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:	**ELR053311**
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 LEARNING OUTCOMES	
relating to knowledge:	
PEU_W01	He or she knows the key concepts in the field of electromagnetic compatibility. He has extensive knowledge in the field of power quality
PEU_W02	He knows the power requirements of the law and regulations relating to electromagnetic compatibility standards - in particular the power quality
PEU_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:	
PEU_U01	He can determine and evaluate the power quality parameters
PEU_U02	He knows the procedure for carrying out the immunity tests of the loads (equipment) on power system disturbances
PEU_U03	He has the skills to assess the disturbances emissions from loads
relating to social competences:	
PEU_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 emmision	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 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 PEU_U03 PEU_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, Measurments and Technology, IEEE Press, New York, 1996
[3] Baggini 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

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