

## **BE 4110 – Medical Imaging**

### **Text:**

Paul Seutens, Fundamentals of Medical Imaging, 2nd Edition, Cambridge University Press, August 2009, ISBN: 9780521519151

### **Course description in catalog:**

Physics and engineering principles associated with x-ray, computed tomography, nuclear, ultrasound, and magnetic resonance, including human visualization and perception of image data.

**Prerequisites:** BE 4100 Biomedical Signal Processing, ECE 4900 Bioinstrumentation

### **ABET/Program Outcomes:**

The Program Outcomes are a set of skills that assure the achievement of the program educational objectives. Before graduating, SECS students will demonstrate their skills in the following key areas:

- a. an ability to apply knowledge of mathematics, science, and engineering
- b. an ability to design and conduct experiments, as well as to analyze and interpret data
- c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- d. an ability to function on multi-disciplinary teams
- e. an ability to identify, formulate, and solve engineering problems
- f. an understanding of professional and ethical responsibility
- g. an ability to communicate effectively
- h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i. a recognition of the need for, and an ability to engage in life-long learning
- j. a knowledge of contemporary issues
- k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

### **Course Objectives:**

In this course, students learn the basic concepts in medical imaging, concentrating on magnetic resonance imaging, ultrasound, computed tomography and nuclear medicine. The approach used evolves from basic physical principles to image formation, image reconstruction, hardware design to clinical applications.

### **Topics Covered:**

- **Image Characteristics and Visual Perception:** Concepts of resolution, point-spread-function, modulation transfer function, signal-to-noise level; Multi-dimensional Fourier

transform; Spatial frequencies; Image filtering in spatial frequency domain; Structure and function of the human visual system.

- **Magnetic Resonance Imaging:** Classical description of nuclear magnetic resonance; Quantum mechanical description of NMR; Effect of radio frequency pulses; The free induction decay; Mechanisms and measurement of relaxation processes; Fourier imaging methods; Pulse sequences in MRI; Contrast agents: paramagnetic and ferromagnetic; Construction of magnetic field gradients and rf coils.
- **Ultrasound Imaging:** Wave propagation; Scattering, absorption, and attenuation of ultrasound; Instrumentation; Resolution in ultrasound imaging; Transducer focusing; Phased and linear arrays; A-mode imaging; B-mode imaging; Real time imaging; Doppler instrumentation; Clinical applications.
- **X-ray and Computed Tomography:** Instrumentation; Electronic structure; Mechanisms of absorption and scattering of x-rays in tissue; Contrast in radiographic images; Computed tomography; Data acquisition; Iterative reconstruction schemes; Clinical applications.
- **Nuclear Imaging:** Radioactivity and types of radioactive decay; The gamma camera; Tissue attenuation; Choice of radio nuclide; The technetium generator; Biodistribution of radio nuclides in the body; Resolution and image processing in nuclear medicine; Positron emission tomography.

### **Assignments:**

### **Exams:**

### **Grading:**

### **Grading Scale:**

The basic grading system at Oakland University is a 32-point system of numerical grades, with passing grades ranging from 1.0 to 4.0, by tenths, and a non-credit grade of 0.0.

### **Classroom Behavior:**

Please be courteous to your classmates and instructor. Setting your cell phone and beeper to mute mode is required in class.

### **Academic Dishonesty:**

Cheating on exams/projects will not be tolerated. Anyone caught cheating faces penalties ranging from a zero on the exam to expulsion from the University.

### **Students Who Need Support Services:**

The Office of Disability Support Services (DSS) is the campus office responsible for verifying that students have disability-related needs for academic accommodations and for planning appropriate accommodations. Students with learning, psychological or physical disabilities who need academic accommodations should request them from DSS: 121 North Foundation Hall, Phone: 248-370-3266; TTY: 248-370-3268.

