

ECE 491-Introduction to Biomedical Imaging

Michigan State University – Department of Electrical and Computer Engineering Spring 2008 Syllabus

Prerequisites: ECE 366 is a prerequisite for this course. Basic understanding of signal processing and Fourier transforms is expected, and experience with computer programming (using Matlab) is required. ECE 305 is also highly desirable (any undergraduate course in optics, acoustics, or electromagnetics will provide useful background for this class).

Instructor:

Dr. Robert J. McGough

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Office: 1213EB

Office hours: Mon./Weds. 3-4pm

Lecture times: Mon./Weds. 4:10-5:30pm

Required Text:

Introduction to Biomedical Imaging
by Andrew Webb (Wiley Interscience, 2003)

Supplemental Texts (on reserve):

Medical imaging systems, Albert Macovski

Diagnostic ultrasound: principles and instruments, by Frederick W. Kremkau.

Principles of computerized tomographic imaging, by Avinash C. Kak and Malcolm Slaney.

Magnetic resonance imaging: physical principles and sequence design, by E. Mark Haacke

Principles and practice of positron emission tomography, editor, Richard L. Wahl

The Essential Physics of Medical Imaging, by Bushberg, Seibert, Leidholdt, and Boone

Course Objective:

The course objective is to provide the student with a basic knowledge of medical imaging systems, namely diagnostic ultrasound, X-ray imaging, CT, MRI, and PET/SPECT. This course will cover the fundamental interactions between different forms of energy and biological tissues, the signal and image processing techniques that are applied, and current clinical applications. In addition, the basic issues of resolution, contrast, acquisition time, and safety will be evaluated for each medical imaging modality.

Grading:

Homework 25%

Computer projects 15%

In-class presentation: 15%

Mid-term exam: 20%

Final exam: 20%

Topics Covered:

X-Ray Imaging and Computed Tomography.

- General Principles of Imaging with X-Rays/X-Ray Production (1 lecture)
- Interactions of X-Rays with Tissue/Linear and Mass Attenuation Coefficients of X-Rays in Tissue/Instrumentation for Planar X-Ray Imaging/X-Ray Image Characteristics (1 lecture)
- X-Ray Contrast Agents/X-Ray Imaging Methods/Clinical Applications of X-Ray Imaging (1 lecture)
- Computed Tomography (1 lecture)
- Image Processing for Computed Tomography (1 lecture)
- Spiral and Helical Computed Tomography/Multislice Spiral Computed Tomography/Radiation Dose/Clinical Applications of Computed Tomography (1 lecture)

Nuclear Medicine: PET & SPECT

- General Principles of Nuclear Medicine/Radioactivity (1 lecture)
- The Production of Radionuclides/Types of Radioactive Decay/The Technetium Generator (1 lecture)
- The Biodistribution of Technetium-Based Agents within the Body/Instrumentation: The Gamma Camera/Image Characteristics (1 lecture)
- Single Photon Emission Computed Tomography/Clinical Applications of Nuclear Medicine (1 lecture)
- Positron Emission Tomography (1 lecture)

Ultrasound

- General Principles of Ultrasonic Imaging/Wave Propagation and Characteristic Acoustic Impedance (1 lecture)
- Wave Reflection and Refraction/Energy Loss Mechanisms in Tissue/Instrumentation (1 lecture)
- Diagnostic Scanning Modes (2 lectures)
- Artifacts in Ultrasonic Imaging/Image Characteristics/Compound Imaging (1 lecture)
- Blood Velocity Measurements Using Ultrasound (1 lecture)
- Ultrasound Contrast Agents, Harmonic Imaging, and Pulse Inversion Techniques (1 lecture)
- Safety and Bioeffects in Ultrasonic Imaging/Clinical Applications of Ultrasound (1 lecture)

MRI

- General Principles of Magnetic Resonance Imaging (1 lecture)
- Nuclear Magnetism (1 lecture)
- Magnetic Resonance Imaging/Instrumentation (1 lecture)
- Imaging Sequences (2 lectures)

- Image Characteristics (1 lecture)
- MRI Contrast Agents/Magnetic Resonance Angiography/Diffusion-Weighted Imaging (1 lecture)
- In Vivo Localized Spectroscopy/Functional MRI/Clinical Applications of MRI (1 lecture)