TOMSK POLYTECHNIC UNIVERSITY | ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY

Director of Nuclear Science & Engineering School
_____ / Oleg Yu. Dolmatov
"25" 06 2020

Course Name: Steam Turbines Design Project

Field of Study: Nuclear Physics and Technology

Programme name: Nuclear Science and Technology

Specialization: Nuclear Power Engineering

Level of Study: Master Degree Programme

Year of admission: 2020

Semester, year: semester 3, year 2

ECTS: 4

Total Hours: 144

Contact Hours: 64

- **Lectures:** 32
- **Practical experience:** 32

Self-study: 80

Assessment: Graded credit-test, credit test

Division: Nuclear Fuel Cycle

Director of Programme _____ / Vera V. Verkhoturova

Instructor _____ / Alexandr V. Vorobev

_____ / Sergey V. Lavrinenko

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Course name: Steam Turbines Design Project

Course Overview

Course Objectives	The objectives of the training course "Steam Turbines Design Project" is the formation of a set of competencies which are required for a specialist to be prepared for conducting professional activities, involving the solution of research and applied problems arising in the design of technological equipment for the production of electric and thermal energy at nuclear power plants, design of structural devices, observance of requirements and operating conditions of steam turbines, application of methods for calculating steam turbines for nuclear power plants.
Learning Outcomes	**Upon completion of the course, a graduate will obtain the knowledge of:** – methodology of systemic and critical analysis of problem situations; – methods of setting goals, determining how to achieve it, and developing action strategies; – systems and critical analysis methods; – methods of developing an action strategy to identify and solve a problem situation; – stages of the project life cycle; – stages of project development and implementation; – methods of development and project management; – features of professional etiquette of Western and domestic cultures; – basics of structuring a report and preparing presentations in a foreign language, accepted in the international environment; – materials used in structures and their operational properties; – technology for the production of electric and thermal energy on NPP; – methods for analyzing the technical condition of turbine equipment; – technical conditions, standards for installation, repair, commissioning, testing of turbine equipment; – technical characteristics of the equipment being serviced, the device and its operation, passport data and the limits of safe operation of equipment and pipelines. **Upon completion of the course, graduates are also expected to develop the following skills:** – apply methods of a systems approach and critical analysis of problem situations; – develop an action strategy, make specific decisions for its implementation; – develop a project taking into account the analysis of alternative options for its implementation, determine the target stages, the main directions of work; – explain goals and formulate tasks related to the preparation and implementation of the project, determine the main stages and directions of work; – manage a project at all stages of its life cycle; – compile and present technical and scientific information used in professional activities in the form of a presentation; – perceive authentic audio and video materials related to training; – apply advanced domestic and foreign experience in operating turbine

	equipment in work; – apply optimization methods for planning working hours, consumption of materials, energy and fuel; – apply measures to ensure the safety of equipment and the conditions for its safe operation; – apply modern information technology; **Upon completion of the course, graduates should acquire the practical experience in**: – methods of development and project management; – methods for assessing resource requirements and project effectiveness; – owns the skills of monologue utterance in a foreign language according to the profile of his specialty, reasonably expounds his position and using auxiliary means (tables, graphs, charts, etc.); – owns acquired knowledge of a foreign language at a sufficient level in his future professional activities; – fluent in engineering calculations and certification evaluations of turbine equipment; – planning working hours, identifying and resolving problem situations, optimizing supplies, energy and fuel; – analyze failures and violations in the operation of equipment and pipelines; – development and maintenance of production and technical documentation.
Course Outline	The target course is taught using a variety of teaching forms such as: – 16 lectures; – 16 practical experiences; – tests; – term project. The course consists of 6 sections, which are given below. Section 1. Introduction Section 2. Turbine stages Section 3. The flow part of the turbine Section 4. Geometrical parameters of turbine stages Section 5. Efficiency turbine installations Section 6. Mechanical characteristics of the turbine Each section includes several lectures and practical experiences. The course ends with a graded credit test. The training course provides for the implementation of 2 tests to check the development of trainees' knowledge and skills. Performance of individual homework assignments is scored with 80 points in total. Each test is scored with the maximum of 10 points. The term project for the training course includes the following tasks to be done by students: 1. The project concept of the thermal scheme of the turbine unit. Construction of the steam expansion process in the turbine. Determination of steam flow to the turbine. 2. Determination of the turbine power limit. Structural diagram of the turbine. 3. Design calculation of the flow of the turbine. 4. The distribution of heat transfer in the turbine at the pressure stage. Determination of the number of stages. 5. Thermal calculation of the first stage of the average diameter.

	6. Determination of the geometric dimensions of the intermediate pressure stages and the construction of a sketch of the opening of the flow of the cylinder. 7. Determination of thermal efficiency of the turbine and turbine installation. 8. Calculation of the axial force on the rotor part on the example of the third stage. 9. Mechanical calculation of turbine elements. 10. Calculation of the strength of the pen and the shank of the blade of the third stage. 11. The calculation of the aperture of the third stage of the deflection. 12. Calculation of the rotor at a critical speed.
Course Structure	The content of the course covers 6 topics. Each topic is studied through lectures and practical experiences. **Section 1. Introduction** The importance of steam and gas turbines in nuclear power industry development and other sectors of the economy. The role of turbines and installations in the power plant operation. Current state of turbine construction for nuclear power plants in Russia and abroad. Types of nuclear power plant turbines. Prospects for the development of turbines for nuclear power. The role of nuclear power for Siberia. Elements of steam turbine installation and their purpose. Thermal cycles of turbine units. **Section 2. Turbine stages** The concept of turbine stages. Grids of turbine stages. Processes in the nozzle grids of steam turbines. The flow of wet steam in the grids. Erosion, reliability, active and passive methods used to eliminate them. **Section 3. The flow part of the turbine** The design of the flow of the steam turbine. Number of steps in the cylinders of steam turbines. Limit the size of the latter steps. **Section 4. Geometrical parameters of turbine stages** Change parameters along the flow path, process in h-s diagram. The advantages of multi-stage turbines, the process in the flow part, the speed triangles. **Section 5. Efficiency turbine installations** Features in the calculation of efficiency of turbine plants of nuclear power plants. Prospects for the use of heating in nuclear power. Prospects for the use of gas turbines at nuclear power plants. **Section 6. Mechanical characteristics of the turbine** The main parameters of reliable operation of the steam turbine NPP: the main load and their causes, the strength of the structural elements of the turbine, the critical speed.
Facilities and Equipment	1. Lecture hall with multimedia equipment: Tomsk, Lenin ave. 30a, building 4, room 32. 2. Physical modelling laboratory which includes 1 steam turbine, 1 air turbine, 6 heat exchangers, 5 heat exchange loops, 4 electric boilers, 5 air blowers, 1 steam generator, 1 deaerator, 2 pumps, 1 compressor, etc.: Tomsk, Lenin ave. 30a, building, rooms 101b, 101c.
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 material and the results of practical activities (performance tests, perform tasks, problem solving). Max score for current assessment is 40 points, min – 22 points.

	– Course final assessment (exam/ credit test) is performed at the end of the semester. Max score for course final assessment is 60 points, min – 33 points. The final rating is determined by summing the points of the current assessment during the semester and protection of the course project at the end of the semester. Maximum overall rating corresponds to 100 points, min pass score is 55.
Course Policy	Attendance is strictly controlled. All classes are obligatory for attendance.
Teaching Aids and Resources	**Compulsory reading:** 1. Fuchs Ewald F., Masoum Mohammad A.S. Power Conversion of Renewable Energy Systems / Ewald F. Fuchs, Mohammad A.S. Masoum. – Boston: Springer, 2011. — 692 p. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-1-4419-7979-7 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. **Additional reading:** 1. Souza, G. Thermal Power Plant Performance Analysis / G. Souza. – London : Springer-Verlag Ltd., 2012. — 287 p. – Текст : электронный // SpringerLink. – URL : https://link.springer.com/book/10.1007/978-1-4471-2309-5 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ.
Instructors	1. Dr. Alexandr V. Vorobe, Associate professor, the Butakov Research Center, School of Energy and Power Engineering e-mail: worob@tpu.ru, phone: +7 (3822) 701-777 (ext. 1627), personal site: https://portal.tpu.ru/SHARED/w/WOROB/eng 2. Sergey V. Lavrinenko, Associate professor, the Butakov Research Center, School of Energy and Power Engineering e-mail: serg86@tpu.ru, phone: +7 (3822) 701-777 (ext. 1696), personal site: https://portal.tpu.ru/SHARED/s/SERG86/eng