TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

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

Electric Power Systems and Networks

Syllabus

Field of Study: 13.04.02 Electrical Power Engineering and Electrical Engineering

Program: Electric Power Generation and Transportation

Level of Study: Master Degree Program

Year of Admission: 2020
Year: 1
Semester: 1

ECTS: 6

Total Hours: 216
Contact Hours: 64

- **Lectures:** 8
- **Labs:** 24
- **Practical experience:** 32

Assessment: exam

Department: Division for Power and Electrical Engineering

Head of Department: Alexander S. Ivashutenko

Instructor: Natalia P. Fix

2020

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Electric Power Systems and Networks

Course Overview

Course Objectives	Course objectives: training students in knowledge of technical processes, electrical networks, power engineering equipment, understanding of technical processes, analyzing modes of systems and networks by special engineering software, constructing models of power systems and networks, obtaining skills in designing of power networks.
Learning Outcomes	In compliance with the primary curriculum requirements, mastering the course is focused on developing the following learning outcomes in students, including in accordance with the Federal State Educational Standards: • be able to apply methods to build up and analyze of power system and network component models, forecast their properties and behavior; • be able to formulate conceptual design documents, apply modern packages and tools to solve tasks in designing of electric power systems and network; • be able to choose modern commercial equipment and design new electric network; • be able to apply modern research methods, evaluate and perform results of practical engineering activity in designing of electric power systems and networks.
Course Outline	This course belongs to the professional cycle and introduces the standards and vocabulary used in the electric utility industry. Students will learn about the segments and common components of the electric power system. The course is a combination of online activities and face-to-face communication. The content of the course includes laboratory practical, practical problems, course project and theoretical background. Students' everyday self-guided work is focused on extending and reinforcing students' knowledge, developing practical skills and includes working with lecture materials, overviewing sources of information in compliance with an individually predetermined course problem, performing home tasks, getting prepared for classes and examination. Creative self-guided work includes analyzing, structuring and presenting information, performing calculation, course project. The results of self-guided work are to be assessed in the following way: defending laboratory works; survey on seminars; course project defense.
Prerequisites	The course is based on knowledge and understanding of mathematics. Students taking this course should have some background in electric power systems or a very good background in electric circuits. Experience in modeling and simulation is beneficial.
Course Structure	**Section 1. Fundamentals of Power Systems and Networks**
	Electric power system structure. Terms and definitions: power system; electrical network; electrical installation; power line. Types and configuration of electrical networks. Reliability theory and consumer categorization. Substation engineering. Substation equipment. How a substation happens: back-ground; needs determination; traditional and innovative substation design. High-voltage substation: site location; design philosophy; mesh-type

	substations; single and double-busbar arrangement. Medium-voltage substations.
	Section 2. Modeling of Power System Components
	Components of electric circuit. Overhead power lines modeling. Equivalent circuits of overhead lines. Calculation of equivalent circuits parameters. Underground transmission lines. Transformers and Autotransformers. Construction and operating characteristics of transformers and autotransformers. Equivalent circuits of transformers and autotransformers. Calculation of equivalent circuits parameters. Loads modeling.
	Section 3. Load Flow Analysis
	Steady-state modes: calculations and assessment. Basic load flow problem: problem variables; basic node types. Performance methods for power flow studies. Power system analysis software applications.
	Section 4. Balancing Active and Reactive Power, Voltage Regulation
	Operating states of a power system. Fundamentals of speed governing. Generator response to load change. Load response to frequency deviation. Control of generating unit power output. Production and absorption of reactive power. Methods of voltage control. Compensation equipment: shunt reactors; shunt capacitors; series capacitors. Voltage drop. Voltage regulators and regulation techniques.
	Section 5. Electric Power and Energy Losses
	Power losses in transmission lines. Power losses in transformers and autotransformers. Energy losses.
	Section 6. Electric Power System Analysis and Design
	Data for network design and basic approaches for network planning. Nominal voltage level, voltage standards and choice of network voltage. Overhead transmission lines technical design. Conductor typical construction and data.
Facilities and Equipment	Computer classrooms. Rooms for lectures and seminars. Presentation equipment.
Grading Policy	Evaluation of the quality of learning performance and achievements for the discipline during formative and summative assessment is performed in compliance with TPU rating system. Current assessment which is performed on a regular basis during the semester by scoring the quality of mastering of theoretical material and the results of practical activities (performance tests, perform tasks, problem solving). Max score for current assessment is 80 points. Course final assessment (exam) is performed at the end of the semester. Max score for course final assessment is 20 points. The maximum mark for the course final project is 100 points including: marks for formative assessment is 40 points; marks for summative assessment (defense) is 60 points. The final rating is determined by summing the points of the formative assessment during the semester and summative assessment scores at the end of the semester. Maximum overall rating corresponds to 100 points, min pass score is 55.
Course Policy	To be allowed to take the final exam, a student must submit reports for all assessed activities applicable to the course. Exam details: closed-book; written; scheduled during the examination period; 1.5 hours in duration.

Teaching Aids and Resources	**Compulsory Readings:** 1. Alexandra von Meier, Electric Power Systems. A conceptual Introduction. – A John Wiley and Sons, Inc., Publication, 2006. – 328 p. Access by Tomsk Polytechnic University: https://www.lib.tpu.ru/fulltext_db/wiley-online-library.html. 2. Electric Power Systems. Edited by Michel Crappe. – A John Wiley and Sons, Inc., Publication, 2008. – 376 p. Access by Tomsk Polytechnic University: https://www.lib.tpu.ru/fulltext_db/wiley-online-library.html. **Additional Readings:** 1. Electric Power Generation, Transmission and Distribution. Second Edition. Electric Power Engineering Handbook. Edited by Leonard L. Grigsby. – CRC Press Taylor and Francis Group, 2007. – 500 p. 2. T.A. Short, Electric Power Distribution Equipment and Systems. – CRC Press Taylor and Francis Group, 2007. – 312 p. 3. Electric Power Substation Engineering. Edited by John D. McDonald. – CRC Press LLC, 2003. – 287 p. **Online Resources:** 1. Electric Power Systems and Networks: Online Course. Available at: http://www.stud.lms.tpu.ru. 2. Science databases. Available at: https://www.lib.tpu.ru/fulltext_db.html. **Software:** RastrWin Software package. Available at: http://www.rastrwin.ru.
Instructor	Natalia P. Fix, PhD, Associate Professor, Tomsk Polytechnic University, http://tpu.ru, e-mail: nataliafix@tpu.ru