

## **BMED/MP/NRE 4750 Diagnostic Imaging Physics**

**Credit:** 3-0-3

**Prerequisite:** NRE/MP 3112 or BMED 3500

### **Catalog Description**

Physics and image formation methods for conventional X-ray, digital X-ray CT, nuclear medicine, and magnetic resonance and ultrasound imaging.

### **Textbook**

Cho ZH, Jones JP, Singh M: Foundations of Medical Imaging, (John Wiley & Sons, N.Y.), 1993.

### **Objective**

1. To train students in the fundamentals of image acquisition, deconvolution, radiation production back projection
2. To teach students about various imaging devices and applications.

### **Outcomes**

By the end of the course the students will be able to demonstrate:

1. an understanding of x-ray ultrasound and magnetic resonance interactions with tissue and the various components of imaging systems. (Program Outcome 1)
2. the ability to use fundamentals of mathematics and physics to analyze image data. (Program Outcomes 1 and 2)
3. a knowledge of modern imaging devices and their application in medicine and in industry. (Program Outcome 9)

### **Topical Outline**

1. Conventional Planar Imaging
  - (a) X-ray production
  - (b) X-ray image formation and contrast
  - (c) Photographic process and film characteristics
  - (d) Fluoroscopic imaging systems
  - (e) Image Noise
2. Digital X-ray Imaging and Computed Tomography
  - (a) Digital imaging systems and image processing
  - (b) Computed tomography (CT) image formation
  - (c) CT image quality
  - (d) Specialized digital techniques
  - (e) Bioeffects and safety
3. Nuclear Medicine Imaging

- (a) The gamma camera
  - (b) Detection and process of gamma-ray signals
  - (c) Tomographic image formation
  - (d) Image quality
  - (e) Bioeffects and safety
4. Magnetic Resonance Imaging (MRI)
- (a) Intrinsic and extrinsic parameters affecting MRI contrast
  - (b) The magnetic field  $B_0$  and the equilibrium distribution
  - (c) The Larmor Frequency and the radiofrequency field  $B_1$
  - (d) Relaxation mechanisms ( $T_1$ ,  $T_2$ ,  $T_2^*$ ) and effects of common contrast agents
  - (e) The spin-echo sequences
  - (f) Spatial coding using linear magnetic field gradients
  - (g) Imaging quality
  - (h) Bioeffects and safety
5. Ultrasound Imaging
- (a) Ultrasound plane waves
  - (b) Propagation of sound waves through tissue
  - (c) Single element transducers
  - (d) Transducer arrays
  - (e) Pulse echo equipment signal processing
  - (f) B-mode Imaging
  - (g) Continuous wave and pulse Doppler
  - (h) Flow imaging with ultrasound
  - (i) Imaging quality
  - (j) Bioeffects and safety