

MUS 470 Independent Study Syllabus

Semester: Spring 2020
Course title: Audio Design Project III
Instructor: Professor Matt Klassen
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COURSE DESCRIPTION:

This course explores advanced topics in audio design and implementation. Lectures address issues that come up in audio programming at several levels: low level algorithms, mid-level components such as plugins and graphs, and high-level programming such as user interfaces and interactive music. Lecture topics include: audio engine design and implementation, spatial audio, and digital signal processing.

PREREQUISITES and COREQUISITES:

Prerequisites: CS 246, MAT 320, MUS 371, MUS 371L

Corequisites: MUS 470L

COURSE GOALS AND OBJECTIVES:

- 1) Students learn the basic definitions and low-level algorithms in spatial audio
- 2) Students will become familiar with mid-level components and plugins
- 3) Students gain experience with user interface design for audio applications
- 4) Students will implement an application related to audio engine design, spatial audio, or digital signal processing

EXAMS:

There will be no exams, but progress on project work, assigned reading, and milestones, will be checked on a weekly basis.

DISABILITY SUPPORT 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 students need assistance in the event of an evacuation, they should let the instructor know.

GRADING:

Homework 50%
Milestones 50%

Grades will be determined based on total course percentage. Percentage scores will determine letter grades according to the scale: (in the worst case)

A : 93 – 100, A- : 90 – 92.9, B+ : 87 – 89.9, B : 83 – 86.9, B- : 80 – 82.9, C+ : 77 – 79.9, C : 73 – 76.9, C- : 70 – 72.9, D : 60 – 69.9, F : < 60

ACADEMIC INTEGRITY:

Academic dishonesty in any form will not be tolerated in this course. Cheating, copying, plagiarizing, or any other form of academic dishonesty (including doing someone else's individual assignments) will result in, at the extreme minimum, a zero on the assignment in question, and could result in a failing grade in the course or even expulsion from DigiPen.

All students are asked to help in promoting a culture of academic integrity by discouraging cheating in all forms.

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\[at\]digipen\[dot\]edu](mailto: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.

GUEST SPEAKERS and TOPICS:

Guest speakers may be invited to speak on various topics relating to audio programming for games, audio for virtual and augmented reality, and spatial audio. Such guest speakers could come from DigiPen or from the audio community and industry. Topics in the course will change from year to year, and will be partially based on the students' interests, as well as research interests of the instructor. Students are expected to attend these lectures, and be prepared to ask questions and possibly incorporate this material into their work.

RELIGIOUS ACCOMMODATION:

DigiPen Institute of Technology provides reasonable accommodations to students who may be absent from activities or incur significant hardship due to religious holidays or observances. These holidays or observances must be part of a religious denomination, church, or religious organization, and the course instructor must be notified in writing during the first two weeks of the course. The institute's policy for grievances is published in the course catalog.

MATERIALS:

Reference Materials: (not required)

Head-Related Transfer Function and Virtual Auditory Display, by Bosun Xie.

A User's Guide to Spherical Harmonics, by Martin Mohlenkamp.

Numerical Sound Synthesis, by Stephan Bilbao.

Physical Audio Signal Processing, by Julius Smith.

Immersive Sound: The Art and Science of Binaural and Multi-Channel Audio, edited by Agnieszka Roginska and Paul Geluso.

Spatial Hearing, by Jens Blauert.

Virtual Auditory Space: Generation and Applications, by Simon Carlile.

Immersive Audio Signal Processing, Sunil Bharitkar and Chris Kyriaskakis

TENTATIVE WEEKLY TOPICS:

Week	Dates	Topics
1	Jan 6 - 10	Audio components and audio engine design and implementation
2	Jan 13 - 17	Spatial sound and human auditory system. Localization cues: interaural time difference (ITD), interaural level difference (ILD), spectral cues
3	Jan 20 - 24	Definition of HRTF, time and frequency domain versions. Localization one or more sound sources, stereophonic law of sine, precedence effects
4	Jan 27 - 31	User Interface Elements for audio design (guest lecture) Spherical harmonics and first-order ambisonics: definitions
5	Feb 3 - 7	Binaural recording, synthesis, and virtual auditory display, introduction to HRTF measurements.
6	Feb 10 - 14	HRTF equalization, signal generation and processing, quality and errors, far-field HRTF databases
7	Feb 17 - 21	Near-field HRTF measurements, time and frequency domain features of HRTF, minimum phase
8	Feb 24 - 28	Higher order ambisonics, sound field rotations (guest lecture)
9	Mar 2 - 6	Sound synthesis and physical modeling, numerical techniques
10	Mar 9 - 13	Spherical head model for HRTF: far-field calculations, interaural localization cues (guest lecture)
11	Mar 23 - 27	Filter models and approximation, FIR vs IIR, frequency warping
12	Mar 30 - Apr 3	Spatial interpolation for HRTF, principle component analysis (PCA)
13	Apr 6 - 10	Spatial basis functions, sound-field signal mixing
14	Apr 13 - 17	Binaural reproduction through headphones and loudspeakers, crosstalk cancellation
15	Apr 20 - 24	Final Exams