Duke University
Department of Electrical and Computer Engineering

Audio and Acoustic Signal Processing

ECE 196 **General Information** **Spring 2012**

1. Overview of the course:

This course is designed to provide an introduction to the fundamental concepts, theory, and practice of digital audio and acoustic signal processing (DAASP). Digital audio concerns the process of transducing, digitizing, filtering, transforming, coding, storing, manipulating, transmitting, distributing, analyzing, and reproducing *high quality* music and other acoustic signals. With the advent of multimedia applications, digital audio signal processing has emerged as a field quite distinct from digital speech processing. The field is extremely broad spanning the disciplines of acoustics, hearing, signal processing, music, and psychophysics. This course will focus on those elements of the field with the greatest signal processing and acoustics content. The emphasis will be on providing students with an intuitive understanding of the principles behind DAASP algorithms. In addition, some experience with the most common algorithms will be provided via MATLAB exercises with real digital audio signals. Prerequiste: ECE54

2. Instructor: Dr. Jeffrey Krolik, Professor of Electrical and Computer Engineering
CIEMAS 3465
E-mail: jk@ee.duke.edu
Telephone: 660-5274

3. *Tentative* textbook: B. Gold and N. Morgan, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", Wiley, 2000.

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4. Supplementary References:

Udo Zolzer, "Digital Audio Signal Processing, 2nd Edition", Wiley, 2008.

M. Kahrs and K. Brandenburg, "Applications of Digital Signal Processing to Audio and Acoustics", Kluwer Academic Publishers, 2002.

A. Spanias, T. Painter, and A. Venkatraman, "Audio Signal Processing and Coding", Wiley, 2007.

Ivan Tashev, "Sound Capture and Processing", Wiley, 2009.

Udo Zolzer, et.al. "DAFX: Digital Audio Effects", Wiley, 2002.

A. V. Oppenheim, R. Schafer and J. Buck, "Discrete-time signal processing, 2nd edition", Prentice-Hall, 1999.

L. Kinsler and A. Frey "Fundamentals of Acoustic, 4th edition", Wiley, 2000.

5. Grading: Homework Assignments (including Matlab exercises): 30%

Mid-Term tests: One 75 minute long test to be given during regular class periods during the semester: 30%

Individual Project: 40%

Individual Project: Each student will pick a course project to be completed during the second half of the semester on an audio signal processing topic of their choice. Each student will prepare a report, not to exceed 15 double-spaced pages in total, and a 15 minute talk describing their project results. The project should be limited in scope so that it can be completed in about 4 weeks. Each presentation must use computer generated viewgraphs. Evaluation of the project will be based on the student's ability to convey their technical understanding of the project and to critically assess their work.

6. Teaching Assistant: Jonathan Odom, CIEMAS 2413
E-mail: jonathan.odom@duke.edu
Telephone: 660-5540
Office Hours: TBD

7. Prerequisites:

Mandatory: ECE 54 Signals and Systems. **Optional:** ECE 180 or ECE 189 but may be waived with consent of instructor.

8. Tentative List of Topics (subject to change depending on the background preparation of the students in the class).

Number	Topic
1	Discrete-time signals and systems review
2	Analysis of discrete-time LTI systems
3	Frequency analysis of discrete-time signals and systems
4	Signal quantization
5	Dither
6	A/D and D/A Conversion including Sampling and Reconstruction
7	Sampling rate conversion (decimation and interpolation)
8	Audio Digital Filtering and Equalization

9 Fundamentals of Hearing for Audio Applications

10 Audio Perceptual coding (e.g. Mp3)

Mid-Term Test

11 Time and Pitch scale modification of audio signals

12 Nonlinear processing for dynamic range control and special effects

13 Fundamentals of acoustics for audio

14 Digital simulation of room acoustics

15 Spatial effects in sound reproduction

16 3-D with Headphones and the Head-related Transfer Function

17 Sound capture with microphone arrays

18 Conventional beamforming in the near and far field