BIOMEDICAL ENGINEERING 325
INTRODUCTION TO MEDICAL IMAGING
FALL 2020 ALAN V. SAHAKIAN Version 1.4

Class Room and Times: No room. Synchronous, remote. Mon., Wed., Fri. 1:50 – 2:40 PM via Zoom. Please log in using "Northwestern Online Passport" or via Canvas. If you get stuck in the dreaded Zoom "waiting room" for a long time please get my attention or Jasmine's.

Instructor: Alan V. Sahakian, 847-491-3641, e-mail: a-sahakian@northwestern.edu
Office Hours: (Tentative) Mon., Wed., Fri. 2:40-3:30 p.m., Online. **Send me an email to be invited to a zoom office session.** I will give priority for the earliest office times to students taking BME 301 since that lecture starts at 3 pm. Although I won't be in them often, my offices are: Tech. room L253 (Associate Dean's office), M394 (faculty office) and M355 (research lab).

Teaching Assistant: Jasmine Vu jasminevu2018@u.northwestern.edu Office hours TBA.

***TENTATIVE* SCHEDULE (THIS MAY CHANGE)**

Week	Dates	Topics	Readings (pp.)
1	Sept. 16,18	Introduction to basic concepts of medical imaging	Ch. 1,2,3,6,7
2	Sept. 21,23,25	Generation and Detection of x-rays	(above)
3	Sept. 28,30 Oct. 2	x-ray continued, direct methods, body section radiography	(above)
4	Oct. 5,7,9	x-ray methods continued; Computed Tomography; Biological effects	Ch. 10,11
5	Oct. 12,14,16	Ultrasound: Acoustic fundamentals; Generation and detection of ultrasound	Ch. 14
6	Oct. 19,21	Ultrasound methods; Biological effects	(above)
6	**Fri. Oct. 23**	**Exam 1**	
7	Oct. 26,28,30	Ultrasound continued, midterm returned by Wednesday. Starting Radionuclide methods. **Project proposals due Monday Oct. 26.**	
8	Nov. 2,4,6	Radionuclide methods	Ch. 15,16,17,18,19
9	Nov. 9,11,13	Magnetic Resonance (NMR/MRI)	Ch. 12,13
10	Nov 16,18,20	MRI continued. Diagnostic value, statistical performance measures.	Lecture notes
11	Nov. 23,25, Nov. 30	Emerging methods. Graduate student project presentations. Last lecture and **PROJECT REPORTS DUE on Mon. Nov 30.**	Lecture notes
12	Mon. Dec 7	**FINAL exam (nominally 2 hours long)**	

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. Amazon has this book for sale or rent.

Reference Texts (with HathiTrust links):

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, October 26 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. **The Project report is due on Monday November 30 at 5 pm CST.**

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

Special Considerations arising due to Online Delivery: This class or portions of this class will be recorded by the instructor for educational purposes. These recordings will be shared only with students enrolled in the course and will be deleted at the end of the end of the quarter. Your instructor will communicate how you can access the recordings.

Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact AccessibleNU. Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University's Copyright Policy, faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.