TOMSK POLYTECHNIC UNIVERSITY
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY

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

Course Name: Treatment Planning

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 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, term project

Division: Nuclear Fuel Cycle

Director of Programme ____________________ / Vera V. Verkhoturova

Instructor ____________________ / Evgeniia S. Sukhikh

Course Name: Treatment planning

Course Overview

Course Objectives	The objectives of "Treatment Planning" course include the development of students' knowledge and ideas of modern methods, algorithms and procedures used for calculation/simulation of the radiation dose distribution in patients during radiation therapy (RT). The course also deals with clinical aspects of RT, which include pretreatment procedures based on CT, MRI images, importance and use of immobilization devices, prescription for RT course, dosimetric treatment planning, certain aspect of treatment procedures themselves, Quality Assurance (QA) of radiotherapy equipment and individual treatment plans. The clinical aspects 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 radiotherapy and dosimetric equipment. Special attention during the course is given to practical skills of the application of methods of calculation of dose distribution in the patient's body generated by various sources ionizing radiation and dose delivery techniques; principles of control levels calculating for tumour and damage to healthy tissues and organs at risk; to QA aspects of radiotherapy equipment and individual treatment plans.
Learning Outcomes	**Upon completion of the course, a graduate will obtain the knowledge of:** – physical and radiobiological basics of the radiotherapy and the treatment planning, which include algorithms, treatment planning principles, calculation and simulation of the dose distribution, QA procedures – main documents of the radiotherapy departments that deals with the treatment planning – main international protocols of the treatment planning procedures and different aspects – main recommendation of national and international standards and protocols 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 the treatment planning, QA, and treatment procedures. – to use special software for the treatment planning – treatment planning systems – to develop the treatment plan for the particular patient following the treatment prescription to apply different dosage delivery techniques during dosimetric treatment planning in order to obtain safe irradiation via external and internal irradiation – to calculate irradiation fractionation regimens, allowing maximum control probability of tumor growth and minimal probability of complications for organs at risk – to develop independent research skills aimed at improving methods for calculating dose distributions in radiotherapy and ensuring the quality of radiotherapy/ **Upon completion of the course, graduates should acquire the practical experience in:** – comparison and analysis of the international protocol of the of the treatment planning, QA, and treatment procedures

	– calculating the dose distribution in patient's body from various sources of ionizing radiation, the principles of fixing and immobilizing the patient on the therapeutic table, the principles of calculating the level of control over the tumor and damage to healthy tissues, as well as reading tomographic images – development the treatment plan for the particular patient following the treatment prescription – analysis and QA of the developed treatment plans – Use of different treatment planning systems.
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. Pretreatment procedures and Radiobiology in radiotherapy.** **Section 2. Dosimetric treatment planning** **Section 3. Special Technique for Radiotherapy. Set-up of patient** **Section 4. Brachytherapy** **Section 5. Quality Assurance of radiotherapy equipment and individual plans** Each section includes several lectures, practical and laboratory experiences. Laboratory experiences aim to teach students practical skills to apply methods of 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, Quality Assurance (QA) of radiotherapy equipment and individual treatment plans. The training course ends 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 home assignment implies compiling necessary technical and dosimetric parameters of the equipment, 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 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 (Pretreatment procedures and Radiobiology in radiotherapy)** Treatment planning of radiotherapy include performing several sequential procedures: pretreatment procedure based on CT/MR/PET scanner with immobilization devices, prescription for RT course (radiobiology calculation), dosimetric planning, Quality Assurance (QA) of radiotherapy equipment and individual treatment plans, performing of treatment. Special attention in this section is given to clinical application of various medical imaging devices (such as X-ray equipment, CT, MRI, ultrasound, PET) and different type of immobilization devices that are routinely used in pretreatment procedures of radiation therapy. This section also includes basic radiobiological models and calculation of different radiotherapy courses in order to control the tumor and damage to normal tissues. The international radiobiological protocols (QUANTEC, RTOG) for tolerant levels of critical organs are additionally introduced. **Section 2. Dosimetric treatment planning** Students will learn main algorithms for the calculation of dose distributions in tissue-equivalent medium (pencil beam method for electron beams, the Monte Carlo methods) for conventional RT, 3D conformal radiation therapy (3DCRT), electron RT, modern treatment techniques such as intensity-modulated radiotherapy (IMRT\VMAT) for stereotactic radiotherapy and radiosurgery (SBRT/SRS). For the treatment plan evaluation students will learn international protocols (ICRU 38, ICRU 50, ICRU 58, ICRU 62, ICRU 71, ICRU 83). **Section 3. Special Technique for Radiotherapy. Set-up of patient** This section is focused on use of special techniques and set-up of patients for radiation therapy such as total body irradiation (TBI), stereotactic radiotherapy and radiosurgery (SBRT/SRS) with image-guided radiotherapy (IGRT) based on MV and kV X-ray images and MR images, proton RT, neutron RT, intro-operative RT (IORT). **Section 4. Brachytherapy** This section is focused on the fundamental concepts of Brachytherapy physics and dosimetry. Lectures cover the history and evolution of Brachytherapy,

	terminology, units, radiobiological basics, current clinical practices and protocols, AAPM Task Group 43 and ESTRO (booklet №10) recommendations, regulatory and radiation control issues, and modern high dose-rate facility design. **Section 5. Quality Assurance of radiotherapy and dosimetry equipment, and individual plans** This section gives students knowledge about those significant guidance documents which are used in the field of Medical Physics (AAPM task group reports and IAEA documents) for Quality Assurance of radiotherapy and dosimetry equipment (AAPM task group 142, TRS 430) and individual plans (AAPM task group 119, AAPM task group 228, ESTRO booklet 9).
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.
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