

BME 16:125:561 BIOIMAGING METHODS

FALL 2024 SYLLABUS

Course Description:

This course will cover the basic principles of medical imaging and other methods of imaging biological tissue. Topics include a general introduction to imaging followed by a discussion of specific imaging methods including X-ray imaging and computed Tomography, Magnetic Resonance Imaging, Ultrasound, Positron Emission Tomography, Single Photon Emission Computed Tomography, Optical Coherence Tomography, Fluorescence Microscopy. Emphasis is placed on the physics and instrumentation underlying image formation in the different imaging modalities.

EXCEPT WHERE NOTED, LECTURES ARE ON TUESDAYS & FRIDAYS 12:10-1:30 PM IN BME ROOM 126

Instructor:

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Office Hours: Mondays 11 AM – 12 PM: Log into Conferences via *BigBlueButton* on Canvas

Textbooks:

Recommended:

1. *Introduction to Medical Imaging*
Nadine Barrie Smith and Andrew Webb
Cambridge University Press; 2011, ISBN: 9780521190657
2. *Principles of Computerized Tomographic Imaging*
A. C. Kak and Malcolm Slaney
Society of Industrial and Applied Mathematics, 2001.
Also available electronically at <http://www.slaney.org/pct/>.

Other useful textbooks available at Rutgers Libraries

3. *Optional: The Essential Physics of Medical Imaging*, 4th Edition
By Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt, Jr., and John M. Boone
Wolters Kluwer, 2021
ISBN: 9781975103224 *Electronic version available at the Rutgers Libraries*
4. *Optional: Fundamentals of medical imaging*, 3rd Edition
P. Suetens
Cambridge University Press; 2017, ISBN-13: 978-1107159785 *Electronic version available at the Rutgers Libraries*

Grading Policy:

Quiz 1: 25%

Quiz 2: 25%

Quiz 3: 25%

Special Topic Homework: 25%

Final Grade: **A:** >=90, **B+:** 85-89, **B:** 80-84, **C+:** 75-79, **C:** 65-74, **F:** <65

Other complementary courses to consider:

125:431 Introduction to Optical Imaging (Boustany)

125:571 Biosignals and Bioimaging (Niu)

******Policy on Plagiarism:******

In general, you may not use any material created or originated by someone else **and claim it as your own** in order to fulfill an assignment for this class.

This applies to copying work from a fellow student, copying previous material created in previous years of this class, or copying material from public sources such as the world-wide web or published papers, articles, generative AI, etc...

- Specific policy on plagiarism when the assignment consists of a report write up or presentation:

While paraphrasing published material is acceptable with proper referencing, blatant plagiarism (copying published or previous material) will result in a failing grade. Excessive paraphrasing with proper referencing but with a clear lack of understanding of the material at hand is also discouraged, and could also amount to plagiarism. Excessive paraphrasing without proper referencing will always result in a failing grade. Within presentations, all figures downloaded from the web must have a reference to the source website. Decision about what constitutes plagiarism will be made at the discretion of the instructor.

For more detail please refer to the **Rutgers Policy on Academic Integrity at:**

[Home | Academic Integrity - Rutgers University](#)

Another useful link on plagiarism may be found at:

<http://ori.dhhs.gov/education/products/plagiarism/>.

IT IS IN FACT ASSUMED THAT ALL STUDENTS ARE FULLY AWARE OF THESE POLICIES ON PLAGIARISM AND ACADEMIC INTEGRITY PRIOR TO REGISTERING FOR THIS CLASS. IF YOU ARE IN DOUBT, PLEASE CONTACT THE INSTRUCTOR.

ALL REPORTS AND WRITE-UPS GENERATED BY STUDENTS WILL BE SUBMITTED TO A PLAGIARISM SOFTWARE AND SCRUTINIZED FOR INSTANCES OF PLAGIARISM.

All instances of academic integrity violation will be reported to the Dean and will result in at least a failing grade on the assignment in question. Repeat offenders may suffer more serious consequences such as a failing grade for the course, a “disciplinary” failing grade (XF) or suspension.

DATE	TOPIC (Course pace and schedule may be adjusted)	READING
Tue. Sep. 3 Fri. Sep. 6	• Introduction to Medical Imaging- • General Analysis of Imaging System- ◦ <i>Image quality- Resolution the PSF</i>	Chap. 1 in Smith and Webb + handout on analysis of 2D Signals and Systems
Tue. Sep. 10 Fri. Sep. 13	• General Analysis of Imaging Systems- ◦ <i>Frequency analysis of imaging systems</i> ◦ <i>Sampling theorem</i> ◦ <i>Contrast and noise</i>	Problem Set 1 Due Chap. 1 in Smith and Webb + handout on analysis of 2D Signals and Systems
Tue. Sep. 17 Fri. Sep. 20	• Intro to OCT • OCT demo with Thorlabs Mobile Photonics Lab	OCT references posted on Canvas Problem Set 2 Due
Tue. Sep. 24 Fri. Sep. 27	• Demo Wrap-up • General Analysis of Imaging Systems- ◦ <i>ROC curves</i>	Chap. 1 and Section 2.8 in Smith and Webb Problem Set 3 Due
Tue. Oct. 1 Fri. Oct. 4	• Problem Review • Quiz 1	
INDEPENDENT READING	• X-Ray radiography (READING) ◦ <i>X-ray tubes</i> ◦ <i>Source and projection geometry</i> ◦ <i>X-ray detectors (film and digital)</i> • X-Ray Computed Tomography (READING) ◦ <i>X-ray CT instrumentation</i> ◦ <i>Sources of artifact in X-ray CT</i>	Chap. 2 in Smith and Webb
Tue. Oct. 8 Fri. Oct. 11	• X-Ray imaging ◦ <i>Interaction of radiation with matter, absorption and HVL</i> • X-Ray Computed Tomography ◦ <i>Projection data X-ray CT</i>	Chap. 2 and Section 1.10 in Smith and Webb Chapter 3 (p. 49-68 and 75-86) and Section 4.1 in Princ. of Comp Tomography (Kak and Slaney) Problem Set 4 due
Tue. Oct. 15 Fri. Oct. 18	• X-Ray Computed Tomography ◦ <i>Filtered back projection - parallel beam</i> ◦ <i>Basics of fan-projection X-ray CT</i> • Review CT radiography and CT instrumentation	Problem Set 5 due
Tue. Oct. 22	• SPECT and PET	Chap. 3 in Smith and Webb and Section 4.2 in Princ. of Comp Tomography
Fri. Oct. 25 BMES Meeting	• No in person Class - Ultrasound lecture – Asynchronous - INDEPENDENT WORK	Chap. 4 in Smith and Webb and Section 4.3 in Princ. of Comp Tomography
Tue. Oct. 29 Fri. Nov. 1	• Problem Review • Quiz 2	Problem Set 6 due
Tue. Nov. 5 Fri. Nov. 8	• Ultrasound lecture and Demonstration at the Medical School. Dr. Yanamala and faculty • Ultrasound Demo – Prof. Stan On	12:00 – 1:45 PM on Tuesday
Tue. Nov. 12 Fri. Nov. 15	• Magnetic Resonance Imaging ◦ <i>Basic physics of magnetic resonance</i> • Magnetic Resonance Imaging ◦ <i>Image contrast, Spin-Echo, T1, T2, Rho weighted</i>	Chap. 5 in Smith and Webb and Section 4.4 in Princ. of Comp Tomography Problem set 7 due
Tue. Nov. 19 Fri. Nov. 22	• MRI (continued) ◦ <i>Image reconstruction</i>	Problem set 8 due
Wed. Nov. 27 Fri. Nov. 29	• Problem Review • <u>NO CLASS – Thanksgiving Holiday</u>	
Tue. Dec. 3 Fri. Dec. 6	• Advanced MRI: Diffusion Tensor Imaging, Dr. Jeff Luc • MRI Demonstration at CAHBIR	Problem set 9 due
Tue. Dec. 10	• Quiz 3	Last day of class

SYLLABUS ADDENDUM:

1. Resources available at Rutgers. <https://success.rutgers.edu/>
2. The following resources can also be found at <https://success.rutgers.edu/>:
 - a. Academic Integrity - <https://academicintegrity.rutgers.edu/>
 - b. Self-Reporting Absence Application - <https://sims.rutgers.edu/ssra/>
 - c. Absence Verification & Student Support - <https://studentsupport.rutgers.edu/>
 - d. Academic Advising & Policies - <https://soe.rutgers.edu/academic-advising-and-policies/advising-resources>
 - e. University Policies on Final Exams - <https://scheduling.rutgers.edu/final-exam-policies>
 - f. Tutoring, Academic Coaching, Learning Support - <https://learningcenters.rutgers.edu/>
 - g. Counseling (CAPS) - <https://health.rutgers.edu/medical-and-counseling-services/counseling-services>
 - h. Violence Prevention & Victim Assistance (VPVA) - <https://vpva.rutgers.edu/>
 - i. Disability Services - <https://ods.rutgers.edu/>