COURSE DESCRIPTION CARD - SYLLABUS

Course name
High voltage engineering [S2Eltech2>TWN]

Course

Field of study
Electrical Engineering

Year/Semester
2/3

Area of study (specialization)
Distribution Devices and Electrical Installations

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

The student is able to name and characterize the basic physical phenomena occurring in electrical insulating materials and to list and characterize the typical structures of high voltage power devices. In addition, the student has the ability to perform basic diagnostic measurements of high-voltage power devices and the values that characterize the high-voltage insulation system. The student is able to work and cooperate within a team

Course objective

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.

Course-related learning outcomes

Knowledge:
1. The student has an extended knowledge of the construction and operation of insulation systems of

high voltage devices
2. The student has knowledge of the physicochemical phenomena occurring in high voltage insulation systems.
3. The student has detailed knowledge of the diagnostics of high voltage devices and has knowledge of the development of experimental results.

Skills:
1. The student is able to plan the process of testing and diagnosing the high-voltage insulation system
2. The student is able to process and correctly interpret the results of diagnostic measurements used to assess the technical condition of a high voltage device.
3. The student is able to obtain information from the literature and other sources related to the construction and diagnostic methods of high voltage devices.

Social competences:
1. The student recognizes the importance of knowledge in the field of diagnostics of high-voltage power devices and accessories in ensuring the continuity of electricity supply for industry, institutional and individual consumers.
2. The student is aware of the scale of threats and the impact of the consequences of failure of high voltage devices on the natural environment.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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.

Programme content

The main program content includes physical phenomena occurring in high-voltage insulation systems (including aging processes, partial discharges, moisture issues) and modern methods of diagnostics of high-voltage devices.

Course topics

Lecture:
- Physicochemical degradation processes occurring in high-voltage insulation systems
- Problems of partial discharges occurring in high-voltage insulation systems
- The problem of moisture in paper-oil insulation
- Construction of modern transducers and sensors for PD detection (acoustic emission transducers, UHF antennas, high-frequency current transformers)
- Modern methods of diagnostics of high voltage devices:
a) conventional and unconventional methods of detecting partial discharges, i.e. electromagnetic HF/VHF/UHF, EA, IEC 60270)
b) methods of assessing insulation moisture
(Karl-Fischer, capacitive probes)
c) methods for detecting deformation of power transformer windings (FRA/SFRA)
d) analysis of gases dissolved in insulating oil (DGA)
e) partial discharge localization techniques (trilateration, standard SAT auscultation technique).

Laboratory:
1) Dissolved Gas Analysis (DGA) in Oil
2) Methods for Measuring Moisture Content in Electrical Insulating Liquids
3) Measurement of the Acid Number in Oil

4) Detection of Transformer Winding Deformations Using the SFRA Method
5) Localization of Partial Discharge Sources Using the Acoustic Emission (AE) Method
6) Measurement of Partial Discharges Using the Conventional Electrical Method (IEC 60270)

Teaching methods

Lecture: multimedia presentation (including drawings, photos, animations) supplemented with examples given on the board, taking into account various aspects of the issues presented, including: economic, ecological, legal and social issues, presenting a new topic preceded by a reminder of related content known to students in other subjects .
Laboratory: detailed review of reports, demonstrations, teamwork.

Bibliography

Basic:
1.Kaźmierski M., Olech W., Diagnostyka techniczna i monitoring transformatorów, ZPBE ENERGOPOMIAR - ELEKTRYKA Sp. z o.o. Gliwice; wyd. 2013r.
2. Florkowska B., Diagnostyka wysokonapięciowych układów izolacyjnych urządzeń elektroenergetycznych, Wydawnictwo AGH Kraków, 2009
3. Gulski E., Diagnozowanie wyładowań niezupełnych w urządzeniach wysokiego napięcia w eksploatacji, Prace Naukowe Politechniki Warszawskiej, 2003
4. Flisowski Z., Technika wysokich napięć, WNT Warszawa, 2009
5. Gacek Z., Wysokonapięciowa technika izolacyjna, Wydawnictwo Politechniki Śląskiej, Gliwice, 2006
6. Mościcka-Grzesiak H., pod red., Inżynieria wysokich napięć w elektroenergetyce, Wydawnictwo Politechniki Poznańskiej, tom I, 1996, tom II, 1999
7. Fleszyński J., pod red., Laboratorium wysokonapięciowe w dydaktyce i elektroenergetyce, Oficyna Wydawnicza Politechniki Wrocławskiej, 1999

Additional:
1. Sivaji Chakravorti,Debangshu Dey,Biswendu Chatterjee , Recent Trends in the Condition Monitoring of Transformers, Spinger-Verlag, 2013
2. S.V. Kulkarni,S.A. Khaparde, Transformer Engineering: Design, Technology, and Diagnostics, Second Edition, CRC Press, 2013
3. Sikorski W., Acoustic emission, InTech, 2012
4. Sikorski W, Acoustic emission: research and applications, InTech 2013
5. Sikorski W., Ultraczułe przetworniki emisji akustycznej zoptymalizowane do monitoringu wyładowań niezupełnych w transformatorach, Przegląd Elektrotechniczny, Tom 92, Wydanie 10, str. 11-16, 2016
6. Szymczak C., Sikorski W., Projektowanie i optymalizacja anten UHF do monitoringu wyładowań niezupełnych w transformatorze energetycznym, Przegląd Elektrotechniczny, Tom 92, Wydanie 10, str. 75-79, 2016

Breakdown of average student's workload

	Hours	ECTS
Total workload	70	3,00
Classes requiring direct contact with the teacher	32	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	38	1,50