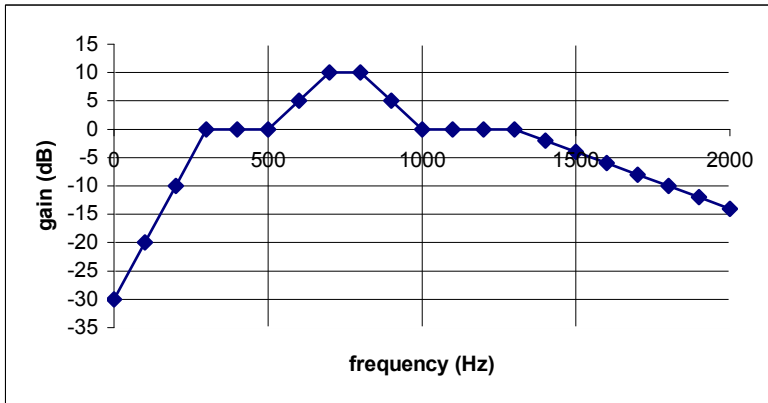


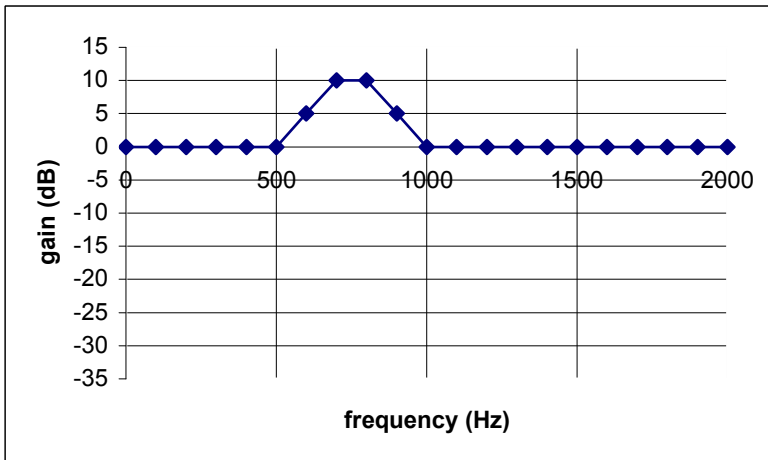
## Signals, systems, acoustics and the ear: Coursework IV

You may discuss these questions with others, but please write your answers by yourself. Show your work to a reasonable degree. For example, don't show the calculations for every harmonic in question 1. One or two is sufficient as long as you explain exactly what you're doing.

- 1) Draw the spectrum (on dB SPL and linear frequency scales) of the first 10 harmonics of a sawtooth wave whose fundamental period is 10 ms, and whose fundamental component has a level of 3.56 Pa. **(10 points)**



- 2) The sawtooth from (1) is then put through a cascade of two systems which together have the amplitude response at left. Draw the spectrum of the output wave. **(10 points)**



- 3) The first system in this cascade of systems has the amplitude response shown at left. Draw the amplitude response of the second system in the cascade **(15 points)**.

- 4) Sketch, on dB and logarithmic frequency scales (over a frequency range of 100 Hz – 6.4 kHz), a bandpass filter which has a gain of 6 dB in the passband which ranges from 400 Hz to 1.6 kHz, and which rolls off at 6 dB/octave on the low frequency side, and 12 dB/octave on the high frequency side. For simplicity, assume the filter cutoffs have the same gain as the passband does, rather than being 3 dB down. Hint: You do not need logarithmic graph paper. Set out the frequency axis in octaves, using the values 100, 200, 400, 800, 1600, 3200 & 6400 Hz. **(10 Points)**