**MPY205: Aspects of Medical Imaging and Technology**

**Semester: 1** **Credits: 10**

**Taught by: Dr. J.W.Fenner**

**Prerequisites: None**
**Co-requisites:None**

*Brief Description (including aims of module)*
This module provides an introduction to medical radiation physics (both ionising and non-ionising) and emphasises its diagnostic role in medicine. The course begins with imaging foundations/theory and then considers the generation and behaviour of electromagnetic waves, proceeding to explore the breadth of their application across the electromagnetic spectrum. This includes magnetic resonance imaging at low energies and X-rays at high energies. The importance of radiation in diagnosis is covered by discussion of imaging theory and primary imaging modalities, such as planar radiography and CT. The therapeutic role is briefly alluded to (radiotherapy).

*Objectives*
At the end of the course the student will:

- have a grasp of basic imaging theory (convolution, Fourier interpretations)
- be familiar with the differences between electrostatics and electrodynamics
- have an understanding of the structure of atoms and X-ray generation
- be familiar with a physical interpretation of Maxwell's equations
- appreciate the difference between ionising and non-ionising electromagnetic radiation
- be aware of methods of detecting ionising and non-ionising radiation
- have a grasp of the interactions that occur between electromagnetic radiation (ionising and non-ionising) and tissue
- know important SI units and definitions of parameters associated with electromagnetic radiation
- understand the nature of magnetic resonance signal acquisition - how it relates to net magnetisation, simple RF pulse sequences
- understand how RF pulse sequences in combination with gradient fields can lead to MR image production, maps of proton density, T1, T2.
- have a general understanding of the physical principles, construction and function of a diagnostic X-ray unit
- have a general understanding of the physical principles, construction and function of a CT scanner
- have an appreciation of image reconstruction using computed tomography
- have an appreciation of the theoretical description of imaging systems
- appreciate the role of the medical physicist in the management of medical imaging systems, safety aspects and quality assurance

*Outline Syllabus*

- Atomic structure: the atom, nucleus, X-rays
- Electromagnetic tissue interactions: absorption, resonance,
- Ionising radiation/matter interactions: photoelectric effect, Compton scatter, pair production, dose
- Radiation detection: gas ionisation, solid state, scintillation
- Diagnostic RF radiation: MRI, proton spin, precession, net magnetisation, RF fields, 90 and 180 degree pulse sequences, receiver coils, signal localisation, image production, MRI hardware, safety
- Diagnostic X-rays: tubes, bremsstrahlung, generation, design considerations, film, digital, diagnosis
- Diagnostic X-rays: tomographic technology, reconstruction techniques, noise, dose
- Imaging theory, conjugacy, PSF, MTF, convolution, Fourier decomposition
- Imaging components, transducers, gain, linearity, dynamic range, noise
- Digital acquisition, ADC/DAC, latch, sampling

*Mathematics used in the Module*

- Differentiation / Integration
- Exponential behaviour
- Convolution and convolution theorem
- Fourier series/transforms and interpretation
- Delta function
- Spatial frequency, point spread function, modulation transfer function
- Simple numerical example of iterative reconstruction

*Module Format*

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| Lectures | 19 |
| Tutorial Classes | 3 |
| Laboratory work | 1 |
| Private study | 36 |

*Main Text Books*

Comprehensive printed notes complement the slides presented in the lectures.
A reading list is provided.

*Assessment*

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| Two hour written examination | 80% |
| Laboratory work - formative | 0% |
| Tutorial assignments x2 | 10% |

Note: Aspects of the formative lab exercises will be explored in the exam.