ECE 321 - Homework #3

Filters. Due Monday, November 30th

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

$$Y = \left(\frac{30}{(s+2)(s+6)} \right) X$$

1a) What is the differential equation relating X and Y?

1b) Find y(t) for

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

2) Design a circuit to implement

$$Y = \left(\frac{20}{(s+2)(s+6)} \right) X$$

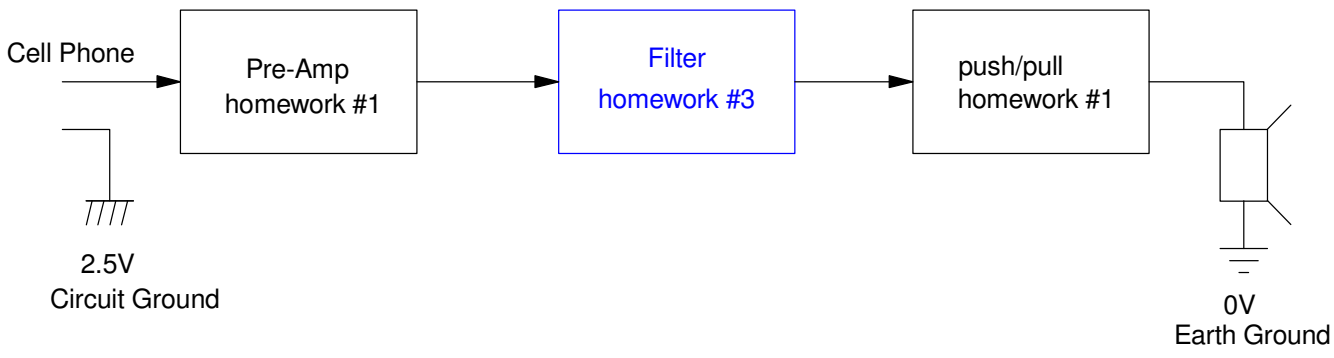
Check your design in CircuitLab

3) Design a circuit to implement

$$Y = \left(\frac{20}{(s+1+j6)(s+1-j6)} \right) X$$

Check your design in CircuitLab

Problem 4-8) Add a filter to the amplifier from homework set #1



4) Requirements: Specify the requirements for a filter.

Option #1: Low Pass Filter

- $0.9 < \text{gain} < 1.1$ for frequencies between 20Hz and 250Hz
- $\text{gain} < 0.2$ for frequencies above 500Hz

Option #2: Band-Pass Filter

- $0.9 < \text{gain} < 1.1$ for frequencies between 200Hz and 240Hz
- $\text{gain} < 0.1$ for frequencies above 500Hz
- $\text{gain} < 0.1$ for frequencies below 50Hz

Option #3: High-Pass Filter

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

Option #4: Other.

- Your choice
- (just don't make it too easy - such as "gain > 0.1 for 0 < f < 20kHz". A wire satisfies that requirement.)

5) Analysis: Design a filter to meet these requirements. Include in your calculations

- The required number of poles
- The transfer function of your resulting design,
- A gain vs. frequency plot for your filter, and
- The gain at the design points (250Hz and 500Hz in the above example)

6) Simulation: Test your circuit design in CircuitLab (or similar program) to verify your design is correct

7) Validation: Build your circuit and take measurement to show that it does (or does not) meet your requirements

8) Demo. Demonstrate your filter (live on zoom or with a video)