ECE 512
Computer Assignment #1

Objective:

The objective of this assignment is to design and simulate simple passive first order and second order filters.

1) Design a first order lowpass filter with a cutoff frequency of 10 kHz. The available capacitor value is 10 nF.
   a) Verify your design using Pspice by plotting the magnitude (in dB) and phase responses.
   b) What is the frequency where the magnitude response is -12 db?
   c) Find the frequency where the phase response is - 45^0.

2) It is required to design a second order highpass 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

   $\boldsymbol{x_1(t) = \cos(2000\pi t + \pi/3),\ x_2(t) = 10\cos(10{,}000\pi t)\ and\ x_3(t) = 11\cos(20{,}000\pi t + \pi/4)}$.

   a) What values of cutoff frequency and Q values do you choose? Give reasons. From part a), calculate the values of the circuit elements needed, assuming the capacitor value available is in the nano Farad range.
   b) Give an expression of the output of the filter at steady state ($y_{ss}(t)$).

3) It is required to design a filter to pass the frequency band described by 95 kHz $\leq$ f $\leq$105 kHz and filter out the rest bands. Assume that the capacitor used is 100 pF.
   a) Calculate an appropriate center frequency and quality factor.
   b) Give the complete design of the filter. Hence, verify the frequency response through simulation.
   c) If the value of the capacitor c is changed by $\pm$ 5%, $\pm$10% and $\pm$20% of its nominal value, find the corresponding percentage change in the center frequency (f_o) and quality factor (Q). Hence, plot the percentage change in f_o and Q versus percentage change in the value of c.

Verify your results through simulations.