ECE 321 - Homework #3

Butterworth & Chebychev filters, Analog Computers. Due Monday, November 29th

Please make the subject "ECE 321 HW#4" if submitting homework electronically to Jacob_Glower@yahoo.com (or on blackboard)

Filter Analysis

1) Assume X and Y are related by the following transfer function

$$Y = \left(\frac{60}{(s+3)(s+10)} \right) X$$

a) What is the differential equation relating x and y?

b) Determine y(t) assuming

$$x(t) = 2 + 3\cos(5t) + 4\sin(5t)$$

c) Plot the gain vs. frequency for this filter from 0 to 30 rad/sec

Filter Design (hardware)

2) Design a filter to implenent the following transfer functions

a) $$Y = \left(\frac{60}{s^2+13s+30} \right) X = \left(\frac{60}{(s+3)(s+10)} \right) X$$

b) $$Y = \left(\frac{60}{s^2+3s+30} \right) X = \left(\frac{60}{(s+1.5+j5.268)(s+1.5-j5.268)} \right) X$$

Filter Design using *fminsearch()*

3) Design a filter of the form

$$Y = \left(\frac{ace}{(s+a)\left(s^2+bs+c\right)\left(s^2+ds+e\right)} \right) X$$

to give a gain vs. frequency as close to Gd(s) as possible over the range of (0,10) rad/sec

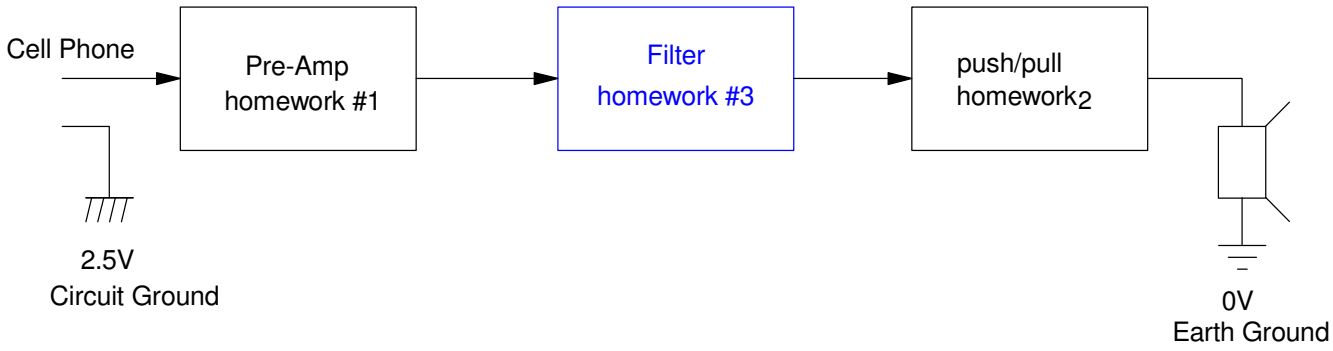
$$G_d(j\omega) = \begin{cases} 1 & 0 < \omega < 2 \\ 2 - 0.5\omega & 2 < \omega < 4 \\ 0 & \omega > 4 \end{cases}$$

Plot the resulting gain vs. freqency for this filter.

Butterworth and Chebychev Filters

Design a filter for your cell-phone to speaker circuit. Some suggestions are...

- Subwoofer Crossover. Pass frequencies below 250Hz. Reject frequencies above 500Hz.
- Cow-Bell Filter: Pass frequencies between 590 and 630Hz. Reject frequencies below 500Hz or above 700Hz.
- Middle-C Filter: Pass frequencies between 220Hz and 440Hz. Reject frequencues below 150Hz and above 650Hz.
- Other...



4) Requirements. Specify

- The frequencies that should be passed ($0.9 < \text{gain} < 1.1$),
- The frequencies that should be rejectd ($\text{gain} < 0.2$)

5) Filter design:

- Give the transfer function for a filter which meets your requirements.
- Plot the gain vs. frequency of your filter.

6) Simulation: Simulate your filter in CircuitLab to verify that it meets your requirements

- $0.9 < \text{gain} < 1.1$ in the pass-band region, and
- $\text{gain} < 0.2$ in the band-reject region

7) Hardware: Build your filter and verity it meets your requirements.

- $0.9 < \text{gain} < 1.1$ in the pass-band region, and
- $\text{gain} < 0.2$ in the band-reject region

8) Demo: Demonstrate your pre-amp - filter - power amp circuit.