ECE 317
Summer 2005
Lab Assignment #4

Passive Filter Design

1) Design a first order low-pass filter with a cutoff frequency of 2.5 kHz. Assume that only a 0.22 μF capacitor is available.
   A) Show how you designed the filter. List all component values and include the circuit schematic.
   B) Use PSpice to verify your design by plotting the magnitude response (in dB) and phase response (in degrees) of the filter.
   C) What is the frequency where the magnitude response is –10 dB?
   D) What is the frequency where the phase response is –45°?

2) Design a second order high-pass filter to filter out the signal $x_1(t)$ and pass the signals $x_2(t)$ and $x_3(t)$ from the composite signal $x(t) = x_1(t) + x_2(t) + x_3(t)$, where $x_1(t) = 0.9\cos(3{,}000\pi t - \pi/2)u(t)$, $x_2(t) = 1.1\cos(18{,}000\pi t)u(t)$, and $x_3(t) = \cos(12{,}000\pi t + 2\pi/3)u(t)$. Assume that only a 0.47 μF capacitor is available.
   A) Show how you designed the filter. List all component values and include the circuit schematic.
   B) Explain your choices for the cutoff frequency (ω_c) and quality factor (Q).
   C) Use PSpice to verify your design by plotting the magnitude response (in dB) of the filter.
   D) What is the attenuation (in dB) of the filter at each of the three input frequencies?
   E) Give an expression for the steady-state output of the filter, $y_{ss}(t)$. Provide numerical values for the amplitudes and phase shifts (in radians).

3) Design a filter to pass the frequency band 124 kHz $\leq$ f $\leq$ 136 kHz and filter out any other frequencies. Assume that only a 75 pF capacitor is available.

   A) Show how you designed the filter. Include the center frequency (f_0), quality factor (Q), all the component values, and the circuit schematic.

   B) Use PSpice to verify your design by plotting the magnitude response (in dB) of the filter.

   C) If the value of the capacitor, C, is changed by 20%, 10%, 5%, –5%, –10% and –20% from its nominal value (75 pF), find the corresponding <u>percent</u> changes in the center frequency (f_0) and quality factor (Q). Thus, plot the percent change in f_0 (y-axis) vs. the percent change in C (x-axis) and the percent change in Q (y-axis) vs. the percent change in C (x-axis). Do the filter's center frequency and quality factor have a high or a low sensitivity to variations in the value of the capacitor?