TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY

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

Course Name: Nuclear and Radiation Safety

Field of Study: Nuclear Science 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 2, year 1

ECTS: 3

Total Hours: 108

Contact Hours: 32

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

Self-study: 76

Assessment: Exam

Division: Nuclear Fuel Cycle

Director of Programme _____ / Vera V. Verkhoturova

Instructor _____ / Maxim E. Silaev

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Course name: Nuclear and Radiation Safety

Course Overview

Course Objectives	The objective of the course is to develop students' theoretical knowledge and practical skills, which are necessary to conduct professional activity involving the usage of principles and techniques of nuclear and radiation safety and control.
Learning Outcomes	**Upon completion of the course, a graduate will obtain the knowledge of:** – professional etiquette of Western and Russian cultures; – a report structuring and preparation of presentations in a foreign language that are accepted for the international auditorium; – modern methods of research, evaluation and presentation of the results of the performed work; – national and international laws and requirements in the field of nuclear and radiation safety; – basic principles of the safety culture; – conditions of operation of nuclear and radiation facilities in regular and emergency situations; – the list and content of methods of assessing of nuclear and radiation characteristics; – rules and regulations in fields of nuclear and radiation safety; – methods of accident prevention and response; – regulations and management issues of safety operation of nuclear and radiation facilities; – Russian and international requirements in fields of nuclear and radiation safety; – methods of occupational and public dose calculating from external and internal exposure; – methods of radiation situation prediction; – order of use of control systems/devices and protection measures against ionizing radiation; – conventional methods of calculations; – conventional methods of accidents prevention and response; – national and international laws and requirements in the field of environmental protection; – regulation and rules of nuclear safety and radiation protection. **Upon completion of the course, graduates are also expected to develop the following skills:** – to compile and present technical and scientific information used in professional activities in the form of a presentation; – to perceive authentic audio and video materials related to training program; – to apply modern research methods, evaluate and present the results of the performed work; – to use regulatory and technical documentations in his professional activities;

	– to collection and record necessary data; – to compare working parameters with regulatory requirements; – to study and use best practices in his professional activities; – to perform a search of the necessary scientific and regulatory information from open sources of information; – to use of modern methods of assessing of nuclear and radiation parameters; – to apply modern mathematical methods for calculations and results processing; – to apply generic principles of safe operation to nuclear and radiation facilities; – to apply methods of monitoring of nuclear and radiation parameters for nuclear installation; – to perform assessments of parameters to support nuclear and radiation safety in normal operation constraints and deviations from normal conditions; – to determine necessary protective means and types of radiation exposure individual control; – to apply measures of prevention of environment pollution; – to develop safety measures in case of design accidents and severe accidents; – to apply of standards and methodologies in fields of nuclear and radiation safety. **Upon completion of the course, graduates should acquire the practical experience in:** – a monological speech in a foreign language and in accordance with the profile of his specialization. The position of speaker should be proved by reasons and supported by auxiliary means (such as tables, graphs, charts, etc.); – a foreign language at a sufficient level for professional activities in future; – applying modern research methods, evaluating and presenting the results of performed work; – analyzing and identification of trends, development proposals to improve reliability and safety; – the selection and application of methods for development of models for description of effects of ionizing radiation exposure to human and environment; – initial data preparation; – calculating nuclear and radiation characteristics; – development of technical and administrative measures and measures to improve the safety and fail-safe operation of nuclear and radiation facilities; – methods and technologies of the environmental and radiation situation forecast, and for assessing of incurred to workers and population individual dose in case of possible radiation accidents.
Course Outline	The target course is taught using a variety of teaching forms such as: – 8 lectures; – 8 practical experience;

	– 2 colloquiums; – 2 tests. Within the framework of the course students study the following sections: **Section 1. Radiation safety and protection against ionizing radiation** **Section 2. Nuclear safety of facilities and activities** Each section includes several lectures and practical experiences. The course ends with an exam. *Learners' self-study* involves studding of theoretical materials from the lectures, books and regulatory documents, preparation for colloquiums and tests.
Prerequisites (if available)	1. Nuclear Physics. 2. Special chapters of Advanced Mathematics. 3. Materials of Nuclear Facilities. 4. Dosimetry and shielding from ionizing radiation
Course Structure	The target course consist of two sections **Section 1. Radiation safety and protection against ionizing radiation** Radiation safety is provided by means of a set of measures (administrative and technical) that protect people and the environment from the dangers caused by ionizing radiation. All possible radiation exposure conditions (occupational, existent and emergency), as well as groups of exposed persons (workers, population and medical patients) are considered. The risk management system, developed on the basis of fundamental safety principles, allows to insure an acceptable level of probability of occurrence of undesirable consequences of radiation exposure in all possible conditions. These are handling with radiation sources in existent living conditions, at facilities, as well as in radioactive waste management. **Section 2. Nuclear safety of facilities and activities** The safety of any facilities or activities should be assessed by analyzing a number of characteristics, including possible radiation risks, safety functions, site characterization, radiation protection measures, engineering and technical aspects of operation, human factors, aging and wearing and so on. Generic safety approaches are defense in depth, safety margins and multiple safety barriers. One of the most significant hazard factors is the possibility of an uncontrolled fission chain reaction. The limitation of this factor is achieved by regulating the neutron multiplication coefficient and reactivity. A combination of all achievements in field of safety represents a safety culture of the facility. Maintenance and development of safety culture is a factor of paramount importance.
Facilities and Equipment	Lecture hall with multimedia equipment: 634050, Tomsk, 2, Lenina ave., building 10, room 228, room 340.
Grading Policy	Two types of assessment in accordance with TPU rating system are used: - Current assessment is performed on a regular basis during the semester. It is a quantitative evaluation of a quality of the study and understanding of theoretical and practical material of the course. Current assessment is performed by means of 2 tests and 2 colloquiums. The maximum score for current assessment is 80 points. The minimum score is 44 points. - Course final assessment is performed at the end of the semester. Maximum score of the course final assessment is 20 points. Te minimum score is 11 points. 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 is from 100 points to 55.

	Tests are performed in writing form. They are an individual assign for every student. Each of tests includes 3 or 4 tasks/problems that should be solved in 1.5 hours. The maximum score of the test is 20. The minimum one is 8. Colloquiums are performed in written form. They are an individual assign for every student. Assigns supposed answers on set of questions. Each set includes four questions. Colloquium timeframe is 1.5 hours. The maximum score is for the colloquium is 20. The minimum one is 8. Final assessment is performed in written and verbal forms and consists of two parts. The first part (45 minutes) is in written form. Student should to solve two tasks based on the course materials. The maximum score is 10; the minimum score is 6. The second part is theoretical one. Every student should to answer on two theoretical questions (preparation to answer takes 45 minutes). The maximum score is 10; the minimum score is 5.
Course Policy	Attendance at lectures and practical experience is compulsory.
Teaching Aids and Resources	**Compulsory reading:** 1. Pham H. Safety and Risk Modeling and Its Applications / H. Pham. – London : Springer-Verlag Ltd., 2011. – 429 p. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-0-85729-470-8 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. 2. Domenech H. Radiation Safety Management and Programs / H. Domenech. – Cham : Springer International Publishing, 2017. – 334 p. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-319-42671-6 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. 3. Prince R. Radiation Protection at Light Water Reactors / R. Prince. – Berlin : Springer-Verlag, 2012. – 372 p. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-642-28388-8 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. 4. Marguet, S. The Physics of Nuclear Reactors / S. Marguet. — Cham : Springer International Publishing AG, 2017. — 1445 p. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-319-59560-3 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. **Additional reading:** 1. Safety Cultures, Safety Models Taking Stock and Moving Forward / by editors C. Gilbert, B. Journé, H. Laroche; C. Bieder. - Cham : Springer Open, 2018. - Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-319-95129-4 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ.
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