THE UNIVERSITY OF TEXAS AT AUSTIN
Department of Biomedical Engineering
BME 357/381J: Biomedical Imaging Modalities
Spring 2023: 15310/15345

Professor: Adam Bush, PhD
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Web Page: Canvas, http://canvas.utexas.edu

Class Period:

- Monday 4pm-6pm ECJ 1.204 or the BME Learning Resource Center
- Tuesday and Thursday: 11am – 12:30am, GLT 1.106

Office Hours: Monday 12pm– 1pm or by Appointment.

Canvas will be the primary mode of communication for this course. Course notes and additional resources will be posted to canvas. Students are expected to use the internet to supplement their learning.

Textbook: There is no required textbook for this course. We will draw from and reference many sources:

Medical Imaging Signals and Systems: Prince and Links. 2nd Edition

Introduction to Medical Imaging: Physics, Engineering and Clinical Applications: Smith and Webb. 1st Edition

Medical Imaging Systems: Macovski

Magnetic Resonance Imaging: Physical Principles and Sequences Design (2nd Ed), Brown, Haacke et al. Downloadable PDF for UT Students: https://onlinelibrary.wiley.com/doi/book/10.1002/9781118633953

Principles of Magnetic Resonance Imaging, Dwight Nishmura (3rd Ed). Paperback 35$, hardback 42$ https://www.lulu.com/search?page=1&q=dwight+nishimura&pageSize=10&adult_audience_rating=00

Physiology textbooks
Text of Medical Physiology: Guyton and Hall
Human Physiology An Integrated Approach (8th Ed) Silverthorn.

Description: Exploration of the fundamental imaging modalities in "modern" radiology. In particular, we will introduce basic engineering, physics and physiological and clinical uses of X-ray radiography, computed tomography (CT), ultrasound (US), optical imaging, and magnetic resonance imaging (MRI). We will use homework, projects and hands imaging to reinforce and assess learning.

Course Objectives

- Students will learn the physics of image formation in medical imaging
- Students will learn the main instrumentation used in medical imaging
- Students will learn the mathematics of image reconstruction
- Students will learn how to assess image quality in medical imaging
- Students will learn how to use, model and analyze medical imaging systems, images and data

Student Outcomes

- 1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- 2. an ability to apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, as well as global, cultural, societal, environmental, and economic factors
- 3. an ability to communicate effectively with a range of audiences
- 5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- 6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions 7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Program Criteria (PC):

A) Applying principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics;
B) Solving bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;
C) Analyzing, modeling, designing, and realizing bio/biomedical engineering devices, systems, components, or processes; and
D) Making measurements on and interpreting data from living systems.

Prerequisites: BME 251 (Biomedical Image, Signal, and Transport Process Laboratory) and BME 348 (Modeling of Biomedical Engineering Systems). This is an elective course.

Grading and Evaluation:

Letter Grades: A = 93-100; A- = 90-92; B+ = 87-89; B = 83-86; B- = 80-82; C+ = 77-79; C = 73-76; C- = 70-72; D+ = 67-69; D = 63-66; D- = 60-62; F = 0-59

You will be scored against the rubric, NOT against each other. Should the median of the class grades be less than 80% at the end of the term, the final grades may be curved as the instructor sees fit.

Category	Final Grade Percentage
Class Participation	25%
Exam 1	25%
Monday Assignments and Homework	50%
Exam 2	25%

Dropped Score:

The lowest category score will be dropped from your final grade score. Should your lowest score be in the homework and Monday assignments category, it will only contribute 25% to your final grade.

Class Participation: Class participation will be assessed via participation during in class question and answer periods using the Kahoot platform. Full credit will be awarded for participation.

Monday Assignments and Homework: Weekly assignments will be posted prior to 4pm on Monday and due the following Monday by 11:59pm CST. Longer assignments will be occasionally assigned and will be weighted in the category grade based on their assigned duration. For instance, a two week assignment is worth twice as much as a one week assignment. You are free to work together to solve the assigned homework problems, however, the work appearing on your submitted homework assignment must be your own. Some topics will require MATLAB based simulation, image processing or use of image systems and supplies only available during the Monday class period. Plan accordingly. Late assignments will be penalized -25% per day.

COVID and Sickness Policy: Students are encouraged not to attend class while ill. Notify Dr. Bush as soon as possible. Illness must be reported BEFORE a missed class period for class participation to be excused. Any missed class participation and homework assignments during an excused illness will not be counted against your final participation or homework grade.

Tentative Course Schedule

Week	Lecture Dates	Material covered	Book Chapter(s)
26-Aug	Monday	Syllabus, Intro, Imaging History	Notes
27-Aug	Tuesday	Image Characterization	Notes, Webb CH1
29-Aug	Thursday	X-ray Physics	Notes, Prince CH4
2-Sep	Monday	NO Class: Labor Day	
3-Sep	Tuesday	X-ray Physics 2	Notes, Prince CH4,5
5-Sep	Thursday	X-ray Projection: Filters and Formation	Notes, Prince CH5
9-Sep	Monday	Monday Assignment: Inverse Square	
10-Sep	Tuesday	CT Intro	Notes, Prince CH6
12-Sep	Thursday	Fourier	Notes
16-Sep	Monday	CT Reconstruction/Visit MicroCT	
17-Sep	Tuesday	CT: Reconstruction	Notes, Prince CH6
19-Sep	Thursday	CT: Reconstruction	Notes, Prince CH6
23-Sep	Monday	CT Reconstruction/Visit MicroCT	
24-Sep	Tuesday	CT: Applications	Notes
26-Sep	Thursday	CT: Applications	Notes
30-Sep	Monday	CT Reconstruction/Visit MicroCT	
1-Oct	Tuesday	US: Physics and Waves	Notes, Webb CH4
3-Oct	Thursday	US: Physics/System	Notes, Webb CH4
7-Oct	Monday	Ultrasound: Attenuation/Bubbles	
8-Oct	Tuesday	US: Physics/System	Notes, Webb CH4
10-Oct	Thursday	US: Doppler Cardiac	Notes, Webb CH4
14-Oct	Monday	Ultrasound: Kidney, Heart	
15-Oct	Tuesday	US: Doppler Cardiac	Notes, Webb CH4
17-Oct	Thursday	US: Focused Ultrasound/ Neuro Modulation	
21-Oct	Monday	Ultrasound: Kidney, Heart	
22-Oct	Tuesday	Special Topics/Review	
24-Oct	Thursday	Exam 1: Part 1	
28-Oct	Monday	Exam 1: Part 2	
29-Oct	Tuesday	MRI: System	Notes, Prince CH12,13
31-Oct	Thursday	MRI: Bloch/Signal	Notes, Prince CH12,13

4-Nov	Monday	Bloch Simulator	
5-Nov	Tuesday	MRI: Image Formation, Contrast	Notes, Prince CH12,13
7-Nov	Thursday	MRI: Pulse Sequences	Notes, Prince CH12,13
11-Nov	Monday	Scanner	
12-Nov	Tuesday	MRI: Pulse Sequences	Notes, Prince CH12,13
14-Nov	Thursday	MRI: BOLD, Oximetry	Notes
18-Nov	Monday	Scanner	
19-Nov	Tuesday	MRI: Diffusion, Perfusion	Notes
21-Nov	Thursday	MRI: Perfusion, Flow	Notes
25-Nov	Monday	Fall Break	
26-Nov	Tuesday	Fall Break	
28-Nov	Thursday	Fall Break	
2-Dec	Monday	Special Topics	
3-Dec	Tuesday	Special Topics	
5-Dec	Thursday	Special Topics	
9-Dec	Monday	Last Day of Class	
Final Exam Day: TBD		Exam 2	

Possible TBD topics: Fat/Water, Spectroscopy, CEST, Pediatric Imaging, In-Class presentations…

Disclaimer

Instructor reserves the right to modify course policies, the course schedule, and assignment point values and due dates.

Drop Policy:

The last day to drop this course without permission from the Dean is the 4th class day. After this day, drops are approved only in the case of health or personal problems. An engineering student should make an appointment with his/her departmental advisor to discuss adding or dropping any course if the change will alter the classes that were originally approved by the departmental advisor. If the add or drop requires the approval of the Dean, then the student will need to schedule an appointment with an Academic Advisor in the Office of Student Affairs to discuss the request. Additional information can be found at:
http://www.engr.utexas.edu/current/policies/pol_add-drop-wdraw.cfm

Academic Dishonesty:

Cheating will be dealt with in the harshest possibly way, according to the policies established by the office of the Dean of Students.

Class Recordings:

Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.

Regrade Policy:

If you want your Exam regraded, you must approach me within 1 week of getting your homework/project score back.

Religious Holy Days:
A student who misses classes or other required activities, including examinations, for the observance of a religious holy day should inform the instructor at least 14 days in advance of the absence so that arrangements can be made to complete an assignment within a reasonable period after the absence. Students who have questions or concerns may contact the Office for Inclusion and Equity

Students with disability:

The University of Texas at Austin provides, upon request, appropriate academic accommodations for qualified students with disabilities. For more information, contact Services for Students with Disabilities at 512-471-6259 or ssd@austin.utexas.edu.

Classroom Evacuation for Students:

All occupants of university buildings are required to evacuate a building when a fire alarm and/ or an official announcement is made indicating a potentially dangerous situation within the building. Familiarize yourself with all exit doors of each classroom and building you may occupy. Re- member that the nearest exit door may not be the one you used when entering the building. If you require assistance in evacuation, inform your instructor in writing during the first week of class. For evacuation in your classroom or building:
1. Follow the instructions of faculty and teaching staff.
2. Exit in an orderly fashion and assemble outside.
3. Do not re-enter a building unless given instructions by emergency personnel.