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ECEN-325-512

ECEN 325 - Lab Report 1

1a) Lowpass Filter -3dB

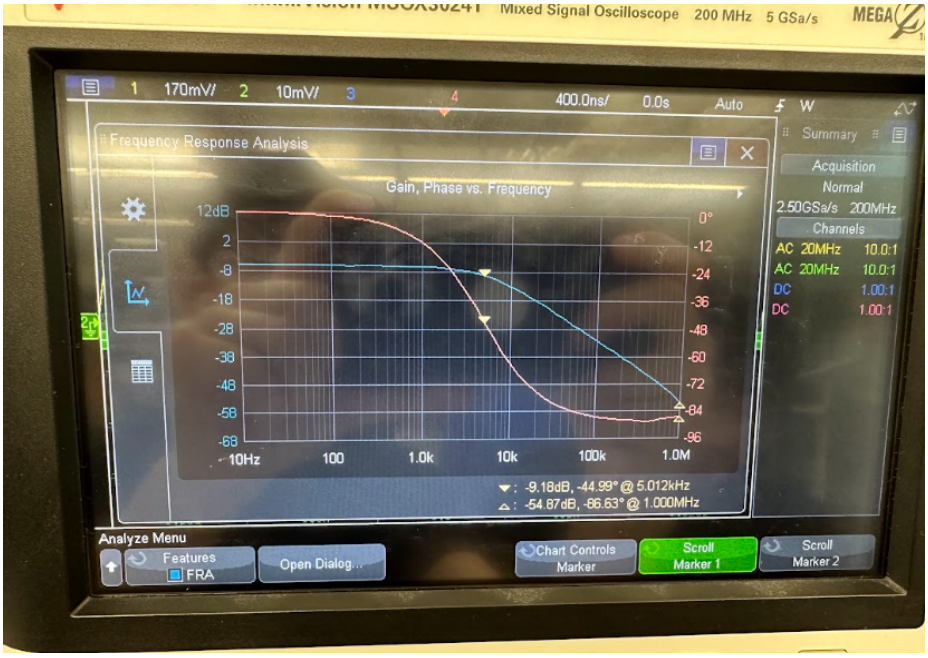


Figure 1a) Lowpass Filter 3-dB frequencies and passband gain.

1b) Lowpass Filter @ 6kHz

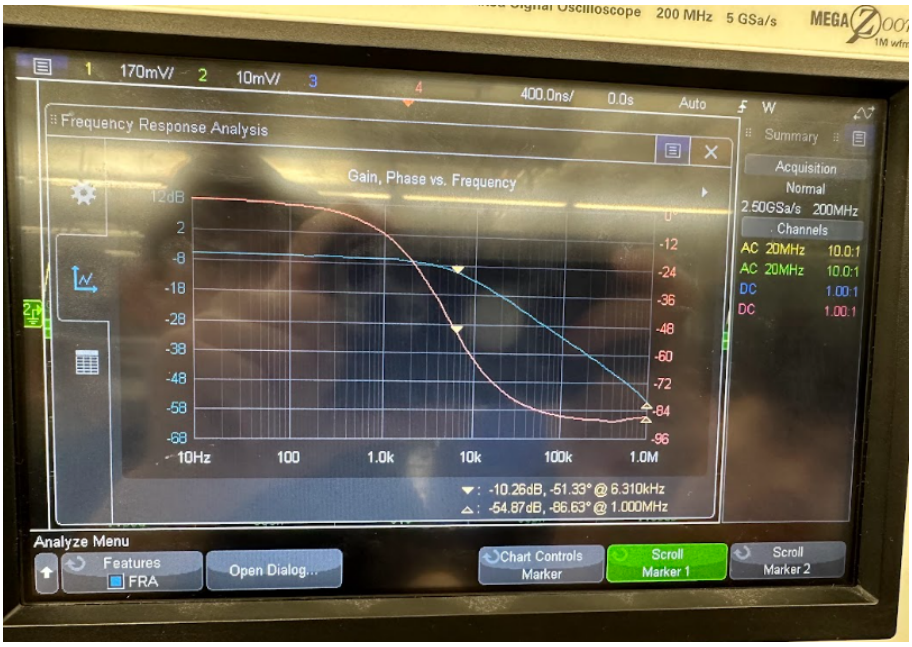


Figure 1b Low Pass Filter: Bode Plot @ 6kHz.

1c) Low Pass Filter @ 4kHz

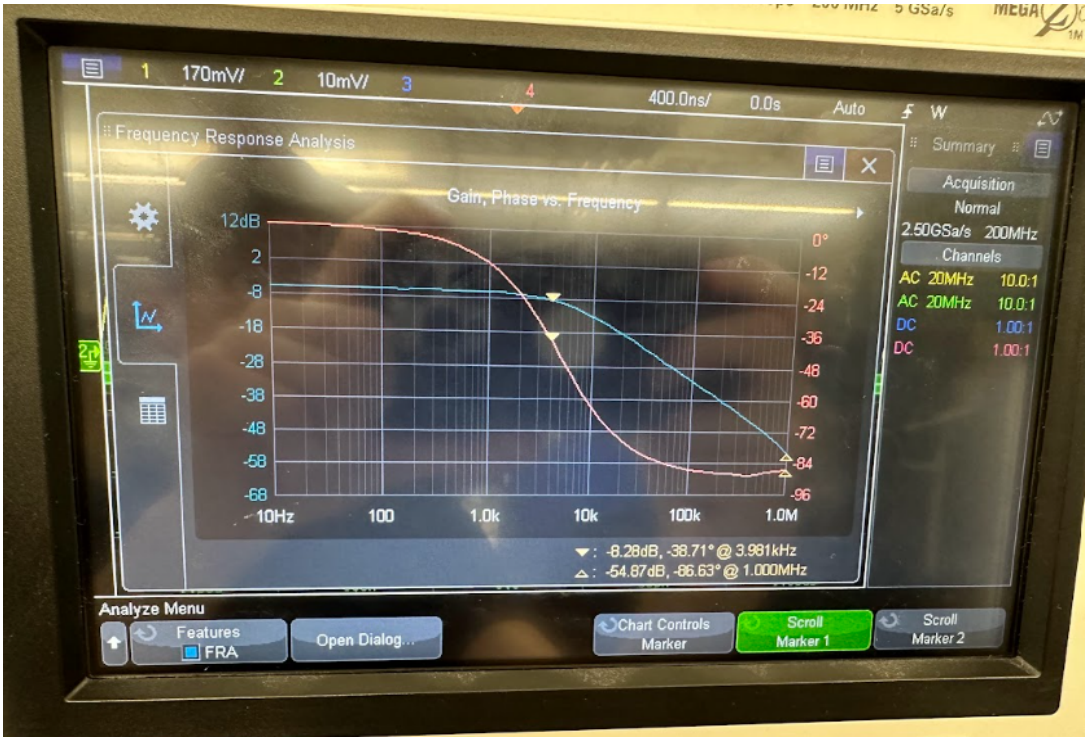


Figure 1c Low Pass Filter: Bode Plot @ 4kHz.

1d) High Pass Filter -3dB

Figure 1d) High Pass Filter: 3-dB frequencies and passband gain.

1e) High Pass filter @ 6kHz

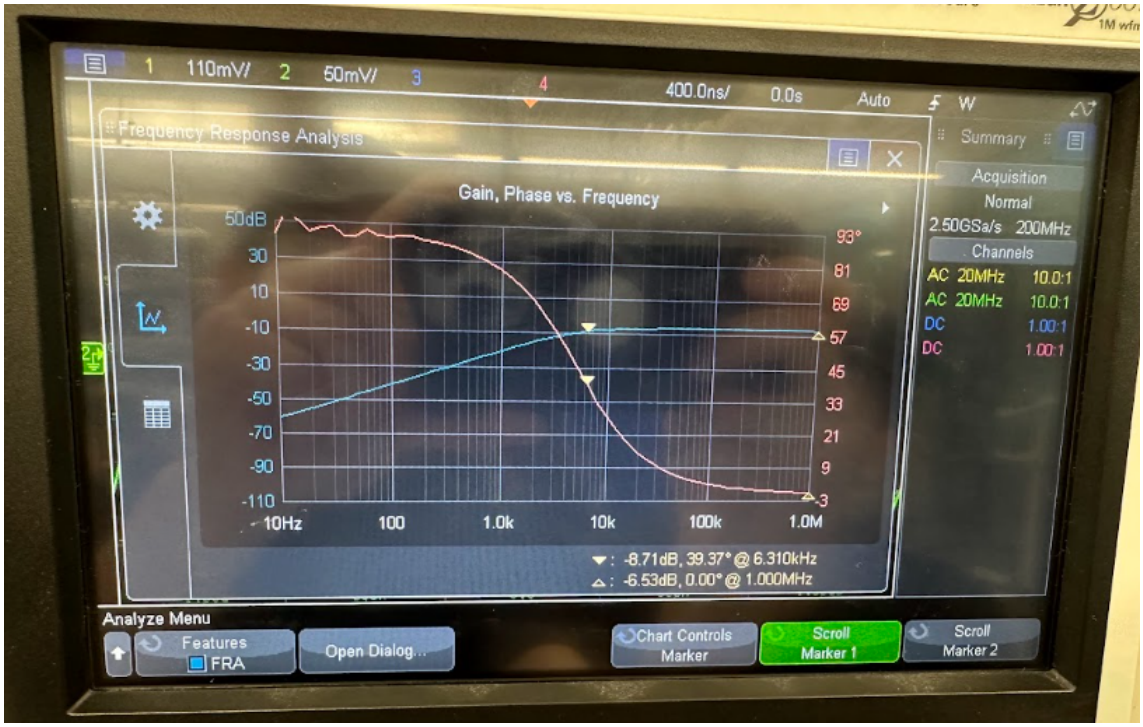


Figure 1e) High Pass Filter: Bode Plot @ 6kHz.

1f) High pass filter @ 4kHz

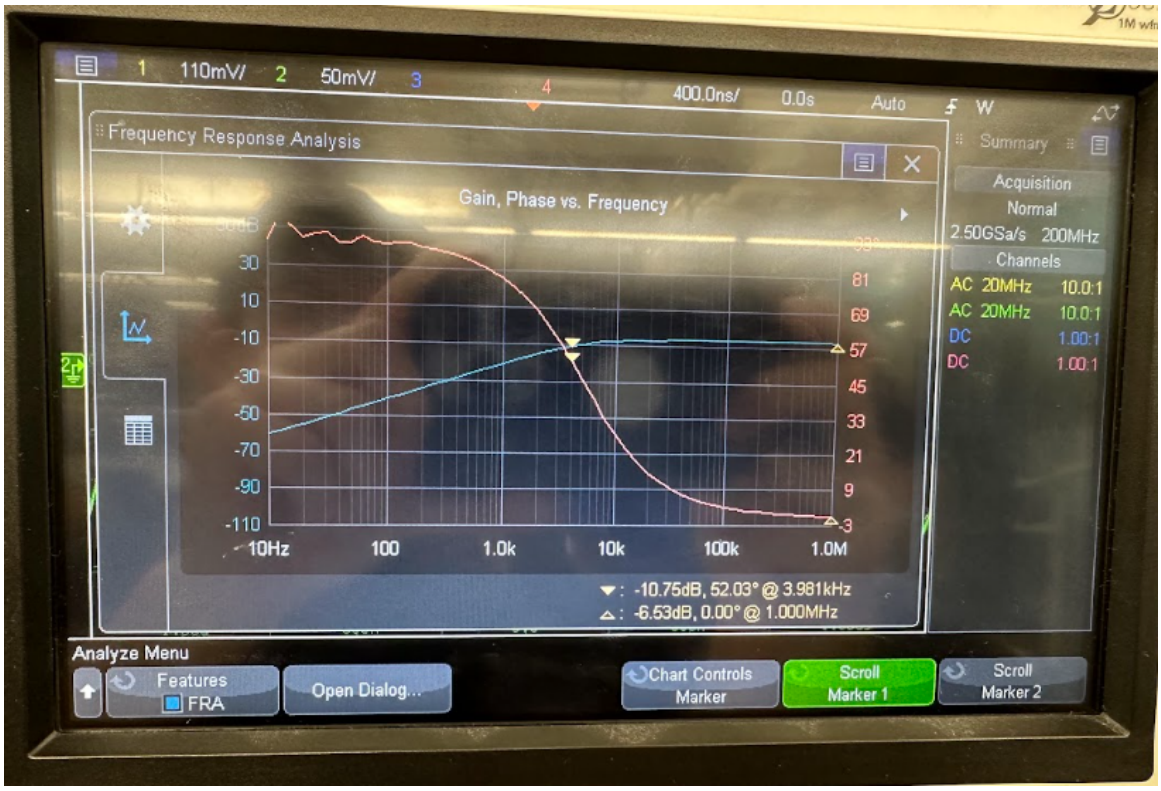
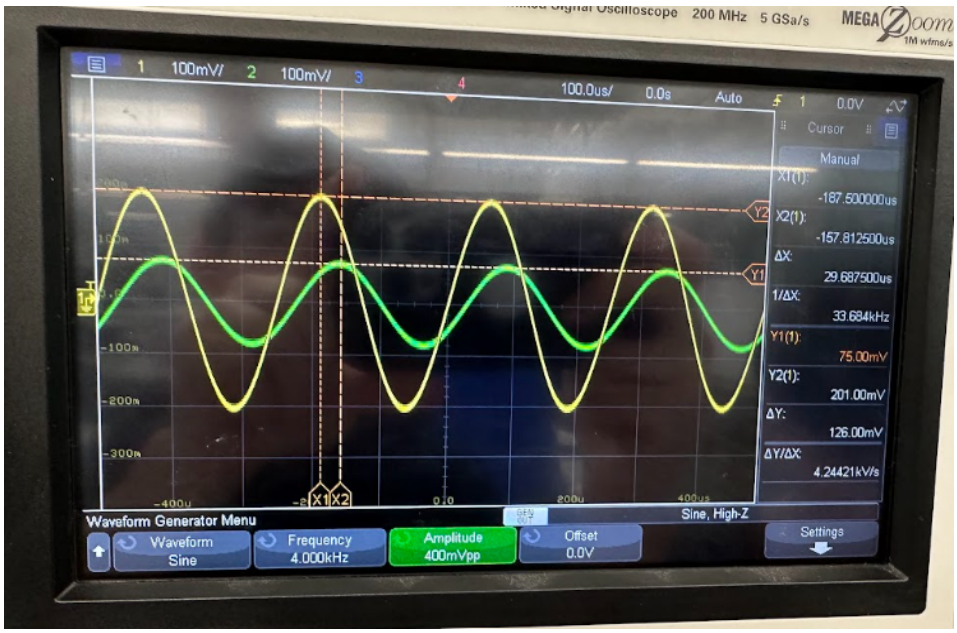


Figure 1f) High Pass Filter: Bode Plot @ 4kHz.

2a) Low Pass time-domain waveforms for $V_i(t) = 0.4sin(2\pi 4000t)$



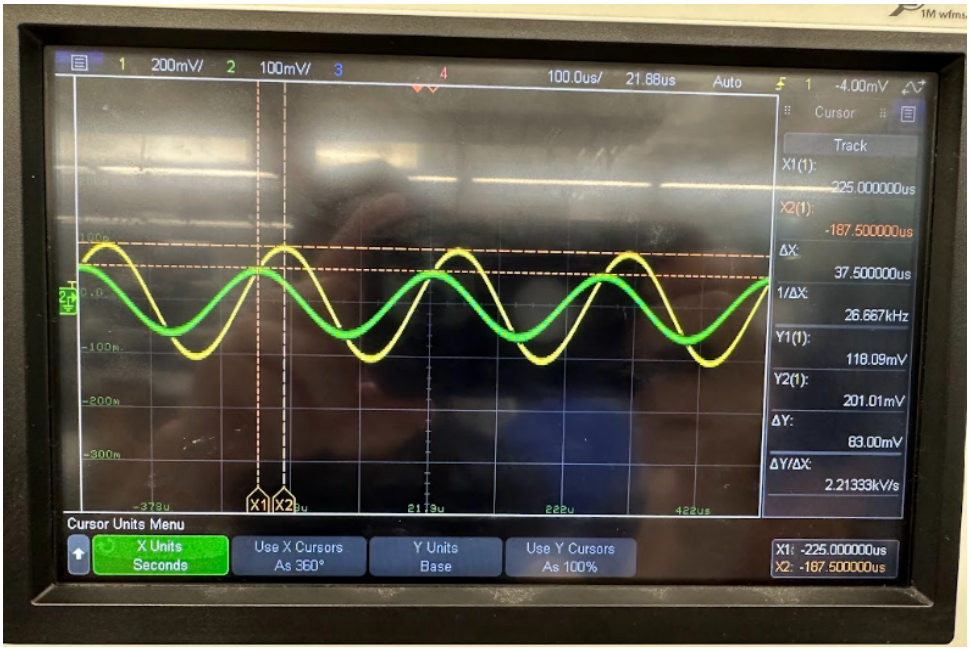
Low pass filter calculations:

$$|H| = \frac{V_{out}}{V_{in}} = \frac{75mV}{201mV} = 0.587$$

$$\Delta t = (-187.5\mu S + 157.8\mu S) = -29.7\mu S \Rightarrow T = \frac{1}{f} = \frac{1}{4000} = 250\mu S$$

$$\angle H = \frac{\Delta t}{T} \times 360^\circ = \frac{-29.7\mu S}{250\mu S} \times 360^\circ = -42.77^\circ$$

2b) High Pass Filter time-domain waveforms for $V_i(t) = 0.4sin(2\pi 4000t)$



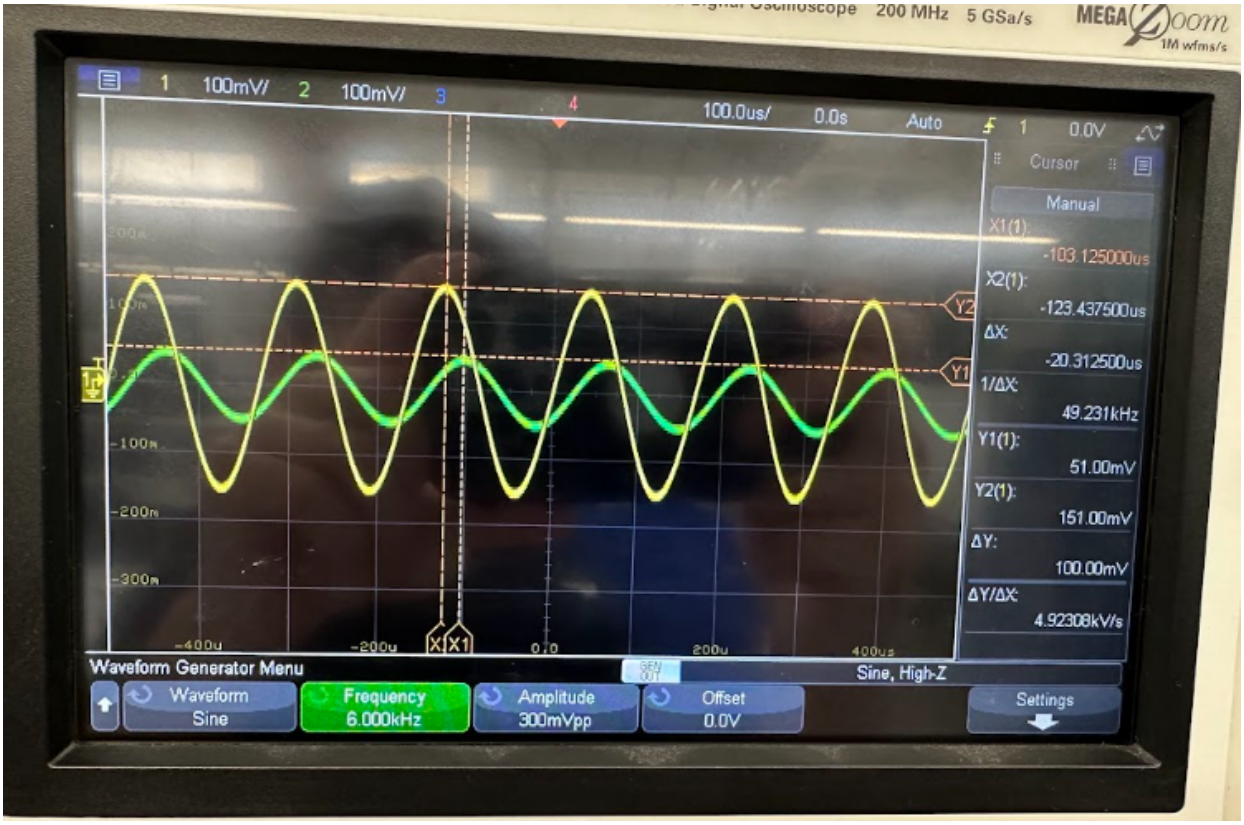
High pass filter calculations:

$$|H| = \frac{V_{out}}{V_{in}} = \frac{118mV}{201mV} = 0.373$$

$$\Delta t = (225\mu S - 187.5\mu S) = 37.5\mu S \Rightarrow T = \frac{1}{f} = \frac{1}{4000} = 250\mu S$$

$$\angle H = \frac{\Delta t}{T} \times 360^{\circ} = \frac{37.5\mu S}{250\mu S} \times 360^{\circ} = 54^{\circ}$$

3a) Low Pass for $V_i(t) = 0.3sin(2\pi 6000t)$



Low pass filter calculations:

$$|H| = \frac{V_{out}}{V_{in}} = \frac{51mV}{151mV} = 0.337$$

$$\Delta t = (-123.4\mu S + 103.1\mu S) = -20.3\mu S \Rightarrow T = \frac{1}{f} = \frac{1}{6000} = 167\mu S$$

$$\angle H = \frac{\Delta t}{T} \times 360^{\circ} = \frac{-20.3\mu S}{167\mu S} \times 360^{\circ} = -43.76^{\circ}$$

3b) High Pass Filter $V_i(t) = 0.3sin(2\pi 6000t)$

High pass filter calculations:

$$|H| = \frac{V_{out}}{V_{in}} = \frac{51mV}{152mV} = 0.336$$

$$\Delta t = (143.8\mu S - 126.7\mu S) = 17.1\mu S \Rightarrow T = \frac{1}{f} = \frac{1}{6000} = 167\mu S,$$

$$\angle H = \frac{\Delta t}{T} \times 360^\circ = \frac{17.1\mu S}{167\mu S} \times 360^\circ = 36.86^\circ$$

Data Table:

Below is a table with all of our calculated, simulated, and measured values. We chose this format to easily detect any inconsistencies in our data and compare results. The table split in half for the top being Lowpass and the bottom half being High Pass data.

	Calculated	Simulated	Measured
Lowpass -3dB frequency	5.00 kHz	5.09 kHz	5.01 kHz
Lowpass Magnitude @ 6kHz	-9.90 dB	-9.84 dB	-10.26 dB
Low Pass Phase @ 6kHz	-49.85°	-50.12°	-51.33°
Lowpass Magnitude @ 4kHz	-8.17 dB	-8.20 dB	-8.28 dB
Low Pass Phase @ 4kHz	-38.65°	-39.01°	-38.71°
Low Pass gain $V_i(t) = 0.4sin(2\pi 4000t)$	0.390	0.390	0.587
Low Pass Phase Difference $V_i(t) = 0.4sin(2\pi 4000t)$	-38.65°	-37.9°	$-42.77°$
Low Pass gain $V_i(t) = 0.3sin(2\pi 6000t)$	0.320	0.319	0.337
Lowpass Phase Difference $V_i(t) = 0.3sin(2\pi 6000t)$	-49.85°	-52.6°	-43.76°
High Pass -3dB frequency	5.00 kHz	4.96 kHz	5.01 kHz
highpass Magnitude @ 6kHz	-8.31 dB	-8.25 dB	-8.71 dB
high pass Phase @ 6kHz	59.04°	39.98°	39.37°
highpass Magnitude @ 4kHz	-10.12 dB	-10.05 dB	-10.75 dB
high pass Phase @ 4kHz	68.18°	51.03°	52.03°
high pass gain $V_i(t) = 0.4sin(2\pi 4000t)$	0.312	0.312	0.373
high pass Phase Difference $V_i(t) = 0.4sin(2\pi 4000t)$	68.18°	54.4°	54°

high pass gain $V_i(t) = 0.3sin(2\pi 6000t)$	0.384	0.385	0.336
high pass Phase Difference $V_i(t) = 0.3sin(2\pi 6000t)$	59.04°	46.09°	36.86°

Results:

Upon reviewing the tabulated results, it becomes evident that certain discrepancies, particularly in the phase values for the high pass filter, stand out. Notably, the calculated phase values diverge from the simulated and measured data. This divergence can likely be attributed to calculation errors or inaccuracies in the theoretical model used for the filter. Interestingly, the gain values for the high pass filter consistently match across calculated, simulated, and measured results, suggesting that the discrepancies primarily pertain to the phase differences.

Another notable discrepancy is observed in the low pass filter's gain for the input signal Vi(t) = 0.4sin(2π4000t), where the measured value deviates significantly from both the simulated and calculated values. Such a disparity could be attributed to various factors, including measurement errors, real-world component variations, or unexpected circuit behaviors under specific input conditions.

These observations underline the intricate nature of electronic circuit analysis, where even minor calculation errors or non-ideal component behaviors can lead to noticeable differences in phase measurements.