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ADANA ALPARSLAN TÜRKEŞ SCIENCE AND TECHNOLOGY UNIVERSITY

FACULTY OF ENGINEERING

EEE 222 ELECTRICAL CIRCUIT LABORATORY II

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Dr. Özgür ÇELİK

EXPERIMENT V

Band-Pass and Band-

Reject Filters

1. Objectives

The objective of this experiment is to analyze band-pass and band-reject filters.

2. Introduction

Band-pass filters are used to pass voltages within a particular band of frequencies to the output while filtering out voltages at frequencies outside this band. These filters have two cutoff frequencies which identify the passband. For realistic band-pass filters, these cutoff frequencies are defined as the frequencies for which the magnitude of the transfer function equals to $(1/\sqrt{2})H_{max}$, where H_{max} is the maximum magnitude of the transfer function.

There are three other important parameters that characterize a bandpass filter. The first is the **center frequency, ω_o,** defined as the frequency for which a circuit's transfer function is purely real. Another name for the center frequency is the **resonant frequency, f_r.** It is where $X_L=X_C$ in a series RLC circuit. The center frequency can be calculated by $\omega_o = \sqrt{\omega_{C1}\omega_{C2}}$.

The second parameter is the **bandwidth, $\boldsymbol{\beta}$**, which is the width of the passband. The final parameter is the **quality factor**, which is the ratio of the center frequency to the bandwidth.

Band-reject filters pass source voltages outside the band between the two cut-off frequencies to the output (passband) and attenuate source voltages before they reach the output at frequencies between to cut-off frequencies (stopband). Band-reject filters and band-pass filters thus perform complementary functions in the frequency domain.

Band-reject filters are characterized by the same parameters as band-pass filters; the two cut-off frequencies, the center frequency, the bandwidth, and the quality factor. In figure 1, the frequency response plots of a band-pass and a band-reject filter are given.

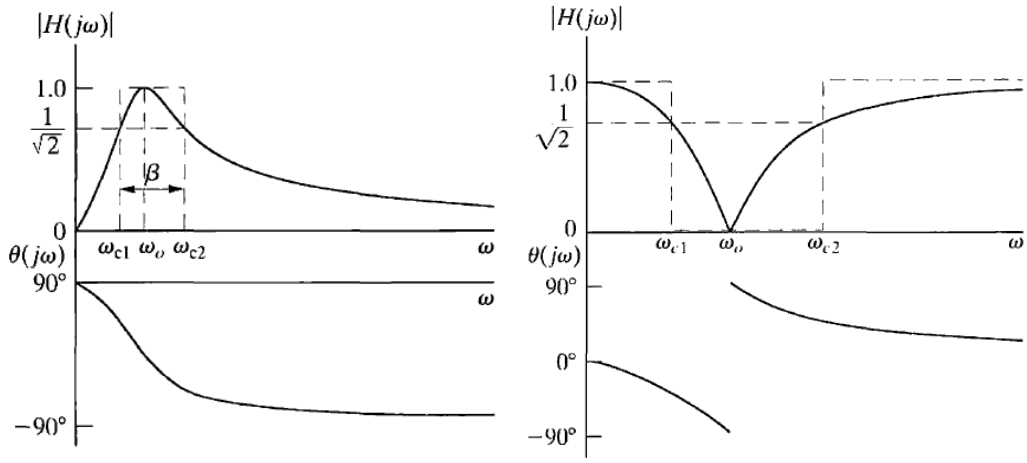

Figure 1. Frequency response plots for series RLC band-pass and band-reject filters.

3. Preliminary Work

1) Read the related section textbook and study to the calculations. At the laboratory quiz, you will be responsible for all calculations below.

2) Design a ***series RLC band-pass filter*** with cut-off frequencies of 1 KHz and 10 KHz. Use a 1 uF capacitor.

- **a.** Calculate the center frequency.
- **b.** Calculate the value of the inductor.
- **c.** Calculate the quality factor.
- **d.** Calculate the value of the resistor.
- **e.** Simulate the circuit you designed with the parameters you calculated. Obtain the graph of the frequency response of the output. Indicate the cut off frequencies and the center frequency on the graph. **Bring the circuit schematic and the simulation print out to the laboratory with you. You will implement this circuit at the laboratory, so show all your works in details, and write down all calculations clearly <u>in a separate sheet</u>.**

3) Modify your circuit to become to the form of the band-reject filter by using the same R, L, C parameters that you obtained for the band-pass filter designed in part 1.

- **a.** Draw the schematic of the designed band-reject filter.
- **b.** Perform the simulation and observe the frequency response.
- **c.** **Bring the schematic and simulation print-outs together with you to the laboratory.** Indicate the center frequency and the cut-off frequencies on the graph. **Don't forget that you will implement this circuit at the laboratory, so show all your works in details.**

4. Experimental Work

1) Set-up the band-pass circuit you designed in the preliminary work part 1. If you don't see the component values you calculated in the laboratory, use approximate values that you find.

- **a.** Start from 10 Hz and increase the frequency value and observe the change of the output voltage.
- **b.** Take measurement values and table them. According to the table you obtained, plot the output peak voltage versus frequency.
- **c.** On your graph show the cut-off frequencies and center frequency.

2) Set-up the band-reject circuit you designed in the preliminary work part 2. In this part, you will use the same components as in experimental work part 1.

- **a.** Start from 10 Hz and increase the frequency value and observe the change of the output voltage.
- **b.** Take measurement values and table them. According to the table you obtained, plot the output peak voltage versus frequency.
- **c.** On your graph show the cut-off frequencies and center frequency.