TOMSK POLYTECHNIC UNIVERSITY
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY

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

Course Name: Mathematical Methods in Radiology

Field of study: Nuclear Science and Technology

Programme name: Nuclear Science and Technology

Specialization: Nuclear medicine

Level of Study: Master Degree Programme

Year of admission: 2019

Semester, year: semester 2, year 1

ECTS: 2

Total Hours: 72

Contact Hours: 40

- **Lectures:** 16
- **Labs:** 16
- **Practical experience:** 8

Assessment: Exam

Division: Division for Nuclear-Fuel Cycle

Director of Programme _______________ / Vera V. Verkhoturova

Instructor _______________ /Alexey V. Bogdanov

TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Course Name: Mathematical methods in radiology

Course Overview

Course Objectives	The objective of the course is to develop learners' knowledge and skills to perform professional activity in a variety of forms including research and technological activities in the fields related to nuclear medicine.
Learning Outcomes	**Upon completion of the course, a graduate will obtain knowledge of:** – basics of probability theory and mathematical statistics; – methods for descriptive statistics for data analysis; – knowledge of the basic principles of setting and solution methods of innovative engineering and physical problems; – approaches of projects realization in the field of medical physics and nuclear medicine, radiation therapy and radiation dose planning. **Upon completion of the course, a graduate will be able to**: – use uniform random numbers for simple discrete outcomes simulation; – use uniform random number for simulation of continuous values and outcomes; – use Monte Carlo method to solve simple phenomena and mathematical tasks; – simulate complex phenomena for example complex radioactive decay, interaction of particles with matter; – create mathematical models and simulate ionizing radiation interaction processes with matter; – apply methods used for errors reduction, receiver operator characteristic curve analysis, statistical simulation; – set and solute the innovative engineering and physical problems; – develop algorithms and methods for designing modern physical medical installations and devices. **Upon completion of the course, a graduate will have experience in**: – application of deep mathematical and professional knowledge in theoretical and experimental research in the field of medical physics and nuclear medicine; – creation of theoretical, physical and mathematical models describing the distribution and interaction of ionizing radiation with matter and living tissue.
Course Outline	Forms of teaching used for this course include lectures, labs and practical tutorials. There are 4 laboratory works, which shall be done during the course to allow trainees demonstrate their theoretical and practical knowledge obtained within the study of the course. The course finishes with the examination.
Prerequisites (if	Bachelor degree with good knowledge in mathematics.

available)	
Course Structure	The structure of the training course comprises of five sections. **Section 1. Introduction** As a result of mastering this section, students will learn the basics of probability theory and mathematical statistics. Probability: classical, bayesian. The basic concepts of the description of random phenomena are described and some formulas of the probability theory are given. **Section 2. Uniformly distributed random numbers** At the end of this section, a student will have a knowledge of ways to generate uniformly distributed random numbers and how to use this numbers for simulation of simple discrete events. Methods for obtaining random points in a multidimensional space are described. **Section 3. Random points in multidimensional space** As a result of mastering the section, a student will know how to generate random points in multidimensional space and how to use it for solving some additional problems. **Section 4. Non-uniform random number** At the end of this section, student will know the several methods of continuous non-uniform random method generation. In addition, how to use this method to solve and simulate some additional tasks. **Section 5. The Poisson Distribution** As a result of learning this section, students will know that the Poisson distribution could occur in many real phenomena and Poisson flow of events helps to simulate various phenomena from radioactive decay till passing of radiation trough matter.
Facilities and Equipment	1. Classroom with multimedia equipment (projector, PC): 634050, Tomsk, Lenina Ave., 2, building 10, room 125A.
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 the course final assessment is 20 points. The final rating is determined by summing the points of the current assessment during the semester and credit test scores at the end of the semester. Maximum overall rating corresponds to 100 points, min pass score is 55. Laboratory works (current assessment) are scored according to the scheduled course assessment calendar. The correctness and completeness of calculations are taking in account when assessment of the lab-based works is performed. At the end of the course examination is conducted in oral form. The learners are offered examination papers, each of which consists of 4 questions. Learners are to provide answers to all 4 questions within the set period of

	time. Each question is scored with 5 points.
Course Policy	Class attendance will be taken into consideration when evaluating students' participation in the course / Students are expected to actively engage in class discussions about the assigned readings. Attendance is strictly controlled. All classes is obligatory to presence. In addition, submission of a laboratory work for verification after deadline reduces the maximum score for this assignment by 10% for every week of delay.
Teaching Aids and Resources	**Compulsory reading:** 1. Binder, K. Monte Carlo Simulation in Statistical Physics. An introduction / Kurt Binder, Dieter W. Heermann. - 5 edition. – Berlin: Springer, 2010. – 200 с. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-642-03163-2 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. 2. Parodi, K. Monte Carlo Methods for Dose Calculations / K. Parodi. - Текст: электронный // Ion Beam Therapy. Fundamentals, Technology, Clinical Applications / by editor U. Linz. – Berlin : Springer, Berlin, 2012. – C. 97-116. – URL: https://link.springer.com/chapter/10.1007/978-3-642-21414-1_7 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. 3. Min Gu. Microscopic Imaging Through Turbid Media. Monte Carlo Modeling and Applications / Min Gu,Xiaosong Gan, Xiaoyuan Deng. – Berlin : Springer, 2015. – 187 с. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-662-46397-0 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. **Additional reading:** 1. Mias, G. Mathematica for Bioinformatics. A Wolfram Language Approach to Omics / G. Mias. – Springer, Cham, 2018, – 384 с. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-319-72377-8 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ.
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