ECE 321 - Homework #4

Butterworth & Chebychev filters, Analog Computers. Due Monday, April 24th
Please email to jacob.glower@ndsu.edu, or submit as a hard copy, or submit on BlackBoard

Analog Computers

1) Design an analog computer to implement

$$Y = \left(\frac{2s+10}{s^3+5s^2+10s+30} \right) X$$

Butterworth and Chebychev Filters

2) Specify the requirements for a filter. For example:

Subwoofer

- Pass frequencies below 250Hz
  - $0.9 < \text{gain} < 1.1$ for $f > 250\text{Hz}$
- Reject frequencies above 500Hz
  - $\text{gain} < 0.2$ for $f > 500\text{Hz}$

Filter for a 555 timer which outputs 500Hz to 1000Hz square wave (i.e. a Theramin)

- Passes the 1st harmonic
  - $0.9 < \text{gain} < 1.1$ for $500\text{Hz} < f < 1000\text{Hz}$
- Rejects the 3rd harmonic
  - $\text{gain} < 0.2$ for $f > 1500\text{Hz}$

Fiter for a cow bell (600Hz)

- Pass 600Hz
  - $0.9 < \text{gain} < 1.1$ for $f = 600\text{Hz}$
- Reject 650Hz
  - $\text{gain} < 0.2$ for $f > 650\text{Hz}$
- Reject 550Hz
  - $\text{gain} < 0.2$ for $f < 550\text{Hz}$

Other

3) Filter Design. Give the transfer function for filter which meets your requirements.

- Choose any time of filter you like (RC, Butterworth, Chebuchev, etc.)
- Plot the gain vs. frequency of your filter.

4) 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

Lab:

5) Add a low-pass filter to circuit from homework #1

- Measure the gain at several frequencies
- Use sine waves (makes measurement easier)

6) Demonstrate your filter + speaker driver

- With a sine-wave input
- With music as an input