

# Music and Engineering

## Homework 2

Prof. Hoerning

February 5th, 2019

**Due: February 26th**

You must use the prototype function declarations and example script distributed via email. This will facilitate smooth evaluation of your work. If the code does not execute, the assignment will be given an automatic F.

All plots and source code should be printed and handed in. Every plot must include an appropriate title, x label, y label, and z label when appropriate. Additional text should be added to the plot when requested. Make sure the font size is appropriate and legible. If you don't know how to do this, please ask in class or email me.

Explanatory text is expected. When you are asked to Discuss something, please use the amount of text necessary to answer the question to the best of your ability. Please try to use this to explain the rationale behind your calculations.

In addition to a printed paper summary of your results (including plots, source code and essay responses) you must publish to your github account and email a link to me at *tim@musicandengineering.com*. I will clone from github to grade your assignment.

This is not a programming course. However, you will be expected to follow normal guidelines for structured programming (tab levels, copious amounts of explicit comments, etc).

You are expected to do your own work. You may discuss the assignment with other students. Helping and teamwork is encouraged. However, I do not want to see two copies of the exact same source code handed in twice. If two separate copies of the same assignment are handed by two different people, both will fail the assignment.

Homework should be handed in on the due date. If not, your maximum grade will be reduced by 10 percent for each day after the due date.

**Goal:** Simulate 4 different types of synthesized waveforms using the following methods: additive, subtractive, frequency modulation and wave shaping. Use the outline code provided in class.

First use the simple version of the script (found at the link below), then use the more complicated real time implementation. Your synthesis should work with both. Test the real-time version with the scales and chorst from HW1. Getting this working will make the 3rd assignment much easier.

[https://github.com/ece413musciandengineering/ECE413HW2\\_simple.git](https://github.com/ece413musciandengineering/ECE413HW2_simple.git)

1. Additive - Create an additive synthesis based sound model. It may be one of the following
  - (a) Bell from Figure 4.28 of Jerse
  - (b) Drum from Figure 4.27 of Jerse
  - (c) Anything you can find a recipe for online (must provide references and note any changes you made)
2. Subtractive - Create an Subtractive synthesis based sound model. It may be one of the following
  - (a) A square wave sound with a filter that closes (moves the resonant frequency from high to low) quickly with each note and no amplitude modification
  - (b) A sawtooth wave sound with a filter that opens slowly (moves from low to high) with an envelope modifier that makes the signal fade in.
  - (c) Anything you can find a recipe for online (must provide references and note any changes you made)
3. Frequency Modulation - Create an frequency modulation synthesis based sound model (or multiple modes). It may from the following
  - (a) One of the basic Chowning instruments (bell, brass, etc) from Figure 5.9 of Jerse
  - (b) Any of the other more complicated instruments in Figures 5.10 – 5.16
  - (c) Anything you can find a recipe for online (must provide references and note any changes you made)
4. Wave Shaping - Create an wave shaping synthesis based sound model. It may be one of the following
  - (a) Clarinet as shown in Figure 5.28 of Jerse
  - (b) Drum as shown in Figure 5.31 of Jerse
  - (c) Anything you can find a recipe for online (must provide references and note any changes you made)
5. Chords – Compare the same chords from HW1 using each of the four synthesized instruments.
  - (a) Create the major chord from the just tempered scale
  - (b) Create the major chord from the equal tempered scale
  - (c) Play a short sample of each chord. (2-3 seconds)

- (d) Create the minor chord from the just tempered scale
  - (e) Create the minor chord from the just tempered scale
  - (f) Play a short sample of each chord. (2-3 seconds)
6. Discussion - Reconsider the questions from the previous homework
- (a) Can you hear the difference between the just tempered Major chord and the equal tempered Major chord?
  - (b) Which one sounds better? - Why (explain)
  - (c) Can you hear the difference between the just tempered Minor chord and the equal tempered Minor chord?
  - (d) Which one sounds better? - Why (explain)

Some Ideas for extra credit:

- Create additional instruments of any type
- Write functions that create scales (or other riffs) and play the passages