STUDY MODULE DESCRIPTION FORM

Name of the module/subject		Code
High voltage engineering		**1010322221010311585**
Field of study	Profile of study (general academic, practical)	Year /Semester
Electrical Engineering	**(brak)**	**1 / 2**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
-	**polish**	**obligatory**
Cycle of study:	Form of study (full-time,part-time)	
Second-cycle studies	**full-time**	
No. of hours		No. of credits
Lecture: **1** Classes: **-** Laboratory: **1** Project/seminars: **-**		**2**
Status of the course in the study program (Basic, major, other)	(university-wide, from another field)	
(brak)	**(brak)**	
Education areas and fields of science and art		ECTS distribution (number and %)
technical sciences		**2 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Student has basic knowledge about physical phenomena occurring in insulating materials Student has knowledge about typical construction of high voltage equipments and apparatus
2	**Skills**	Student has the ability to design the basic high-voltage insulation systems Student has the ability to conduct basic diagnostic tests on high-voltage equipments and apparatus
3	**Social competencies**	Student has the ability to work and collaborate in groups

Assumptions and objectives of the course:

Construction of high-voltage equipment and insulation systems. The methods for proper selection of high-voltage insulation materials. The parameters and physical phenomena in diagnostics of high-voltage equipment. The review of modern diagnostic techniques and assessment of the insulation condition of high-voltage equipment. The digital processing and proper interpretation of measurement data for assessment of high-voltage equipment condition.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Student has knowledge about physical phenomena occurring in high-voltage insulation systems - [K_W03++]
2. Student has knowledge about design of high-voltage insulation systems - [K_W05+++]
3. Student has detailed knowledge about high voltage equipment diagnostics; Student has knowledge in the area of elaborating of experiment results - [K_W11+++]
4. Student has extended knowledge about construction and functioning of high-voltage equipment insulating systems - [K_W15+++]

Skills:

1. Student can process and properly interpret measurement data to evaluate technical condition of high-voltage equipment - [K_U03+++]
2. can apply an adequate diagnostic method to evaluate condition of high-voltage equipment insulation system - [K_U09++]
3. Student can gain information based on literature and other sources related to construction and diagnostic methods of high-voltage equipment - [K_U01++]

Social competencies:

1. Student is aware of the role of high-voltage equipment diagnostics in assuring continuity of energy supply for industry and population - [K_K02++]
2. Student is aware of threats scale and influence of high-voltage equipment breakdown results on natural environment naturalne - [K_K02++]

Assessment methods of study outcomes

Lectures:
- evaluation of knowledge and skills proven on written or oral examinations during examination session

Laboratory classes:
- tests and rewarding knowledge necessary to realise basic problems in the given laboratory task field
- continuous evaluation, on each class - rewarding improvement of ability to use the known rules and methods,
- evaluation of knowledge and skills related to realisation of laboratory task, evaluation of report on task carried out
- evaluation of knowledge and skills proven on written or oral test

Course description

LECTURE:
- Construction of high voltage equipment and systems
- Ageing processes occurring in high-voltage insulation systems
- Problems of partial discharges occurring in high voltage insulation systems
- Problems of moisture of paper-oil insulation
- Methods of high-voltage equipment diagnostics:

a) methods of partial discharges detection (HF, UHF, EA, conventional),
b) evaluation methods of insulation system moisture content (Karl-Fischer, FDS, PDC, RVM, capacitive probe),
c) detection methods of power transformer windings deformation (FRA/SFRA),
d) methods

LABOARTORY:
1. Detection and location of partial discharges using acoustic emission method (EA)
2. Measurement of partial discharges using conventional electric method (PN-EN 60270)
3. Detection of partial discharges registered in HF/UHF frequency band
4. Detection of power transformer insulation system defects basing on analysis of gases dissolved in insulation oil
5. Evaluation of moisture content insulation system using physicochemical methods (Karl-Fischer, capacitive probe)
6. Evaluation of moisture content insulation system using physicochemical methods (FDS/PDC/RVM)
7. Detection of power transformer windings deformation using FRA/SFRA method

Basic bibliography:

1. Florkowska B., Diagnostyka wysokonapięciowych układów izolacyjnych urządzeń elektroenergetycznych, Wydawnictwo AGH Kraków, 2009
2. Gulski E., Diagnozowanie wyładowań niezupełnych w urządzeniach wysokiego napięcia w eksploatacji, Prace Naukowe Politechniki Warszawskiej, 2003
3. Flisowski Z., Technika wysokich napięć, WNT Warszawa, 2009
4. Gacek Z., Wysokonapięciowa technika izolacyjna, Wydawnictwo Politechniki Śląskiej, Gliwice, 2006
5. Mościcka-Grzesiak H., pod red., Inżynieria wysokich napięć w elektroenergetyce, Wydawnictwo Politechniki Poznańskiej, tom I ? 1996, tom II ? 1999
6. Fleszyński J., pod red., Laboratorium wysokonapięciowe w dydaktyce i elektroenergetyce, Oficyna Wydawnicza Politechniki Wrocławskiej, 1999

Additional bibliography:

1. Kuffel E., Zaengl W., Kuffel J., High Voltage Engineering. Fundamentals, Butterworth-Heineman, 2001

Result of average student's workload

Activity	Time (working hours)
1. Participation in lecture classes	15
2. Participation in laboratory classes	15
3. Consultations	2
4. Preparation for examination	10
5. Preparation for laboratory classes	7
6. Preparation of reports	10
7. Participation in examinations	3

Student's workload		
Source of workload	**hours**	**ECTS**
Total workload	62	2
Contact hours	35	1
Practical activities	32	1