



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

High voltage engineering [N1Eltech1>TWN]

### 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
part-time	compulsory

### Number of hours

Lecture	Laboratory classes	Other (e.g. online)
20	20	0
Tutorials	Projects/seminars	
0	0	

### Number of credit points

5,00

### Coordinators

dr hab. inż. Hubert Morańda prof. PP  
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mgr inż. Cyprian Szymczak

### Lecturers

### Prerequisites

Student has knowledge in frame of electric engineering material science, and knows fundamental principles of theory of electrical circuits . He/she can build simple electrical system. He/she can work and cooperate in group.

### Course objective

To know simple tasks connected to high voltage engineering. To know sources of test Voltage. To know methods of measurements of typical properties for high voltage engineering. To know fundamental definitions regarding to Overvoltage protection.

### Course-related learning outcomes

Knowledge:

1. Student has knowledge about the life cycle, design and operation of electrical power equipment, knows and understands the principle of their operation.
2. He/She has structured and theoretically founded knowledge about the construction, principles of

operation and operation of transformers, electrical machines and technical systems, knows the processes occurring in their life cycle.

3. He/She has basic knowledge necessary to understand social, ethical, economic, legal and other non-technical conditions of engineering activities, knows the basic principles of ergonomics, health and safety and hazards occurring in the industry related to the awarded qualification.

4. He/She knows and understands the physical phenomena occurring in high-voltage insulation systems, systems for generating high voltage and surge protection, has basic knowledge about the life cycle of this type of systems.

Skills:

1. He/She is able to plan and carry out simulations and measurements of basic quantities characteristic for electrical systems; can present the results in numerical and graphical form, make their interpretations and draw the right conclusions.

2. He/She is able to design and perform, in accordance with the specification and using the right methods, techniques, tools and materials, typical electrical systems designed for different applications.

3. He/She can compare different design solutions in the technical, system and non-technical field, due to selected functional and economic criteria.

4. He/She is able to use his knowledge in the selection of measuring apparatus for the measurement and acquisition of basic measurable quantities characteristic of electrical engineering, in typical and atypical conditions (not fully predictable).

5. He/She is able to correctly operate electric devices in accordance with general requirements and technical documentation.

Social competences:

1. He/She is aware of the necessity to initiate activities for the public interest, understands various aspects and effects of the electrical engineer's activity, including the impact on the environment, and the related responsibility for decisions.

2. He/She can think and act in an entrepreneurial way in the field of electrical engineering.

3. He/She correctly identifies and resolves dilemmas related to the profession.

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Lectures:

- assessment of knowledge and skills proved on tests.

Laboratories:

- Tests and preemie of knowledge which is necessary to realize fundamental tasks in some fields of laboratory,

- Continuous assessment on each laboratory's preemie of knowledge increase,

- Assessment of knowledge and skills connected to realization of laboratory tasks, assessment of report,

- Assessment of knowledge and skills demonstrated on written or oral colloquium.

### Programme content

The lecture presents knowledge about the sources of DC, AC and pulse test voltages, methods of measurements of electrical properties describing high voltage engineering. In addition, the lecture provides knowledge about statistical analysis, measurement results and electric and magnetic fields.

In frame of laboratory are realized subjects connected to high voltage techniques.

### Course topics

The lecture presents knowledge about sources of AC (high voltage test and power transformer), DC test voltage (Van de Graff generator, rectifiers and rectifier systems), and pulse test voltage (Marx generator). Method of measurements of electrical properties, describing high voltage engineering, such as electrical strength (plate spark gap, spherical spark gap, cylindrical spark gap, sharp spark gar), resistance (Schering bridge), surfacial resistance, capacity (Schering bridge), partial discharge, dielectric losses factor (Schering bridge). Overvoltage protection (overvoltage factor, source of overvoltage, spares, attenuation of overvoltage waveform, overvoltage installations, touch voltage). Electrical and magnetic fields: professional and environmental exposure.

In addition, the classes provide basic knowledge about the statistical analysis of measurement results. In frame of laboratory, following subjects are realized: measurements of electrical strength of plate spark gap, spherical spark gap, cylindrical spark gap, needle spark gap, tests of volume and surface resistance of insulation partial discharges measurements (including corona discharges), determination of the dielectric loss coefficient  $\tan(\delta)$  using a Schering bridge, influence of space charge on electrical strength of air, analysis of transformer oil, analysis of voltage distribution on HV line insulator.

### Teaching methods

**LECTURE** - lecture with multimedia presentation (including drawings, photos, animations) supported with the content given on the board, taking into account various aspects of the issues presented, including: economic, ecological, legal and social, presenting a new topic preceded by a reminder of related content known to students from other items.

**LABORATORY** - detailed review of reports by the laboratory leader and discussions on comments, demonstrations, teamwork.

### Bibliography

#### Basic

1. Flisowski Z., Technika wysokich napięć, Wydawnictwo WNT, Warszawa, 2015.
2. Laboratory exercises in electrotechnical material science and high voltage techniques, redaction: H. Mościcka-Grzesiak, script, publisher: Wydawnictwo Politechniki Poznańskiej, Poznań, 2002.
3. Florkowska B., Electrical strength of gas high voltage insulating systems, publisher: Uczelniane Wydawnictwo Naukowo-Dydaktyczne AGH, Kraków, 2003.

#### Additional

1. Florkowska B. i inni, Mechanizmy, pomiary i analiza wyładowań niezupełnych w diagnostyce układów izolacyjnych wysokiego napięcia, Uczelniane Wydawnictwo Naukowo-Dydaktyczne AGH, Kraków, 2001.
2. PN-EN 60270:2003 Wysokonapięciowa technika probiercza - Pomiary wyładowań niezupełnych
3. 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
4. Nadolny Z., Grzybowski A., Kasprzak W., Ludwikowski K., Lopatkiewicz R., Moranda H., Przybyłek P., Sikorski W., Siodła 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

### Breakdown of average student's workload

	Hours	ECTS
Total workload	128	5,00
Classes requiring direct contact with the teacher	68	3,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	60	2,00