TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY
Director of Power Engineering School
_____ A.S. Matveev
«30» 06 2020

SYLLABUS FOR

"PROTECTION OF ELECTRIC POWER SYSTEMS"

Field of study: 13.04.02 "Electric Power and Electrical Engineering"

Program name: "Electric Generation and Transportation"

Level of study: Master

Year of admission: 2019

Semester, year: semester - 1; 2019.

ECTS: 3

Total Hours: 108

Contact Hours: 48

- **Lectures:** 16
- **Labs:** 16
- **Practical experience:** 16

Assessment: exam

Type of intermediate certification: no

Department: Department for Electric Power and Electrical Engineering

Head of department: of Electric Power and Electrical Engineering Department _____Ivaschutenko A.S.

Instructor: _____ Andreev M.V.

2020

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<td>Course Objectives</td>
<td>
Formation of knowledge and skills in the field of calculation and design of power supply systems based on renewable energy sources are the main objectives of the discipline for students.
Objectives O1, O3 and O5 of basic educational program (BEP) “Electric Power and Electrical Engineering” will be reached as a result of learning this discipline. Achieved knowledge, skills and experience will prepare the student for:

design and engineering activity in the field of electro energy and electro technic and to be able to choose modern equipment, design new world competitive electro technical objects, systems and units using modern automated design soft, to be able evaluate technical and economical effectiveness (O1);
scientific and research activity including interdisciplinary areas such as mathematical modeling of processes and objects, to be able to do experimental research and analysis of the results, design of innovation methods increasing effectiveness of designing and operation of electrical energy systems and objects (O3);

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<td>Learning Outcomes</td>
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According to the requirements of BEP and Federal Government Educational Standard (FGES) studying the discipline “Advanced topics of power supply” is focused on formation among the students next competences (see table 1):
Constituents of the learning outcomes
<table>
<tr><td rowspan="2">Learning Outcomes</td><td colspan="5">Learning outcomes components</td></tr>
<tr><td>Code</td><td>Knowledge</td><td>Code</td><td>Skills</td><td>Code</td><td>Experience</td></tr>
<tr><td>LO 8</td><td>K 8.1</td><td>standards and normative documents focused on effectiveness of energy consumption</td><td>S 8.1</td><td>development of methodological and normative data</td><td>E 8.1</td><td>working with technical documentation and standards</td></tr>
<tr><td>LO 10</td><td>K10.1</td><td>Work with devices and installations for experimental research</td><td></td><td></td><td></td><td></td></tr>
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Masters that have acquired the discipline should be achieved results, listed in Table 2.
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<tr><td></td><td>Table 2
Expected results of acquiring the discipline<table><tr><th>№</th><th>Result</th></tr><tr><td>CO 8</td><td>To be able to choose and calculate protection and automation devices for individual elements of the power system and analyze their behavior in the event of an emergency in the power system.</td></tr><tr><td>CO 10</td><td>Be able to plan and conduct experimental research related to the construction and operation of the main types of relay protection devices.</td></tr></table></td></tr>
<tr><td>Course content</td><td>Section 1. General information about relay protection. Current and voltage transducers in the circuits of relay protection.
Section 2. Principles of relay protection operation: overcurrent, voltage dependent overcurrent, directional overcurrent, distance, Differential and phase comparison protection. Relay protection settings calculation.
Section 4. Communication of relay protection systems. Communicational protocols. IEC 61580
Section 5. Relay protection utilization features. Hardware-in-the-Loop testing of relay protection systems.
Practical lessons
Calculation of settings and verification of the sensitivity of transformer differential protection.</td></tr>
<tr><td>Prerequisites</td><td>Electric power grids and systems; Electric power machines; Electronics and microprocessors devices; Theory of power engineering; English language competence of CEFR level B1.</td></tr>
<tr><td>Corequisites</td><td>Emergency control in power systems</td></tr>
<tr><td>Facilities and Equipment</td><td>• Laboratory of Relay Protection and Automation: computers based on Intel E2220, Intel G2020, Intel E7500, Celeron 440 - 15 pcs .; Testing system for relay protection with RETOM-41M software - 1 pc;
• Testing system for relay protection: RETOM-51M - 1; RETOM-11M - 1;
• Protection and control system SEPAM 1000+ S40;
• Protection and control system Siemens Siprotech 7SJ62;
• Protection and control system Micom P14D;
• Specialized lecture: Projector Panasonic VX400 XGA, monoblock MSI Wind Top, screen computer based on Intel E2220, Intel G2020, Intel E7500, Celeron 440 - 1 pc
• Classrooms for practical classes: computers based on Intel E2220, Intel G2020, Intel E7500, Celeron 440
• Audiences for independent studies: computers based on Intel E2220, Intel G2020, Intel E7500, Celeron 440 - 20 pieces</td></tr>
<tr><td>Grading Policy</td><td>Assessment of the quality of the discipline in the course of the current and intermediate certification of students is carried out in accordance with the Regulations for the Intermediate Attestation of Students of the Tomsk Polytechnic University.
The maximum score for the discipline in the semester is 100 points, including:
• within the current control - 80 points,
• for intermediate certification (exam / test) - 20 points.
Assessment of the quality of the discipline is based on the results of evaluation activities.
Evaluation activities of the current monitoring by sections and types of educational activities are given in the Appendix "Calendar rating-plan for</td></tr>
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	studying discipline (module)".
Course Policy	Class attendance will be taken into consideration when evaluating students` participation in the course. Students are expected to actively engage in class discussions about the assigned readings. Attendance is strictly controlled and all class is obligatory to presence.
Teaching Aids and Resources	**Main literature.** 1. Gerhard Ziegler Numerical Differential Protection. Principles and Applications. Berlin: Publicis Erlangen. – 2012. – 258 p. http://catalog.lib.tpu.ru/catalogue/simple/document/RU%5CTPU%5Cbook%5C139702 2. Gerhard Ziegler Numerical Dstancel Protection. Principles and Applications. Berlin: Publicis Erlangen. – 2012. – 396 p. http://catalog.lib.tpu.ru/catalogue/simple/document/LANBOOK%5C72351 3. J. Lewis Blackburn and Thomas J. Domin. Protective Relaying: Principles and Applications, 4-th Edition, CRC Press, ISBN-10: 1439888116, 2014 **Additional literature:** 4. Operation and Control of Electric Energy Processing Systems / edited by J. Momoh, L. Mili. — Hoboken: IEEE Press John Wiley & Sons, Inc., 2010. — 185 p.: il. — Bibliography: p. 173-175. — Index: p. 177-185. — ISBN 978-0-470-47209-5. 5. Wood, Allen. Power Generation, Operation, and Control / A. J. Wood, B. F. Wollenberg, G. B. Sheble. — 3rd ed. — Hoboken: John Wiley & Sons, Inc. IEEE Press, 2014. — 632 p.: il. — Index: p. 630-632. — ISBN 978-0-471-79055-6. 6. Padilla, Evelio. Substation Automation Systems. Design and Implementation / E. Padilla. — Chichester: John Wiley & Sons, Ltd., 2016. — 251 p.: il. — Index: p. 247-251. — ISBN 978-1-118-98720-9. 7. Z. Q. Bo, Q. Wang, L. Wang, F. Zhou, S M Ge, Baohui Zhang, Boming Zhang. Novel architecture for integrated wide area protection and control, Power Engineering Conference (UPEC), 2015 50th International Universities, 1-4 Sept. 2015, Stoke on Trent, pp. 1-4. 8. Yi Lv, Dahai You, Ke Wang, Liang Wang, Zhenhai Chen, Simin Huo. Study on wide-area backup protection system for the smart grid, Electric Utility Deregulation and Restructuring and Power Technologies (DRPT), 2011 4th International Conference on, Weihai, Shandong, 6-9 July 2011, pp. 218-224. 9. Su Sheng, K. K. Li, W. L. Chan, Xiangjun Zeng, Dongyuan Shi, Xianzhong Duan. Adaptive Agent-Based Wide-Area Current Differential Protection System, IEEE Transactions on Industry Applications (Volume: 46, Issue: 5), 2010, pp. 2111-2117. 10. Zhenxing Li, Xianggen Yin, Zhe Zhang, Zhiqin He. Wide-Area Protection Fault Identification Algorithm Based on Multi-Information Fusion, IEEE Transactions on Power Delivery (Volume: 28, Issue: 3), 2013, pp. 1348-1355.
Instructor	Andreev Mikhail Vladimirovich, andreevmv@tpu.ru