CS 245: *Introduction to Interactive Sound Synthesis*

Spring 2018

Prerequisites

MAT 100 or MAT 140, CS 170, CS 180, PHY 200

General Information

Lecture:	WF 9:00–10:20am
Class room:	Gibran
Lecturer:	Jason Hanson, Ph.D.
Office Phone Number:	425–895–4434
Email Address:	`jhanson@digipen.edu`
Homepages:	`http://www.digipen.edu/~jhanson`
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Office Hours:	TuTh 9:00–11:30am, W 10:30–11:30am, or by appointment

Course Description [Taken from the course catalog]

This course explores dynamic sound synthesis, 3D-directional auditory effects, and sonic ambience to real-time simulation and video games. The subjects include mixing audio and modulating dry recorded sounds using wave table synthesis. Students will learn how to create collision sounds using additive synthesis, wind effects using subtractive synthesis, natural sounds using granular synthesis and physical modeling, ambiences using layering and spectral filtering, 3D spatialized surround sound panning, inter–aural time difference, inter–aural intensity difference, and Head Related Transforms (HRTFS). Students will also study algorithms and techniques for real–time multi–threaded programming and synthesized sound integration for the game engine.

Course Rational

Sound is an integral part of computer gaming, and a programmer must be versed in both off–line and real–time sound manipulation. Games make use of preprocessed sound recordings for sound effects, background music, and voiceovers. However, these sounds must be mixed on the fly in response to asynchonous events within the game. Although this course covers many general topics within computer sound generation, the essential ingredients needed by the game programmer are discussed.

Course Goals and Objectives

The student will be able to (1) read and write audio files in uncompressed WAVE file format, (2) manipulate raw audio data: normalize and resample, (3) generate and interpret MIDI messages (4) synthesize sound using additive and frequency modulation, and (5) be able to program using low–level and mid–level audio libraries.

Required text

Real Sound Synthesis for Interactive Applications, by Perry R. Cook; published by A K Peters, 2002; ISBN: 156881–168–3. The textbook is available online via *ebrary,* which can be accessed from the DigiPen library webpage.

In–class Lab Work

Roughly once a week, some class time will be set aside for a lab session. Lab work will consist of written problems for the students to solve during the session, and will involve the material discussed during the lectures. The lab assignments will be collected and graded.

Homework

Several programming assignments will be given over the course of the semester. These should be turned in by midnight of the day that they are due; late assignments are accepted, but with a ten percent penalty for every week after the due date. All code submitted should adhere to reasonable coding standards. In particular, all files should have a header that contains the name of the student, the course number, the assignment number, and the due date of the assignment. Code should be written in *standard* C++ (C++11 may be used) that compiles without warnings using the MSVC 2015 and the GNU (whichever version is installed on the DigiPen machines) compilers.

Grading

The final numerical average for the class will be a weighted average of the programming assignments, lab assignments, midterm exam, and final exam; these items are weighted as follows.

Lab: 25% *Programming:* 25% *Midterm:* 25% *Final:* 25%

Individual lab assignments and programming projects will be considered to be of equal weight in computing their respective averages. The final letter grade for the class will be determined from the above numerical average according to the *Standards of Progress* section of the DigiPen course catalog.

Course Organization

The rough plan for the semester is as follows; however, it is entirely possible that temporal deviations will occur.

Week 1: Digital sound representation, bit resolution, sampling rate. WAVE files.

Week 2: Nyquist limit, signal to noise ratio, DC offset. Linear resampling.

Week 3: MIDI: notes and pitches, messages, programming.

Week 4: Lowlevel audio programming.

Week 5: Wavetable synthesis.

Week 6: Exponential and ADSR envelopes. Looping.

Week 7: Midterm exam.

Week 8: Discretized harmonic functions. Harmonic series. Additive synthesis.

Week 9: Fourier sine series.

Week 10: Sound modeling: partials and envelopes.

Week 11: Midlevel audio programming.

Week 12: Feedback. Simple FM synthesis model.

Week 13: Complex FM synthesis.

Week 14: Implementation of FM synthesis.

Academic Honesty

Students are welcome to work together, ask the instructor for help, and consult alternate text books; however, all work submitted must the individual students own work. Any student found plagiarizing the work of others, or cheating on exams, will be given the grade of F (0%) for the class and will be subject to disciplinary action.

Disabled Student Services

If students have disabilities and will need formal accommodations in order to fully participate or effectively demonstrate learning in this class, they should contact the Disability Support Services Office at (425)629-5015 or `dss@digipen.edu`. The DSS Office welcomes the opportunity to meet with students to discuss how the accommodations will be implemented. Also, if you may need assistance in the event of an evacuation, please let the instructor know.