ASSIGNMENT 3

1. Load 'guitar.wav' using the MIRToolbox. Design a high-pass filter such that we still hear the melody but as virtual pitch after filtering. This might require you to extract pitch information (*mirpitch*) and then decide the cut-off frequencies. Use the fdatool to design the filter, export the coefficients and filter the audio using the *filter* function. Which cut-off frequency ensures you hear virtual pitch?

2. Feedforward Echo effect: Design a filter that adds reverberation to the file 'guitar.wav'. In other words, add a delayed and attenuated version of the audio file to itself

$$y(n) = x(n) + ax(n - D)$$

   Set the gain *a* to 0.5 and delay to 250ms

3. Feedback Design a filter that adds echo/reverberation to the file 'guitar.wav'. In other words, add a delayed and attenuated version of the audio file to itself

$$y(n) = ay(n - D) + x(n)$$

   Use an attenuation value/gain *a* = 0.5. Vary delay *(D)* from 50ms to 500ms in steps of 50ms. At which point is the reverb noticeable? At that timepoint of noticeable reverb, change gain from 0.1 to 1 in steps of 0.1 and comment on the results.

4. Design a resonant filter with the following specifications:
   - Resonant frequency = 440Hz
   - BW = 50Hz

$$y(n) = A_0 x(n) + a_1 y(n-1) - a_2 y(n-2)$$

   where $A_0 = (1 + R^2)\sin(\theta)$; $a_1 = 2R\cos(\theta)$; $a_2 = R^2$; $R = 1 - (BW/2)$

   θ = normalized (by fs) frequency

5. Create a 2-second long complex wave that is a sum of a two sine waves of frequencies 400 Hz and 1000Hz (fs = 44100hz). Design a notch filter to attenuate the 1000hz wave. Listen to the filtered wave and comment on the effect of the filter. Plot the wave before and after filtering and comment on the effect of filtering. Repeat the same with the frequency spectrum (*plot(abs(fft(wave)))*). Comment on the stability of the filter.