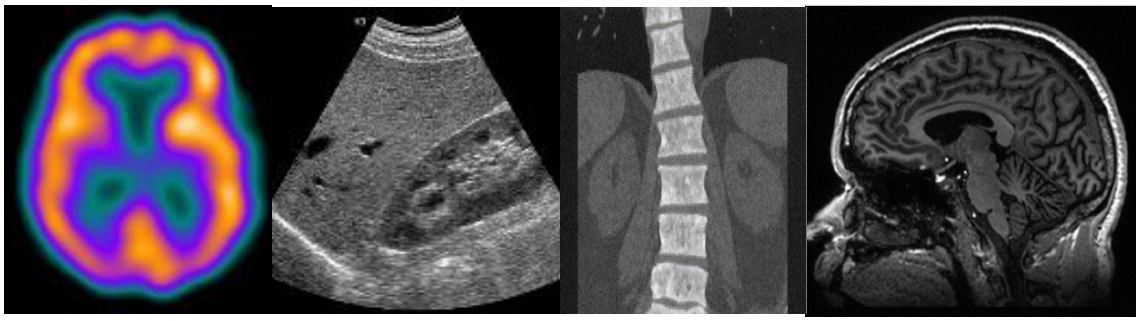

ECE 447-Introduction to Biomedical Imaging

Michigan State University – Department of Electrical and Computer Engineering
Spring 2019 Syllabus

Prerequisites: Working knowledge of Matlab is required. ECE 366 is also a prerequisite for this course. Basic understanding of signal processing and Fourier transforms is expected. 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
Email: mcgough@egr.msu.edu
Office: 1213EB
Office hours: Mon. 4:30-5:30pm and Tues. 4-5pm in 1213EB

Lecture times: Mon./Weds. 3-4:20pm in 1255 Anthony Hall

Required Text:
Introduction to Medical Imaging
by Nadine Smith and Andrew Webb (Cambridge University Press, 2011)

Supplemental Texts (optional):
Diagnostic ultrasound imaging [electronic resource] : inside out, Thomas L. Szabo (Amsterdam; Boston: Elsevier/AP, Academic Press is an imprint of Elsevier, 2014).
The Fourier transform and its applications, Ronald Newbold Bracewell (New York : McGraw-Hill, 1986)
Medical imaging systems, Albert Macovski
Fundamentals of Acoustics, Kinsler and Frey
Fundamentals of Physical Acoustics, David T. Blackstock (John Wiley and Sons, Inc., 2000)
Diagnostic ultrasound: principles and instruments, Frederick W. Kremkau.
Principles of computerized tomographic imaging, Avinash C. Kak and Malcolm Slaney.
Magnetic resonance imaging: physical principles and sequence design, E. Mark Haacke et al.
Principles and practice of positron emission tomography, editor, Richard L. Wahl; associate editor Julia W. Buchanan.

Introduction to Biomedical Imaging, Andrew Webb

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:

Mid-term exams (1): 25% (on Weds. right before spring break)
Homework: 25% (due at the beginning of class every Weds.)
Matlab assignments/computer projects/other projects: 10%
Class participation: 5%
In-class presentation: 10%
Final exam: 25%
At least one homework/project (sometimes two) will be assigned each week.

Topics Covered:

Ultrasound

- General Principles of Ultrasonic Imaging/Wave Propagation and Characteristic Acoustic Impedance
- Wave Reflection and Refraction/Energy Loss Mechanisms in Tissue/Instrumentation
- Diagnostic Scanning Modes
- Artifacts in Ultrasonic Imaging/Image Characteristics
- Blood Velocity Measurements Using Ultrasound
- Ultrasound Contrast Agents
- Safety and Bioeffects in Ultrasonic Imaging/Clinical Applications of Ultrasound

X-Ray Imaging and Computed Tomography

- General Principles of Imaging with X-Rays/X-Ray Production
- 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
- X-Ray Contrast Agents/X-Ray Imaging Methods/Clinical Applications of X-Ray Imaging
- Computed Tomography
- Image Processing for Computed Tomography
- Spiral and Helical Computed Tomography/Multislice Spiral Computed Tomography/Radiation Dose/Clinical Applications of Computed Tomography

Nuclear Medicine: PET & SPECT

- General Principles of Nuclear Medicine/Radioactivity

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

MRI

- General Principles of Magnetic Resonance Imaging
- Nuclear Magnetism
- Magnetic Resonance Imaging/Instrumentation
- Imaging Sequences
- Image Characteristics
- MRI Contrast Agents
- Clinical Applications of MRI

Between 2 and 4 guest lectures are planned this semester.

The material provided in this syllabus is a guideline. The order in which the material is presented, the amount of material covered for each imaging modality, and the formula for calculating the final grade are all subject to change.