electrodynamic meters and knows measurement circuits using these instruments.
- PEK\_W02 Has a knowledge of the resistance and impedance measurements and its components using the deflection and zero method.
- PEK\_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:*

- PEK\_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.
- PEK\_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:*

- PEK\_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 ferrodynamic 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:		<b>30</b>

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 arrears.	2
Total hours:		<b>15</b>

## TEACHING TOOLS USED

- N1. Traditional lecture, multimedia presentations.  
 N2. Check knowledge in oral and writing answer form, report preparation, office hours.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT		
Evaluation <i>F – forming (during semester)</i> <i>P – concluding (at semester end)</i>	Educational effect number	Way of evaluating educational effect achievement
F1(W)	PEK_W01 PEK_W02 PEK_W03	Test.
P(W)	P=F1	
F1(L)	PEK_U01 PEK_U02	Check preparation to laboratory.
F2(L)	PEK_U01 PEK_U02 PEK_K01	Activity.
F3(L)	PEK_U01 PEK_U02	Report.
P(L)	$P=0,3F1+0,1F2+0,6F3$	

PRIMARY AND SECONDARY LITERATURE
<b>PRIMARY LITERATURE:</b> [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] <a href="http://www.imnipe.pwr.edu.pl">www.imnipe.pwr.edu.pl</a> <b>SECONDARY LITERATURE:</b> [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
Daniel Dusza, <a href="mailto:daniel.dusza@pwr.edu.pl">daniel.dusza@pwr.edu.pl</a>

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT  
**ELR043315 - Electrical Metrology 2**  
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_W22	C.1 C.2	Lec1 Lec2 Lec3 Lec7	N.1
PEK_W02	K1ETK_W22	C.1 C.2	Lec4 Lec5 Lec6	N.1
PEK_W03	K1ETK_W22	C.1 C.2	Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14	N.1
PEK_U01	K1ETK_U19	C.3 C.4	Lab1 Lab2 Lab3 Lab4 Lab7	N.2
PEK_U02	K1ETK_U19	C.3 C.4	Lab5 Lab6	N.2
PEK_K01	K1ETK_K05	C.1 C.2 C.3 C.4	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14 Lec15 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.1 N.2