## Date

Fall 2016

## Contact

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office hours: Monday 4:30–5:30pm and by appointment

## 1. Credits and Hours

3 credit hours

Lecture: Monday and Wednesday, 3:05–4:25pm in Couch 102

## 2. Course Description and Objectives

Research in music, as well as music production and composition increasingly relies on sophisticated digital signal processing techniques. This course will review fundamental elements of digital audio signal processing, such as sinusoids, spectra, digital filters, and Fourier analysis and their application to the fundamental music analysis problems of modeling and synthesis. We will discuss audio effects and techniques such as sinusoidal modeling, phase vocoder, reverb, chorus / flanger, pitch-shifting, time compression, etc. The class will include practical lab sessions as well as presentations of state of the art papers and student’s projects.

**Learning Outcomes**

Upon completion of the course, students will demonstrate:

1. the ability to comprehend typical representations of digital systems such as block diagrams and difference equations,
2. an understanding of typical transforms in DSP such as the Fourier transform and the Z-transform,
3. an understanding of typical signal processing approaches to audio and music signals,
4. the ability to use this understanding to design audio processing systems such as audio effects, and
5. the ability to implement such designs in a programming language such as Matlab.

## 3. Prerequisites

MUSI 2526 Introduction to Audio Technology II as prior coursework in signals and systems is expected. Programming experience and familiarity with Matlab will be helpful.

## 4. Procedures

Class will meet two times weekly, see Section 1. Attendance is expected but not factored into your grade.

## 5. Course Materials

### 5.1. Recommended Reading

• Cook, Perry: “Real sound synthesis for interactive applications,” CRC Press, 2002.

• Zolzer, Udo: “Digital Audio Signal Processing,” Wiley, 2008.

• Zolzer, Udo:”DAFX: Digital Audio Effects,” Wiley, 2011.

### 5.2. Software

The assignments and project work will be done in Matlab. This will include implementation of functions for signal synthesis, system analysis (transfer functions), the Fourier transform, the Z-transform, and signal processing (audio effects). Please note the following license information: [www.matlab.gatech.edu](http://www.matlab.gatech.edu). Other tools and programming languages can be used if approved by the instructor.

## 6. Undergraduate vs. Graduate Students

Both undergraduate and graduate students will be attending this class. In addition to having the same workload as undergraduate students, graduate students will:

• Work on a term project, and

• Receive an additional question on each assignment.

The term project will be based on one or more of the key concepts central to the class. To this end, the materials required for the undergraduates will be substantively augmented through additional assigned readings, journal articles, and references to current trends in the discipline. The first phase of the project will be a prospectus — to be approved by the instructor and briefly presented to the class. An online journal/history (or other appropriate documentation) of the project will be maintained weekly, and the final phase will culminate with the completed project, a written report, and a formal presentation.

The additional questions for each assignment will require the integration of concepts, findings, and formulae from seminal articles, critical mongraphs, and selected conference proceedings. The questions themsleves will be reflective of the assignment topics listed under Method of Evaluation, but will require a depth, breadth, and demonstration of understanding commensurate with the expectations of graduate level work. Additionally, the two Audio FX assignments will require original creative work and practical application in a recording studio setting.

## 7. Method of Evaluation

The final project is a team effort. Group size will be about four students. The grades for paper, final presentation and project will all be per group. The assignments will be done and graded individually. The overall grade consists of:

• Assignments: 30%

* Assignment 1 — Signals and Sampling
* Assignment 2 — Fourier Analysis
* Assignment 3 — Filters 1
* Assignment 4 — Z-Transform and Filters 2
* Assignment 5 — Audio FX 1
* Assignment 6 — Audio FX 2

• Final Project: 10%

• Quizzes and Exams: 40%

• Presentations: 20%

All assignments, papers, presentations and tests will be graded by points. The final grade for the course will be determined by dividing the total points earned by the number of points possible for each of the categories listed above. These numbers will be converted into a grade according to the following scale:

• *A*=100−90%

• *B*=89−80%

• *C*=79−70%

• *D*=69−60%

• *F*=59% and below.

The project grades are **per group**. Students are encouraged to support each other with both the assignments and project work, but each submission has to be clearly executed by the individual/group being graded. More specifically, two or more individuals/groups handing in the same code/answers will be reported for academic misconduct.

## 8. Grading Policies

Homework assignments and the final project paper are due **ON THE DUE DATE**. The due date will be announced per assignment, but will usually be the following Monday on 3:05pm. A penalty of **ten points per day** will be applied to all late assignments and late project papers. Documented illnesses and family emergencies are excepted, of course. Quizzes and exams cannot be made up unless you have a valid, documented excuse.

## 9. Course Outline

• Week 1: Introduction, course overview

• Week 2: Signals, Sampling, Quantization

• Week 3: Dither and Noise-Shaping

• Week 4: Fourier Analysis (continuous)

• Week 5: Fourier Analysis (discrete) and Processing

• Week 6: Linear Systems, Digital Filters (FIR, IIR)

• Week 7: Z-Transform

• Week 8: Audio Effects — Delay and Reverb

• Week 9: Modulated Audio Effects

• Week 10: Sinusoidal Modeling

• Week 11: Audio Effects — Spectral Processing (Fast Convolution)

• Week 12: Audio Effects — Spectral Processing (Phase Vocoder)

• Week 13: Audio Effects — Time-Segment Processing

• Week 14: Project Work

• Week 15: Presentations

• Week 16: Presentations

• Week 17: Final Exam

## 10. Academic Integrity

Students must do their own work on assignments, projects, and tests unless collaboration is previously specified and approved by the instructor. Students caught cheating will receive zero credit for that assignment/quiz/test and may be subject to further sanctions through the Office of Student Integrity. Students are expected to abide by the Georgia Tech Honor Code and avoid any instances of academic misconduct, including but not limited to:

• Possessing, using, or exchanging improperly acquired written or oral information in the preparation of a paper or for an exam.

• Substitution of material that is wholly or substantially identical to that created or published by another individual or individuals.

• False claims of performance or work that has been submitted by the student.

Please refer to the published Georgia Institute of Technology Academic Honor Code for further information: [www.deanofstudents.gatech.edu/integrity/policies/honor\_code.html](http://www.deanofstudents.gatech.edu/integrity/policies/honor_code.html).

## 11. Statement regarding Students with Disabilities

In accordance with the Americans with Disabilities Act, students with bona fide disabilities will be afforded reasonable accommodation. The ADAPTS Office will certify a disability and advise faculty members of reasonable accommodations. The web site for a student requesting accommodation is:

[www.adapts.gatech.edu/faculty\_guide/sturespon.htm](http://www.adapts.gatech.edu/faculty_guide/sturespon.htm).