STUDY MODULE DESCRIPTION FORM

Name of the module/subject	Code
High voltage engineering fundamentals	

Field of study	Profile of study (general academic, practical)	Year /Semester
Mathematics in Technology	**general academic**	**2 / 4**
Elective path/specialty	Subject offered in:	Course (compulsory, elective)
-	**Polish**	**compulsory**

Cycle of study:	Form of study (full-time,part-time)
First-cycle studies (Polish Qualifications Framework level six)	**full-time**

No. of hours					No. of credits
Lecture: **30**	Classes: **-**	Laboratory: **30**	Project/seminars: **-**		**4**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
major	**university-wide**

Education areas and fields of science and art	ECTS distribution (number and %)
Technical sciences	**4 100%**
Technical sciences	**4 100%**

Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	1. He/She has extended and in-depth knowledge of physics [K_W05 (P6S_WG)] 2. He/She has ordered knowledge of the theory of signals, measurements, data acquisition and analysis [K_W07 (P6S_WG)] 3. He/She has basic knowledge of the principles of ergonomics, health and safety at work, and risks in industry, etc. [K_W13 (P6S_WK)]
2	**Skills**	1. He/She is able to use mathematical tools and methods, including numerical ones to solve engineering problems [K_U03 (P6S_UW)] 2. He/She can formulate an engineering problem, conduct detailed research using analytical or simulation or experimental methods, interpret the results obtained and draw conclusions [K_U05 (P6S_UW)] 3. He/She can choose the appropriate method and use measuring apparatus to measure the basic measurable quantities; he/she can use the basic methods of processing and analysis of signals or data [K_U07 (P6S_UW)]
3	**Social competencies**	1. He/She is aware of the level of his knowledge in relation to the conducted research in exact and technical sciences [K_K01 (P6S_KK)] 2. He/She is aware of deepening and extending the knowledge to solve newly created technical problems [K_K02 (P6S_KK)]

Assumptions and objectives of the course:

Getting to know the basic issues related to the high voltage technique. Understanding the test sources of high voltages. Understanding the measurement techniques of typical high voltage parameters. Understanding the physical phenomena occurring in insulating systems under high voltage.

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

Knowledge:

1. He/She has structured and theoretically founded knowledge in the field of technical sciences, including electrical engineering, electronics and automation [KW_04 (P6S_WG)]
2. He/She has basic knowledge in the field of material properties and applications [KW_10 (P6S_WG)]

Skills:

1. He/She is able to choose the appropriate method and use measuring apparatus to measure the basic measurable quantities; he/she can use the basic methods of processing and analysis of signals or data [K_U07 (P6S_UW)]
2. He/She is able to use devices, tools, etc. in accordance with general requirements and technical documentation; he/she knows how to apply the principles of health and safety at work [KU_09 (P6S_UW)]
3. He/She is able to use the knowledge and methods and tools to solve typical engineering tasks [KU_10 (P6S_UW)]
4. He/She is able to prepare documentation or to prepare a speech with a multimedia presentation related to the implementation of an engineering task using specialized terminology [KU_12 (P6S_UK)]

Social competencies:

1.He/She is able to think and act in a creative and entrepreneurial way, taking into account the safety, ergonomics of work and its economic aspects, he/she is aware of the need to initiate action for the public interest and responsibility for the effects of the team and its participants [K_K03 (P6S_KO)]
2. He/She is aware of its social role as a graduate of a technical university, is ready to communicate popular scientific content to the society and to identify and resolve basic problems related to the field of study [K_K05 (P6S_KR)]

Assessment methods of study outcomes

Lecture: assessment of knowledge and skills shown at the written exam.

Laboratory exercises:

- test and rewarding knowledge necessary for the accomplishment of the problems in the area of laboratory tasks,
- continuous assessment, for each classes - rewarding gain skills they met the principles and methods,
- assessment of knowledge and skills related to the implementation of the tasks of exercises, evaluation of the reports from classes.

Course description

Direct current (DC) test sources (rectifier circuits), alternate current (AC) test sources (high voltage test transformer), surge voltage test sources (Marx generator).

Methods of measurement of high voltage electrical parameters, such as electrical strength (flat spark gap, sphere-sphere spark gap, cylindrical spark gap, edge spark gap), volume resistance and surface capacitance (Schering bridge), partial discharges, dielectric loss factor tan(delta) (Schering bridge).

Statistical analysis of the measurements results.

In the laboratory, will be performed the following topics: measurement of electrical strength of the flat, sphere-sphere, cylindrical and edge spark gaps; analysis of the corona phenomenon; dependence of electrical strength of air pressure; the effect of the space charge on the strength of the air; partial discharges; voltage distribution in chain of insulators; high voltage measurement techniques; development of conductive bridges in the oil; investigation of transformer oil.

Update 2018: partial discharges -> partial discharges: test methods.

Basic bibliography:

1. Flisowski Z., Technika wysokich napięć, Wydawnictwo WNT, Warszawa, 2017.
2. Ćwiczenia laboratoryjne z materiałoznawstwa elektrotechnicznego i techniki wysokich napięć, pod redakcją H. Mościckiej-Grzesiak, skrypt, Wydawnictwo Politechniki Poznańskiej, Poznań, 2002.
3. Florkowska B., Wytrzymałość elektryczna gazowych układów izolacyjnych wysokiego napięcia, Uczelniane Wydawnictwo Naukowo-Dydaktyczne AGH, Kraków, 2003.

Additional bibliography:

1. Gacek Z., Wysokonapięciowa technika izolacyjna, Wydawnictwo Politechniki Śląskiej, Gliwice, 2006.
2. Gacek Z., Kształtowanie wysokonapięciowych układów izolacyjnych stosowanych w elektroenergetyce, Wydawnictwo Politechniki Śląskiej, Gliwice, 2002.
3. Florkowska B. i inni, Mechanizmy, pomiary i analiza wyładowań niezupełnych w diagnostyce układów izolacyjnych wysokiego napięcia, Uczelniane Wydawnictwo Naukowo-Dydaktyczne AGH, Kraków, 2001.
4. PN-EN 60270:2003 Wysokonapięciowa technika probiercza - Pomiary wyładowań niezupełnych
5. Sikorski W., Morańda H., Lokalizacja źródeł wyładowań niezupełnych w transformatorach energetycznych metodą emisji akustycznej i konwencjonalną metodą elektryczną, Pomiary Automatyka Kontrola, 2017, T. 57, ss. 356-359
6. Nadolny Z., Grzybowski A., Kasprzak W., Ludwikowski K., Lopatkiewicz R., Moranda H., Przybylek P., Sikorski W., Siodla K., Analysis of electric and magnetic field intensity generated by overhead power distribution lines of high voltage in Poznan, Przegląd Elektrotechniczny, T. 86, Wyd. 11b, 2010/11, ss. 254-257

Result of average student's workload

Activity	Time (working hours)
1. Participation in lectures classes	30
2. Participation in laboratory classes	30
3. Participation in the consultations related to the implementation of the education process, especially laboratory classes	2
4. Finishing (as part of own work) reports on laboratory exercises	6
5. Preparing for laboratory exercises	15
6. Preparing to pass the lecture and participate in it	17

Student's workload

Source of workload	hours	ECTS
Total workload	100	4
Contact hours	64	2
Practical activities	53	2