Imperial College London

Module Outline

Medical Imaging: X-rays and Ultrasound

Module Code	PHYS96026	FHEQ Level	Level 6
Pre-requisites	None	Co-requisites	None
Primary Department	Physics		
Module Leader	Dr James McGinty		
Additional Teaching Departments	None		
Teaching Staff	Dr James McGinty + Associate		

Programmes on which the Module is delivered	Core/Elective
All UG Physics programmes (F300, F303, F309, F325, F390, F3W3)	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 an 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.

Assessment	Assessment Type	Weighting
Written exam	Exam	100%

Learning & Teaching Hours	Independent Study Hours	Placement Hours	Total Hours
23.5	51.5	0	75

ECTS Credit	3	CATS Credit	6
Date of introduction	October 2016	Date of Last Revision	May 2020