

# ATEC-321: Synthesis I

Time: Tuesday 5:30pm - 8:00pm  
Location: Katzen 135

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Textbook: *The Theory and Technique of Electronic Music* by Miller Puckette. Available online at <http://crca.ucsd.edu/~msp/techniques.htm>

Software: *Pure Data*. Pd is open source, free, and multi-platform for Linux, Mac OSX, and Windows. Available online at <http://www.crca.ucsd.edu/~msp/software.html>

Additional Resources: <http://en.flossmanuals.net/puredata> : an online guide to Pd fundamentals; [http://aspress.co.uk/ds/sample\\_chapters.php](http://aspress.co.uk/ds/sample_chapters.php) : a thorough introduction to Pd from Any Farnell's *Designing Sound* (see *Pd intro*), and several sound design examples (see *Code Examples*).

## Summary

This course introduces audio synthesis using the Pure Data (Pd) programming environment with a focus on understanding exactly *why* the sounds we'll be making behave the way they do. We will work through many standard synthesis techniques, learning reliable strategies for managing control information and sequencing as we go. There are several assignments to complete. It is essential that you keep up with these tasks—if you're stuck on any aspect of an assignment, don't hesitate! See me for help as soon as possible.

Your final project will involve the creation of a short piece in Pd that incorporates at least three of the synthesis techniques we cover.

## Quizzes

There will be two in-class quizzes, to take place during our regular lab time. These will be designed to be completed within about half that amount of time, and will only require concepts and knowledge that have been covered in the course so far. The quizzes will take place on the following dates:

- 09/21/10
- 10/19/10

## Assignments

There are ten assignments spread throughout the course. Toward the beginning of the course, there is one assignment per week. The pace relaxes to once every two weeks as the assignments become more involved. This is also intended to give you more time to work on your final projects. Presentations of your individual projects will be given during the final exam time.

## Midterm & Final exam

- No midterm
- Final exam: 12/07/10
- NOTE: you must be present for the final exam

## Grading breakdown

- Attendance: 10%
- In-class quizzes: 15%
- Assignments: 50%
- Final project: 25%

## Policies

- Make-up exams and quizzes will only be considered in extreme circumstances (medical emergency, death in the immediate family, etc.)
- Assignments are due by the start of class one week after they are assigned. Late assignments will be accepted with a penalty of one letter grade reduction per day.

# Academic Integrity/Plagiarism

The Academic Integrity Code for the American University describes standards for academic conduct, rights and responsibilities of members of the academic community, and procedures for handling allegations of academic dishonesty. Academic dishonesty as defined by the Code includes, but is not limited to: plagiarism, inappropriate collaboration, dishonesty in examinations (in-class or take-home), dishonesty in papers, work done for one course and submitted to another, deliberate falsification of data, interference with other students' work, and copyright violations (including both document and software copyrights). Copies of the Academic Integrity Code are available from the Office of the University Registrar.

Plagiarism is defined as taking the language, ideas, or thoughts of another, and representing them as your own. If you use someone's ideas, cite them; if you use someone's words, clearly mark them as a quotation. Plagiarism includes using another's computer programs or pieces of a program. Consult one of the many "writer's guides" that are available in the library and bookstores for citation practices. All instances of plagiarism will be reported to the Dean of the College of Arts and Sciences for appropriate action.

## Overview of Topics

- Introduction to Pd
  - Popular real-time synthesis environments
  - The graphical programming paradigm
  - Mastering control processes
  - Reading: Puckette Chapter 1/Section 1.8, Farnell Chapter 2, Chapter 3
  - Documentation patches: 2.control.examples/00-24
- Making & mixing sinusoids
  - Definition of a sinusoid
  - Phase cancellation
  - Frequency beating
  - Amplitude enveloping
  - Generating complex waveforms by combining sinusoids
  - Reading: Puckette Chapter 1
  - Documentation patches: 3.audio.examples/A01-A10
  - Farnell examples: ALARMS, BELL, DTMF, PHONETONES
  - Objects to be familiar with: osc~, phasor~, line~, cos~, +~, \*~, dac~
- Wavetable synthesis
  - Generating tones from hand-drawn waveforms
  - Spectral effects of waveform edges
  - Interpolation
  - Manipulating recorded samples
  - Transposition formulas for looping wavetables
  - Reading: Puckette Chapter 2
  - Documentation patches: 3.audio.examples/B01-B16

- Objects to be familiar with: mtof, ftof, rmstodb, dbtorms, arrays, tabread, tabwrite, tabread~, tabwrite~, soundfiler, tabread4~, tabplay~, tabosc4~
- Control information, sequencing and scheduling
  - Nyquist and foldover
  - Control vs. audio
  - Block processing
  - Using audio streams as control streams
  - Sensing the physical world via audio and video input
  - Interfacing with MIDI devices and other control input sources
  - Reading: Puckette Chapter 3; Farnell Chapter 3 (especially 3.7::Common idioms)
  - Documentation patches: 3.audio.examples/C01-C10
  - Objects to be familiar with: arrays, tabread, list, list length, list split, select, pack
- Automation and voice management
  - Hiding discontinuities
  - Subpatches vs. abstractions
  - Polyphony
  - Voice banks
  - Internal bussing
  - Instrument design
  - Granular synthesis
  - Reading: Puckette Chapter 4
  - Documentation patches: 3.audio.examples/D01-D14
  - Objects to be familiar with: poly
- Amplitude and frequency modulation
  - Multiplying audio streams
  - Waveshaping
  - Ring Modulation
  - Reading: Puckette Chapter 5, Farnell Chapter 6
  - Documentation patches: 3.audio.examples/E01-E10
- Controlling spectral properties
  - Timbre
  - Formants
  - Reading: Puckette Chapter 6
  - Documentation patches: 3.audio.examples/F01-F14
- Delays
  - Doppler pitch shifting
  - Introduction to complex numbers
  - Delays in comb filtering
  - Reading: Chapter 7
  - Documentation patches: 3.audio.examples/G01-G09
  - Objects to be familiar with: delwrite~, delread~, vd~