

# ECE 3043

## Spring 2020 Homework Problem Set 6 for Experiment No. 7

### Due Week of February 24

The critical frequency,  $f_{crit}$ , for the filters that will be designed is the  $-3$  dB frequency for the low-pass and high-pass filters, pole and/or zero for the shelving filters, and the center frequency for the all-pass filter. The critical frequency is the experimenter's birthday (sans year) in kHz for birthdays prior to July and the birthday divided by two for birthdays from July to December. For instance, if the experimenter was born on May 24 the critical frequency is 5.24 kHz and if the experimenter was born on December 13 the critical frequency is  $12.13/2 = 6.065$  kHz.

1. Design a first order low-pass filter with a dc gain of  $20dB$  and a  $-3$  dB frequency of  $f_3 = f_{crit}$ .
2. Design a first order high-pass filter with a infinite frequency gain of  $20dB$  and a  $-3$  dB frequency of  $f_3 = f_{crit}$ .
3. Design a first-order low-pass shelving filter with a pole frequency of  $f_p = f_{crit}$ , a dc gain of  $20dB$ , and an infinite frequency gain of  $6dB$ .
4. Design a first-order high-pass shelving filter with a zero frequency of  $f_z = f_{crit}$ , a dc gain of  $6dB$ , and an infinite frequency gain of  $20dB$ .
5. Design a first-order all pass filter with a phase shift of  $90^\circ$  at  $f_o = f_{crit}$ .

Simulate each of the circuits designed above with National Instruments (Multisim). Plot the Bode plots from a frequency a decade below the smallest pole/zero frequency to a decade above the pole/zero frequency. (The word Bode plot means the vertical axis on the gain plot is in dB). Make the same plots with either Mathcad and Matlab.

Each of these filters will be built in lab and the frequency response obtained. For the first four filters only the amplitude response is required to be measured in lab. But for the all pass filter both amplitude and phase must be measured; ELVIS might be the preferred choice for this filter.