

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Kompatybilność elektromagnetyczna**
 Name in English: **Electromagnetic Compatibility**
 Main field of study (if applicable): **Electrical Engineering**
 Specialization (if applicable): **Renewable Energy Systems**
 Level and form of studies: **2nd level, full-time**
 Kind of subject: **obligatory**
 Subject code: **ELR033311**
 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. He has basic knowledge in the field of linear circuits with sinusoidal waveforms. He knows the rules for creating circuit models and their mathematical description.
2. He or she has knowledge in the analysis of transients in linear electric circuits. He has knowledge of the macroscopic electromagnetic field approach
3. He has a basic knowledge of metrology and measurement units, knows basic metrological characteristics of measuring instruments, are knowledgeable about the design of measurement known calculation methods used in developing the measurement results, a knowledge of the latest measurement technology
4. He or she is able to do basic measurements of electrical devices using analog and digital oscilloscope. Can set on the basis of measurements of nonlinear characteristics of the elements. Able to present the results in the form of numerical tables and graphics to make their interpretations and draw conclusions

SUBJECT OBJECTIVES

- C1. Understanding the concepts of electromagnetic compatibility
- C2. Understanding the principles of interaction between the elements of the power system
- C3. Knowledge of voltage quality parameters, evaluation of the impact of power quality on loads and the impact on the quality of the loads
- C4. Knowing regulations and standardization of components which improve power quality
- C5. Getting the practical skills in the assessment of power quality and surge protection
- C6. Acquisition and consolidation of social skills including emotional intelligence skills involving the cooperation of a group of students with a view to effective problem solving. Responsibility, honesty and fairness in the procedure observance force in academia and society

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

- PEK_W01 He or she knows the key concepts in the field of electromagnetic compatibility. He has extensive knowledge in the field of power quality
- PEK_W02 He knows the power requirements of the law and regulations relating to electromagnetic compatibility standards - in particular the power quality
- PEK_W03 He or she has knowledge of the location and control the interference sources and their affect on the device. Know the methods of overvoltage protection. He or she knows methods to improve the power quality and ways to reduce disturbances

relating to skills:

- PEK_U01 He can determine and evaluate the power quality parameters
- PEK_U02 He knows the procedure for carrying out the immunity tests of the loads (equipment) on power system disturbances
- PEK_U03 He has the skills to assess the disturbances emissions from loads

relating to social competences:

- PEK_K01 He or she is aware of their own responsibility for their work and a willingness to comply with the principles of teamwork. He searches information and its critical analysis, properly identifies and resolves the dilemmas of working in the profession

PROGRAMME CONTENT

Form of classes - lecture		Number of hours:
Lec 1	Electromagnetic Compatibility. Power quality parameters	2
Lec 2	Definitions of parameters determining the power quality - the conditions of measurement, presentation the impact of the distortion on electric loads	2
Lec 3	Power quality standards	2
Lec 4	Sources and external parameters of electromagnetic interference. Lightning as a source of interference, Elements lightning protection, the basic parameters of the varistor, varistor assembly rules	2
Lec 5	Design rules for hybrid security systems, information transmission systems.	2
Lec 6	Voltage variation. Long and short term flicker.	2
Lec 7	Methods of reducing the voltage distortion - examples	2
Lec 8	Measurement methods of harmonics and interharmonics.	2
Lec 9	Shielding. The effectiveness of shielding against electromagnetic interference and electrical. Shielding low-frequency magnetic fields, the materials for the construction of the shield	2
Lec 10	Harmonic filters. Examples of calculating analysis of the effectiveness of filters.	2
Lec 11	Electric energy losses due to voltage distortion.	2
Lec 12	EMC issues in control systems	2
Lec 13	Methods of immunity test of electric loads. Measurement of disturbances emission	2
Lec 14	Electromagnetic Compatibility i radio frequency range. Electrostatic discharge (ESD) Fast transients (BURST) and high - energy surges (SURGE)	2
Lec 15	test	2
Total hours:		30

Form of classes - laboratory		Number of hours:
Lab 1	Presentation of the safety rules and principles of assessment laboratory. Presentation of laboratory	1
Lab 2	Voltage quality - measurement of voltage variation, frequency, unbalance, dips, and short interruption, harmonics and interharmonics, mains signalling voltage	2
Lab 3	Current and voltage waveforms analysis - determining of harmonics and interharmonics contents	2
Lab 4	Testing of nonlinear loads influence on waveform distortion	2
Lab 5	Voltage variation, dips and short interruption immunity tests	2
Lab 6	Measurement of harmonics emission of electric equipments	2
Lab 7	Harmonic analysis of active, reactive and apparent power in circuits with non-sinusoidal voltage and current waveforms	2
Lab 8	Spectrum Analyzer	2
Total hours:		15

TEACHING TOOLS USED

- N1. Traditional Lecture with audio-visual techniques
- N2. Laboratory run in the traditional manner of exercises + student groups, a report

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 PEK_U03 PEK_K01	Average grade of laboratory reports
P(L)	P=F1	

PRIMARY AND SECONDARY LITERATURE	
PRIMARY LITERATURE:	
[1] Hasse P.: Overvoltage protection of low voltage systems, TJ International, Padstown, 2000 [2] Pradas Kodali V.: Engineering Electromagnetic Compatibility Principles, Measurements and Technology, IEEE Press, New York, 1996 [3] Baghini A., Handbook of Power Quality, John Wiley&Sons, Ltd, 2008 [4] PN-EN 50160:2010, Voltage Characteristics in Public Distribution Systems [5] Henry W. Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons, Inc., Hoboken, New Jersey 2009	
SECONDARY LITERATURE:	
[1] IEEE Std 1159-2009: IEEE Recommended Practice for Monitoring Electric Power Quality [2] Dugan R.C., Mc Gramaghan M.F., Beaty H. W., Santoso S: Electrical Power System Quality, Wyd 2. MC Graw-Hill 2002 [3] Standler R. B.: Protection of electronic circuits from overvoltages John Wiley & Sons, New York, 1989 [4] Clayton R. P.: Introduction to electromagnetic compatibility John Wiley & Sons, New York, 1992 [5] Arrillaga J. Watson N. R.: Power System Quality Assessment, John Wiley & Sons, New York, 2000	

SUBJECT SUPERVISOR
Grzegorz Kosobudzki, grzegorz.kosobudzki@pwr.edu.pl

MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR033311 - Electromagnetic Compatibility
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**
AND SPECIALIZATION **Renewable Energy Systems**

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	S2RES_W11	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14	N.1
PEK_W02	S2RES_W11	C.1 C.2 C.3 C.4	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14	N.1
PEK_W03	S2RES_W11	C.1 C.2 C.3	Lec1 Lec2 Lec3 Lec4 Lec5 Lec6 Lec7 Lec8 Lec9 Lec10 Lec11 Lec12 Lec13 Lec14	N.1
PEK_U01	S2RES_U11	C.4 C.5 C.6	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2
PEK_U02	S2RES_U11	C.4 C.5 C.6	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2
PEK_U03	S2RES_U11	C.4 C.5 C.6	Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.2
PEK_K01	S2RES_K02	C.6	Lec15 Lab1 Lab2 Lab3 Lab4 Lab5 Lab6 Lab7 Lab8	N.1 N.2