TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

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

SYLLABUS FOR

Integration of Renewable energy units into power supply systems

Field of study: "Electric Generation and Transportation"
Programme name: 13.04.02 «Electrical Power Engineering and Electrical engineering»

Level of Study: Master Degree Program

Year of admission: 2020 year

Semester, year: 2, 2021

ECTS: 4
Total Hours: 144
Contact hours:

- **Lectures:** 8
- **Labs:** 16
- **Practical expertise:** 24

Assessment: Exam / grading test (for Course Project)

Department: Department for Electric Power and Electrical Engineering

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

Instructor: _____ M.A. Surkov

2020

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Integration of Renewable energy units into power supply systems

Course Overview

Course Objectives	The objective of the course is to obtain knowledge and skills of application of specialized software for electric power system operating. Course aimed to achieve of objectives O3, O4 and O5 of the Basic Educational Program «Electrical Power Engineering and Electrical engineering»; knowledge, skills and experience gained will qualify the graduate for: – research activities, including interdisciplinary branches, connected with mathematical modeling of processes in power systems and its elements, performance of the experiments and its analysis (O3); – industrial activities in the field of exploitation, installation and adjusting, maintenance and examination, diagnostics and monitoring of electrical power engineering and electrical engineering equipment correspondently to specialization (O4); – self-education and mastering new knowledge and skills for the purpose of future professional career realization (O5).
Learning Outcomes	– Classification and range of application of existing specialized software complexes for power system operating (CO1) – Formulate tasks in the field of autonomous systems of electricity, analyze them and solve them using all required and available resources (CO2) – Design electric power and electrical systems and their components (CO3) – Characteristics and parameters of equipment and power systems necessary for working with specialized software complexes and approaches of their calculation (CO4) – Apply modern methods and tools of practical engineering activity in solving problems in the field of electric power engineering and electrical engineering. (CO5)

Course Outline	The discipline is divided into four parts: Part 1. Bases of the course. Energy characteristics of solar radiation. Solar power plants. Part 2. Wind energy characteristics. Wind power plants. Part 3. Energy characteristics of water flows. Micro hydropower plants. Part 4. Geothermal power plants. Biomass power. Technical and economic characteristics of RES Lab work 1 "Studv of standalone power supply system based on photovoltaic module. Lab work 2 "Study of standalone power supply system based on wind turbine AIR-X". Course project: Design of isolated power supply system.
Prerequisites	Energy saving and energy audit of the enterprise
Course Structure	*Module 1. Bases of the course. Energy characteristics of solar radiation. Solar power plants.* Role and prospects of renewable energy. Classification of primary energy carriers. Features of renewable power engineering and methods of matching energy characteristics of primary energy carrier with electricity consumers. Definition of main energy characteristics of solar radiation affected by geography, landscape, climate and weather conditions. Basic relation to determine energy characteristics of solar radiation. *Lab work 1* "Study of standalone power supply system based on photovoltaic module" *Practice Unit 1.* Calculation of Photovoltaic power plant energy efficiency. Thermodynamic solar power plants; design, advantages, disadvantages, technical and economic characteristics. Photovoltaic power plants. Electrical characteristics of solar cells influenced by lighting, temperature of tapped off electrical power. Design of photovoltaic plants, their energy and technical-economic characteristics. *Module 2. Wind energy characteristics. Wind power plants.* Definition of main wind energy characteristics. Impact of climate, landscape, weather conditions in the region on energy characteristics. Classification of wind power plants and principle of operation. Energy characteristics of wind turbines, wind turbine operation modes. Methods of matching capacity of wind turbine with load, standalone and electric network wind power plants. Construction of wind power plants, their energy and technical-economic characteristics.

	Practice Unit 2. Calculation of the wind power potential. Calculation of wind power plant energy efficiency *Module 3. Energy characteristics of water flows. Micro hydropower plants.* Definition of main energy characteristics of water flow. Impact of climate and geography factors on water energy flow. Classification micro hydropower plants (micro HPP) and principle of operation. Energy characteristics of hydraulic turbines, micro hydropower plant operation modes. Methods of voltage stabilization at micro HPP. Auto-ballast stabilization system of micro HPP operation modes. Construction of micro HPP, their technical and economic characteristics. *Lab work 2* "Study of standalone power supply system based on wind turbine AIR-X" *Practice Unit 3.* Calculation of water flow power potential. Calculation of hydropower plant energy efficiency *Module 4. Geothermal power plants. Biomass power. Technical and economic characteristics of RES.* Classification and principle of operation of GeoTPP. How to convert low-potential geothermal water into electricity. Energy and technical-economic characteristics of Geothermal power plants. Types and methods of producing biofuels. Varieties of TPP using chemical energy of biofuels, their technical and economic characteristics. Criteria for technical and economic efficiency of standalone power plants running on RES. Methods of analysis of power supply system designs and rational options selection. Examples of technical-economic characteristics calculation of standalone power supply systems. *Practice Unit 4*. Seminar on geothermal power plants. Seminar on biomass power. Calculation of technical and economic characteristics of RES power plants.
Facilities and Equipment	– practical works are held in specialized classrooms; computers are connected to the net-work of the Institute of Power Engineering with access to the Internet; the tutorial for practical works on discipline «Integration of Renewable energy units into power supply systems» is provided; – lectures are delivered in educational classrooms equipped with all necessary technical means: computers, blackboards, projectors; lectures are supported with Power Point presentations;
Grading Policy	In accordance with TPU rating system we use: Current assessment which is performed on a regular basis during the semester by scoring the quality of mastering of theoretical ma-

	terial and the results of practical activities (performance tests, perform tasks, problem solving). Max score for current assessment is 80 points, min - 55 points. Course final assessment grading test is performed at the end of the semester. Max score for course final assessment is 20. The final rating is determined by summing the points of the current assessment during the semester and exam (credit test) scores at the end of the semester. Maximum overall rating corresponds to 100 points, min pass score is 55 points
Teaching Aids and Resources	**Compulsory Readings:** 1. M.A. Surkov, B.V. Lukutin Renewable energy sources: Tutorial / M.A. Surkov, B.V. Lukutin. ; Tomsk Polytechnic University. – Tomsk: TPU Publishing House, 2013. – 147 p. **Additional Readings:** 2. Lukutin B.V. and other. Renewable energy in decentralized power supply. - Monograph. - Moscow: Energoatomizdat, 2008. – 231 p. 3. Udalov S. Renewable Energy Sources: Textbook. - Novosibirsk, Publishing House NSTU, 2007. 4. Danchenko A.M. and other. Inventory of opportunities / Ed. By B.V. Lukutin. - Tomsk: Publishing House NTL, 2002. – 280 p. 5. Gavrilin A.I. and other. Energy Saving. Electronic textbook. - Tomsk Polytechnic University, 2004. 6. Renewable energy sources. Analytical album / under scientific Ed. A.I. Gritsenko. - Moscow: VNII PgiGT, Nagorno-Karabakh Autonomous Region, company "Energosberezhenye", JSC "Aviaizdat", 1996. – 270 p. 7. Lukutin B.V., Obukhov S.G., Shandarova E.B. Standalone power supply from micro hydropower plant. - Tomsk: STT, 2001. - 120p. 8. Kopylov I.P. Electrical Machines. Textbook for higher education. - M.: High School, 2004. - 607 p. 9. Boot D.A. Contactless electrical machines. - M.: High School, 1990. 10. Lukutin B.V. Energy efficiency of conversion and transmission of electricity. Tutorial. - Tomsk, Ed. Kursiv, 2000. – 130 p. 11. Laboratory operation manual "Alternative methods of energy conversion " (authors Surkov M.A., Shutov E.A., Obukhov S.G.) **Internet resources** 12. Electronic tutorial "Renewable Energy Sources". Author prof. B.V. Lukutin. - Tomsk

	http://www.lib.tpu.ru/fulltext2/m/2010/0 13. Website "Intersolar center" - [electronic resource] www.intersolar.ru 14. Website of the American Wind Energy Association - [electronic resource] www.awea.com
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