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Music 420A: Signal Processing Models in Musical Acoustics

1 Course Overview

Music 420A (EE 367A) is about computational electroacoustic modeling for digital audio effects, sound synthesis, and signal processing for physical modeling in general.

1.1 When, Where, Who

**Term:** Winter Quarter, every other year (including 2016-2017)
**Location:** Main CCRMA Classroom (Knoll 217)
**Time:** Tuesdays and Thursdays, 3:30-4:45 PM,
**Instructor:** Julius Smith (jos@ccrma.stanford.edu)
**TA:** Irán Roman (iran@ccrma.stanford.edu)
**TA Office Hours:** Wednesdays 8-10pm
**JOS Office Hours:** by appointment after class and/or other times as arranged by email
**Website:** [https://ccrma.stanford.edu/courses/420/](https://ccrma.stanford.edu/courses/420/)

1.2 Prerequisites

The prerequisites for Music 420A consist of prior first courses in signal processing and elementary dynamics, together with programming in C++ and matlab. Familiarity with UNIX-style programming tools (make, bash, etc.) is desirable.

Example Prerequisite Courses

At CCRMA, Music 320A&B and Music 256A generally provide adequate preparation in conjunction with a physics background up to and including dynamics (all about “\( f = ma \)“):

- Music 320AB or equivalent (prior exposure to complex numbers, sinusoids, elementary linear systems theory, digital filters, Laplace and \( z \) transform analysis);
- Music 256A or equivalent (prior experience with C++ programming for real-time audio applications);
- Physics 21 (mechanics), or equivalent experience with Newton’s law of motion, “\( f = ma \)”. Having taken Music 256A will support more advanced independent project work.

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1 [http://explorecourses.stanford.edu/search?view=catalog&filter-coursestatus-Active=on&page=0&catalog=&academicYear=&q=music+420a&collapse=](http://explorecourses.stanford.edu/search?view=catalog&filter-coursestatus-Active=on&page=0&catalog=&academicYear=&q=music+420a&collapse=)
3 [https://ccrma.stanford.edu/courses/320/](https://ccrma.stanford.edu/courses/320/)
4 [https://ccrma.stanford.edu/courses/256A/](https://ccrma.stanford.edu/courses/256A/)
Prerequisite Software

C++ and Matlab\(^5\) (or Octave\(^6\)) are required for many of the exercises and starter software.

2 Administrative Information

2.1 Announcements

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

[https://piazza.com/stanford/spring2017/music420a/home](https://piazza.com/stanford/spring2017/music420a/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.

2.2 Weekly Homework

There will typically be weekly to bi-weekly assignments consisting of reading, working theory problems, and carrying out lab exercises. The lab portions typically require programming in matlab and basic C++.

The theory and lab assignments are normally assigned together on Thursdays. The theory part is normally due the following Thursday at 4:30 pm in the 420A mailbox (located in the Knoll Ballroom with the other mailboxes). The lab part is due on Friday at midnight, the day after the theory problems are due.

For lab assignments, we will be using the Canvas\(^7\) website. To sign up, go to the Canvas website and find Music420A. 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 (§3 on page 5).
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 for sharing answers to posted questions with the whole class. To sign up, see the 420A Piazza site. 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 after class, or other times when necessary.

2.6 Computer Usage
Lab exercises will be computer based. All students may obtain a computer account at CCRMA in order to use the computer facilities. It is also possible to work entirely on your own computer, as long as you have the necessary software. However, note that some course materials are restricted to on-campus access, so you should have at least one Stanford computer account from which you access those.

Here is how to obtain a CCRMA computer account:

https://cm-knoll.stanford.edu/userssignup

Note: This link only works at CCRMA.

Once you have your account, please log in at CCRMA and take a look at the User’s guides tab in the left-frame menu of the main CCRMA website to learn more about computer usage and other facilities at CCRMA.

2.7 Units
You may sign up for 3 or 4 units. Three units involves only in-class time, assigned reading, any assigned videos, and homework/lab problems, and final exam. A fourth unit adds an independent project and report, which can be based on reading and/or lab work.

2.8 Final Project (Optional 4th Unit)
The purpose of the final project is to go beyond the content of the lectures and assigned reading in the direction most interesting to you. Your project can be on any topic related to lectures and assignments. A one-page project specification/proposal is due by the 4th class meeting, and the final written report is due by the end of finals week. You are also invited to present your project results during the last class. There are two primary project types:

- Outside reading and report

8https://www.piazza.com
9https://piazza.com/stanford/spring2017/music420a/home
10http://ccrma.stanford.edu/guides/
• Programming project and report

Your project can consist of any combination of the above components. A research-oriented project typically consists of the following main phases:

Phase I: Outside reading (explore the topic)
Phase II: Software project (implement your best ideas from Phase I)
Phase III: Write-up

It is normal to iterate the above phases to some extent, rather than to perform them entirely sequentially.

2.9 Required Software

Lab exercises in this course require basic C++ programming, on the level of the Synthesis Tool Kit (STK). Also, for sound analysis and display, proficiency with (and access to) Matlab or Octave is assumed.

2.10 Important Pointers

The course schedule and outline in on page lists all topics covered, lecture overheads, reading assignments, lecture videos, and hw/lab assignments.

2.11 Textbook

The text for this course is Physical Audio Signal Processing by JOS:

• Available for free online in HTML format.
• Printed hardcopies also available.
• Reading assignments will be specified in the course schedule and outline.

2.12 Prerequisite-Level Reading

This course assumes the student is familiar with elementary signal processing on the level of the following textbooks:

• Mathematics of the Discrete-Time Fourier Transform (DFT) — prerequisite material pertaining to the DFT (Music 320 text)

• Introduction to Digital Filters — prerequisite material in the area of digital filtering and linear systems theory (Music 320 text)

[16] https://ccrma.stanford.edu/~jos/mdft/
3 Schedule

Below is our current schedule, with pointers to all reading assignments, lecture overheads, and theory/lab exercises for the course.

[TBA]