BIOMEDICAL ENGINEERING 325
INTRODUCTION TO MEDICAL IMAGING
FALL 2019 ALAN V. SAHAKIAN

Class Room and Times: Tech. M345, Mon., Wed., Fri. 1:00 – 1:50 PM

Instructor: Alan V. Sahakian, 847-491-3641, e-mail: a-sahakian@northwestern.edu
Office Hours: (Tentative) Mon., Wed., Fri. 2:00-2:50 p.m., Tech. room L253 (Associate Dean's office) or M394 (faculty office).

Teaching Assistant: Drew Beauchamp james.beauchamp@northwestern.edu tentative office hours M,W,F 11-1 pm, room TBA (the TA will be unavailable October 14-16 and 21-23)

***TENTATIVE* SCHEDULE v1.2 (THIS MAY CHANGE)**

Week	Dates	Topics	Readings (pp.)
1	Sept. 25,27	Introduction to basic concepts of medical imaging	Ch. 1,2,3,6,7
2	Sept. 30, Oct 2,4	Generation and Detection of x-rays	(above)
3	Oct 7,9,11	x-ray continued, direct methods, body section radiography	(above)
4	Oct. 14,16,18	x-ray methods continued; Computed Tomography; Biological effects	Ch. 10,11
5	Oct. 21,23,25	Ultrasound: Acoustic fundamentals; Generation and detection of ultrasound	Ch. 14
6	Oct. 28, 30	Ultrasound diagnostic methods; Biological effects	(above)
6	**Friday Nov 1**	**Exam 1**	
7	Nov.4,6,8	Ultrasound continued, midterm returned by Wednesday. Starting Radionuclide methods. Project proposals due Monday Nov. 4.	
8	Nov 11,13,15	Radionuclide methods	Ch. 15,16,17,18,19
9	Nov. 18,20,22	Magnetic Resonance (NMR/MRI)	Ch. 12,13
10	Nov 25,27 No class on 29	MRI continued. Diagnostic value, statistical performance measures. Nov 28 is Thanksgiving	Lecture notes
11	Dec. 2,4,6	Emerging methods. Graduate student project presentations. **All written project reports are due Friday Dec. 6 in class and electronically.**	Lecture notes
12	Thurs. Dec 12	**FINAL exam** 9:00 to 11:00 am in Tech M345 (comprehensive)	

Tentative Grade Breakdown: Homework: 25%, Exam 1: 25%, Project: 25%, Final Exam: 25%

Prerequisites: The EA math sequence, some Signals and Systems course covering Fourier concepts (co-registration in BME 305 is OK) Note: the text's Appendix G has a review of Fourier Transforms and Convolution; Physics 135-3 (Fields and Waves), or equivalents, or consent of instructor.

Required Text:
The Essential Physics of Medical Imaging, **Third Edition**, J.T. Bushberg, J. A. Seibert, E.M. Leidholdt, J.M. Boone, Publisher: Lippincott, Williams and Wilkins, 2012. (on reserve at the library).

Reference Texts (on reserve at the library):

1) Principles of Medical Imaging, K. Kirk Shung, Michael B. Smith, Benjamin Tsui, Academic Press, 1992.
2) Christensen's Introduction to the Physics of Diagnostic Radiology, Thomas S. Curry, III, James E. Dowdey and Robert C. Murry, Jr., Leigh and Febiger, 1984.

Course Description: Fundamentals of the four most-important clinical medical imaging modalities: X-ray, Ultrasound, Radionuclide, and MRI. The primary focus is on the physical principles, instrumentation methods, and imaging algorithms, however the medical interpretation of images, and the clinical, research and ethical issues in medical imaging are also included where possible to give students a deeper understanding of the development and applications of medical imaging.

Projects: Each student will individually complete a written report (about fifteen double-spaced pages, including figures and references) on a topic related to the course. In addition, each **Ph.D.** student will give a short (about 15 minute) presentation on his or her project during the final week of class. The choice of project topic is left to the student, but students must submit a short (one-page) proposal of their project to the instructor by Monday, November 4 for approval. The report may be a discussion of a new imaging modality, a new development in a classical modality, a new clinical application, an in-depth review of the history of some modality, a detailed technical discussion of some aspect of a modality (perhaps including a Python, MATLAB or other program), a discussion of a clinical or research imaging problem and solutions, or another relevant topic which you find interesting. **All** students will be responsible for attending the Ph.D. students' oral presentations, and this material will be considered fair game on the final.

Coding: The course includes coding examples which I write in Python 3.7 You can download the version appropriate for your own machine here: https://www.python.org/downloads/ Mark Pilgrim's *Dive into Python 3* is an excellent resource: https://diveinto.org/python3/about.html