

# EE513 Audio Signals and Systems

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[donohue.youcanbook.me/](https://kevin-donohue.github.io/)

**Background:** Students should have engineering standing and have completed EE422 before taking this course (or equivalent experience with Matlab and have taken EE421G).

## Expected Student Outcomes:

A student who has successfully completed this course should be able to:

1. Characterize digital audio systems with difference equations and transfer functions.
2. Characterize digital audio signals with correlation functions and power spectra.
3. Design systems for processing audio data for applications such as filtering, audio effects, and signal classification.
4. Know the fundamental principles of beamforming and acoustic imaging.
5. Program with mathematics software to implement and evaluate designs.
6. Solve multi-component problems related to audio signal processing.

**Text:** Class Notes and Assigned Articles.

**Materials:** Matlab will be needed for most assignments.

<b>Grading:</b>	Final Project (1)	22%
	Quizzes (4)	24%
	Project Assignments (4)	40%
	Homework (7)	14% for undergraduate students 7% for graduate students
	Paper Review (1)	7% for graduate students (not required for undergraduate students)

**Grading scale:** For undergraduates 100-90% = A, 90-80% = B, 80-70% = C, 70-60% = D, and 60-0% = E.  
For graduates 100-90% = A, 90-80% = B, 80-70% = C, 70-0% = E.

**Project Assignments:** Project assignments involve designing, implementing, and demonstrating a solution to a posed problem. Time in class will be given to interact with other students and instructor to comment on code and problem solving/design process. Some assignments may require a short description of the results (a few paragraphs and figures), but also may require a short demonstration to the class and oral questions from the instructor. The final grade will have a common component based on the solution. The project assignments primarily assess all course outcomes.

**Final Project:** The final project will be to the other project assignments but will draw on multiple the topics from the class. This will address course outcomes 3, 5 and 6.

**Quizzes:** Quizzes will be given throughout the semester to test recently acquired skills / knowledge. In-class quizzes will typically involve problems that can be solved without the help of specialized computer software. Take-home quizzes will require the use of specialized software and the solutions are to be completed **independently**. There will likely be 5 quizzes, and the 4 highest quiz scores will be taken to compute the final grade. The quizzes primarily assess course outcomes 1 through 4.

**Homework:** Homework primarily involves problems assigned in the lecture notes and assesses outcomes 1 through 4.

**Paper Review:** *For graduate students only*, read a research paper (approved first by instructor) on audio signals/systems and write a critical report on it. The report must accurately summarize what the authors claim to show, describe their methods, site other related works that support/contradict the findings, and critically assess the degree to which they established their claims. The paper review primarily assesses outcomes 1 through 4.

Tentative Course Schedule EE513				
	Lecture Dates	Projects	Problems	Lecture Topics
1	1-11,13	Project 1 Due 1/20	Synthesize sound with Matlab (Problem in lecture note)	History/Introduction to Matlab's sound functions
2	1-18,20		HW 1 problems in lecture notes Due 1/27	DSP general models (Z-transforms and difference equations)
3	1- 23,25,27	Project 2 Due 2/3	Digital oscillator for a complex tone	Digital oscillators, Complex tones
4	1-30, 2-1,3		HW 2 problems in lecture notes Due 2/10	(Quiz 1) DFTs, Power spectra, Spectrograms, and correlation functions (graduate students: select review paper)
5	2-6,8,10		HW 3 problems in lecture notes Due 2/17	(Quiz2) Filter design
6	2- 13,15,17		HW 4 problems in lecture notes Due 2/24	(Quiz 3) Noise and distortion
7	2-20,22,24	Project 3 Due 3/6		Beamforming/Spatial Filtering/Acoustic Imaging
8	2-27,3-1,3			
9	3- 6,8,10		HW 5 problems in lecture notes Due 3/24	(Quiz 4) Speech (modeling sounds from human voice mechanics)
			Spring Break	
10	3-20,22,24		HW 6 problems in lecture notes Due 3/31	LPC analysis/synthesis and windowing
11	3-27,29,31	Project 4 Due 4/7		Voice analysis and modification detection of voice and unvoiced speech
12	4-3,5,7			
13	4 -10,12,14		HW 7 problems in lecture notes Due 4/21	
14	4-17,19,21	Final Project		(Quiz 5)
15	4-24,26,28		Review	
	Wednesday 5/3 1pm		Final Project Due 5/3 at 1pm	