Music 170 assignment 3

1. In a complex, periodic tone, how many harmonics lie between two and three octaves above the fundamental (not including the lower and upper limit)?

2. What is the interval, in half tones (twelfths of an octave), between the second and third harmonic of a complex harmonic tone?

3. A low-pass filter has a frequency-dependent gain of

$$g(f) = \frac{1}{\sqrt{1 + f/(1000Hz)}}$$

What is the gain, in decibels, at 1000Hz?

4. If you send a sinusoid at frequency 100 Hz. and average power one, through the filter of exercise 3, what is the average power of the output?

5. What is the lowest-frequency pair of partials of a 1000-Hz.complex harmonic tone that lies within a critical band?

6. If two frequencies above 550 Hz. are separated by one bark, how many half-tones are they apart?

Project: Critical bands and loudness. This project tries to investigate how loudnesses of clusters of sinusoids are perceived differently when they are spaced withing a critical band than otherwise. For this experiment you should try to set yourself up with a reasonable listening environment, either using headphones or playing through a stereo (but not your laptop speaker).

Start by connecting a single "sinusoid" object with frequency 1000 Hz. to a "switch" object (these objects are both in the Music 170 library).

Now make another version (in the same patch) with four sinusoids tuned to 960, 980, 1000, anad 1020 Hz.. Connect all four to the input of a second "output" so that you can turn them on and off as a group, independently of the first one.

Make a third group of objects in the same way (or just duplicate the second group) but now set the frequencies to 500. 1000, 2000, and 4000.

Now, by turning them on and off (using the onoff control on the three output objects) equalize the outputs until all three are at a comfortable (reasonably soft) listening level. (If you have to push any of the output gains past about 90 dB, you should turn up your speaker instead. On my system I'm using gain values between 50 and 70.)

Now adjust the three output gains so that, as you turn them on one at a time, you judge them to have roughly equal loudnesses. Write down the three gain values you had to use to equalize them.

Since the four frequencies are roughly at the same level on the equal-loudness contour chart (Wikipedia is your friend), the different frequencies should be less a factor than the spacing. Is it in fact nearly true (or totally false) that in the close spacing example, you ended up adjusting the comples tone so that its power was roughly equal to the power of the single 1000 Hz. tone? Is that still true when the four frequencies are spread widely (500-4000)?