# University of Pennsylvania
# Department of Electrical and Systems Engineering
# Digital Audio Basics

ESE250 Spring 2012 Administrative Handout Thursday, January 12

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## 1 General Information

**Prerequisite(s):** one intro programming course (*e.g.* CIS110, ESE112, ESE116, CIS120)
**Units:** 0.5
**Lecture:** To be determined, for now in Towne 303.
**Lab:** In Detkin Lab (Moore 101) and Ketterer Lab (Moore 204) with dates TBD.

| **Course Staff:** | | Office Hours | Office |
|---|---|---|---|
| Lecturer | Koditschek | TBD | Moore 202 |
| TAs | Agatha Oliveira | Check course website for time and place | |
| | Eric Pinter | | |
| | Shilpa Sarode | | |
| | Emily Shaeffer | | |

**Description:** Primer on digital audio. Overview of signal processing, sampling, compression, human psychoacoustics, MP3, intellectual property, hardware and software platform components, and networking (*i.e.*, the basic technical underpinnings of modern MP3 players and cell phones).
**URL:** http://www.seas.upenn.edu/~ese250

## 2 Reading

*The Theory behind MP3* http://www.mp3-tech.org/programmer/docs/mp3_theory.pdf provides the basic document for 4 of the lectures. Additional readings associated with each week will be linked to the online course schedule. Most of these readings will be available online.

*N.b.* Blue URLs should function in a modern PDF reader (*e.g.* acroread); you can click on them to follow the link.

# 3 Syllabus by Weeks

1. Overview
2. Sampling / PCM / Digital Audio
3. Lossless compression
4. Time-Frequency conversion
5. Nyquist-Shannon sampling theorem
6. Human Perception
7. Psychoacoustical compression
8. Hardware organization
9. Operating System (sharing hardware)
10. File System
11. Networking
12. User Interface
13. Intellectual Property

# 4 Grading

Grading comes entirely from lab work. Each of the 13 labs will have a written turn-in. Many will also require in-lab check-off. Labs are graded on a 1-10 scale. You get 1 point for turning in the lab. The grading reflects your understanding of the key ideas, your ability to demonstrate the skills needed for the lab, and your ability to draw meaningful conclusions from the key ideas and results in the lab.

We will drop the lowest graded attempt; *n.b.*, a skipped lab does not count as a *graded attempt* and will not be dropped.

Grade range targets:

| Grade | High | Low |
|---|---|---|
| A | 120 | 100 |
| B | 99 | 84 |
| C | 83 | 70 |
| D | 69 | 50 |
| F | 49 | 0 |

**Lab Timelines and Lateness** Lab writeups are due by noon the Monday following the lab. Late labs will not be accepted. A written note from the academic dean or medical doctor will be required to gain consideration for extenuating circumstances.

**Credit Adjustment** Make sure you call any problems with grading to your TA's attention immediately and not later than the next class meeting after they are returned or posted on blackboard.

Our TAs will be responsible for adjudicating these problems—the instructors will only be involved as a possible court of last appeal in case there is some truly difficult decision to make (*i.e.*, in most cases, we will not be willing to second guess the TA's decisions). To submit a request to the TA for a review of a credit assignment on a lab assignment send an email to the TA stating the nature of the problem and the remedy you desire and then hand back the work in question with a copy of your email stapled to the front. We have instructed the TAs not to consider any requests for grade adjustments that are submitted later than the one week grace period after the grades are posted on blackboard. You are responsible for checking your posted grades in a timely manner.

# 5 Collaboration

**Team Work** Students will work in groups of two or three depending on the lab. We encourage students to work with a different partner(s) each week; if we do not see adequate diversity in teaming, we reserve the right to enforce diversity in later labs. We expect everyone in the group to contribute to the lab work. While the tasks for the lab may be divided among the students, we expect each student to fully understand all parts of the lab. The TAs may interrogate any individual team member about any aspect of the lab. Teams should make sure that every individual member has all the files and results needed for the lab writeup before leaving the lab. It is acceptable to discuss the lab questions in your group before you begin the lab writeup. Identify your team mates in the lab writeup.

**Individual Lab Writeups** Lab writeups must be completed individually and represent your own thinking and original work. Once you begin your lab writeup, you should not discuss the lab with anyone else, including your group. Nor should you compare your written solutions, whether in scrap paper form, or your final work product, to that of other students (and vice versa). You are also not allowed to possess, look at, use, or in anyway derive advantage from the existence of solutions prepared in prior years, whether these solutions were former students' work product or copies of solutions that had been made available by me or other previous instructors. For questions with raw, numerical data from the group lab experiment, we will naturally expect identical answers within a team. However, for prelab questions, inferences, and discussion, we expect the unique expression of the individual.

# 6 Turn In

All labs will be turned in electronically through the Penn Blackboard website. Once logged in, select ESE250 under My Courses, go to Assignments and click on the assignment you want to submit. Attach all files and click submit.

We prefer and encourage you to hand in all writeups, excluding code and LabVIEW files, as PDFs. If a lab requires multiple files you are free to attach multiple file or bundle all files together (using zip, tar, etc.) and submit one file.

# 7 Course Goals

- Provide the digital audio basics necessary for the revised ESE350 where you will build a complete digital audio platform.
- Provide context and motivation for the Computer Engineering major.
- Appreciate how Computer Engineering (Electrical Engineering, Computer and Information Science) impacts today's world and people's lives.
- Help you to start thinking like engineers (quantitative assessment, bottlenecks, benchmarking, optimization, design) and see systems in context.
- Contribute to the outcomes of the Computer Engineering major, including:

  a. an ability to apply knowledge of mathematics, science, and engineering (transforms, sound modeling)

  b. an ability to design and conduct experiments, as well as to analyze and interpret data (psychoaccoustics experiments, hardware bottlenecks, software behavior)

  c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (design file system)

  f. an understanding of professional and ethical responsibility (intellectual property, user interfaces)

  h. the broad education necessary to understand the impact of engineering solutions in global, economic, environmental, and societal context (security and enabled capabilities)

  j. a knowledge of contemporary issues (grounding in contemporary performance of components, security, user interfaces)

  k. an ability to use the technique, skills and modern engineering tools necessary for engineering practice (oscilloscopes, graphical programming for signal processing, spreadsheets and programming, benchmarking, and profiling)