Course Code	Course Title	ECTS Credits
MED-107	Physics in Medicine II	6
School	**Semester**	**Prerequisites**
Medical School	Spring (Semester 2)	MED-101
Type of Course	**Field**	**Language of Instruction**
Required	Medicine	English
Level of Course	**Year of Study**	**Lecturer(s)**
Undergraduate	1st	Dr Constantinos Zervides
Mode of Delivery	**Work Placement**	**Co-requisites**
Face-to-face	N/A	None

Objectives of the Course:

The main objectives of the course are:

- To give students an introduction to the basic principles of physics in medicine.
- To cultivate an appreciation of the importance of physics in medical imaging.
- To assist students in the development of strong problem-solving skills.
- To help students cultivate critical thinking in the approach to learning.

Learning Outcomes:

The following list provides the learning objectives that will be covered in the lectures and tutorials of each week:

Week 1

LOBs covered during lectures:

1. Explain the principles of the use of Lasers in medicine.
2. Describe applications of lasers in medicine.
3. Understand the importance of safety in using medical lasers.

Week 2

LOBs covered during lectures:

4. Describe the production of an ultrasound beam.
5. Explain the detection of echoes with a transducer.
6. Describe the interaction of ultrasound with material.
7. Explain A, B and M-mode imaging.
8. Describe Doppler imaging of blood flow.
9. Describe elastograhy.
10. Outline the importance of safety and quality assurance of US.

Tutorial (all groups):

Review of topics covered in week 1.

Week 3

LOBs covered during lectures:

11. Explain how ionising radiation is absorbed in the human body.
12. Explain how ionising radiation is detected and measured.

13. Describe how an ionisation chamber works.

Week 4

LOBs covered during lectures:

14. Outline the "anatomy" of an X-ray tube.
15. Describe how x-rays are produced.
16. Explain the importance of bremsstrahlung and characteristic X-ray radiation.
17. Describe how an X-ray exposure in controlled.
18. Explain the importance of quality assurance.

Tutorial (all groups):

Review of topics covered in weeks 2 & 3.

Week 5

LOBs covered during lectures:

19. Describe the health effects of exposure to ionising radiation.
20. Explain the risks associated with exposure to ionising radiation.
21. Explain the philosophy of radiation protection.
22. Describe how to build a radiation safety program.
23. List the allowable radiation doses to radiation workers and the general public

LOBs covered during radiology department visit (all groups):

24. Use an ionisation chamber and a radiation multimeter to measure radiation dose during radiography.
25. Link radiation dose to possible health effects due to exposure to ionising radiation.

Week 6

LOBs covered during lectures:

26. Describe film-based imaging.
27. Explain how fluoroscopes function.
28. Outline the importance of semiconductor detectors in radiology.
29. Explain the workings of a photomultiplier tube.
30. List the factors that determine X-ray image quality.
31. Describe applications of X-rays in medicine.
32. Explain CT image formation principles.
33. Explain CT image reconstruction.
34. Describe the engineering aspects of CT scanners.

Tutorial (all groups):

Review of topics covered in weeks 4 & 5.

Week 7

MIDTERM EXAM

LOBs covered during lectures:

35. Describe how image quality is affected.
36. Distinguish between patient and machine caused artefacts.
37. Understand the importance of quality assurance and dose reduction for CT.

LOBs covered during labs (all groups):

38. Visualise and manipulate images on a workstation.

Week 8

LOBs covered during lectures:

39. Describe the modes of radioactive decay.
40. Explain the desirable attributes of a radiopharmaceutical.
41. Describe the importance of the Anger Camera in Nuclear Medicine.
42. Explain the principles of SPECT and list applications.
43. Explain the principles of PET and list applications.
44. Describe the multi-modality imaging used in Nuclear Medicine.

Tutorial (all groups):

Review of topics covered in weeks 6 & 7.

Week 9

LOBs covered during lectures:

45. Describe the MRI principles.
46. Describe the MRI instrumentation.
47. Describe the different MRI pulse sequences.
48. Explain how MRI is able to track flow during image acquisition.

LOBs covered during labs (all groups):

49. Investigate the effect of distance on radiation dose received.
50. Investigate the effect of shielding on radiation dose received.

Week 10

LOBs covered during lectures:

51. Explain the principles of FMRI.
52. Explain the principles of diffusion imaging.
53. List safety issues in MRI.

Tutorial (all groups):

Review of topics covered in weeks 8 - 10.

Week 11

LOBs covered during lectures:

54. Define radiotherapy.
55. Explain how radiotherapy can treat cancer.
56. Outline the purpose of conformal radiotherapy.
57. Explain the criteria for selecting suitable isotope sources for radiotherapy.

58. Describe the safety issues seen in radiotherapy.

LOBs covered during labs (all groups):

59. Investigate the effect of beam positioning in treatment planning.
60. Describe the importance of isodose curves in treatment planning.

Week 12

LOBs covered during lectures:

61. Explain the current and future trends in medical imaging and image analysis.
62. Describe targeted imaging.
63. Explain optical imaging.
64. Explain photoacoustic imaging.

Tutorial (all groups):

Review of topics covered in weeks 11 & 12.

***Revision*.**

Course Contents:

Lecture Topics:

- Laser theory.
- Laser interaction with human tissue.
- Laser applications and safety.
- Ultrasound theory.
- Imaging with ultrasounds.
- Ultrasound applications and safety.
- Ionising radiation: Dose and exposure.
- Ionising radiation: Measurements and standards.
- X-rays.
- Quality assurance.
- Radiation health effects.
- Radiation Safety.
- X-ray detectors.
- X-ray image quality.
- X-ray applications.
- CT: Image formation and reconstruction.
- CT: Image quality and artefacts.
- CT: Quality assurance and dose reduction.
- Introduction to nuclear medicine.
- Tomographic nuclear imaging.
- MRI principles and instrumentation.
- MRI pulse sequences and flow imaging.
- FMRI and diffusion imaging.
- MRI safety.

- Radiotherapy.
- Dose measurement and quality assurance in radiotherapy.
- Multi-parameter medical imaging and analysis.
- Optical imaging and other emerging modalities.
- Model based and multiscale analysis.

Visit Topics:

- Ionisation chambers.
- Radiography Quality assurance.
- Radiation dose and health effects.

Laboratory Experiments and Demonstrations:

- Image processing.
- Radiation.
- Radiotherapy treatment planning.

Learning Activities and Teaching Methods:

Lectures, Tutorials, Practical Sessions, Visits to Clinics.

Assessment Methods:

Laboratory reports (10%), Midterm Exam (30%), and Final Exam (60%). Assessment is by Single Best Answers (SBAs) and Short Answer Questions (SAQs).

Required Textbook:

Authors	Title	Publisher	Year	ISBN
M.A. Haidekker	Medical Imaging Technology	Springer	2013	9781461470724

Recommended Textbooks/Reading:

Authors	Title	Publisher	Year	ISBN
A.B.Wolbarst P.Capasso A.R.Wyant	Medical Imaging: Essentials for Physicians	Wiley-Blackwell	2013	9780470505700
J. T. Bushberg, J.A. Seibert, E.M. Leidholdt, Jr., J.M. Boone	The Essential Physics of Medical Imaging	Lippincott Williams & Wilkins	2012	9780781780575
A.P.Dhawan	Medical Imaging Analysis	Wiley-IEEE Press	2011 2nd Edition	9790470622056
S. A. Kane	Introduction to Physics in Modern Medicine (2nd Ed)	CRC Press	2009	9781584889434

B.H. Brown, R.H. Smallwood, D.C. Barber, P.V. Lawford, D.R. Hose	Medical Physics and Biomedical Engineering	Taylor and Francis Group	1999	9780750303682