TOMSK POLYTECHNIC UNIVERSITY | ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY

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

Course Name: Quality assurance for radiation therapy

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: 2020

Semester, year: semester 3, year 2

ECTS: 6

Total Hours: 216

Contact Hours: 112

- **Lectures:** 32
- **Practical experience:** 32
- **Laboratory experience:** 48

Self-study: 104

Assessment: Credit-test, graded credit-test

Division: Nuclear Fuel Cycle

Director of Programme _____ / Vera V. Verkhoturova

Instructor _____ / Evgeniia S. Sukhikh

Course name: Quality assurance for radiation therapy

Course Overview

Course Objectives	The objectives of " **Quality Assurance for Radiation Therapy** " course include the development of students' knowledge and ideas of modern methods, algorithms and procedures of **Quality assurance (QA)** used for calculation/simulation of the radiation dose distribution in patients during radiation therapy (RT). The clinical aspects of QA are given for the major malignancies which medical physicists will deal during their career. Students will learn to find the solution of research and applied problems connected with QA for radiotherapy, diagnostic, nuclear medicine and dosimetric equipment. Special attention during the course is given to practical skills of the application of methods of QA for calculation of dose distribution in the patient's body generated by various sources ionizing radiation and dose delivery techniques; to principles of control levels calculating for tumour and damage to healthy tissues and organs at risk.
Learning Outcomes	**Upon completion of the course, a graduate will obtain the knowledge of:** – physical and radiobiological basics of QA procedures for the radiotherapy and the treatment planning, which include algorithms, treatment planning principles, calculation and simulation of the dose distribution – main documents of the departments of QA procedures for radiotherapy and diagnostic, nuclear medicine that deals with the treatment planning – main international protocols of QA procedures for the treatment planning procedures and different aspects – main recommendation of national and international standards and protocols of QA procedures with respect to the equipment of radiotherapy departments. **Upon completion of the course, graduates are expected to develop the following skills:** – To analyze and compare international protocols of QA for the treatment planning and treatment procedures. – To use special software of QA for the treatment planning – treatment planning systems – To develop the QA procedures of treatment plan for the particular patient following the treatment prescription **Upon completion of the course, graduates should acquire the practical experience in:** – Comparison and analysis of the international protocol of QA for the of the treatment planning and treatment procedures – Development the QA procedures of treatment plan for the particular patient following the treatment prescription – Analysis and QA of the radiotherapy, diagnostic, nuclear medicine.
Course Outline	The training course is delivered through the following teaching modes: – 16 lectures; – 16 practical experiences; – 24 laboratory experiences; – term project. The course consists of 5 sections, which are given below.

	Section 1. Introduction. Quality Assurance Basics in Radiation Therapy **Section 2. Quality assurance of radiotherapy and dosimetry equipment** **Section 3. Quality assurance of dosimetric planning systems** **Section 4. Quality Assurance in Brachytherapy** **Section 5. Quality assurance of special equipment for radiotherapy and individual exposure plans. Features of monitoring the position of the patient during treatment** Each section includes several lectures, practical and laboratory experiences. Laboratory experiences are aimed to obtaining practical skills in the application of methods of quality assurance for calculation of the dose distribution in patient's body from various sources and technical delivery of ionizing radiation (conventional RT, ortovoltage radiotherapy, 3D conformal radiotherapy (3DCRT), electron RT, brachytherapy, intensity modulated radiotherapy (IMRT\VMAT) for stereotactic radiotherapy and radiosurgery (SBRT/SRS)), the principles of calculating the level of control over the tumor and damage to healthy tissues. The training course finishes with a credit test and requires obligatory completion and defense of a term project. As part of the study, the course provides 12 individual home assignments for students' self-study. Individual homework consists in compiling the necessary technical and dosimetric parameters of the equipment for quality assurance (QA), depending on the types of radiation therapy that will be performed. The list of equipment for performing any type of radiation therapy includes: radiotherapy equipment (accelerators, gamma apparatus), treatment planning system (TPS), dosimetric equipment, immobilization devices. A set of types of radiation therapy is individual for each student. The term project includes the following a set of types of radiation therapy: 1. Conventional RT, interstitial and intracavitory brachytherapy, ortovoltage radiotherapy. 2.3D conformal radiotherapy (3DCRT), electron RT, intracavitory brachytherapy, ortovoltage radiotherapy. 3.Conventional RT, 3D conformal radiotherapy (3DCRT), interstitial brachytherapy, ortovoltage radiotherapy. 4.3D conformal radiotherapy (3DCRT), electron RT, intracavitory and intraluminal brachytherapy. 5. 3D conformal radiotherapy (3DCRT), electron RT, intensity modulated radiotherapy (IMRT). 6. 3D conformal radiotherapy (3DCRT), intensity modulated radiotherapy (IMRT\VMAT). 7. 3D conformal radiotherapy (3DCRT) and intensity modulated radiotherapy (IMRT\VMAT) with image-guided radiotherapy (IGRT) based on MV images. 8.Intensity modulated radiotherapy (IMRT\VMAT) with image-guided radiotherapy (IGRT) based on MV and kV images. 9. Intracavitory, interstitial and intraluminal brachytherapy, ortovoltage radiotherapy. 10. Intensity modulated radiotherapy (IMRT\VMAT) for stereotactic radiotherapy and radiosurgery (SBRT/SRS) with image-guided radiotherapy (IGRT) based on kV images in real time. 11. Intensity modulated radiotherapy (IMRT\VMAT) for stereotactic radiotherapy and radiosurgery (SBRT/SRS) with image-guided radiotherapy (IGRT) based on MR images.

	12. Intensity modulated radiotherapy (IMRT\VMAT) for stereotactic radiotherapy and radiosurgery (SBRT/SRS) with image-guided radiotherapy (IGRT) based on kV images and control active breathing.
Course Structure	The content of the course covers 5 topics. Each topic is studied through lectures and practical experiences. **Section 1. Introduction. Quality Assurance Basics in Radiation Therapy** The section covers the main aspects of quality assurance in clinical practice, as well as in conducting RT, including such stages as: preradiation preparation based on CT, MR (ultrasound, PET) scanners, use of immobilizing devices, prescribing RT course (radiobiological calculation), dosimetric planning, treatment, laying the patient on the treatment table, assessing the effect of the procedure (RT). **Section 2. Quality assurance of radiotherapy and dosimetry equipment** The section is devoted to the physico-dosimetric aspects of the quality assurance of radiotherapeutic and dosimetric equipment for such types of RT: conventional RT, conformal RT (3DCRT), electronic RT, modern treatment methods such as intensity-modulated radiation therapy (IMRT \ VMAT). It also describes the quality assurance procedures for dosimetric equipment to ensure quality radiotherapy. **Section 3. Quality assurance of dosimetric planning systems** This section is devoted to providing quality assurance for dosimetric planning systems for such types of RT: conventional RT, conformal RT (3DCRT), electronic RT, modern treatment methods such as intensity modulated radiation therapy (IMRT \ VMAT). In the framework of practical classes, students are shown the process of creating regulations and protocols to ensure the quality of dosimetric planning on the appropriate equipment in clinical practice (preparation for laboratory work). **Section 4. Quality Assurance in Brachytherapy** This section is dedicated to providing quality assurance for all types of brachytherapy. In the framework of practical classes, students are shown the process of creating regulations and protocols to ensure the quality of therapeutic equipment and dosimetric planning for brachytherapy based on international recommendations (preparation for laboratory work). **Section 5. Quality assurance of special equipment for radiotherapy and individual exposure plans. Features of monitoring the position of the patient during treatment.** The section is devoted to the physical dosimetric aspects of the quality assurance of radiotherapy equipment for such types of radiotherapy as: total body irradiation (TBI), stereotactic radiotherapy and radiosurgery (SBRT / SRS), visual control radiation therapy (IGRT) based on MV and kV, MR images, proton RT, neutron RT, intraoperative RT (IORT). As part of the practical exercises, students are shown the process of verifying the patient's placement on the treatment table and individual dosimetric plans on the appropriate equipment for stereotactic radiation therapy and radiosurgery (SBRT / SRS) and other specialized treatment methods.
Facilities and Equipment	1. Lecture room: 634050, Tomsk, Lenina Ave., 2, building 10, room 228. 2. Laboratory room: 634050, Tomsk, Lenina Ave., 2, building 10, room 123. 3. Facilities and equipment for laboratory works and practical training available at Tomsk, Ivana Chernyh 96/16, rooms 213, 212, 105 (Treatment Planning system (PLUNC, XIO, MONACO, HDRplus); rooms 123, 140, 107, 105 (Dosimetric equipment for QA (SP3 and IMRT phantom, set of ionization chamber,

	MatriXX, ArcCHECK, SNC and 3DVH system, Refraction system, phantom PTW T9193, diodes PTW T9113 and PTW T9112); rooms 123, 140, 107, 105 (Radiotherapy equipment (Linear accelerator Elekta Synergy, gamma apparatus Theratron Equinox 100 and Multisource HDR, Xstrahl 300 X-ray tube).
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 37 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 63 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. Podgorsak, Ervin B. Radiation Physics for Medical Physicists / Ervin B. Podgorsak. – Cham : Springer International Publishing, - 2016. — 906 p. — Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-319-25382-4 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. 2. Amestoy, William. Review of Medical Dosimetry / William Amestoy. - Cham : Springer International Publishing, - 2015. — 867 p.— Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-319-13626-4 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. 3. Stereotactic Body Radiation Therapy / by editor Yasushi Nagata. — Tokyo: Springer, - 2015. – 254 p. — Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-4-431-54883-6 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. 4. Brachytherapy. Techniques and Evidences / by editors Y.Yoshioka, J. Itami, M. Oguchi, T. Nakano. - Singapore: Springer, 2019. – 304 p. — Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-981-13-0490-3 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. **Additional reading:** 1. Handbook of Image-Guided Brachytherapy / by editor J. Mayadev, Stanley H. Benedict, M. Kamrava. - Cham: Springer, 2017. — 582 p. - Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-319-44827-5 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ. 2. Badakhshi, Harun. Image-Guided Stereotactic Radiosurgery / Harun Badakhshi. - Cham: Springer, 2016 — 251 p. - Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-3-319-39189-2 (дата обращения: 20.09.2020). – Режим доступа: из корпоративной сети ТПУ.
Instructor	Evgeniia S. Sukhikh**,** Associate professor, Nuclear Fuel Cycle Division, School of Nuclear Science and & Engineering, Tomsk Polytechnic University, e-mail: e.s.sukhikh@gmail.ru, Tel.: +7 (3822) 909-500 ext. 6025