Syllabus
Biomedical Engineering Principles of Nuclear Medicine Physics and Radiation Therapy
(הפיסיקה של הרפואה הגרעינית והרדיותרפיה 336545)
Short name: Medical Physics/פיזיקה רפואית
Spring semester, 2021
(2.0 credits)

Description

This course discusses the (i) physics of radiation therapy in oncology and (ii) physics of diagnostics and treatment in nuclear medicine. The lectures will be delivered in an interleaved sequence by two specialists in these two subjects. The first part of the course is dedicated to the basic physics of the interaction of ionizing radiation with matter that is relevant to the physics and radiation safety considerations of both subjects (i) and (ii). Knowledge of the hardware and software used for radiation therapy planning, radiation therapy treatment, radiotracer diagnostic imaging, and radiopharmaceutical treatment will be learned in both the classroom and hospital environments. Fundamental physics and engineering aspects will be used to model practical clinical applications and the development of new technologies. The emphasis will be on how the engineering and physics provides solutions to medical needs in the clinic. Consequently, mathematical analysis is presented primarily via actual clinical and research examples. The course provides the student with a view of the breadth of medical physics. The course is aimed at advanced Bachelor students (e.g. 4th year) and graduate students, with prior exposure to introductory physics (e.g. atomic structure) and anatomy (e.g. organs and tissues). Prior exposure to a medical imaging course is suggested but not mandatory.

Prerequisites

• Recommended: Principles of Medical Imaging (336502 or similar)

Instructors

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Teaching Assistant

N/A

Meetings
TBD

Textbooks
• R. Bar-Deroma, J.A. Kennedy, Lecture notes.
• E.B. Podgorsak – Technical Editor.
Radiation Oncology Physics: A handbook for teachers and students.
IAEA – Int. Atomic Energy Agency
Location: www-pub.iaea.org/books
• Simon R. Cherry, James A. Sorenson, Michael E. Phelps.
Physics in Nuclear Medicine,
4th Edition 2012
Elsevier Inc.
Location: 615.849 CNE Biomedical Engineering
• Haim Azhari, John A. Kennedy, Noam Weiss, Lana Volokh.
From Signals to Image: A Basic Course on Medical Imaging for Engineers.
2020 Springer Nature Switzerland AG
Location: https://link.springer.com/book/10.1007%2F978-3-030-35326-1
(Springer Link via Technion VPN)

Online Resources
• Moodle: all lecture notes/supplementary material/slides available as delivered.

Course Objectives
• To teach students to analyze medical equipment as engineered systems with design constraints.
• To teach students the application particle physics to medical diagnostics and treatment.
• To teach students the relevance of radioactive decay to clinical supply chains.
• To teach students to manipulate test objects to ensure patient safety and quality control.
• To teach students to analyze ray projections to relate radiative scanning to treatment.
• To teach students the physical fundamentals radiation safety.
• To teach students the physical mechanisms radiation detection.

Course Topics

INTRODUCTION
• Ionizing radiation and its interaction with matter
• Radiation safety including detection and monitoring

PART (i): RADIATION THERAPY PHYSICS
• Physics of photon and electron beams and the.
• Principles of clinical treatment and treatment planning
• Principles of radiation therapy dosimetry
• Engineering and design of radiotherapy devices

• Calibration of photon and electron beams
• Brachytherapy
• Radiation safety practice and regulations for radiotherapy

PART (ii): PHYSICS IN NUCLEAR MEDICINE
• Physics of radionuclides
• Radiopharmaceuticals including radiotracers
• Diagnostic imaging and hybridization of SPECT and PET with CT
• Imaging performance evaluation and quality control test objects
• Radionuclide treatments and dosimetry
• Radiation safety practice and regulations for nuclear medicine

Course Expectations & Grading
The course will include two academic hours of lectures per week.
Breakdown of course grading:
Midterm Test – 35 %
Final Exam – 65%

There will be no online testing. Therefore, if in-class tests cannot be written due to corona, a final project will be assigned based on a relevant scientific article and questions, with the course grading as:
Final project – 100 %

Key Dates
TBD

Assignments & Readings
- Weekly lecture notes (available through Moodle).
- Supplementary material will be made available through Moodle.

Ethics
The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any violations you witness to the instructors.

Students with Disabilities
Any student with a disability who may need accommodations in this class must obtain an accommodation letter from Technion International's guidance counselor, at counselor@int.technion.ac.il

ABET Outcomes

(a) Ability to apply knowledge of mathematics, science and engineering.

(b) Ability to design and conduct experiments, as well as to analyze and interpret data.

(c) Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

(d) Ability to function on multidisciplinary teams.

(e) Ability to identify, formulate, and solve engineering problems.

(f) Understanding of professional and ethical responsibility.

(g) Ability to communicate effectively.

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

(i) Recognition of the need for, and an ability to engage in life-long learning

(j) Knowledge of contemporary issues.

(k) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.