ULTRASOUND AND PHOTOACOUSTIC BEAMFORMING (EN.520.631) SPRING 2025

Department of Electrical & Computer Engineering
Johns Hopkins University

Instructor: Muyinatu A. Lediju Bell, Barton 208, mbell36@jhu.edu

Lectures: TTh 10:30 am – 11:45 am

Location: Hackerman 320

Teaching Assistant: Jiaxin Zhang, Gareth Keene

Text: Lecture Notes

Website: Canvas course website

Books on Reserve at Eisenhower Library:
Szabo, Diagnostic Ultrasound Imaging: Inside Out
Cobbold, Foundations of Biomedical Ultrasound
Christensen, Ultrasonic Bioinstrumentation

Course Description
This course will discuss basic principles of ultrasound and photoacoustic imaging and provide an in-depth analysis of the beamforming process required to convert received electronic signals into a usable image. We will cover basic beamforming theory and apply it to real clinical and pre-clinical data. The course will culminate with student projects to design and implement a new beamformer derived from the principles taught in class.

Project Presentations
Student presentations will be performed and graded individually and will count toward the final project grade.

Grading
Grades for this course will be assigned according to the following rubric:
Final Project 40%
Presentations 25%
Homework 35%

Academic Ethics and Basic Rules
All students are expected to honor the university's ethics code. Together, we share a responsibility to ensure that we work in a community where integrity is upheld.

Breaches in academic integrity include direct copying of homework problems, cheating on quizzes, and taking the credit for group work without making significant contributions. In addition, the submission of term papers based on the ideas of others without proper citation is also a violation. If you believe that a person in this course is not upholding our ethics code, please notify the instructor immediately.

As a student in this course you may receive access to proprietary computer code and/or data. Therefore, do not redistribute course materials without instructor permission. In addition, all students are required to sign a non-disclosure agreement.

Lecture Schedule

Date	Subject	HW # / Due Date
Jan. 21 Jan. 23	Introduction Ultrasound Image Formation	 #1 / due Feb. 11
Jan. 28 Jan. 30	In-Class Assistance with Homework #1 - Part 1 Advanced Beamforming Techniques	
Feb. 4 Feb. 6	Photoacoustic Imaging Elastography Principles	 #2 / due Feb. 25
Feb. 11 Feb. 13	k-wave Simulations k-wave Simulations	
Feb. 18 Feb. 20	Field II Simulations Field II Simulations	
Feb. 25 Feb. 27	Sequence Programming Data Acquisition	 #3 / due Mar. 6
Mar. 4 Mar. 6	Beamforming Lab Project Presentation, Q&A, and Project Selection	
Mar. 11 Mar. 13	Student Presentations (Proposal, Literature Review, & Timeline) Student Presentations (Proposal, Literature Review, & Timeline)	#4 – Project Proposal / due Mar. 11

Project Schedule

Date	Topic
Mar. 18 Mar. 20	NO CLASS – SPRING BEAK
Mar. 25 Mar. 27	Student presentations - progress report #1 Student presentations - progress report #1
Apr. 1 Apr. 3	Student presentations - progress report #2 Student presentations - progress report #2
Apr. 8 Apr. 10	Student presentations - progress report #3 Student presentations - progress report #3
Apr. 15 Apr. 17	Student presentations - progress report #4 Student presentations - progress report #4
Apr. 22 Apr. 24	Final presentations (recorded videos) Final presentations (recorded videos)