Lab Report1

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Objective

To analyze the magnitude and phase response of 1-stage, 2-stage, and 3-stage RC low-pass filters using Bode plots.

Apparatus

- Resistors ($1k\Omega$ each)
- Capacitors (100nF each)
- Function generator
- Oscilloscope

Theory

A low-pass filter allows low-frequency signals to pass while attenuating higher-frequency signals. The transfer function for an n-stage RC low-pass filter is given by:

$$H_n(s) = \frac{V_C(s)}{V_0(s)} = \frac{1}{(1 + RCs)^n} \tag{1}$$

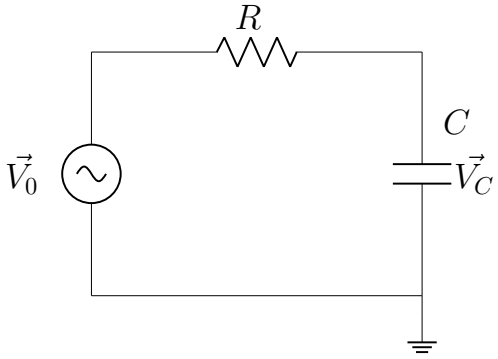
where R is the resistance and C is the capacitance.

The magnitude response in dB is:

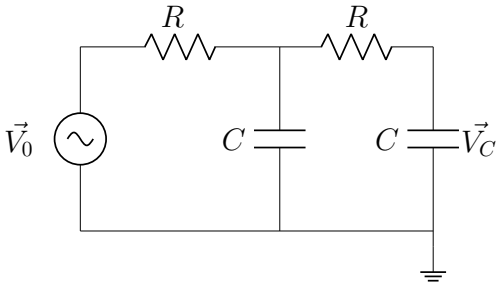
$$|H_n(j\omega)|_{dB} = 20n \log_{10} \left(\frac{1}{\sqrt{1 + (\omega RC)^2}} \right) \tag{2}$$

The phase response is:

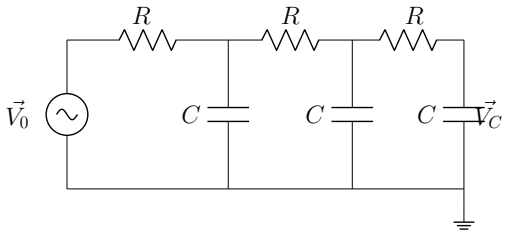
$$\angle H_n(j\omega) = -n \tan^{-1}(\omega RC) \tag{3}$$



(a) Stage1



(b) Stage2



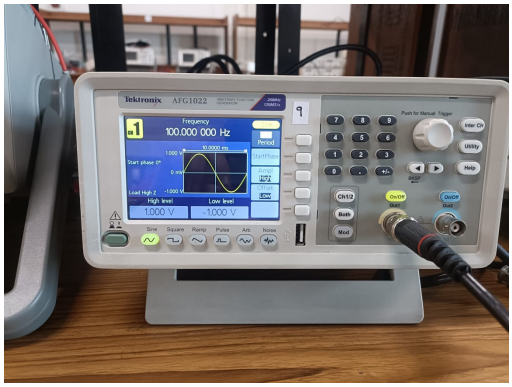
(c) Stage3

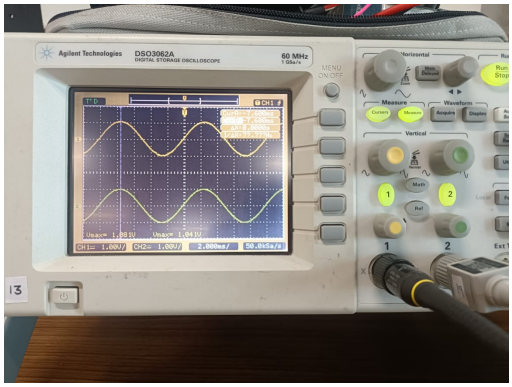
Procedure

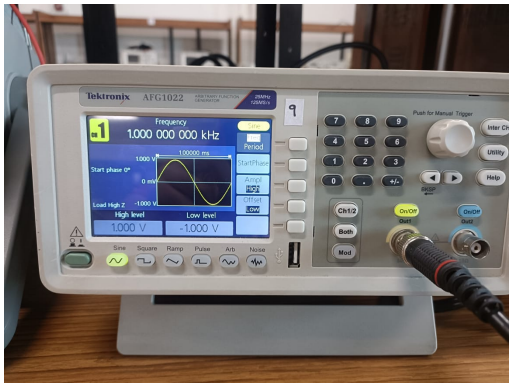
1. Assemble the RC low-pass filter circuits for 1-stage, 2-stage, and 3-stage configurations.
2. Apply an AC signal of varying frequency using the function generator.
3. Measure the output voltage using the oscilloscope.
4. Compute the magnitude and phase response.
5. Plot the Bode magnitude and phase graphs.

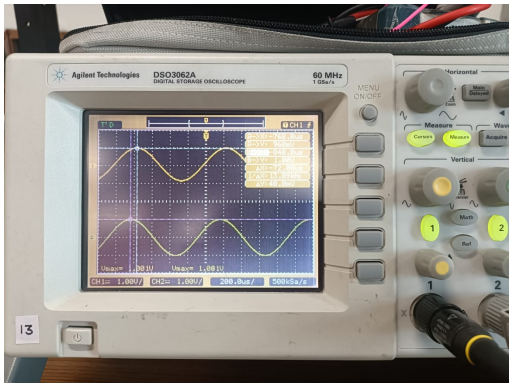
Readings

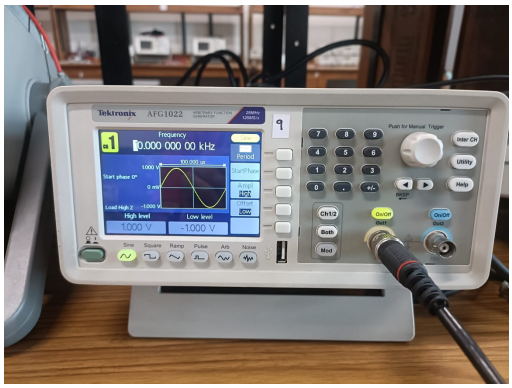
Stage1

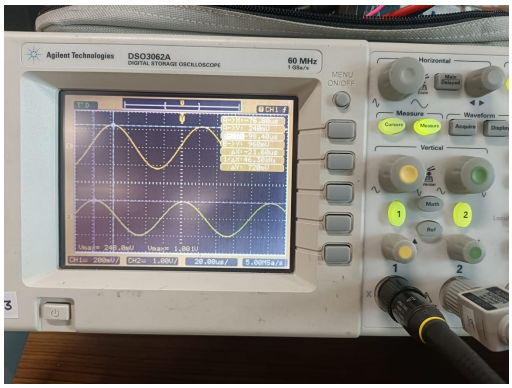








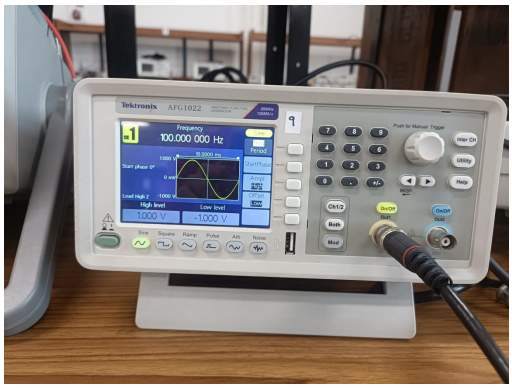


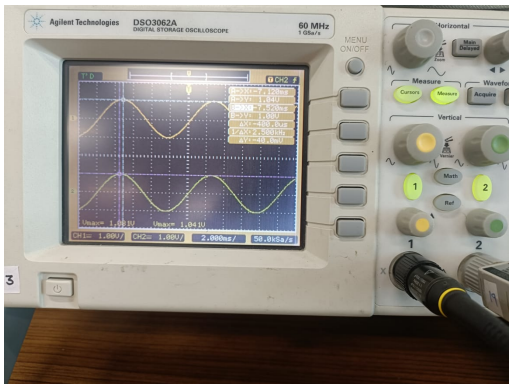


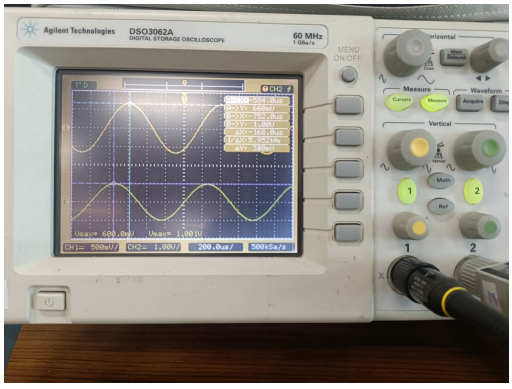
Frequency (Hz)	$\lvert H_n(j\omega)\rvert_{dB}$(dB)	Phase (deg)
10^2	0	-0.3
10^3	-0.81643989	-3.0
10^4	-28.54232711	-30.0

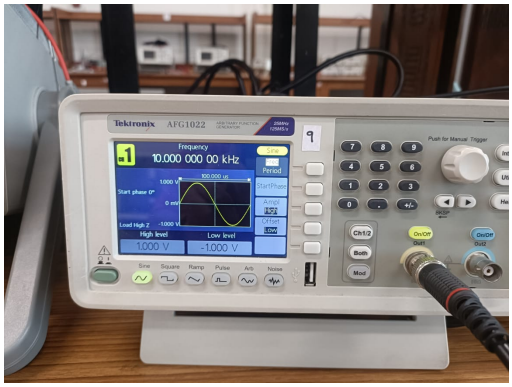
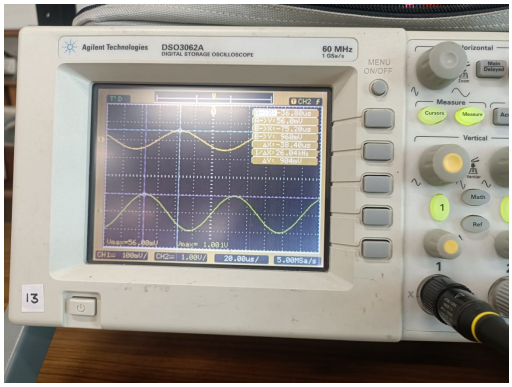
Table 1: Stage1

Stage2





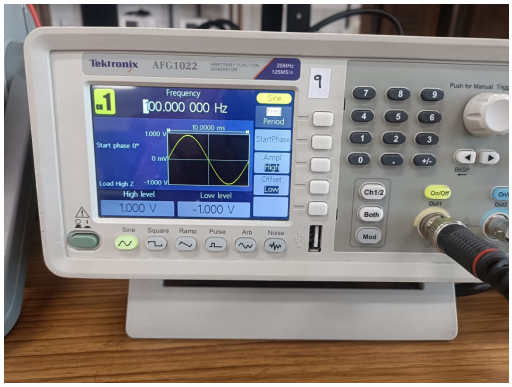
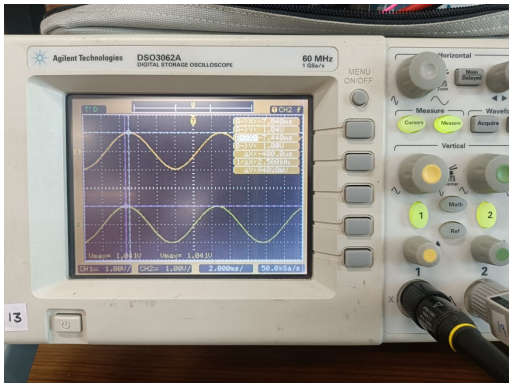


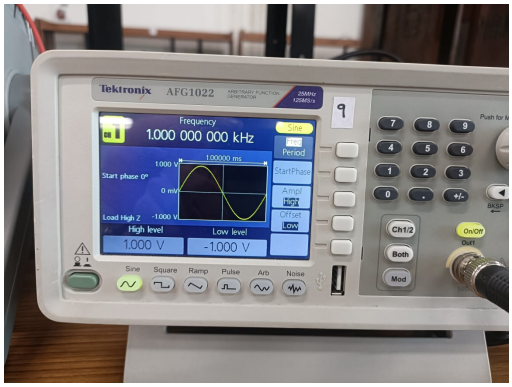
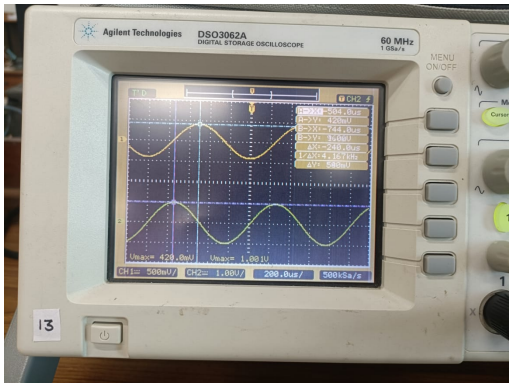



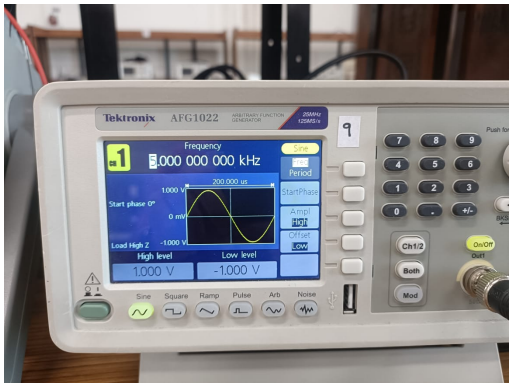
Frequency (Hz)	$\|H_n(j\omega)\|_{dB}$(dB)	Phase (deg)
10^2	0	-14.4
10^3	-8.31030888	-60.48
10^4	-57.64807176	48.24

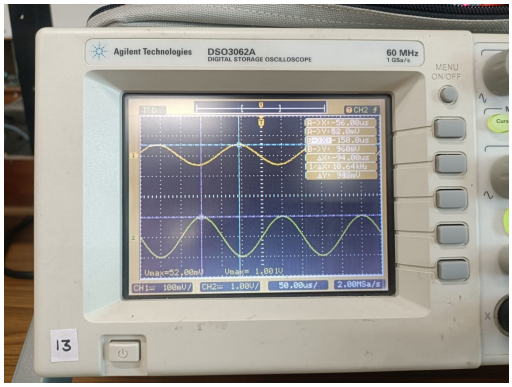
Table 2: Stage2

Stage3



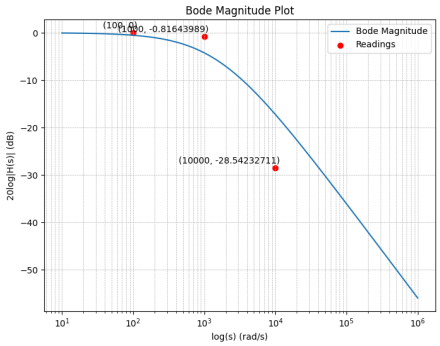


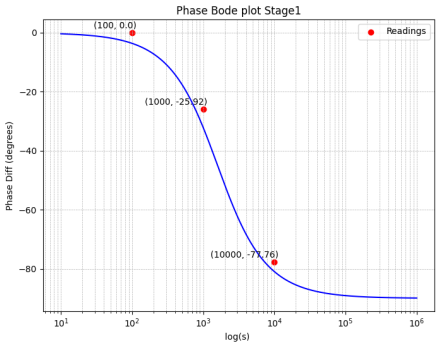
Frequency (Hz)	$\lvert H_n(j\omega)\rvert_{dB}$(dB)	Phase (deg)
10^2	0	-14.4
10^3	-17.35001135	-86.4
10^4	-59.13023121	-79.2

Table 3: Stage3

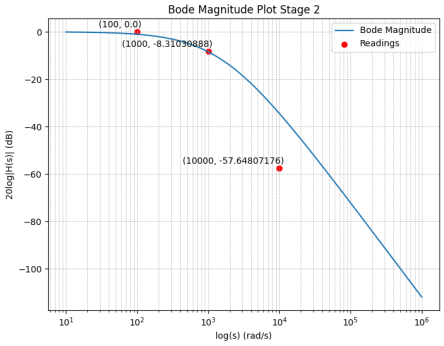
Graphs

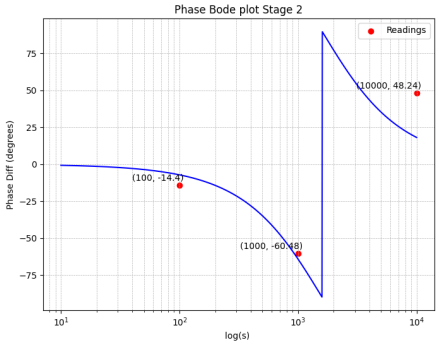
Stage1



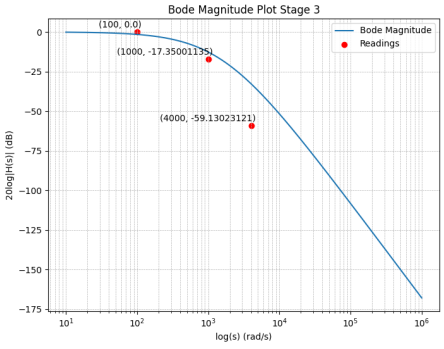


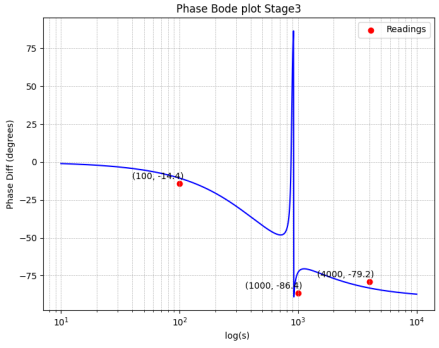
Stage2





Stage3





Thank You