## Medical Imaging: X-rays and Ultrasound

<table>
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<tr>
<th>Module Code</th>
<th>PHYS96026</th>
<th>FHEQ Level</th>
<th>Level 6</th>
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<tr>
<td>Pre-requisites</td>
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<td>Co-requisites</td>
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<tr>
<td>Primary Department</td>
<td>Physics</td>
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<tr>
<td>Module Leader</td>
<td>Dr James McGinty</td>
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<td>Additional Teaching Departments</td>
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<tr>
<td>Teaching Staff</td>
<td>Dr James McGinty + Associate</td>
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### Programmes on which the Module is delivered
- All UG Physics programmes (F300, F303, F309, F325, F390, F3W3)  
  
**Core/Elective**  
Elective

### Learning Outcomes

#### On completing the Medical Imaging: X-rays and Ultrasound course, students will be able to:

**X-ray imaging:**
- explain how x-rays are produced for medical imaging applications and the actors affecting the x-ray spectrum
- discuss the factors affecting the performance of an x-ray tube and calculate its performance in a given situation
- explain the main x-ray tissue interactions and discuss how these lead to image contrast and dose to the patient
- calculate the attenuation of x-rays or gamma-rays in a given situation
- calculate the energies of the interacting particles for each x-ray matter interaction in a given situation
- explain the main techniques used for the detection and recording of x-ray images
- discuss the main factors limiting the resolution of an x-ray image and be able to calculate the resolution of an x-ray imaging system in a given situation
- recall what fluoroscopy is and how it is achieved
- discuss desirable properties for x-ray contrast agents
- recall what is meant by signal to noise ratio and contrast to noise ratio in an image and be able to explain and calculate these parameters

**X-ray tomography:**
- explain how an x-ray computed tomography (CT) dataset is acquired and discuss the various parameters affecting its performance
- recall and apply the Central Slice Theorem
- explain the process of filtered back projection for CT image reconstruction and discuss modifications such as the Hann or Shepp-Logan filters
- recall and discuss the main differences between the different generations of x-ray CT instrumentation

**Ultrasound**
- recall the basic mechanical properties of tissues that govern the behaviour of acoustic waves
- define the term acoustic impedance
- calculate ultrasound wave peak particle displacement amplitude, peak particle velocity and intensity
- explain and discuss scattering, reflection and attenuation of sound waves in tissue
- calculate ultrasound attenuation in a given situation
- calculate ultrasound reflection and transmission coefficients for a plane wave incident on a boundary
- explain the key components of a medical ultrasound scanner and discuss the main parameters defining its performance
- discuss the compromises inherent in the design and construction of ultrasound transducers
- calculate parameters required for the active element, matching layer and backing layer
- describe and discuss the process of image acquisition and image formation in ultrasound imaging
- calculate the resolution of an ultrasound system in a given situation
- calculate the maximum imaging depth, imaging speed and data rates of an ultrasound system in a given situation
- discuss common ultrasound image artefacts and propose ways they can be reduced

**Description of Content**

This course introduces two of the most commonly used medical imaging techniques: X-ray imaging and Ultrasound. The course will introduce basic concepts concerning how both X-rays and ultrasound are generated, how these interact with matter and how images are formed and analysed.

The aim is to provide students with a general overview of how physical principles are to generate contrast in modern medical imaging using X-rays and ultrasound. Students should gain an appreciation of the physical factors determining the resolution, speed and sensitivity of imaging modalities including X-ray imaging, X-ray computed tomography and ultrasound.

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<th>Assessment</th>
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<td>3</td>
<td>6</td>
<td>October 2016</td>
<td>May 2019</td>
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