

**Homework 9, HONS 280 (Physics of Sound and Music)**  
**Spring 2020**  
**DUE Friday, March 6th, 2020**

In class I spent quite a bit of time laying out the conceptual underpinnings of a spectral decomposition of a signal. It is important to me that you leave this class understanding not just the end result, but also the basic idea behind what we're seeing. As such, this homework tasks you to craft a narrative tying together the basic big ideas that I presented in class into a coherent, complete explanation. In short, I'm asking you to summarize the main content of the class discussion we had getting us from "Sound is a thing" to "and that's what a spectrum means and how it relates to timbre." To help you, here are the key bullet points that I tried to establish along the way:

1. Everything near its equilibrium acts like a spring.
2. The frequency of oscillations in a wave depend on material constants and the environment.
3. Any periodic function can be uniquely written as an infinite series of sine (or cosine) waves related to the harmonics of the fundamental.
4. We know how to calculate how much of each harmonic is needed to reconstruct the periodic signal.
5. Computers can efficiently do this computation of the amount of each harmonic needed.
6. There are multiple ways to represent the frequencies needed to reconstruct a signal; the nomenclature is varied, but these representations are broadly called "spectra" of the underlying signal and provide a graphical representation of how much of each wave's frequency is required to reconstruct a signal.

Make sure you (1) fully explain/justify each step, (2) present enough of a conceptual link to get us from step to step, (3) type your responses, and (4) don't say anything factually incorrect.

It should be clear from your answer that you understand the underpinnings of Fourier analysis and what a spectrum represents.

I will be picky when grading these. There is not any formal page limit, but I would encourage you to spend some time with this.

For this homework only, you may collaborate with one of your classmates if you want to. If you collaborate, just turn in one copy with both of your names at the top.