



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

High-voltage insulation systems [S1Eltech2>PO5-WUI]

### Course

Field of study	Year/Semester
Electrical Engineering	3/6
Area of study (specialization)	Profile of study
–	general academic
Level of study	Course offered in
first-cycle	Polish
Form of study	Requirements
full-time	elective

### Number of hours

Lecture	Laboratory classes	Other
15	15	0
Tutorials	Projects/seminars	
0	15	

### Number of credit points

3,00

### Coordinators

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### Lecturers

### Prerequisites

The student possesses knowledge in electrical materials science, electromagnetic field theory, and high-voltage technology. They can construct a simple electrical circuit and measure basic electrical quantities. They can work and collaborate in a team.

### Course objective

The aim of the course is to familiarize students with the construction of high-voltage insulation systems and the characteristics of the materials they comprise, as well as the analysis of electric field distribution in various insulation systems.

### Course-related learning outcomes

Knowledge:

1. Possesses advanced knowledge of the construction of insulation systems for electrical power equipment
2. Knows and understands the physical phenomena occurring in high-voltage insulation systems and has knowledge of the influence of specific material properties on the electrical strength of high-voltage insulation systems

#### Skills:

1. Is able to diagnose selected high-voltage insulation devices and systems.
2. Is able to design selected high-voltage insulation systems using electric field strength distribution analysis.
3. Is able to conduct physical experiments involving measurements of quantities describing the condition of insulation systems.

#### Social competences:

1. Understands the role of own work, teamwork and responsibility for team tasks performed within high voltage engineering.

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

#### Lecture:

1) Knowledge and skills related to the topics covered during the lectures are assessed during an exam. A passing grade on the exam requires a score of at least 50%.

#### Laboratory classes:

- 1) Assessment of laboratory reports.
- 2) Continuous monitoring of preparation for the laboratory classes and rewarding knowledge necessary to complete the assigned problems in a given laboratory area.

#### Project:

- 1) Evaluation of the completed project.

### Programme content

This course discusses the structure of insulation systems in selected high-voltage devices and the properties of dielectrics. Furthermore, it addresses issues related to the distribution of the electric field in insulation systems and its control.

### Course topics

The lectures cover the following topics:

- 1) Construction of insulation systems for selected high-voltage devices
- 2) Characteristics of dielectrics used in insulation systems
- 3) Electric strength and electric field - unlayered parallel plates system, unlayered coaxial cylinder system, parallel coaxial cylinder system, concentric and eccentric sphere system, point to point system, series and parallel layered parallel plates system, series layered cylindrical system
- 4) The influence of impurities on the electric field distribution in a dielectric
- 5) Controlling the electric field distribution
- 6) Using CAD software to analyze the electric field distribution

The laboratory classes covers the following topics:

- 1) The effect of barriers on the flashover voltage in air-insulated systems
- 2) The effect of mesh screens on the electric field distribution around power equipment
- 3) Tests of surge arresters
- 4) Tests of partial discharges in a power cable
- 5) Determination of the electric field distribution on a cable model
- 6) Tests of spark gaps used to protect overhead lines

The project covers the following topic:

1. Preparation of the power capacitor project

### Teaching methods

The theory presented during lectures is closely linked to practice. A discussion is initiated during the lecture. The lecture includes a multimedia presentation (including drawings, photos, and videos) supplemented by information provided on the board.

The laboratory classes are designed for teamwork. Laboratory reports are reviewed and discussed by the instructor.

Project activities are supplemented with multimedia presentations, and the project documentation is thoroughly reviewed by the instructor. Tools enabling students to complete the tasks at home (e.g.,

open-source software) are provided.

## Bibliography

### Basic:

1. Gacek Z., Wysokonapięciowa technika izolacyjna, Wydawnictwo Politechniki Śląskiej, Gliwice 2006
2. Florkowska B., Kuniewski M., Florkowski M., Włodek R., Wysokie napięcie w elektroenergetyce. Wybrane zagadnienia i obliczenia., Wydawnictwa AGH, Kraków 2020
3. Szczepański Z., Lechowski Z., Rosicki A., Wodziński J., Układy izolacyjne urządzeń elektroenergetycznych, WNT, Warszawa 1978
4. Flisowski Z., Technika wysokich napięć, Wydawnictwo Naukowo-Techniczne, Warszawa 2017
5. Florkowska B., Furgał J., Technika wysokich napięć - Podstawy teoretyczne i laboratorium, Wydawnictwo AGH, Kraków 2017

### Additional:

1. Mościcka-Grzesiak H., Inżynieria wysokich napięć w elektroenergetyce, Wydawnictwo Politechniki Poznańskiej, tom I - 1996
2. Mościcka-Grzesiak H., Inżynieria wysokich napięć w elektroenergetyce, Wydawnictwo Politechniki Poznańskiej, tom II - 1999
3. Celiński Z., Materiałoznawstwo elektrotechniczne, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2005
4. Gielniak J., Ćwiczenia laboratoryjne z inżynierii materiałowej w elektrotechnice, Wydawnictwo Politechniki Poznańskiej, Poznań 2009
5. Sikorski, W., Walczak, K., Przybyłek, P., Moisture Migration in an Oil-Paper Insulation System in Relation to Online Partial Discharge Monitoring of Power Transformers. Energies 2016, 9, 1082. <https://doi.org/10.3390/en912108>

## Breakdown of average student's workload

	Hours	ECTS
Total workload	77	3,00
Classes requiring direct contact with the teacher	47	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00