1.

Say that the first 30 values of a digital audio file, $x(n)$, are those given below, and you apply the nine-tap FIR filter, $h(n)$, below. What is the value of the 10th digital sample after filtering?

$x(n)$ = [138, 232, 253, 194, 73, −70, −191, −252, −233, −141, −4, 135, 230, 253, 196, 77, −66, −189, −251, −235, −144, −7, 131, 229, 253, 198, 80, −63, −186, −251]

$h(n)$ = [0.0788, 0.1017, 0.1201, 0.1319, 0.1361, 0.1319, 0.1201, 0.1017, 0.0788]

2.

Say that you have an IIR filter $y(n) = \sum_{k=0}^{N-1} a_k x(n-k) - \sum_{k=1}^{M} b_k y(n-k)$ where a = [0.389, −1.558, 2.338, −1.558, 0.389] and b = [2.161, −2.033, 0.878, −0.161]. Note that vector **a** is numbered starting at index 0 and vector **b** is numbered starting at index 1.
To find $h(n)$ for this filter so that you can define it with

$$y(n) = h(n) \otimes x(n) = \sum_{k=0}^{\infty} h(k)x(n-k),$$

you can evaluate a unit impulse run through the function

$y(n) = \sum_{k=0}^{N-1} a_k x(n-k) - \sum_{k=1}^{M} b_k y(n-k)$. Do this to get $h(n)$. You' ll have to give it a finite length. Try 32 taps. You might want to write a program to do the computation for you. Graph the impulse response that you get.

4.

For a peaking filter, assume that you want the center frequency of the curve defining the peak to be at 8000 Hz, and you want the bandwidth of the peak to be 1000 Hz.

a. What is the Q-factor?
b. What is the corresponding bandwidth of this filter, in octaves?
c. What is the Q-factor of a peaking filter with a central frequency of 2000 Hz and a bandwidth of 1000 Hz?
d. What is the corresponding bandwidth of the filter, in octaves?
e. What is Q if you want the peaking filter to span one octave?