UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering
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	Homework 1	**EECS 247**
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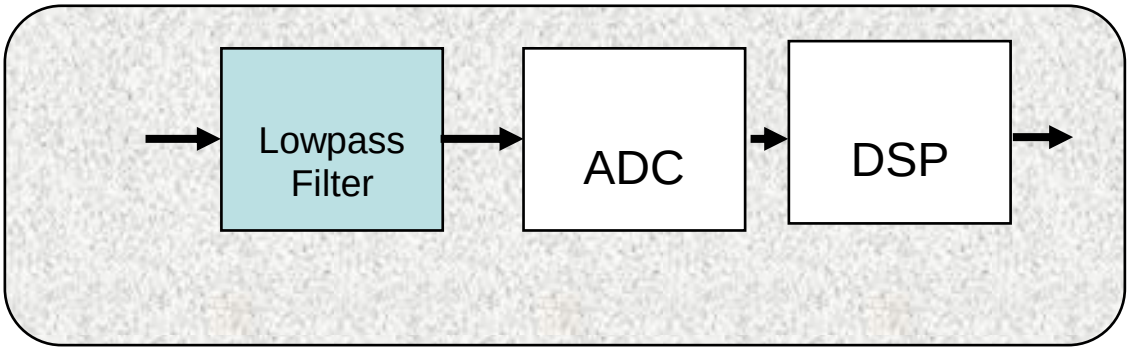
	Please add your email address to your submission	**2010**

Problem 1-

1. Derive an expression for the total output noise associated with a 1st order RC highpass filter.
2. Choose the component values for a -3dB frequency of 7KHz and total output noise of 15μVrms at 27degree C.
    a. Simulate and plot the magnitude response in terms of dB with log x-axis. Measure the level of attenuation provided at 60Hz. Comment on the potential application for addition of such a filter in a system.
    b. Simulate and plot the noise spectral density and total noise at the output of the highpass filter from 1Hz to 1GHz. Does the simulated total noise agree with your computation?
3. Design a 1st order RC lowpass filter with corner frequency at 200KHz assuming total output noise for the lowpass filter same as the highpass filter total noise.
4. Simulate the magnitude and phase response of the above highpass filter cascaded with the lowpass filter using a voltage-controlled voltage source as a buffer in between the two filters from 1Hz to 10MHz. Explain the shape of the filter.
5. Simulate and plot noise spectral density and total noise at the output of the combined filter from 1Hz to 1GHz. Comment on the result.

Problem 2-

The block diagram shown below, denotes the baseband portion of the receive path for a communication system.



You are to find a filter type among: Butterworth, Chebychev I, and Elliptic which satisfies all the following requirements:

a) The corner frequency is 60kHz (if you are using Matlab then fpass=60kHz, if not assume f_{-3dB}=64kHz)
b) The out-of-band rejection at 90kHz should be -50dB
c) Passband ripple, if any <0.5dB
d) Since the output of the filter is converted to the digital form. The system designers believe as long as the (maximum-minimum) group delay within the band of 1kHz to 55kHz is less than 20μs the phase distortion can be corrected for by the DSP.

e) Design should be optimized for minimum Silicon area and power dissipation. This to first order corresponds to a filter with minimum number of poles.

You can use any CAD tool you like to find the required filter order for each of the 3 filter types and the max-min group delay within the specified band. If using ***fdatool*** in ***Matlab***, note that it deals with discrete filters and you need to specify a sampling frequency. For simplicity, choose $f_{sampling}=1,000,000$. In that case, when you graph group-delay the numbers on the y-axis should be divided by the sampling frequency (or multiplied by 1e-6).

Please submit:

1.Corresponding graphs for all the 3 filter types:
   a. Overall magnitude response (frequency range 0 to 200kHz and magnitude range 0dB to -80dB)
   b. Magnitude response showing detail of the passband (frequency range 0 to 70kHz and magnitude range 1dB to -4dB). Measure the -3dB point for each filter if you used Matlab Rpass
   c. Phase response
   d. Group delay, as a function of frequency within 1KHz to 55KHz range
2. Fill in the table shown below, indicating the required order for each filter type, group delay for the specified frequency range,
3. Circle the filter you recommend for the above application.

Filter Type	Filter Order *n*	Group Delay Measured within 1kHz to 55kHz $GD_{max.}$-$GD_{min.}$
Butterworth		
Cheybshev I		
Elliptic		