CMPT 468: Computer Music Theory and Sound Synthesis

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School of Computing Science, Simon Fraser University

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Course Information

Meeting Time and Place

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Section</th>
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</thead>
<tbody>
<tr>
<td>Lecture:</td>
<td>Wed 1:30PM - 2:20PM</td>
<td>SUR5100</td>
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<tr>
<td>Midterm Exam</td>
<td>Frid 12:30PM - 2:20PM</td>
<td>SUR5100</td>
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<td>Final Exam:</td>
<td>October 25</td>
<td>SUR5100</td>
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<tr>
<td>Office hours:</td>
<td>Dec. 10, 3:30PM - 6:30PM</td>
<td>TBA</td>
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Course Description

This course introduces the fundamentals of digital audio, computer music, basic sound synthesis algorithms and digital audio effects and processing. Understanding of theoretical concepts will be consolidated through practical programming assignments in Matlab (3 credits).

Prerequisites

MATH 152 and one of CMPT 125, 126 or 128 (or permission of instructor).

Topics

- Concepts of Sound and Digital Audio
- Sampling and Quantization
- Sound Synthesis
- Spectrum Analysis
- Frequency and Amplitude Modulation
- Digital Filters
- Convolution
- Sound Processing and Effects
- Physical Modelling (a brief introduction time permitting)

**Grading**
- Midterm 20%
- Assignments 30%
- Project 15%
- Final Exam 30%
- Participation 5%

**Required Text**
- CMPT 468 on-line notes

**Strongly Recommended Text (Formerly Required)**

**Reference**
- A Digital Signal Processing Primer, Ken Steiglitz, Addison Wesley, 1996, 9780805316841
Schedule and Online Lecture Notes

• Week 0:
  – Wednesday:
    * Course Overview
    * Introduction to Computer Music with Audio and Music Demonstrations
  – Friday:
    * Sound and Sinusoids I
    * Fundamentals of Digital Audio
    * Matlab Tutorial 1

• Week 1:
  – Wednesday:
    * Fundamentals of Digital Audio (start Aliasing)
    * Matlab Tutorial 2
  – Friday:
    * Sinusoids II and Phasors

• Week 2:
  – Wednesday:
    * Sinusoids II and Phasors (start Complex Sinusoids)
    * Additive Synthesis I
  – Friday:
    * Discrete Fourier Transform
    * script done in class: classSept20.m

• Week 3:
  – Wednesday:
    * Matlab tutorial 3: Analysis with the Fast Fourier Transform (FFT)
  – Friday:
    * Continue with Matlab tutorial 3: Analysis with the Fast Fourier Transform (FFT)
    * classSept25.m
    * classSept27.m
    * In class example analysis of BbClar.ff.D3.wav

• Week 4:
– Wednesday:
  * Amplitude Modulation

– Friday:
  * Amplitude Modulation (AM) (continued)
  * AM examples
  * Frequency Modulation

• Week 5:
  – Wednesday:
    * Frequency Modulation Synthesis of Musical Instruments

  – Friday:
    * Frequency Modulation Synthesis of Musical Instruments
    * fmbell.m
    * fmclar.m, woodenv.m
    * fmbrass.m, brassenv.m

• Week 6:
  – Wednesday:
    * Waveshaping Synthesis

  – Friday:
    * Waveshaping Synthesis

• Week 7:
  – Wednesday:
    * Waveshaping Synthesis

  – Friday:
    * Midterm
    * Midterm solutions: PDF

• Week 8:
  – Wednesday:
    * Subtractive Synthesis

  – Friday:
    * Subtractive Synthesis

• Week 9:
- Wednesday:
  * Subtractive Synthesis

- Friday:
  * Delay Effects

**Week 10:**
- Wednesday:
  * Delay Effects
- Friday:
  * Localization

**Week 11**: Psychoacoustics
- Wednesday:
  * Localization
  * Demos with video: [demo1], [demo2]
  * Matlab script for stereo imagery: stereoLocal.m
  * drums.wav
- Friday:
  * Fund. Acoustics (decibels, start p. 8)
  * Psychoacoustics

**Week 12:**
- Wednesday:
  * Psychoacoustics
- Friday:
  * Student Project Presentations

**Assignments**

**Week 0:**
- Read Chapter 1 of *Computer Music* (suggested).
- Go through [Matlab Tutorial 1](#) and [Matlab Tutorial 2](#)

**Week 1:**
- Read Chapter 2 of *Computer Music* (suggested).
• Assignment 1 (PDF or PS).

• Week 2:
  – Read Chapter 3 of Computer Music (suggested).
  – Assignment 2 (PDF or PS).
  – Solutions: adsr.m, tonegen.m

• Week 3:
  – Read Chapter 4 of Computer Music (suggested).
  – Go through Matlab Tutorial 3

• Week 4:
  – Read Chapter 5 (Synthesis Using Distortion Techniques) of Computer Music.
  – Assignment 3 (PDF or PS)
  – BbClar_fl_D3.wav
  – Some interesting student results for clarinet synthesis:
    * Andrew: acoccimi.wav, acoccimi.m
    * Ryan: rdone.wav, rdone.m
    * Edward: eddiel.wav, eddiel.m
    * Matthew: msawtzk.wav, msawtzk.m
  – Solutions for written part: (PDF or PS)

• Week 5:
  – Continue reading Chapter 5 (Synthesis Using Distortion Techniques) of Computer Music.

• Week 6:
  – Assignment 4 (PDF or PS)

• Week 7:
  – Midterm
  – Midterm solutions: PDF

• Week 8:
  – Assignment 5 (PDF or PS)

• Week 9:
- Assignment 6 ([PDF] or [PS])
- Vocal source (source.wav)
- Impulse response (ir.wav)
- Matlab code for flanger (flange.m) flangeCircDL.m (circular delay line implementation)

- Week 10:
  - work on projects

- Week 11:
  - work on projects

- Week 12:
  - work on projects
  - Presentations Nov. 29

**Projects**

- Please find the final project HTML template [here](#)

- Current Projects

  - Andrew Coccimiglio (acoccimi)
  - Adam Dekleer (adekleer)
  - Aman Singh Dilpreet (dsa52)
  - Duy Vo (dvo)
  - Edward Lee (eddiel)
  - Emilio Miralles (emiralle)
  - Huiqing Yang (huiqingy)
  - Jeffery Almond (jca37)
  - Jialuo Gu (jga45)
  - Jiming Ma (jma65)
  - Josh Lim (jmllim)
  - Junhao Lu (junhaol)
  - Mio Kaneda (mkaneda)
  - Matthew Sawatzky (msawatzk)
– Onur Demiralay (odemiral)
– Pawandeep Kaur (pka26)
– Ryan Done (rdone)
– Sohrab Salehi (ssalehi)
– Scott Williams (swa53)
– Yiqing Zhou (yza168)

• Past Projects
  – cha42
  – eth3
  – gmh7
  – hys1
  – jbl4
  – mwk2
  – nnf
  – rj13
  – rodricky
  – synyus
  – tga18
  – thk3
  – vlc1
  – wenday
  – wsh1
  – yhw3