BME 3310 / 5310 Medical and Preclinical Imaging

Instructor: Alex Kwan <alex.kwan@cornell.edu>
Professor of Biomedical Engineering

Course assistant: TBD

Lectures: Tuesday and Thursday, 1:25–2:40 pm
In-person

Office hours: TBD (1 hour per week), led by Instructor, 111 Weill Hall
TBD (1 hour per week), led by TA

(Times to be decided by polling students at start of semester; attendance requirement – see below*)

Credit hours: 3 credit hours, letter grade only

This course includes engagement of 2,250 minutes in the semester, including 28x 75-minute class time and *150 minutes of office hour discussion during the semester. Students are expected to spend 6 hours per week on this course outside of scheduled meetings.

Pre-requisites: CS 1112/1114 or equivalent in MATLAB or Python programming, BME 3030 or equivalent knowledge in signals and systems

Required text: *Medical Imaging Signals and Systems 2nd edition*
Jerry L. Prince and Jonathan M. Links

Optional text: *Fundamentals of Medical Imaging 2nd edition*
Paul Suetens

Course website: Course schedule, slides, and problem sets will be posted on Canvas.

Course description:
This course teaches the fundamentals and applications of medical imaging techniques, including x-ray imaging and computed tomography, ultrasound imaging, magnetic resonance imaging, and nuclear medicine. Through lectures and lab tours, the class provides a rigorous introduction to medical imaging, beginning with the basic physical principles of image formation and then onto image reconstruction and descriptions of the hardware used in clinical applications. Concepts covered include resolution, point-spread-functions, modulation transfer functions, signal-to-noise ratio, Fourier transform, and image filtering in spatial domain. The course is open to undergraduate (**BME 3310**) and M.Eng. students (**BME 5310**).

Learning objectives: To understand the physics and engineering principles behind modern medical imaging techniques.

Learning outcomes:

- Apply the appropriate medical imaging approaches to visualize and quantify different physiological structures and functions
- Explain the physics behind the major medical imaging methods
- Demonstrate a mathematical understanding of image formation and reconstruction processes
- Optimize the instrumentation used for medical imaging

Exercises: At the end of each week's lectures, there will be a short in-class exercise. At the end of semester, the lowest 3 scores will be dropped and do not count towards the total.

Problem sets: There will be 4 problem sets. Problem sets are due at 5 pm on the due dates and submitted through Canvas. For late submissions, there will be a 25% deduction of points for each extra day. Re-grade requests must be made within one week after the assignment is returned. You may work together on the problem sets but please write your own code and answers to questions.

Prelim exam: There will be 2 in-class prelim exams. The exam will cover materials presented up to that point and since the last prelim exam. Instructor will provide an equation sheet. Student can bring a calculator, but otherwise cannot use the textbook or other digital devices during exam. Re-grade requests must be made within one week after the exam is returned.

Grading rubric:
(for BME 3310)

20% In-class exercises
20% Problem sets
30% Prelim exam 1
30% Prelim exam 2

Grading scale:
(for BME 3310)

A+ (96.7 – 100%)	A (93.3 – 96.7%)	A- (90 – 93.3%)
B+ (86.7 – 90%)	B (83.3 – 86.7%)	B- (80 – 83.3%)
C+ (76.7 – 80%)	C (73.3 – 76.7%)	C- (70 – 73.3%)
D+ (66.7 – 70%)	D (63.3 – 66.7%)	D- (60 – 63.3%)
F (<60%)		

Scores will be tallied based on the grading rubric, may be curved separately for BME 3310 and 5310 rosters, and convert to a letter grade at the end of the semester.

Final project: (for BME 5310)
At the end of the course, each student will prepare and make a slide presentation. The presentation will focus on a novel technology or application in medical imaging.

Grading rubric: (for BME 5310)
16% In-class exercises
16% Problem sets
24% Prelim exam 1
24% Prelim exam 2
20% Final project

Grading scale: (for BME 5310)

A+ (96.7 – 100%)	A (93.3 – 96.7%)	A- (90 – 93.3%)
B+ (86.7 – 90%)	B (83.3 – 86.7%)	B- (80 – 83.3%)
C+ (76.7 – 80%)	C (73.3 – 76.7%)	C- (70 – 73.3%)
D+ (66.7 – 70%)	D (63.3 – 66.7%)	D- (60 – 63.3%)
F (<60%)		

Scores will be tallied based on the grading rubric, may be curved separately for BME 3310 and 5310 rosters, and convert to a letter grade at the end of the semester.

Accommodations
Accommodations may be made for the course, but you must register and make an official request at Cornell's Student Disability Services (SDS).

Academic integrity
While you are encouraged to discuss content of the class with your peers, you must use your own words for any written exercises, problem sets, and exams. You should read the papers, listen to the lectures, and develop your own understanding of the material. You may discuss the questions with other people, but then answer the questions by describing your own understanding in your own words. You must adhere to Cornell University's Code of Academic Integrity. Violations of the Code of Academic Integrity will result in a 0 grade for all parties involved for the assignment or exam and be referred to the Academic Integrity Hearing Board of the College of Engineering.

Generative Artificial Intelligence (GenAI) policy
The use of Generative Artificial Intelligence (GenAI) tools (e.g., ChatGPT, Copilot, Gemini) is permitted in this course, including for problem sets, as a learning aid to help explore concepts, check understanding, and refine reasoning. However, students are expected to develop their own understanding of the material. Core concepts and methods from the problem sets may be included in exams without GenAI assistance.

Distribution of course materials
All course materials, including but not limited to past exams lecture slides, problem sets, exams, and their solutions are provided for individual use by students enrolled in this course

only. The sharing, buying, selling, or posting of course materials to other students, online platforms, group chats, repositories, or commercial services without written authorization from the instructor constitutes a violation of the University Code of Academic Integrity.

Inclusiveness in the classroom

Cornell is committed to creating an inclusive environment, see https://diversity.cornell.edu/. As your instructor, I will strive to create a classroom space where differences are respected and valued. Every student in the class is encouraged to speak up and participate in class discussions. At the same time, you are expected to demonstrate diligence in understanding how your peers' perspectives and worldviews may be different from your own.