TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY

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

Course Name: Fundamentals of Nuclear Fuel Cycle

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: 2019

Semester, year: semester 1, year 2

ECTS: 2

Total Hours: 72

Contact Hours: 32

- **Lectures:** 16
- **Practice:** 16

Self-study: 40

Assessment: Exam

Division: Nuclear Fuel Cycle

Director of Programme _____ / Vera V. Verkhoturova

Instructor _____ / Andrey O. Semenov

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Course name: Fundamentals of Nuclear Fuel Cycle

Course Overview

Course Objectives	The objective of the course is to develop knowledge and skills to perform professional activity in a variety of forms including research and technological activities in the fields related to nuclear power engineering.
Learning Outcomes	**Upon completion of the course, a graduate is expected to acquire the knowledge of:** – modern communication technologies in a foreign language in the field of nuclear fuel cycle; – key features of the nuclear core of power plants. – nuclear fuel cycle stages; – types of storage and disposal facilities; – nuclear fuel production methods and technologies; – transportation of nuclear fuel; – closed and open nuclear fuel cycles stages; – prospects of the nuclear fuel cycle development. **Graduates are also expected to develop the following skills:** – to apply knowledge of modern communication technologies in a foreign language in the field of nuclear fuel cycle; – to analyze the stages of the nuclear fuel cycle, including storage and transportation of nuclear fuel, its production; – to assess the prospects of the nuclear fuel cycle development, the stages of closed and open nuclear fuel cycles, key features of the nuclear core of power plants. **Graduates should acquire the practical experience in:** – carrying out analysis of the stages of the nuclear fuel cycle, including storage and transportation of nuclear fuel, its production; – conducting assessment of the prospects of the nuclear fuel cycle development: – making comparative analysis of the stages of closed and open nuclear fuel cycles, key features of the nuclear core of power plants.
Course Outline	The target course is taught using a variety of teaching forms such as: – 8 lectures; – 8 practical experiences; – 2 colloquiums; – 3 tests; – 1 review and oral report. Within the framework of the course, students study the following sections: Section 1. Nuclear fuel cycle. Pre-reactor part. Section 2. Nuclear reactors and their application for energy production. Section 3. Fuel reprocessing and management of radioactive waste and spent nuclear fuel. Learners' self-study is arranged in a form of individual research of the topics, preparation for colloquiums and midterm tests, performing a case study. During the

	course of study, learners are expected to write a report based on the review.
Prerequisites (if available)	1. Nuclear Physics. 2. Materials of Nuclear Installations.
Course Structure	The content of the course covers 3 topics. Each topic is studied through lectures and practical experiences. The target course consists of two sections. **Section 1. Nuclear fuel cycle. Pre-reactor part** Having mastered the content of this section, students will know about the role of nuclear energy in the modern world, obtain knowledge of the main uranium ore deposits, mining and processing of uranium ores technologies, perspective types of uranium enrichment technologies, different types of reactors fuel as well as of fuel fabrication technologies. **Section 2. Nuclear reactors and their application for energy production** Having mastered the content of this section, learners will acquire knowledge of existing and prospective types of Russian and international nuclear reactors, key features, advantages and disadvantages of these reactors. **Section 3. Fuel reprocessing and management of radioactive waste and spent nuclear fuel** Upon completion of this section, students will learn information about the classification of radioactive waste, waste reprocessing technologies and disposal methods. In the framework of the course, students will perform: a report, 2 colloquiums, 3 tests and a final test in the form of exam.
Facilities and Equipment	1. Lecture room with multimedia equipment (projector, PC): Tomsk, Lenina Ave., 2, building 10, room 340. 2. Room for practical classes equipped with PCs:): Tomsk, Lenina Ave., 2, building 10, room 248.
Grading Policy	In accordance with TPU assessment system we use: – Current assessment which is performed on a regular basis during the semester by scoring the quality of mastering the theoretical material and the results of practical activities (tests, 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 current assessment allows revealing the quality of learners mastering the course material referring to all sections of the course “Fundamentals of Nuclear Fuel Cycle”. The current assessment tests must be done in writing within the semester. Three tests are planned for the semester. Report is performed by each of the students independently. Each student receives their individual topic, which must be thoroughly researched. The results of the research work must be presented in a report, which is accompanied by a multimedia presentation. Report must include the literature overview on the given topic and have the following parts: a title page, outline, introduction, main body sections, conclusion and reference list. The volume of the report should be at least 7-15 pages. Defense of the report is carried out in the form of oral presentation, which should be delivered within 7-9 minutes. In order to assess the current level of knowledge, it is supposed to conduct 2 colloquiums in the form of an oral interview. It is necessary to answer on 5 theoretical questions based on the materials of the relevant sections of the discipline. The correct answer to this question is estimated at 4 points. The maximum possible

	number of points for one colloquium is 20 points. Exam is a final assessment form, which aims to reveal developed learning outcomes and determine the degree of their correspondence to those planned in the course programme. A student is admitted to the exam on condition that all the tests and colloquiums are passed, all projects are completed and evaluated by the course instructor. The structure of an exam paper includes two questions. The exam is performed orally. A student answers the questions and presents ways of the problem solution. Additional questions and tasks might be provided by the examiner. The final score is determined by summing the scores of the current assessment during the semester and exam score at the end of the semester. Maximum overall score corresponds to 100 points, min pass score is 55 points.
Course Policy	Class attendance will be taken into consideration when evaluating students' participation in the course. Students are expected to be actively engaged in class discussions on the assigned reading materials. All classes are obligatory to attend.
Teaching Aids and Resources	**Compulsory reading:** 1. Zohuri, B. Thermal-Hydraulic Analysis of Nuclear Reactors / B. Zohuri, N. Fathi, — Cham : Springer, 2015. — 651 с. — Текст : электронный // SpringerLink. — URL: https://link.springer.com/book/10.1007/978-3-319-17434-1 (дата обращения: 20.09.2020). — Режим доступа: из корпоративной сети ТПУ. 2. Kessler, G. Sustainable and Safe Nuclear Fission Energy. Technology and Safety of Fast and Thermal Nuclear Reactors / G. Kessler. — Berlin : Springer, 2012. — 464 с. —Текст : электронный // SpringerLink. — URL: https://link.springer.com/book/10.1007/978-3-642-11990-3 (дата обращения: 20.09.2020). — Режим доступа: из корпоративной сети ТПУ. 3. Sanctis, De E. Energy from Nuclear Fission. An Introduction / E De Sanctis, S. Monti, M. Ripani. — Cham : Springer, 2016. — 278 с. - Текст : электронный // SpringerLink. — URL: https://link.springer.com/book/10.1007/978-3-319-30651-3 (дата обращения: 20.09.2020). — Режим доступа: из корпоративной сети ТПУ.
Instructor	Andrey O. Semenov, Senior lecturer, Nuclear Fuel Cycle Division, School of Nuclear Science and Engineering, TPU, e-mail: semenov_ao@tpu.ru, tel. +7 (3822) 701-777 (ext.2330), personal site: https://portal.tpu.ru/SHARED/s/SEMENOV_AO/eng