

BMME 550  
Medical Imaging: Ultrasonic, Optical, and Magnetic Resonance Systems  
Course Syllabus

1. *Department:* Joint Dept. of Biom. Engr.    *Number:* BMME 550    *Credit Hours:* 3  
*Title:* Medical Imaging: Ultrasonic,  
Optical, and Magnetic Resonance Systems    Elective

2. *Course Description:*

This course presents a preliminary investigation into the physical and mathematical foundations of ultrasonic, optical, and magnetic resonance imaging systems in application to medical diagnostics. The imaging modalities will be examined on a case-by-case basis, highlighting the following critical system characteristics: 1) underlying physics of the imaging system, including the physical mechanisms of data generation and acquisition; 2) image creation, and 3) basic processing methods of high relevance, such as noise reduction. This course is designed to support more in depth investigations into ultrasonic, optical, and magnetic resonance imaging modalities.

3. *Prerequisite(s):* PHYS 028, BMME 106, BMME 121, BMME 223, Statistics; or equivalents.

4. *Textbook(s) and/or other required material:*  
Medical Imaging Signals and Systems, Prince and Links, 2005.

5. *Course objectives. By the end of this course, the student should be able to:*

- 1) Explain the basic principles of each examined imaging modality.
- 3) Analyze a given system in terms of physical mechanisms, data generation and acquisition, image creation and processing.
- 2) Compare the imaging technologies and list strengths and weaknesses associated with each technology.

6. *Topics covered (number of lectures per topic, based on 28 75 -minute lectures per semester):*

The course covers three imaging modalities:

#### Ultrasound

1. Introduction and review of basic principles
2. Acoustic waves
3. Ultrasonic transducers
4. Steering and focusing
5. Image resolution, contrast, frame rate, field of view
6. Image enhancement (introduction to Field II and data acquisition)
7. Doppler and motion tracking
8. Advanced applications ARFI, HIFU, CUS, and MUS
9. Exam on Ultrasonic Imaging

#### Optics

1. Fundamentals of light sources
2. Introduction to coherence
3. Detecting light
4. Using the light, Lenses and optical fibers
5. Simple optical instrumentation
6. Light passing through tissue
7. Optical Coherence Tomography
8. Exam on Optical Imaging

#### MRI

1. The spin system
2. Magnetization and relaxation
3. Bloch Equation
4. Signal formation and detection (1)
5. Signal formation and detection (2)
6. Echo formation
7. 2D and 3D imaging (1)
8. 2D and 3D imaging (2).
9. Exam on MRI

*7. Class/laboratory schedule (sessions per week and duration of each session):*

Two 75-minutes lectures per week.

*Date of preparation and person(s) who prepared this description:*

Caterina M. Gallippi, Ph.D. September 22, 2005