UNITED STATES AIR FORCE ACADEMY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 332 Laboratory Exercise 16d
Band-Pass and Band-Reject Filter Design

1. Objective

State the objectives of the lab.

2. Specifications and Limitations

You should include all the given specifications for both your BPF and your BRF. Putting the specifications in separate tables is helpful. Discuss any limitations (e.g. number of op-amps, any defined source resistance, any defined load resistance, etc.).

3. General Approach

Discuss the methods you will use to design, simulate, build, test, and trouble-shoot your circuit. Importantly describe how you will analyze your data to determine if you met specifications.

4. Design

a. Mathematical Equation

Derive the transfer function for both your BP and BR filters. Once you have the transfer function for each filter, provide a Bode plot from Matlab. From this plot, measure ω_{c1}, ω_{c2}, bandwidth, and passband gain. Show the percent-error from the Matlab plot compared to your specified values. Note this percent error should be very small—on the order of 1-2%. A larger error likely means you have a problem with your transfer function.

b. Circuit Simulation

Using the transfer functions derived in part a, design a circuit for your BR and BP filters with component values. Note for the first set of components, you can use any values. You do not have to limit yourself to values we have in the lab. The key is to create schematics that provide the proper responses. Simulate using Multisim. Provide a Bode plot. From this plot, measure ω_{c1}, ω_{c2}, bandwidth, and passband gain. Overlay with your Matlab plot. Determine the percent error. As before, this percent error should be very small—on the order of 1-2%. Since you are not limited in component values, you should be able to create something very close to the desired response.

Once you have a circuit that works, scale the values and select available part values you can use in the lab. Simulate using Multisim. Provide a Bode plot. From this plot, measure ω_{c1}, ω_{c2}, bandwidth, and passband gain. Overlay with your Matlab plot and your first Multisim plot. Your errors will likely have increased, due to the fact you are using available parts instead of

exact values. Determine the percent error. The goal is +/- 10%. Ideally, you will be within 5%. This gives you some wiggle room once you build the circuit.

5. Implementation

Build your circuits. Include pictures of each. Do whatever you need to do to ensure you can accurately compare your built filters to the designed specifications. Provide a graph with your data overlaid on the ideal response and your simulated response. Create a table with the percent errors. Discuss possible sources of error (e.g. not using exact values, tolerances, etc. Use an RLC meter to measure the exact values for the components you used).

6. Analysis and Testing

This section is critical in determining how you met or did not meet specifications. Using appropriately labeled figures you must clearly demonstrate to the reader that you met specifications. Include a graph overlaying your theoretical response, simulation response, and lab response. Include a table for your error analysis. If you did not meet specifications initially describe what you step you took to meet specifications.

7. Conclusions

Summarize what you did in the lab. Provide lessons learned, what you liked, what you didn't like.