<table>
<tr><td>Course Title</td><td colspan="5">Medical Physics II: Medical Imaging and Radiotherapy</td></tr>
<tr><td>Course Code</td><td colspan="5">MED-107</td></tr>
<tr><td>Course Type</td><td colspan="5">Required</td></tr>
<tr><td>Level</td><td colspan="5">Undergraduate</td></tr>
<tr><td>Year / Semester</td><td colspan="5">Year 1/ Semester 2 (Spring)</td></tr>
<tr><td>Teacher’s Name</td><td colspan="5">Couse Lead:
Dr Anastasia Hadjiconstanti
Contributor:
Dr Stelios Angeli
Dr Constantinos Zervides</td></tr>
<tr><td>ECTS</td><td>6</td><td>Lectures / week</td><td>3</td><td>Laboratories / week</td><td>2</td></tr>
<tr><td>Course Purpose and Objectives</td><td colspan="5">The main objectives of the course are:
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.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="5">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:
Describe the production of an ultrasound beam.
Explain the detection of echoes with a transducer.
Describe the interaction of ultrasound with material.
Explain A, B, and M-mode imaging.
Describe Doppler imaging of blood flow.
Describe elastrography.
Outline the importance of safety and quality assurance of US.
LOBs covered during lab practical:<ol start="8">
Introduce ultrasound probe selection.
Introduce ultrasound screen orientation.
Perform measurements using blood vessels.
Introduce spectral Doppler.</td></tr>
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Week 2

LOBs covered during lectures:

12. Explain the Photoelectric effect.
13. Explain the Compton effect.
14. Explain Pair production.
15. Describe the inverse square law of attenuation.
16. Explain how ionising radiation is measured.
17. Describe how an ionisation chamber works.
18. Describe how a G-M counter works.

Week 3

LOBs covered during lectures:

19. Describe the “anatomy” of an X-Ray tube.
20. Explain the functionality of the X-Ray tube insert.
21. Describe the X-Ray tube insert anode assembly.
22. Describe the X-Ray tube insert cathode assembly.
23. Explain the interaction of high-energy electrons with matter.
24. Explain the importance of bremsstrahlung and characteristic X-Ray radiation.
25. Describe how X-Rays are produced.
26. Describe how and X-Ray exposure is controlled.
27. Explain the importance of quality assurance.

Tutorial:

Review of topics covered in weeks 1 & 2.

Week 4

LOBs covered during lectures:

28. Describe the health effects of exposure to ionising radiation.
29. Explain the risks associated with exposure to ionising radiation.
30. Explain the philosophy of radiation protection.

Week 5

LOBs covered during lectures:

31. Describe how to build a radiation safety program.
32. List the allowable radiation doses to radiation workers and the general public
33. Describe film-based imaging.

34. Explain how fluoroscopes function.
35. Outline the importance of semiconductor detectors in radiology.
36. Explain the workings of a photomultiplier tube.
37. List the factors that determine X-ray image quality.
38. Describe applications of X-rays in medicine.

Tutorial:

Review of topics covered in weeks 3 & 4.

Week 6

LOBs covered during lectures:

39. Explain CT image formation principles.
40. Explain CT image reconstruction.
41. Describe the engineering aspects of CT scanners.
42. Describe how image quality is affected.
43. Distinguish between patient and machine caused artefacts.
44. Outline the importance of quality assurance and dose reduction for CT.

LOBs covered during practical:

45. Visualise and manipulate images on a workstation.

MIDTERM EXAM

Week 7

LOBs covered during lectures:

46. Describe the modes of radioactive decay.
47. Explain the desirable attributes of a radiopharmaceutical.
48. Describe the importance of the Anger Camera in Nuclear Medicine.
49. Explain the principles of SPECT and list applications.
50. Explain the principles of PET and list applications.
51. Describe the multi-modality imaging used in Nuclear Medicine.

Tutorial:

Review of topics covered in weeks 5 & 6.

Week 8

LOBs covered during lectures:

52. Define radiotherapy.
53. Explain how radiotherapy can treat cancer.
54. Outline the purpose of conformal radiotherapy.
55. Explain the criteria for selecting suitable isotope sources for radiotherapy.
56. Describe the safety issues seen in radiotherapy.

Week 9

No lectures in week 9.

Tutorial:

Review of topics covered in weeks 7 & 8.

Week 10

LOBs covered during lectures:

57. Explain paramagnetism, diamagnetism, ferromagnetism.
58. Describe the concept of electromagnetism.
59. Distinguish between different types of magnets used in clinical settings.
60. Describe nuclear alignment using the classical and quantum theories.
61. Describe precession.
62. Explain magnetic resonance.
63. Describe the production and detection of the MR signal.
64. Describe the concept of contrast in MRI.
65. Describe the concept of relaxation in MRI.
66. Describe T1 recovery and T2 decay.

Week 11

LOBs covered during lectures:

67. Explain T1, T2 and PD weighting in MRI.
68. Explain the use of coils in MRI.
69. Describe conventional spin echo.
70. Describe fast or turbo spin echo.
71. Describe inversion recovery
72. Explain gradient echo sequence.

	73. Explain how MRI is able to track flow during image acquisition. 74. Explain Magnetic Resonance Angiography. ***LOBs covered during lab practical:*** 75. Investigate the effect of beam positioning in treatment planning. 76. Describe the importance of isodose curves in treatment planning. **Week 12** ***LOBs covered during lectures:*** 77. Explain the principles of FMRI. 78. Explain the principles of diffusion imaging. 79. List safety issues in MRI. ***Tutorial:*** Review of topics covered in weeks 10, 11 & 12. ***Revision***		
Prerequisites	MED-101 Medical Physics I: The Human Body	Required	None
Course Content	***Lecture Topics:*** • 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. • Radiotherapy. • Dose measurement and quality assurance in radiotherapy		

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MRI principles and instrumentation.
MRI pulse sequences and flow imaging.
FMRI and diffusion imaging.
MRI safety.
Ultrasound theory.
Imaging with ultrasounds.
Ultrasound applications and safety.

Laboratory Experiments and Demonstrations:

Image processing.
Radiotherapy treatment planning.

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<tr><td>Teaching Methodology</td><td>Lectures, Tutorials, Practical Sessions.</td></tr>
<tr><td>Bibliography</td><td>
Required Textbook:
<table>
<tr><th>Authors</th><th>Title</th><th>Publisher</th><th>Year</th><th>ISBN</th></tr>
<tr><td>D.R. Dance, S.Christofides , A.D.A. Maidment,
I.D. McLean,
K.H. Ng</td><td>Diagnostic Radiology Physics. A Handbook for Teachers and Students.</td><td>IAEA</td><td>2014</td><td>9789201 310101</td></tr>
<tr><td colspan="5">E-book Permalinks</td></tr>
<tr><td colspan="5">https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1564webNew-74666420.pdf</td></tr>
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Recommended Textbooks/Reading:
<table>
<tr><th>Authors</th><th>Title</th><th>Publisher</th><th>Year</th><th>ISBN</th></tr>
<tr><td>J. Kissane,
J. Neutze,
S. Harjit</td><td>Radiology Fundamentals. Introduction to imaging & Technology</td><td>Springer
6th Edition</td><td>2020</td><td>97830 30221 720</td></tr>
<tr><td colspan="5">E-book Permalinks</td></tr>
<tr><td colspan="5">http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,sso&db=edsebk&AN=2364214&site=eds-live&custid=s1098328</td></tr>
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	Troy Farncombe and Kris Iniewski	Medical Imaging: Technology and Application	CRC Press 1st edition	2017	97811 38072 282
Assessment	Laboratory report (10%), Midterm Exam (30%), and Final Exam (60%). Assessment is by Single Best Answers (SBAs) and Short Answer Questions (SAQs).				
Language	English				