Boston University Department of Biomedical Engineering

44 Cummington Mall
Boston, Massachusetts 02215
T 617-353-2805 F 617-353-6766

www.bu.edu/bme

BE515: Medical Imaging

1. Introduction

Medical imaging has become an indispensable tool for health care. The goal of this course is to present a comprehensive overview of the four major classes of medical imaging methods: radiography, nuclear medicine imaging, magnetic resonance imaging, and ultrasound imaging. The course will focus on the underlying physics and engineering principles of these methods, and on mathematical approaches for image reconstruction. Students will be assigned exercises and will be required to present an oral report on a current research topic of their choice involving medical imaging instrumentation. There will be a final exam.

2. Instructor and Office Hours

Jerome Mertz:	Friday 2:00 pm – 3:00 pm	LSEB 202

3. Course Hours

Lectures:	Monday and Wednesday 12:20-2:05 pm	TBA

Lecture attendance is mandatory.

4. Expectations and Grading Breakdown

Class participation (10%):

Lecture handouts will be posted on Blackboard. You are required to read the handouts prior to start of lectures. This way you will be able to constructively participate in class discussions. Your active participation will help us assess your understanding of the class material.

Homework (30%):

Homeworks are due in class one week after they are assigned. Any late homeworks will suffer a 20% grade reduction per day.

Class presentation (30%):

Students are required to identify a paper specifically involving medical imaging instrumentation and present a 20-minute presentation on this paper. Your powerpoint presentation is required. Please refer to the syllabus for scheduling details. *Extensions will not be granted unless you can prove illness or other emergency.*

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Final Exam (30%):
An in-class final exam will take place at the end of the course.

Final grades will be curved.

5. Textbooks: required and suggested

Required:

- Paul Suetens, *Fundamentals of Medical Imaging, 3rd Ed.*, Cambridge University Press

Highly suggested:

- Jerry Prince and Jonathan Links, *Medical Imaging Signals and Systems, 2nd Ed.*, Pearson

Suggested:

- Andreas Maier, Stefan Steidle, Vincent Christlein, Joachim Hornegger (Eds)., *Medical Imaging Systems, an Introductory Guide*, Springer Open
- Jerrod Bushberg, J. Anthony Seibert, Edwin Leidholdt, John Boone, *The Essential Physics of Medical Imaging, 4th Ed.*, Wolters Kluwer
- Michael Chappell, *Principles of Medical Imaging for Engineers, From Signals to Images*, Springer

Note that some of these textbooks are available online at the BU Library website:

https://www.bu.edu/library/

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6. Syllabus

Lectures

01: Introduction

02: Basic math: Fourier transforms, resolution, sampling, aliasing

03: Radiography: projection imaging

04: Radiography: computed tomography

05: Nuclear Medicine Imaging: SPECT/PET

06: Nuclear Medicine Imaging : image reconstruction

07: Review so far

08: MRI: physics, relaxation rates, chemical shift, spoiling pulses

09: MRI: slice selection, voxel localization (z,x,y), NMR spectroscopy (temporal FT)

10: MRI: k-space scanning (phase encoding (y), gradient echo, frequency encoding (x)), k-space flipping (spin echo). k-space imaging (spatial FT)

11: MRI: Pulse sequences: T1, T2. PD weightings, inversion imaging (STIR, FLAIR)

12: MRI: fast imaging, MRI angiography, perfusion contrast imaging

13: MRI: phase imaging, DWI, BOLD

14: Review MRI

15: Ultrasound Imaging: physics

16: Ultrasound Imaging: beamforming

17: Ultrasound Imaging: Doppler, speckle tracking

18: Ultrasound Imaging: CPWC, shear wave, harmonic imaging

19: Review everything