

# **ELEN 410-JI, Fall 2009**

## **Introduction to Medial Imaging**

**Instructor:** Jim Ji, 236B WERC, (979) 458-1468 E-mail: [jimji@tamu.edu](mailto:jimji@tamu.edu)

**TA:** Shuo Feng, 236 WERC, E-mail: [f3e7n2g1@tamu.edu](mailto:f3e7n2g1@tamu.edu)

### **Office Hours:**

**TA:** Conference room in 236 WERC, Wed 4:00-5:30 PM.

**Instructor:** Stop by any time when I am in the office. You may catch me in the Magnetic Resonance Systems Lab (<http://ee.tamu.edu/~mrs1>, (979) 458-4521) at USB 109, if I'm not in the WERC office. Email me or see me after class to make an appointment.

**Lectures:** MWF 10:20AM-11:10AM , ZACH 223C

### **URL:**

<http://www.ece.tamu.edu/~jimji>

Grades and notes will be posted on <http://elearning.tamu.edu>. Use you neo id and passwd to get access.

### **Prerequisite:**

MATH 222, or MATH 251, or MATH 253 (or equivalent).

### **Text:**

Andrew Webb, Introduction to Biomedical Imaging, IEEE Press, Wiley  
Additional lectures notes for optical imaging.

### **Other References:**

Guy and Ffytche, An Introduction to the Principles of Medical Imaging, Imperial College Press  
(*Online book that you can download from TAMU Library*)  
Prince & Links, Medical Imaging: Signals and Systems, Prentice Hall  
Shung, K.Kirk Ed. Principles of medical imaging  
Cho, Jones, and Singh, Foundations of Medical Imaging, Wiley & Sons

### **Grading:**

The final grade will be determined from the weightings

Exams = 50 %

HWs and projects = 50%

Guaranteed: 90-100 A, 80-89 B, 70-79 C, 60-69 D, Below 60 F. Any curve will lower these ranges.

### **Homework and Projects:**

The hw will be assigned approximately each Monday, which will typically be due on the next Monday and must be handed in at the beginning of the class. The lowest hw score will be dropped. NO LATE HW will be accepted except those covered under the University Policies on Excused Absences. Grades will be posted on elearning.

You will have an opportunity to present a literature review on medical imaging to the class (project).

**Test:**

There will be two closed book exams. You are allowed to bring a two-sided 8.5 by 11-inch handwritten note to the first test and one additional note (totally two) to the final exam.

Midterm 1: Friday, October 2, 7-9pm (tentative)

Midterm 2: Friday, November 13, 7-9pm (tentative)

**Coverage and Goals:**

This is an undergraduate course that provides an introduction to medical imaging, with a focus on magnetic resonance imaging, x-ray computer tomography, ultrasound, optical imaging and nuclear medicine. The students will learn how external energy sources are injected as stimuli, how signals carrying biological information are generated, and how images are formed subsequently. The engineering principles and basic physics of the various imaging modalities will be described, with plenty of examples. Advantages/disadvantages of various imaging modalities will also be discussed in the context of clinical applications.

After this course, you are expected to be able to:

1. Describe the instrumentation and structure of MRI, CT, UltraSound, SPECT/PET, and optical imaging.
2. Explain the physical principles of the modalities.
3. Know how the data are acquired and how the images are reconstructed in each modality.
4. Understand the characteristics of each imaging modality and major applications of each imaging modality.

This course is listed under: (a) biomedical imaging and genomic signal processing;  
(b) communication, control and signal processing; and  
(c) electrophysics.

**Topics:**

- Overview of medical imaging technologies and applications (1)
- Review of some basic math and physics (2)
- Principle of tomographic imaging (3)
- Magnetic Resonance Imaging (9)
  - a. MRI systems & Applications
  - b. Classical vector model of nuclear spin system
  - c. Radio frequency excitation
  - d. Free induction decay and echo
  - e. Fourier imaging
  - f. Contrast mechanism
- X-ray Computer Tomography (CT) (6)
  - a. CT imaging systems
  - b. Mechanisms of absorption and scattering of x-rays in biological samples
  - c. Backprojection reconstruction and iterative algebraic reconstruction
  - d. Clinical applications

- e. Emerging CT technologies
- Ultrasound Imaging (6)
  - a. Instrumentations and systems
  - b. Generation and propagation of acoustic waves
  - c. Scattering, absorption and attenuation of ultrasound in biological samples
  - d. Linear array and beam forming
  - e. A-mode, B-mode and real time imaging
  - f. Clinical applications
- Nuclear Imaging (4)
  - a. Positron emission tomography (PET) and single photon emission computer tomography (SPECT) systems
  - b. Radioactivity
  - c. Tissue attenuation
  - d. Biological activity and biodistribution of radio nuclides
  - e. Applications
- Optical Imaging (notes) (4)
  - a. Optical imaging systems and principles: confocal microscope, optical coherent tomography
  - b. Property of lights (coherence and diffraction)
  - c. Spectrum window of light in biological samples
  - d. Optical sources, detectors and modulators
  - e. Applications
- Evaluation of quality: resolution, SNR, contrast and speed (2)
- Literature review project presentation (2)
- Course review (2)

**Aggie Honor Code:**

*An Aggie does not lie, cheat or steal or tolerate those who do.*

Honor Council Rules and Procedures: <http://www.tamu.edu/aggiehonor>.

**Students Needing Support Services:**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Cain Hall, Rm. B118, or call 845-1637.

**Classroom Behavior:** Please be courtesy to your classmates and instructor. Setting your cellphone and beeper to mute mode is required in class.