MUS320A&B: Introduction to Digital Audio Signal Processing

Center for Computer Research in Music and Acoustics (CCRMA)
Department of Music, Stanford University

320A (spectra): Autumn Quarter
320B (filters): Winter Quarter

2014–2015

Contents

Music 320 A & B: Introduction to Digital Audio Signal Processing

1 Course Description

Music 320 is a two-quarter first-course in digital signal processing with applications in computer music and audio.

The lectures present fundamental elements of digital audio signal processing, such as sinusoids, spectra, the Discrete Fourier Transform (DFT), digital filters, z transforms, transfer-function analysis, and basic Fourier analysis in the discrete-time case. Matlab is used for in-class demonstrations and homework/lab assignments. The labs focus on practical applications of the theory, with emphasis on working with waveforms and spectra, "getting sound", and developing proficiency in the matlab language.

Prerequisites: High-school level algebra and trigonometry, some calculus, and prior exposure to complex numbers.

Time and Place

Term:	Autumn and Winter Quarters
Location:	CCRMA Classroom (Knoll 217)
Lectures:	Tuesdays and Thursdays 3:15–5:05 PM
Units:	3–4
Instructor:	Julius O. Smith (jos@ccrma.stanford.edu)
TA:	Chet Gnegy (chet@ccrma.stanford.edu)
Office Hours:	See "Office Hours and Getting Help"[1] below
Schedule:	See "Lecture Outline, Schedule, and Assignments"[2] below

2 Administrative Information

2.1 Announcements

Class announcements are often made via *email*. For this we are presently using Piazza:

`piazza.com/stanford/winter2015/music320b/home`

You should have received an invitation from Piazza to join the class after you signed up for it in axess (using the email address known to axess). Otherwise, please join by visiting the above URL and entering your preferred email address.

[1] `http://ccrma.stanford.edu/~jos/intro320/Office_Hours_Getting_Help.html`
[2] `http://ccrma.stanford.edu/~jos/intro320/Lecture_Outline_Schedule_Assignments.html`

2.2 Assignments

There are five homework/lab assignments, each covering roughly two weeks of the course. In each two-week "section", the first week is devoted primarily to theory while the second week is focused more on software and applications. Thus, each assignment contains both a theory and laboratory part. The lab portion typically requires programming in matlab.

Each assignment is typically announced on Tuesday in the first week of the section. The theory part is normally due the following Tuesday at 3:15 pm in the 320 mailbox (located in the Knoll, central wing, second floor, facing the printer). The lab part is normally due by midnight the following Friday, i.e., at the end of the two-week section.

For lab assignments, we will be using the Coursework[3] website. To sign up, go to the Coursework website and find Music320A. Once you are enrolled in the class, you can upload your matlab files in the "drop box" on the left menu.

See §2.5 below regarding obtaining help with theory and lab assignments.

Regarding late homeworks, 7 free late days are allowed (with hours rounded up to the nearest day). Late homeworks beyond this will not be accepted. Only up to 3 late days can be used for any one assignment. When using late days, students are required to write the number of late days used at the top of the assignment (date and time).

Students are encouraged to discuss the homework assignments with each other. It is fine to learn from a classmate how to solve any of the homework problems, but each student is responsible for carrying out and writing up the assignments individually. It is an honor code violation to *copy* the work of others.

2.3 Exams

The final examination will be held in the CCRMA Classroom (Knoll 217) on the University-assigned date, also listed for convenience in the class schedule (§**??** on page **??**).

2.4 Grading

Grades are based on the homeworks/labs (60%), and the final exam (40%). There are also bonus points available based on general participation. The weightings may be changed as we see fit.

2.5 Office Hours and Getting Help

We will be using Piazza[4] for sharing answers to theory and lab questions with the whole class. To sign up, see the 320 Piazza site.[5] It is free and allows you to view past questions from other students, and discuss questions together. Try it first for any homework questions you may have. You are also welcome, of course, to catch us whenever you see us at CCRMA, such as during office hours, etc.

TA weekly office hours will be announced in class and via email to the class. Meetings with JOS are arranged via email for half-hour slots before or after class, or other times when necessary.

[3] `https://coursework.stanford.edu`

[4] `https://www.piazza.com`

[5] `piazza.com/stanford/winter2015/music320b/home`

3 Textbooks

Music 320A (fall) is based on assigned chapters of

Mathematics of the Discrete Fourier Transform (DFT),[6] by Julius O. Smith

Music 320B (winter) is based on assigned chapters of

Introduction to Digital Filters,[7] by Julius O. Smith

See §**??** for the list of assigned chapters. Both books are fully available on-line. Softcover versions are available from Amazon.com.

4 The Flipped Classroom

With the lectures recorded, class time is freed up for other activities. Here is how a typical "flipped class" is organized:

- Q&A session on the reading/video content
- Review of main points in the reading/videos
- Demos in support of the reading/videos
- Presentation of the homework/lab assigment
- Worked problems similar to those in the homework
- Matlab session on theory/lab-related topics
- Live coding in matlab

Additional available time may be devoted to

- More demos
- More discussion
- "Backwards learning" examples:
  - Plugins using spectral techniques
  - Faust language and some of its examples
- More on applications and why all this is useful
- Preview material coming up

5 A Recipe for Learning

Learning something new requires multiple passes on the material. For example:

1. Do the assigned reading at a fixed pace to get a picture of what's covered
2. Watch the lecture videos, pausing and taking notes on anything newly learned
3. Make a first pass on the homework, flagging and skipping when stuck on a problem
4. Discuss nonobvious homework problems with other students, the TA, and/or JOS

[6] `http://ccrma.stanford.edu/~jos/mdft/`
[7] `http://ccrma.stanford.edu/~jos/filters/`

5. Write up the homework problems, everything now understood
6. Exam prep: Reread the text for full comprehension
7. Exam prep: Reread your notes
8. Prepare your one-page summary of the course allowed in the exam
9. Exam experience: Exercise in problem solving using the material

These multiple engagements result in learning.