

Didactic in-person course plans

Course Title: Fundamentals of Radiobiology

Teacher(s) name: Parinaz Mehnati

Prerequisite(s)/Corequisite(s): -

Number of Credits: 2

Type of Credits: Theoretical

The number of theoretical Credit(s): 2

Academic Level of students: Master's Degree

Total Number of Sessions: 17

Course Duration: According to the academic calendar

Weekly Schedule: According to the academic calendar

Location of In-Person Sessions: Faculty of Medicine, Department of Medical Physics

Virtual Class Access Link: Lecture files/materials will be made available to the students.

Main goal of the course:

This course familiarizes students with the fundamental concepts and basic definitions of radiobiology. It examines the physical, chemical, and biological processes through which ionizing radiation interacts with cells, tissues, and various organs of the human body. The course also explains the mechanisms underlying the manifestation of somatic effects (both early and late) and genetic effects resulting from radiation exposure.

Learning Objectives:

Upon successful completion of this course, students will be able to:

- Familiarization with the physical principles of radiobiology and the concepts of RBE (Relative Biological Effectiveness) and LET (Linear Energy Transfer).
- Understanding cell structure, cell organelles, and vital biomolecules of the body.
- Study of radiation chemistry phenomena and reactions, production of free radicals, and the direct and indirect effects of radiation.
- Learning about the mechanisms of cell division and the cell cycle, and the biological effects of radiation on these processes.
- Understanding the target theory, cell survival curves, and parameters such as D_0 and D_q , along with factors influencing them.

- Study of the radiation sensitivity of various mammalian cells and interpretation of the Bergonié–Tribondeau law, the MegaMouth project, and related research findings.
- Midterm evaluation
- Familiarization with deterministic (early) and stochastic (late) effects, as well as other specific somatic effects of radiation.
- Understanding genetic effects of radiation exposure and radiation-induced changes in DNA and chromosomes, along with the mechanisms of DNA and cellular damage repair.
- Study of radiation effects during different stages of embryonic development.
- Understanding the applications of radiobiology in radiotherapy.
- Familiarization with dose–response curves and their biological interpretation.
- Learning about the 4 R’s of radiobiology (Repair, Reassortment, Repopulation, Reoxygenation) and their clinical importance in radiotherapy.
- Understanding the oxygen effect and its influence on the biological effectiveness of different types of radiation.

Teaching Strategies/ methods:

The teaching process in this course is conducted using a video projector, whiteboard, PowerPoint presentations, interactive learning systems, lectures, and question-and-answer sessions.

Assessment and Evaluation Methods:

Midterm exam: 4 points, Final exam: 15 points, Regular class attendance and completion of assignments: 1 point

Minimum Passing Grade: 14

Maximum Permitted Absences: 4

Core Educational References:

Eric J Hall, D. PHIL “Radiobiology for the Radiologist” seventh edition,part1

Supplementary Learning Opportunities:

To enhance the theoretical and practical knowledge of students, the following supplementary learning opportunities are provided:

- Specialized medical physics workshops held throughout the year.
- Scientific congresses in medical physics to familiarize students with the latest scientific and research achievements.
- Educational and specialized webinars offered by the Department of Medical Physics, providing easier access to modern topics and facilitating scientific interaction in a virtual environment.

Contact Information:

- Teacher(s): Parinaz Mehnati, Email: parinazmehnati8@gmail.com

Didactic in-person course plans

Course Title: Laser Applications in Medicine

Teacher(s) name: Dr.hossein Rasta

Prerequisite(s)/Corequisite(s): -

Number of Credits: 1

Type of Credits: Theoretical

The number of theoretical Credit(s): 1

Academic Level of students: Master's Degree

Total Number of Sessions: 8

Course Duration: According to the academic calendar

Weekly Schedule: According to the academic calendar

Location of In-Person Sessions: Faculty of Medicine, Department of Medical Physics

Virtual Class Access Link: Lecture files/materials will be made available to the students.

Main goal of the course:

This course introduces students to the physics of lasers, the characteristics and laws governing laser light, and the different types of lasers used in medicine. It covers both therapeutic and diagnostic applications of lasers, the physics of laser-tissue interaction and its governing principles, as well as methods of laser transmission and utilization. The course also includes an overview of laser-based instruments and medical devices, along with safety considerations and potential hazards of laser radiation for operators, staff, and patients.

During this course, students will become familiar with the fundamentals of laser physics, the nature and properties of laser light, and the components and structure of a laser system. Topics include metastable energy levels in the laser medium, Transverse Modes, Airy Discs, and the calculation of energy, power, intensity, and energy density.

Students will study laser light transmission systems, spatial energy distribution, and the physical processes of reflection, absorption, scattering, and transmission during laser-tissue interactions. The course also covers common medical lasers, their design, features, and clinical applications.

Furthermore, students will learn about laser safety protocols, hazard prevention for users and patients, and practical applications of lasers in clinical settings. The course includes exposure to medical imaging and diagnostic devices that employ laser technology, such as Optical Coherence Tomography (OCT) and Scanning Laser Ophthalmoscopy (SLO).

Learning Objectives:

Upon successful completion of this course, students will be able to:

- Explain the physical principles of lasers.
- Describe the components and structure of a laser device.
- Identify the different types of lasers.
- Explain the longitudinal and transverse modes of lasers.
- Describe laser delivery and transmission systems.
- Perform calculations of laser radiation energies.
- Explain the systems of laser applicators.
- Describe the various laser techniques and explain the characteristics of each method.
- Explain the biological effects of lasers.
- Describe the therapeutic applications of lasers.
- Explain photodynamic therapy (PDT) using lasers.
- Explain the hazards and safety considerations of lasers.

Teaching Strategies/ methods:

The teaching process in this course is conducted using a video projector, whiteboard, PowerPoint presentations, interactive learning systems, lectures, and question-and-answer sessions.

Assessment and Evaluation Methods:

Class Participation: Active participation in each session(1 point).

Assignments: Submission of assigned homework and tasks (3 points).

Final Exam: Written exam at the end of the term, including multiple-choice and descriptive questions (16 points).

Minimum Passing Grade: 14

Maximum Permitted Absences: 2

Core Educational References:

Henderson A. R., "A Guide to Laser Safety, ". Chapman & Hall. London. 1997.

Carruth, Jasand. Mckenzie AL. "Medical Lasere Science and Clinical Practice". Hilger Ltd,1986.

Supplementary Learning Opportunities:

To enhance the theoretical and practical knowledge of students, the following supplementary learning opportunities are provided:

- Specialized medical physics workshops held throughout the year.
- Scientific congresses in medical physics to familiarize students with the latest scientific and research achievements.
- Educational and specialized webinars offered by the Department of Medical Physics, providing easier access to modern topics and facilitating scientific interaction in a virtual environment.

Contact Information:

- Teacher(s): Dr Hossein Rasta, **04133364660**

Didactic in-person course plans

Course Title: Medical Imaging Systems

Teacher(s) name: Tohid mortazazadeh

Prerequisite(s)/Corequisite(s): -

Number of Credits: 2

Type of Credits: Theoretical

The number of theoretical Credit(s): 2

Academic Level of students: Master's Degree

Total Number of Sessions: 17

Course Duration: According to the academic calendar

Weekly Schedule: According to the academic calendar

Location of In-Person Sessions: Faculty of Medicine, Department of Medical Physics

Virtual Class Access Link: Lecture files/materials will be made available to the students.

Main goal of the course:

This course is designed for M.Sc. students in Medical Physics. In this course, students will become familiar with the fundamental principles and basic concepts of medical imaging. They will learn about image formation mechanisms, factors affecting image quality, and basic image processing techniques used to enhance image quality in various medical imaging modalities.

Learning Objectives:

Upon successful completion of this course, students will be able to:

- Apply the principles and mathematical methods used in medical imaging.
- Understand the concepts of sampling and the factors affecting sampling quality.
- Evaluate the influence of different imaging system components on image quality.
- Describe the fundamentals of digital imaging techniques.
- Explain the principles of angiographic imaging.
- Understand the operation and image formation process of CT (Computed Tomography) systems.
- Apply the concepts of image reconstruction in CT imaging.
- Analyze the use of filters in CT image reconstruction.
- Identify factors that affect image quality in CT systems.
- Recognize and interpret common artifacts in CT imaging.

Teaching Strategies/ methods:

The teaching process in this course is conducted using a video projector, whiteboard, PowerPoint presentations, interactive learning systems, lectures, and question-and-answer sessions.

Assessment and Evaluation Methods:

Midterm exam: 4 points, Final exam: 15 points, Regular class attendance and completion of assignments: 1 point

Minimum Passing Grade: 14

Maximum Permitted Absences: 4

Core Educational References:

- The Essential Physics of Medical Imaging by Jerrold T. Bushberg
- Christensen's Introduction to the Physics of Radiology by James E. Dowdey and Thomas S. Curry

Supplementary Learning Opportunities:

To enhance the theoretical and practical knowledge of students, the following supplementary learning opportunities are provided:

- Specialized medical physics workshops held throughout the year.
- Scientific congresses in medical physics to familiarize students with the latest scientific and research achievements.
- Educational and specialized webinars offered by the Department of Medical Physics, providing easier access to modern topics and facilitating scientific interaction in a virtual environment.

Contact Information:

- Teacher(s): Tohid Mortazazadeh , tmortezazadeh@tbzmed.ac.ir

- Understand the structure and operation of Single-Photon Emission Computed Tomography (SPECT) systems.
- Become familiar with the quality control and clinical applications of SPECT imaging systems.
- Understand the structure and operation of Positron Emission Tomography (PET) systems.
- Become familiar with the quality control procedures and clinical applications of PET imaging systems.
- Understand quality control and clinical applications in nuclear medicine imaging in general.

Teaching Strategies/ methods:

The teaching process in this course is conducted using a video projector, whiteboard, PowerPoint presentations, interactive learning systems, lectures, and question-and-answer sessions.

Assessment and Evaluation Methods:

Final exam: 16 points, Assignments: 1 point, Practical exam: 3 points

Minimum Passing Grade: 14

Maximum Permitted Absences: 4

Core Educational References:

1. Saha, Nuclear Medical Physics
2. Ramesh Chandra, Nuclear Medical Physics

Supplementary Learning Opportunities:

To enhance the theoretical and practical knowledge of students, the following supplementary learning opportunities are provided:

- Specialized medical physics workshops held throughout the year.
- Scientific congresses in medical physics to familiarize students with the latest scientific and research achievements.

- Educational and specialized webinars offered by the Department of Medical Physics, providing easier access to modern topics and facilitating scientific interaction in a virtual environment.

Contact Information:

- Teacher(s): Asra Sadat Talebi, Email: asra.talebi@yahoo.com
- Educational Program Coordinator: Asra Sadat Talebi, Email: asra.talebi@yahoo.com
- Educational staff: Asra Sadat Talebi, Email: asra.talebi@yahoo.com

In the name of God

Guide to Principles of radiation detection and dosimetry course unit

instructor/instructors: Dr. Mikaeil Molazadeh – Dr. Asra Sadat Talebi

Prerequisite or concurrent unit: Atomic and nuclear physics

Number of units: 2 Unit type: 1.5 theoretical units and 0.5 practical units Level: Master's degree

Number of sessions: 17

Start and end dates of sessions: According to the educational calendar

Time of sessions per week: According to the educational calendar

Location of in-person sessions: Theoretical (Faculty of Medicine) Practical (Radiotherapy Department, Shahid Madani Hospital)

General Objective and Introduction to the Course Unit:

General Objective: Creating awareness and skills in students in the field of performing dosimetry of ionizing radiation and selecting the appropriate detector in various medical and industrial radiation applications..

Specific Objectives: At the end of this course, the student should be able to:

1. Explain the radiation field and its related quantities.
2. Explain the principles of physics of radiation exchange with matter and state the particle flux, energy and their spectral distribution.
3. Explain the principles of gaseous, scintillation and semiconductor detection.
4. Define the quantities of exposure, kerma, absorbed dose and their relevant units and analyze the mathematical relationships between them.
5. Explain the determination of absorbed dose and radiation using the Bragg-Gray hole theory.
6. Analyze and compare electron, photon and neutron dosimetry in mixed fields.
7. Explain the dosimetry of external and internal sources of radionuclides.
8. Explain the application, advantages and disadvantages of different dosimetry methods.
9. Practically perform field and environmental dosimetry using an appropriate dosimeter.
10. Practically perform specific dosimetry related to quality control and calibration of radiological devices as well as patients.

Educational objectives of the course unit

After completing this course, learners are expected to be able to:

Session	Lesson Topic	Table of Contents
1	Radiation Field	1- Radiation sources 2- Radiation field quantities and their distribution 3- Average and effective energy
2	Measurement of Particle Flux, Energy Flux and Their Spectral Distribution	1- Measurement principles 2- Total absorption measuring devices 3- Partial absorption methods 4- Determination of spectral distributions and stopping power
3	Exposure Measurement	1- History and necessity of defining exposure 2- Charged particle balance 3- Free air chamber 4- Exposure measurement with free air chamber 5- Exposure measurement with calibrated cavity chamber
4	Kerma Concept	1- Definition of kerma 2- Relationship between air kerma and exposure 3- Relationship between air kerma and absorbed dose
5	Methods for Determining Absorbed Dose	1- Determination of absorbed dose using exposure 2- Exposure to absorbed dose conversion factors 3- Calibration of absorbed dose in terms of air kerma 4- Determination of absorbed dose using Bragg-Gray cavity theory 5- Photon collisions in a cavity 6- Cavity and neutron theory 7- Probe dosimeter 8- Cavity chamber as a standard device Exposure
6	Dosimetry Methods (Introduction to TLD Dosimeter and Films)	Passive, active, fluorescence and phosphorescence dosimeters, Traps and their types, storage traps, recombination centers, electron and hole traps, luminescence and thermoluminescence, thermal luminescence dosimetry mechanism, glow curve, advantages and disadvantages of TLDs, comparison of TLD dosimeter with film - introduction to radiographic films and radiochromic films

7	Interaction of Ionizing Radiation with Matter	<ul style="list-style-type: none"> 1- Effective cross sections and collision coefficients 2- Photon-matter interaction 3- Neutron-matter interaction 4- Charged particle-matter interaction
8	Detection of Ionizing Radiation	<ul style="list-style-type: none"> 1- Basics of Detection 2- Gas Detectors 3- Scintillation Detectors 4- Semiconductor Detectors
9	Direct Measurement of Absorbed Dose	<ul style="list-style-type: none"> 1- History of absorbed dose 2- Statistical and non-statistical quantities 3- Units of absorbed dose
10	Comparison of Electron, Photon and Neutron Dosimetry	<ul style="list-style-type: none"> 1- Correction factors 2- Electron dosimetry 3- Photon dosimetry 4- Neutron dosimetry 5- Mixed field dosimetry
11	Dosimetry of radioactive nuclei	<ul style="list-style-type: none"> 1- Activity and its units 2- Air kerma constant Γ 3- Dosimetry of internal radiation sources 4- Dosimetry of external radiation sources
12	Dosimetric methods	<ul style="list-style-type: none"> 1- Radiation dosimetry by calorimeter 2- Ionization chambers 3- Chemical dosimeters
13-16	Practical work in the hospital	<p>Familiarity with the dosimetry instruments available in the Protection and Dosimetry Laboratory of the Medical Physics Department</p> <p>Introduction to the dosimetry instruments available in the radiotherapy department of Shahid Madani Hospital and how to work with them</p>
17	End of semester exam	End of semester exam

Method of providing training

■ Speech ■ Slide ■ Questions and Answers ■ Problem-based learning ■ Practical training

Student evaluation method

Written exam at the end of the semester 70% - Midterm exam 20% - Effective and active class attendance 10%

Minimum passing score for this course: According to the curriculum.

Number of hours of absence allowed for this course unit: According to the approved educational regulations.

Educational resources

1. Khan, F. M., Gibbons I. P., "Khan's The Physics of Radiation Therapy". Wolters Kluwer, Latest Edition
2. Attix, F. "Introduction to Radiological Physics and Radiation Dosimetry". Wiley Interscience. Latest Edition
3. Hajizadeh, Mohsen. Fundamentals of Detection and Dosimetry of Ionizing Radiation. Mashhad University of Medical Sciences Press. Latest edition.
4. Azaf, P.G., Detection of Nuclear Radiation. Mohammadreza Hamidian. University of Tehran Press. Latest edition
5. Cember, N. F. Galliard Ltd. "Medical Radiation Detectors". IOP Publications Ltd. Latest Edition.

Educational resources for further study

Related resources from the Internet and university web pages

Learning opportunities

Holding limited conferences in each session, managed by the teacher and presented by the student

Contact information

Course Instructor/Instructors (Phone, Email, etc.):

Dr. Mikaeil Molazadeh: 04133364660 – molazadeh91@gmail.com

Dr. Asra Sadat Talebi: 04133364660 –asra.talebi@yahoo.com

Educational Expert (Phone, Email, etc.):

Ms. Ghanbari: 04133364660

Beitollah Abbasi: 0413373744

In the name of God

Guide to The Physics of Radiation Therapy 1 course

instructor/instructors: Dr. Alireza Farajollahi – Dr. Mikaeil Molazadeh

Prerequisite or concurrent unit: Principles of Radiation Detection and Dosimetry

Number of units: 2 Unit type: 1.5 theoretical units and 0.5 practical units Level: Master's degree

Number of sessions: 17

Start and end dates of sessions: According to the educational calendar

Time of sessions per week: According to the educational calendar

Location of in-person sessions: Theoretical (Faculty of Medicine) Practical (Radiotherapy Department, Shahid Madani Hospital)

General Objective and Introduction to the Course Unit:

General Objective: To increase students' awareness and skills in the fundamentals of radiotherapy physics in order to plan treatment in teletherapy methods.

Specific Objectives: At the end of this course, the student should be able to:

1. Explain the structure and operation of radiotherapy devices.
2. Understand the physical properties of megavoltage photon fields.
3. Explain the stages of treatment planning.
4. Understand how to treatment planning with photon in different conditions.

Educational objectives of the course unit

After completing this course, learners are expected to be able to:

Session	Lesson Topic	Table of Contents
1	Radiation therapy devices	1- Kilovoltage devices (contact therapy - surface therapy - orthovoltage therapy - supervoltage therapy) 2- Megavoltage devices (Vandograph generator - Cobalt 60 device - linear accelerator - magnetron - klystron - betatron - microtron) 3- Heavy ion accelerator devices (cyclotron)
2	Dose distribution and scattered radiation analysis	1- Phantoms 2- Depth dose distribution 3- Depth dose percentage (dependence on beam quality and depth, effect of field shape and dimensions, dependence on source-surface distance)
3	Dose distribution and scattered radiation analysis	1- Tissue-air ratio (distance effect, backscatter factor, relationship between TAR and depth dose percentage, dose calculation in rotational therapy) 2- Air-scatter ratio (dose calculation in irregular fields - Clarkson method)
4	Effective parameters in radiotherapy dosimetry	1- Dose calculation parameters (collimator scattering factor, phantom scattering factor, tissue-phantom and tissue-maximum ratios, TMR and SMR characteristics, scattering-maximum ratio)
5	Effective parameters in radiotherapy dosimetry	1- Accelerator calculations (SSD technique and isocentric technique) 2- Cobalt 60 device calculations 3- Irregular fields 4- SSD variation in a field
6	Effective parameters in radiotherapy dosimetry	1- Asymmetric fields 2- Off-axis point 3- Off-field point 4- Under-block point 5- SMS and TMR calculations
7	Treatment Planning I: Isodose Distributions	1- Isodose charts 2- Measurement of Isodose curves (sources of Isodose tables) 3- Parameters of Isodose curves (beam quality, source size, source-to-surface distance)

8	Treatment Planning I: Isodose Distributions	<p>1- Parameters of isodose curves (source-to-aperture distance, penumbra effect, collimation and flattening filter, field size)</p> <p>2-Wedge filters (angle of isodose wedged curve, wedge transmission factor, wedge systems, effect on beam quality, wedge filter design)</p> <p>3-Combination of radiation fields (parallel opposing fields, patient thickness versus dose uniformity, edge effect, integral dose, multiple fields)</p>
9	Treatment Planning I: Isodose Distributions	<p>1- Isocentric techniques (fixed beams, rotational therapy)</p> <p>2- Wedge field techniques (uniform dose distribution, combination of open and wedge fields)</p> <p>3- Tumor dose specifications for photon beams (GTV, CTV, ITV, PTV, PRV and treatment volume, irradiated volume, maximum target dose, minimum target dose, average target dose, median target dose, target dose determination)</p>
10	Treatment Planning II: Patient Data Acquisition, Treatment Verification, and Inhomogeneity Corrections	<p>1- Body contours</p> <p>2- Internal structures (Computed tomography, MRI, ultrasound)</p> <p>3- Treatment simulation (Radiograph simulator, CT simulator, PET/CT)</p> <p>4- Treatment confirmation (Port films, Portal electron imaging, Cone beam CT)</p>
11	Treatment Planning II: Patient Data Acquisition, Treatment Verification, and Inhomogeneity Corrections	<p>1- Contour curvature corrections (effective source-to-surface distance method, air-tissue ratio method, dose curve displacement method)</p> <p>2- Tissue non-uniformity correction (beam attenuation and beam scattering corrections, absorbed dose within inhomogeneity)</p>
12	Treatment Planning II: Patient Data Acquisition, Treatment Verification, and Inhomogeneity Corrections	<p>1- Tissue compensation (compensator design, two-dimensional and three-dimensional compensators, compensator wedges, compensator adjustment method)</p> <p>2- Patient positioning (general guidelines, simulation process)</p>
13-16	Practical work in the hospital	<p>Familiarity with the principles of immobilizing patients with fixation devices - thermoplastic stretching - marker placement - how to position patients for CT Simulation - Familiarity with the types of medical linear accelerator devices and their various parts and components - Familiarity with software and foam cutting and casting systems with a Cerrobend pot in the molding room - Performing manual calculations of the delivered dose with the accelerator using SSD methods and SAD techniques - Familiarity with computerized treatment design systems and viewing dose-matching diagrams and treatment plan evaluation parameters</p>
17	End of semester exam	End of semester exam

Method of providing training

■ Speech ■ Slide ■ Questions and Answers ■ Problem-based learning ■ Practical training

Student evaluation method

Class participation in teaching sessions 10%, quizzes 10%, end-of-semester written exam in the form of an essay/test/short answer/limited answer/extended answer 80%

Minimum passing score for this course: According to the curriculum.

Number of hours of absence allowed for this course unit: According to the approved educational regulations.

Educational resources

1. Khan, F. M., Gibbons I. P., “Khan’s The Physics of Radiation Therapy’. Wolters Kluwer, Latest Edition
2. Hende, W. R., Ibbott, G. S. “Radiation Therapy Physics”. Mosby. Latest Edition
3. Khan, F. M., Potish RA. “Treatment Planning in Radiation Oncology”. Williams & Wilkins. Latest Edition

Educational resources for further study

Related resources from the Internet and university web pages

Learning opportunities

Holding limited conferences in each session, managed by the teacher and presented by the student

Contact information

Course Instructor/Instructors (Phone, Email, etc.):

Dr. Alireza Farajollahi: 04133364660 – farajollahia@tbzmed.ac.ir

Dr. Mikaeil Molazadeh: 04133364660 – molazadeh91@gmail.com

Educational Expert (Phone, Email, etc.):

Ms. Ghanbari: 04133364660

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