Załącznik nr 2 do Zarządzenia Nr 915 z 2019 r. Rektora PB

**COURSE DESCRIPTION CARD**

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| **Faculty of Electrical Engineering** | | | | | | | | | | |
| **Field of study** | **Electrical and Electronics Engineering** | | | | | | | **Degree level and programme type** | **bachelor's degree, full time programme** | |
| **Specialization/ diploma path** | **-** | | | | | | | **Study profile** | **-** | |
| **Course name** | **High Voltage Technique** | | | | | | | **Course code** | **IS-FEE-10034S** | |
| **Course type** | **elective** | |
| **Forms and number of hours of tuition** | **L** | **C** | **LC** | **P** | **SW** | **FW** | **S** | **Semester** | **summer** | |
| **30** |  | **30** |  |  |  |  | **No. of ECTS credits** | **6** | |
| **Entry requirements** | **-** | | | | | | | | | |
| **Course objectives** | **The principal objective of lectures is to cover the fundamentals of high-voltage test technique, generation and measurement of high voltages, electrical breakdown in gases, solid and liquid dielectric, travelling waves in high voltage lines, lightning and overvoltage protection and topresent the basics of high voltage insulation design.Skills of performing measurements, tests and studies on high voltage generators, electrical withstand of insulators and insulating materials and measurements of high voltages and high currents. Skills of safe work with high voltage electrical devices and apparatus.** | | | | | | | | | |
| **Course content** | **Lecture High voltage test technique. Generation and measurement of high alternating and direct voltages. Generation and measurements of impulse voltages and currents. Dielectric loss and capacitance measurements. Partial discharge measurements. Disturbances in high voltage laboratory. Electrical breakdown in gases, solid and liquid dielectric. Travelling waves in high voltage lines. Reflection of travelling waves. Reflection of travelling waves against transformers. Lightning, mechanism, philosophy of protection, lightning protection of structures. Lightning and switching transients in power system. Protection against overvoltages. Surge protective devices. Insulation coordination. Construction elements for high voltage circuits. High voltages cables and capacitors. Design, materials and testing. High voltage Transformers. Materials and testing. External insulation. Design and testing. Laboratory class Measurement of voltage distribution across an insulator string. Measurements of electrical withstand of air subjected to high voltage of AC, DC and surge type. Methods of measurement of high voltages. Investigation of surge generators. Investigation of oil insulation.** | | | | | | | | | |
| **Teaching methods** | **lecture and multimedia presentation, experiments in laboratory class** | | | | | | | | | |
| **Assessment method** | **lecture: final written test; laboratory class: evaluation of reports, verification of preparation for classes.** | | | | | | | | | |
| **Symbol of learning outcome** | **Learning outcomes** | | | | | | | | **Reference to the learning outcomes for the field of study** | |
| **LO1** | **develop an in-depth understanding and technical competence of HV test techniques, especially generation and measurement of high AC, AC and impulse voltages and impulse currents, partial discharge, dielectric loss and capacitance measurements; plans, selects appropriate equipment and performs measurement of high surge voltages and surge currents;** | | | | | | | |  | |
| **LO2** | **develop an in-depth technical competence in lightning and overvoltage protection of structures;** | | | | | | | |  | |
| **LO3** | **develop an in-depth understanding of electrical breakdown and withstand of gas, liquid and solid insulators or insulating materials; performs measurements and tests on electrical withstand of gas, liquid and solid insulators or insulating materials;** | | | | | | | |  | |
| **LO4** | **develop an in-depth understanding in the area of lightning power systems protection; achieve a thorough knowledge and technical competence in a wide range of lightning and switching overvoltage protection in HV power station, HV lines and insulation coordination;** | | | | | | | |  | |
| **LO5** | **develop an in-depth understanding of the theory and applications in power systems of High Voltage Direct Current (HVDC) transmission and Flexible AC Transmission Systems (FACTS);** | | | | | | | |  | |
| **LO6** | **define and characterizes methods of generation and measurement of high voltages and high currents; describes basic characteristics and methods of investigation of electrical withstand of gas, liquid and solid insulators; plans, selects appropriate equipment and performs measurement of high voltages;** | | | | | | | |  | |
| **LO7** | **elaborates, illustrates, interprets and compares obtained measurement or test results and draws aproprate conclusions;** | | | | | | | |  | |
| **LO8** | **applies rules of safety and hygiene of work with high voltages; can work in a team.** | | | | | | | |  | |
| **Symbol of learning outcome** | **Methods of assessing the learning outcomes** | | | | | | | | **Type of tuition during which the outcome is assessed** | |
| **LO1** | **exam on lecture contentverification of preparation for laboratory classe** | | | | | | | | **L, LC** | |
| **LO2** | **exam on lecture content** | | | | | | | | **L** | |
| **LO3** | **exam on lecture contentverification of preparation for laboratory classe** | | | | | | | | **L, LC** | |
| **LO4** | **exam on lecture content** | | | | | | | | **L** | |
| **LO5** | **exam on lecture content** | | | | | | | | **L** | |
| **LO6** | **exam on lecture contentverification of preparation for laboratory classe** | | | | | | | | **L, LC** | |
| **LO7** | **work on reports from laboratory classes** | | | | | | | | **LC** | |
| **LO8** | **participation in student-teacher sessions related to the classes** | | | | | | | | **LC** | |
| **Student workload (in hours)** | | | | | | | | | **No. of hours** | |
| **Calculation** | **lecture attendance** | | | | | | | | **30** | |
| **participation in laboratory classes** | | | | | | | | **30** | |
| **preparation for laboratory classes** | | | | | | | | **18** | |
| **work on reports from laboratory classes** | | | | | | | | **24** | |
| **participation in student-teacher sessions related to the lecture** | | | | | | | | **5** | |
| **participation in student-teacher sessions related to laboratory classes** | | | | | | | | **5** | |
| **preparation and performance of presentation on selected topic** | | | | | | | | **14** | |
| **preparation for and participation in exam** | | | | | | | | **24** | |
| **TOTAL:** | | | | | | | | **150** | |
| **Quantitative indicators** | | | | | | | | | **HOURS** | **No. of ECTS credits** |
| **Student workload – activities that require direct teacher participation** | | | | | | | | | **74** | **2,5** |
| **Student workload – practical activities** | | | | | | | | | **77** | **3** |
| **Basic references** | **1. Naidu M.S., Kamaraju V.: High voltage engineering. Mc. Graw Hill, 2003.**  **2. Holzhauen J. P., Vosloo W. L.: High voltage engineering. Practice and theory. Mc. Graw Hill, 2009.**  **3. Cooray V.: Lightning protection. IEEE, 2009.**  **4. Kuffel E., Zaengl W. S., Kuffel J.: High voltage engineering fundamentals. Newness, 2000.**  **Wadhwa C. L.: High voltage engineering. New Age International Publishers, 2007.** | | | | | | | | | |
| **Supplementary references** | **1. Kind D., Feser K.: High voltage test technique. Newness, 2001.**  **2. Cooray V.: The lightning flash. IEEE, 2004.**  **3. Beyer M., Boeck W., Moeller K., Zaengl W.: Hochspannungstechnik. Theoretische und praktische grundlagen für die anwendungen. Springer, 1989.**  **4. Zulkurnain A.: Fast transient response of high voltage surge arrester. VDM, 2010.**  **5. Hasse P., Wiesinger J., Zischank W.: Handbuch für blitzschutz und erdung. Pflaum, 2006.** | | | | | | | | | |
| **Organisational unit conducting the course** | **Department of Photonics, Electronics and Lighting Technology** | | | | | | | | **Date of issuing the programme** | |
| **Author of the programme** | **Renata Markowska, Ph.D. Eng.** | | | | | | | | **07.02.2020** | |

**L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work,**

**S – seminar**