Music 170: Musical Acoustics
Fall 2017

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December 4, 2017

Course Information

Teaching Assistants

- Kevin Haywood: khaywood@ucsd.edu
- Johannes Regnier: jregnier@ucsd.edu

Meeting Time and Place


<table>
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<tr>
<th>Time</th>
<th>Location</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>Lecture:</td>
<td>TuTh 3:30PM—4:50PM</td>
<td>CPMC 136</td>
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<tr>
<td>Office hours:</td>
<td>Tu 5:00PM—5:50PM</td>
<td>CPMC 145</td>
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<td></td>
<td>Th 5:00PM—5:50PM</td>
<td>CPMC 136</td>
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<td>By appointment</td>
<td>CPMC 233</td>
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<td>Final Exam:</td>
<td>Monday Dec. 11, 3PM—6PM</td>
<td>CPMC 136</td>
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Course Description

An introduction to the acoustics of music with some exposure to contemporary digital techniques for understanding and manipulating sound. Prerequisites: Music 1A, 2A, or 4. Offered Fall Quarter Only.

Prerequisites

Music 1A, 2A, or 4 or permission from instructor.
Grading

• 3 exams (25% each, top 2 of 3 (student MUST write all three): 50%
• 7 weekly assignments (5% each, top 6 of 7) 30%
• final paper/project 20%

Required Textbooks

• Music 170 on-line notes.

Reference

• A Digital Signal Processing Primer, Ken Steiglitz, Addison Wesley, 1996, 9780805316841

Paper/Project

There is a choice between a paper or a project.

• PAPER:
This is NOT a research paper in the traditional sense.
The paper should be an approximately 3 -5 page (double spaced) summary of 2 related academic journal articles on a particular acoustic musical instrument or phenomenon of the student’s choosing.
Proposal Requirement: state the chosen acoustic instrument/phenomenon AND include bibliographic entries for 4 journal articles (TAs will help you refine/reduce to 2). Include journal articles (in PDF) with proposal.
Grade will be based on:

1. process of selecting topic and 4 initial papers (proposal stage);
2. student’s ability to read, understand, and translate a technical/academic paper into his/her own words; conveying salient ideas even if omitting mathematical detail;
3. style, quality of writing, clarity, accuracy.

• PROJECT:
If you elect to do a project (strongly encouraged!), you will also be expected to briefly present/demo your project during the final exam time slot. You
must also submit an accompanying short paper (approx. 1-2 pages) documenting your project.

A suitable project would be to design and build your own acoustic musical instrument (or hybrid electro-acoustic), and “play” a short piece during the final presentation. Your instrument should be capable of producing different pitches and should demonstrate that you know about vibration and projection of sound.

Projects may be done in pairs: pairing up is encouraged, though you should be clear in your proposal (see below) with whom you will be working and what each student will contribute.

Proposal Requirement: Each student must submit 2 proposed topics, each with a brief (1-2 paragraph) description (and possibly a drawing if appropriate), ranked in order of preference (the second is an alternative to the first, in case the first is out of scope or otherwise not appropriate). If you will work in a pair, the proposal should state very clearly with whom you will be working, and the role of each contributor. Each student submits a proposal. Due Tuesday, Nov. 7, 2017.

Important Dates


Schedule and Online Lecture Notes (subject to change)

- Week 0:
  - Introduction to Music 170: Musical Acoustics
  - Lecture 0: Sound
- Week 1:
  - Lecture 1a: Quantifying Sound
    * waves,
    * logarithms in sound/music,
    * decibels,
- sound power/intensity/pressure levels

- Lecture 1b: Sinusoids
  - Simple harmonic motion,
  - sine and cosine,
  - period, frequency, and phase,
  - sinusoidal and circular motion,
  - summing sinusoids of same and different frequencies,
  - amplitude envelopes.
  - Pd patch from class: sinsum09-29-16.pd

- Week 2:
  - Lecture 2a: Spectrum
    - summing sinusoids
    - periodic waveforms and harmonicity
    - spectral analysis
    - pitch and frequency
    - beat notes
    - delay and interference
    - Pd patch from class: harmonicTriangle10-04-16.pd
  - Lecture 2b: Spectrum (cont.)
    - Pd patch from class: beatNote10-06-16.pd, sumDelay10-06-16.pd

- Week 3:
  - Lecture 3a: Digital Audio
    - analog vs. digital and continuous vs. discrete time signals
    - analog to digital conversion
    - Practical review of A2 in class.
    - sampling and Nyquist theorem
  - Lecture 3b:
    - aliasing / foldover
    - quantization, bit depth, signal to quantization noise ratio (SQNR)

- Week 4:
  - Lecture 4a: Exam 1
  - Lecture 4b: Waves
    - principle of superposition
* constructive and destructive interference
* boundary reflections
* standing waves (node and antinode patterns)
* string and tube harmonics

• Week 5:
  – Lecture 5a: **Strings**
    * plucked string
    * simple Karplus-Strong plucked string (using Pd’s `vdelay`)
    * `karplusstrong.pd`
  – Lecture 5b: **Strings** (cont.)
    * bowed string
    * resonance
    * instrument bodies

• Week 6:
  – Lecture 6a: **Winds**
    * acoustic tubes
    * pressure-controlled valves
    * mouthpiece, valves and slides
    * tone holes
  – Lecture 6b: **Winds** (cont.)
    * `flute.pd`

• Week 7:
  – Lecture 7a: Exam 2
  – Lecture 7b: **Voice**
    * vocal folds, pressure controlled valve
    * vocal tract, resonance and formants
    * formant tuning (sopranos, Tuvan throat singing)

• Week 8:
  – Lecture 8a: **Voice** (cont.)
  – Lecture 8b: Thanksgiving—no class

• Week 9:
- Lecture 9a: Ear
  * human auditory system
  * spectral analysis and the basilar membrane
  * critical bands
  * loudness and frequency, equal loudness curves
  * auditory localization
- Lecture 9b: Guest Lecture: Nils Peters — Room Acoustics
  * Lecture Slides
  * Hamilton Mausoleum (with links to impulse responses)

- Week 10:
  - Lecture 10a: Space
    * auditory localization
    * interaural time and intensity difference
    * cues for judging distance
    * reverberation
  - Lecture 10b: Exam 3

**Assignments**

Assignments will be available [online](#) every Thursday, and due **Friday the following week**. Late assignments will be accepted up to the following Tuesday (before class) but with a penalty of **10% a day**. This ensures that graded assignments and/or solutions can be returned to students in a timely manner.

- **Week 0:**
  - [Assignment 1](#) (due Friday, Oct. 6)
  - Download Pd and the Music 170 patch library provided by Miller Puckette from [here](#)
  - Follow instructions for putting library in Pd’s search path.
- **Week 1:**
  - [Assignment 2](#) (due Friday, Oct. 13)
  - Solutions 2
- **Week 2:**
  - [Assignment 3](#) (due Friday, Oct. 20)
• **Week 3:**
  - [Assignment 4](#) (due Friday, Oct. 27, 2017)
  - [Solutions 4](#)

• **Week 4:**
  - Exam 1 (Tuesday, Oct. 24)
  - [Assignment 5](#) (due Friday, Nov. 3, 2017)
  - [karplusstrong.pd](#)
  - [Solutions 5](#)

• **Week 5:**
  - Note: Assignment 6 to be available Tuesday Nov. 7

• **Week 6:**
  - Project proposals due (Tuesday, Nov. 7, 2017):
  - [Assignment 6](#) (due Tuesday, Nov. 14)

• **Week 7:**
  - Exam 2 (Tuesday, Nov. 14)

• **Week 8:**
  - Thanksgiving (Thursday, Nov. 23)

• **Week 9:**
  - [Assignment 7](#) (due Friday, Dec. 8, 2017)
  - [flute.pd](#)

• **Week 10:**
  - Exam 3 (Thursday, Dec. 7)