Music 170 assignment 2

1. Two sinusoids with the the same frequency (440 Hz., say), and with peak amplitudes 2 and 3 are added (or mixed, in other words). What are the minimum and maximum possible peak amplitude of the resulting sinusoid?

2. Two sinusoids with different frequencies, whose average powers are 3 and 4 respectively, are added. What is the average power of the resulting signal?

3. Two sinusoids, of period 4 and 6 milliseconds (0.004 and 0.006 second), respectively, are added. What is the period of the resulting waveform?

4. Two sinusoids are added (once again)... One has a frequency of 1 kHz . The resulting signal "beats" 5 times per second. What are the possible frequencies of the other sinusoid?

5. A signal - any signal - is amplified, multiplying it by three. By how many decibels is the level raised?

6. What is the pitch, in octaves, of the second harmonic of a complex harmonic tone, relative to the first harmonic?

Project: comb filtering. In this project you will use the phase-dependent effect of combining two sinusoids to build the simplest type of digital filter, called a *comb filter*.

To start with, make a single sinusoid of frequency 100 Hz (using the sinusoid object in the course library for Pd). You can check the level of its output using the "meter" object; it should be about 97 dB.

Now put the sinusoid into a "vdelay" (variable delay) object, and connect the delay output as well as the original sinusoid output to the meter. When the delay is zero you should see something 6 decibels higher, about 103.

Now measure and graph the amplitudes you measure, changing the delay in ten steps from 0 to 0.005 seconds. (Hint: to make the graph readable, don't make the vertical axis linear in decibels; instead, perhaps make equal spaces for 0, 94, 97, 100, and 103). But if you really want a nice-looking graph and don't mind 5 extra minutes of effort, convert from decibels to power.

Now do the same thing (on the same graph with a different color or line style) with the sinusoid at 200 Hz. instead of 100 Hz. Do you see a relationship between the two?

Now put six sinusoids at 100, 200, 300, 400, 500, 600 Hz. into a "switch" object (that's primarily for convenience; connecting the six to the switch will add them.) Connect the switch output to both the delay and directly to the output as before. As you change the delay between 0 and 10 milliseconds (0.01 second), what do you hear? What special thing happens when you choose a 5 millisecond (0.005 second) delay?