Lab Report:Bode Plot Analysis of RC Low-Pass Filters

Magnitude and Phase Response for 1st,2nd and 3rd Order

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February 20, 2025

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1 INTRODUCTION

This lab investigates the frequency response of single-stage, two-stage, and three-stage RC low-pass filters using Bode plots. The study involves plotting magnitude and phase responses, deriving theoretical equations, and verifying experimental results using an oscilloscope and function generator.

2 CIRCUIT DIAGRAMS

The circuit diagrams for the 1-stage, 2-stage, and 3-stage RC low-pass filters consist of cascaded resistor-capacitor networks.

3 THEORETICAL ANALYSIS

The transfer function for a single-stage RC low-pass filter is given by:

$$H_1(j\omega) = \frac{1}{1 + j\omega RC} \tag{1}$$

For a two-stage filter:

$$H_2(j\omega) = \left(\frac{1}{1 + j\omega RC}\right)^2 \tag{2}$$

For a three-stage filter:

$$H_3(j\omega) = \left(\frac{1}{1 + j\omega RC}\right)^3 \tag{3}$$

The magnitude response in decibels is:

$$|H_n(j\omega)|_{dB} = 20n \log_{10}\left(\frac{1}{\sqrt{1 + (\omega RC)^2}}\right) \tag{4}$$

The phase response is:

$$\theta_n(\omega) = -n \tan^{-1}(\omega RC) \tag{5}$$

4 EXPERIMENTAL SETUP

Equipment Used:

- Oscilloscope

- Function generator

- Resistors (2kΩ)

- Capacitors (1000μF)

- Breadboard & Connecting wires

5 PROCEDURE TO OBTAIN READINGS

1. Construct the RC circuit as per the circuit diagram.

2. Connect the input of the circuit to a function generator and apply a sine wave signal.

3. Use an oscilloscope to measure input and output voltages.

4. Vary the frequency from 10Hz to 1MHz and note the amplitude and phase shift.

5. Use the oscilloscope cursors to measure the phase difference between input and output waveforms.
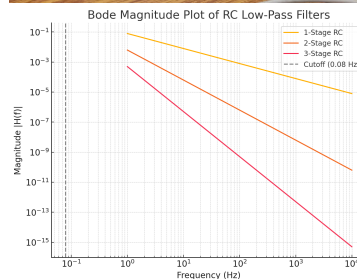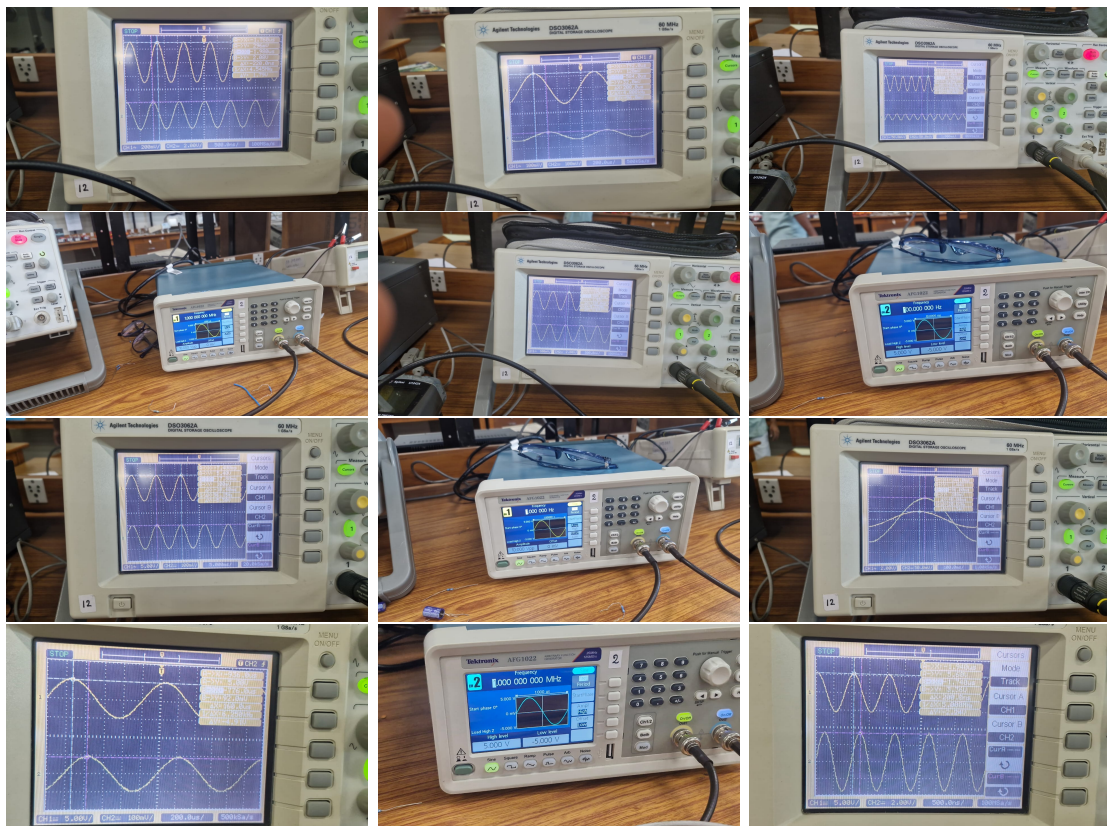
6 Images of the readings

Figure 1: Bode plots

7 CONCLUSION

The experiment successfully demonstrated the frequency-dependent behavior of RC low-pass filters. Higher-order filters provide sharper roll-off characteristics, making them more effective for noise filtering in signal processing applications.