

BME 357/BME 381J/EE 385J: Biomedical Imaging Modalities

Meeting times and places:

Fall 2022; Tuesday, Thursday, 11:00 a.m. – 12:15 p.m in EER 1.528

Monday, 4:00 pm – 5:50 pm in ECJ 1.314

Instructor:

Tom Yankeelov, Ph.D.

Office hours: Mondays, 10:00 a.m. – 11:00 a.m. and by appointment

Zoom ID: 974 7461 9178

Email*: tey@utexas.edu

*Please enter 'BME 357' in subject line

Assistant for “Matlab Mondays”:

David Hormuth, Ph.D.

Office hours: Wednesdays, 2:00 pm - 4:00 pm,

In person (POB 2.118) or Zoom (913 1138 4168)

Email: david.hormuth@austin.utexas.edu

Course text:

Introduction to Medical Imaging: Physics, Engineering, and Clinical Applications by Nadine Barrie Smith and Andrew Webb, Cambridge University Press

Prerequisites:

BME 251 (Biomedical Image, Signal, and Transport Process Laboratory) and BME 348 (Modeling of Biomedical Engineering Systems)

Course learning goals:

Develop familiarity with the fundamental imaging modalities in “modern” radiology. In particular, we will introduce the basic engineering and physics of X-ray radiography, computed tomography (CT), single photon computed tomography (SPECT), positron emission tomography (PET), ultrasound (US), optical imaging, and magnetic resonance imaging (MRI). We will introduce each modality with words, pictures, and, finally, equations. Learning will be assessed homework assignments and three in-class exams. Time permitting, we will also cover some “special topics” as indicated on the schedule.

Grades:

Your final grade will be computed as follows.

Homework: 40%

Exam I: 15%

Exam II: 20%

Exam III: 20%

Class participation: 5%

Grading policy:

100-97 = A+, 96-89 = A, 88-86 = A-

85-82 = B+, 81-74 = B, 73-70 = B-

69 – 60 = C, 59 – 50 = D, below 50 = F

DAY	DATE	TOPIC	CHAPTER
Monday	22-Aug	Course introduction and overview of medical imaging	notes
Tuesday	23-Aug	Image characterization	1
Thursday	25-Aug	Production of x-rays	2
Monday	29-Aug	Matlab Monday and Matlab HW #1 assigned	notes
Tuesday	30-Aug	Interactions of x-rays in body	notes
Thursday	1-Sep	x-ray image formation	2 & notes
Monday	5-Sep	<i>Labor Day holiday -- no class</i>	
Tuesday	6-Sep	CT in words and pictures; Matlab HW #1 due	2
Thursday	8-Sep	Line integrals, Fourier transforms, convolutions; Written HW #1 assigned	notes
Monday	12-Sep	CT: projections and central slice theorem	notes
Tuesday	13-Sep	CT: filtered backprojection	notes
Thursday	15-Sep	Review material from 22-Aug to 13-Sep; Written HW #1 due	notes
Monday	19-Sep	Exam 1: Material from 22-Aug to 13-Sep	
Tuesday	20-Sep	Basic physics of nuclear medicine	3
Thursday	22-Sep	PET in words and pictures	3
Monday	26-Sep	Matlab Monday & Matlab HW #2 assigned	notes
Tuesday	27-Sep	PET reconstruction	notes
Thursday	29-Sep	PET tracers and kinetic modeling	notes
Monday	3-Oct	SPECT in words and pictures; Matlab HW #2 due; Written HW #2 assigned	3
Tuesday	4-Oct	SPECT: detectors and reconstruction	3 & notes
Thursday	6-Oct	Matlab Monday on a Thursday: Matlab HW #3 assigned; Written HW #2 due	notes
Monday	10-Oct	Some thoughts on multi-modality imaging	notes
Tuesday	11-Oct	Ultrasound: words and pictures and instrumentation	4
Thursday	13-Oct	Ultrasound physics	4 & notes
Monday	17-Oct	Ultrasound image formation; Matlab HW #3 due; Written HW #3 assigned	notes
Tuesday	18-Oct	Ultrasound: Doppler & microbubbles	4 & notes
Thursday	20-Oct	Review material from 22-Aug to 18-Oct; Written HW #3 due	4 & notes
Monday	24-Oct	Exam 2: Material from 22-Aug to 18-Oct	
Tuesday	25-Oct	MRI in words and pictures	5
Thursday	27-Oct	Fundamentals of NMR	5
Monday	31-Oct	MRI: k-space; Written HW #4 assigned	notes
Tuesday	1-Nov	MRI: pulse sequences	notes
Thursday	3-Nov	contrast enhanced MRI	notes
Monday	7-Nov	Matlab Monday & Matlab HW #4 assigned; Written HW #4 due	
Tuesday	8-Nov	diffusion MRI	notes
Thursday	10-Nov	Catch up day or review material from 22-Aug to 8-Nov	
Monday	14-Nov	RECIST & clinical trials and Matlab HW #4 due	notes
Tuesday	15-Nov	Introduction to radiomics	notes
Thursday	17-Nov	Individual Zoom meetings	notes
Monday	21-Nov	<i>Thanksgiving holiday -- no class</i>	
Tuesday	22-Nov	<i>Thanksgiving holiday -- no class</i>	
Thursday	24-Nov	<i>Thanksgiving holiday -- no class</i>	
Monday	28-Nov	Intro to image segmentation + Matlab demo (no assignment)	notes
Tuesday	29-Nov	Introduction to clinical radiology	Guest speaker
Thursday	1-Dec	Review material from 22-Aug to 28-Nov	
Monday	5-Dec	Exam 3: material from 22-Aug to 28-Nov	

Classroom Safety and COVID-19:

To help preserve our in person learning environment, the university recommends the following:

- 1) Adhere to university [mask guidance](#).
- 2) [Vaccinations are widely available](#), free and not billed to health insurance. The vaccine will help protect against the transmission of the virus to others and reduce serious symptoms in those who are vaccinated.
- 3) [Proactive Community Testing](#) remains an important part of the university's efforts to protect our community. Tests are fast and free.
- 4) Visit protect.utexas.edu for more information

Expectations for student attendance:

You should stay home if you are sick or contagious, not only to stop the spread of disease but also to promote your personal wellness. Just communicate to me in a timely fashion that you will not be able to make it to class and I will work with you to make sure that you have extra time to complete any assignments and/or get caught up on the material presented in class.

Note: You are not required to reveal or document your health status to me when requesting accommodation for illness or other absences.

While class participation is 5% of the total course grade, I will show flexibility and grace by scaling your participation score to reflect those times when you are able to attend class.

Students with disabilities:

You may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Services for Students with Disabilities, 512-471-6259, <http://diversity.utexas.edu/>. I will work with you to make sure you receive the appropriate accommodations.

Accommodations for religious holidays:

By UT Austin policy, please notify me of your pending absence at least fourteen days prior to the date of observance of a religious holy day. If you must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, you will be given an opportunity to complete the missed work within a reasonable time after the absence.

Academic integrity:

Cheating includes, but is not limited to plagiarism, copying other students' homework, copying other students' exams, consulting outside sources during an exam, and obtaining copies of exams before they are given. Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since such dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. For further information please visit the Student Judicial Services web site: <http://deanofstudents.utexas.edu/sjs/>.

Here is a link to the University Honor Code: <http://deanofstudents.utexas.edu/sjs/conduct.php>.

Emergency situations:

The following recommendations regarding emergency evacuation are from the Office of Campus Safety and Security, 512-471-5767, <http://www.utexas.edu/safety>:

- 1) Occupants of buildings at The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated. Alarm activation or announcement requires exiting and assembling outside.
- 2) Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building.
- 3) Students requiring assistance in evacuation shall inform their instructor in writing during the first week of class.
- 4) In the event of an evacuation, follow the instruction of faculty or class instructors.
- 5) Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or Fire Prevention Services office.
- 6) Links to information regarding emergency evacuation routes and emergency procedures can be found at www.utexas.edu/emergency
- 7) Behavior Concerns Advice Line (BCAL): 512-232-5050

I would like to acknowledge that we are meeting on Indigenous land. Moreover, I would like to acknowledge and pay our respects to the Carrizo & Comecrudo, Coahuiltecan, Caddo, Tonkawa, Comanche, Lipan Apache, Alabama-Coushatta, Kickapoo, Tigua Pueblo, and all the American Indian and Indigenous Peoples and communities who have been or have become a part of these lands and territories in Texas, here on Turtle Island.