TOMSK POLYTECHNIC UNIVERSITY | ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY

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

Course Name: Safety and Reliability of Technical Systems

Field of Study: Nuclear Science and Technology

Programme name: Nuclear Science and Technology

Specialization: Nuclear Safety, Security and Non-Proliferation of Nuclear Materials

Level of Study: Master Degree Programme

Year of admission: 2020

Semester, year: semester 2, year 1

ECTS: 3

Total Hours: 108

Contact Hours: 48

- **Lectures:** 24
- **Practical experience:** 24

Self-study: 60

Assessment: Credit-test

Division: Nuclear Fuel Cycle

Director of Programme _____ / Vera V. Verkhoturova

Instructor _____ / Boris P. Stepanov

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Course name: Safety and Reliability of Technical Systems

Course Overview

Course Objectives	The objective of the training course "Safety and reliability of technical systems" is to introduce students to basic methods and approaches for calculating and predicting the safe and reliable operation of various technical systems, as well as their elements.
Learning Outcomes	**Upon completion of the course, a graduate will obtain the knowledge of:** – basic terms and definitions used in reliability theory; – methods and approaches for calculating and improving the reliability of technical systems; – basic requirements for the reliability of technical systems in the design, construction and operation; – basics of structuring and preparing presentations. **Upon completion of the course, graduates are expected to develop the following skills:** – to calculate the basic indicators of safety and reliability of technical systems; – to use the basic mathematical models of reliability theory to solve the problems of ensuring the safety and reliability of technical systems; – to make calculations and economically justify measures to improve the safety and reliability of technical systems; – to present technical and scientific information in the form of presentation. **Upon completion of the course, graduates should acquire the practical experience in:** – application of the acquired knowledge to determine the basic indicators of safety and reliability of technical systems; – using the obtained knowledge to analyze the safety and reliability of technical systems; – application of the mathematical apparatus of reliability theory for scientific research and solving practical tasks; – using the obtained knowledge to present technical information in the form of presentation and an oral report.
Course Outline	The training course is delivered through the following teaching modes: – 12 lectures; – 12 practical experiences. The course consists of 6 sections, which are given below. **Section 1. Basic terms and definitions** **Section 2. Mathematical and physical foundations of reliability** **Section 3. Reliability models** **Section 4. Structural reliability of technical systems** **Section 5. Design of reliability of technical systems** **Section 6. Reliability tests** Each section includes two lectures and two practical experiences. The course implies conducting one test. Test is performed at the end of the study of the first section of the course. Test is scored with maximum of 4 points.

	As part of the study, students shall solve practical tasks for each section of the course. Practical tasks are a set of tasks with unique individual parameters for each student. The student shall solve a task during practical experiences to test their skills to apply obtained knowledge to solve specific tasks. The solution of practical tasks is evaluated with maximum of 66 points. In addition, as part of the study, students shall perform and submit an oral report during one of the practical experiences. Topics for reports are determined by the instructor. Report shall be accompanied by a multimedia presentation. Oral report is evaluated with maximum of 6 points.
Course Structure	The content of the course covers 6 topics. Each topic is studied through lectures and practical experiences. **Section 1. Basic terms and definitions** Basic terms and definitions of reliability. Classification of objects by reliability. Classification of failure. Failure analysis. Reliability indicators. Durability indicators. Maintainability indicators. Storability indicators. Comprehensive indicators of reliability. Economic indicators of reliability. Normalized indicators of reliability. **Section 2. Mathematical and physical foundations of reliability** Random events. Characteristics of random events. Random variables. Distribution functions of random variables. Characteristics of random variables. Distribution of discrete and continuous random variables. Regression dependencies. Physical and chemical processes in materials. Mechanical destruction processes. Thermal destruction processes. Electrical destruction processes. Aging processes of materials. **Section 3. Reliability models** Reliability modeling methods. Reliability models. Strength reliability (sudden failures model). Parametric reliability (gradual failures model). Sensitivity of technical objects to operating conditions. Statistical modeling of reliability. **Section 4. Structural reliability of technical systems** Reliability analysis of technical systems. Methods for calculating the structural reliability of technical systems. Systems with series and parallel connection of elements. Majority, bridge, combined and multifunctional systems. Methods for improving the structural reliability of systems. Redundancy types. Optimization of structural redundancy. Reliability of technical systems with recovery. Calculation of reliability of technical systems with recovery. Statistical modeling of structural reliability of technical systems. **Section 5. Design of reliability of technical systems** Tasks and methods of design studies of reliability. Justification and calculation of reliability standards. Full and approximate calculation of the reliability. Calculation of system reliability during design. Requirements for reliability indicators of technical systems. Design analysis of system reliability. Calculation of structural schemes of reliability. **Section 6. Reliability tests** Objectives of reliability test. Types of reliability tests. Determination (reliability) test. Reliability test plan. Compliance (reliability) test. Single-stage control method. Sequential control method. Accelerated test.
Facilities and Equipment	1. Lecture Hall with multimedia equipment: 634050, Tomsk, Lenin ave. 2, building 10, room 340.
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, the results of

	practical activities (performance tests, perform tasks, problem solving) and class attendance. The final rating is determined by summing the points of the current assessment during 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. Kołowrocki, K. Reliability and Safety of Complex Technical Systems and Processes / K. Kołowrocki, J. Soszynska-Budny. – London : Springer, 2011. – 419 p. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-0-85729-694-8 (дата обращения: 20.09.2020). – Режим доступа : из корпоративной сети ТПУ. **Additional reading:** 1. Werbińska-Wojciechowska, S. Technical System Maintenance. Delay-Time-Based Modelling / S. Werbińska-Wojciechowska. - Cham : Springer, 2019. - 347 p. - Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-030-10788-8 (дата обращения: 20.09.2020). – Режим доступа : по подписке.
Instructor	Boris P. Stepanov, Associate professor, Nuclear Fuel Cycle Division, School of Nuclear Science and Engineering, TPU, e-mail: sbp@tpu.ru, phone: +7 (3822) 701-777 (ext. 2259), personal site: https://portal.tpu.ru/SHARED/s/SBP/eng