LAB #02
Capacitive Reactance

Fall 2022

CSE-203L CS 2 LAB

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“On my honor, as a student of the University of Engineering and Technology, I have neither given nor received unauthorized assistance on this academic work”

Submitted to:

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(19 Oct 2022)

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Objective:

Capacitive reactance will be examined in this exercise. In particular, its relationship to capacitance and frequency will be investigated, including a plot of capacitive reactance versus frequency.

Theory Overview:

The current – voltage characteristic of a capacitor is unlike that of typical resistors. While resistors show a constant resistance value over a wide range of frequencies, the equivalent ohmic value for a capacitor, known as capacitive reactance, is inversely proportional to frequency. The capacitive reactance may be computed via the formula:

$$X_c = \frac{1}{2\pi f C}$$

The magnitude of capacitive reactance may be determined experimentally by feeding a capacitor a known current, measuring the resulting voltage, and dividing the two, following Ohm's Law. This process may be repeated across a range of frequencies in order to obtain a plot of capacitive reactance versus frequency. An AC current source may be approximated by placing a large resistance in series with an AC voltage, the resistance being considerably larger than the maximum reactance expected.

Equipment:

AC Function Generator
Oscilloscope

Components:

1 μF
2.2 μF
10 kΩ

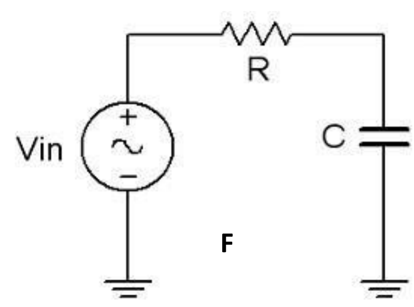
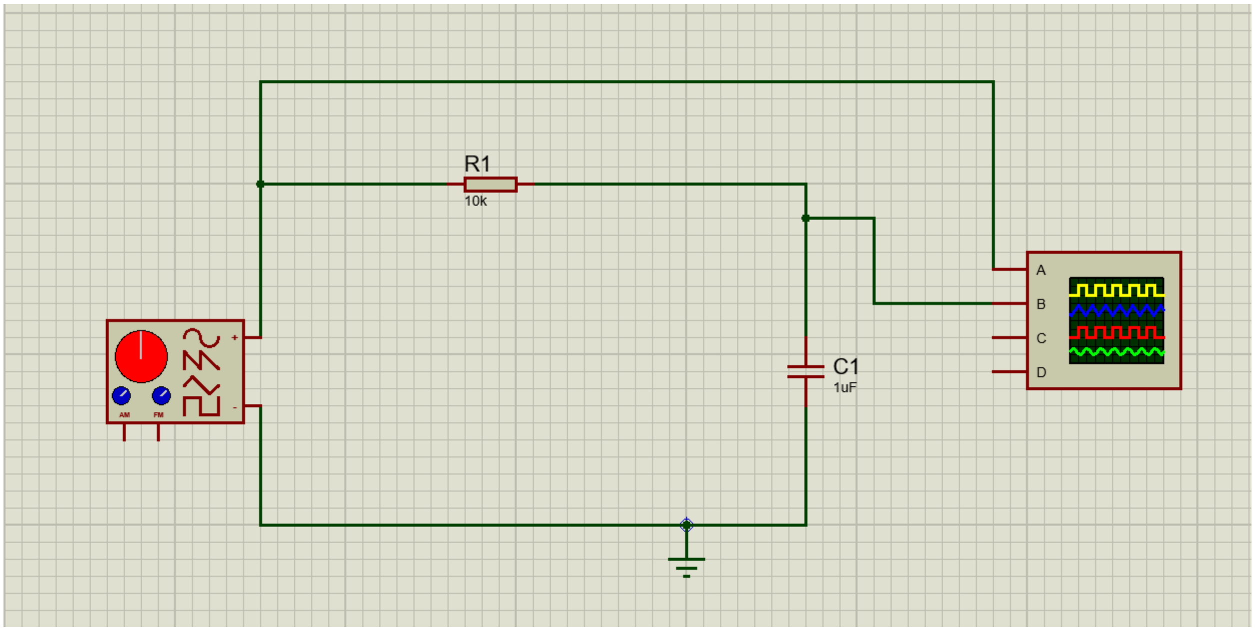


Figure 1



Procedure:

Current Source

1. Using Figure 1 with Vin=10Vp-p and R=10kΩ, and assuming that the reactance of the capacitor is much smaller than 10k and can be ignored, determine the circulating current using measured component values and record in Table 1.

Measuring Reactance

2. Build the circuit of Figure 1 using R=10kΩ, and C=1 µF. Place one probe across the generator and another across the capacitor. Set the generator to a 200 Hz sine wave and 10Vp-p. Make sure that the Bandwidth Limit of the oscilloscope is engaged for both channels. This will reduce the signal noise and make for more accurate readings.
3. Calculate the theoretical value of Xc using the measured capacitor value and record in Table 2.
4. Record the peak-to-peak capacitor voltage and record in Table 2.
5. Using the source current from Table 1 and the measured capacitor voltage, determine the experimental reactance and record it in Table 2. Also compute and record the deviation.
6. Repeat steps three through five for the remaining frequencies of Table 2.
7. Replace the 1 µF capacitor with the 2.2 µF unit and repeat steps two through six, recording results in Table 3.

8. Using the data of Tables 2 and 3, create plots of capacitive reactance versus frequency.

i_{source} (p-p)	0.001 Ampere

Table 1

Frequency	X_c theory	V_c (p-p) Exp	X_c Exp	% div
200	796.17 Ω	0.8 V	800 Ω	-0.481 %
400	398.08 Ω	0.4 V	400 Ω	-0.482%
600	265.39 Ω	0.25 V	250 Ω	-5.79%
800	199.04 Ω	0.2 V	200 Ω	-0.482%
1k	159.23 Ω	0.15 V	150 Ω	5.79%
1.2k	132.69 Ω	125mV	125 Ω	5.795%
1.4k	113.73 Ω	110mV	110 Ω	3.279%
2.0k	79.61 Ω	80mV	80 Ω	-0.489%

Table 2

Frequency	X_c theory	V_c (p-p) Exp	X_c Exp	% div
200	361.89 Ω	0.35 V	350 Ω	3.04 %
400	180.85 Ω	0.18 V	180 Ω	0.47 %
600	120.57 Ω	120 mV	120 Ω	0.47 %
800	90.42 Ω	90 mV	90 Ω	0..46 %
1k	72.34 Ω	70 mV	73 Ω	-0.90 %
1.2k	60.28 Ω	60 mV	60 Ω	0.46 %
1.6k	51.67 Ω	50.5 mV	50.5 Ω	2.27 %
2.0k	36.17 Ω	36 mV	36 Ω	0.472 %

Questions:

- What is the relationship between capacitive reactance and frequency?

Answer: Capacitive reactance is inversely proportional to frequency.

- What is the relationship between capacitive reactance and capacitance?

Answer: Capacitive reactance is said to be inversely proportional to the capacitance and the signal frequency.

- If the experiment had been repeated with frequencies 10 times higher than those in Table 2, what would the resulting plots look like?

Answer: Same (because it will decrease Reactive Capacitance 10 times)

- If the experiment had been repeated with frequencies, 10 times lower than that in Table 2, what effect would that have on the experiment?

Answer: Same (because it will decrease Reactive Capacitance 10 times)

Conclusion:

In this Lab task, we understand how to measure the reactance of a Capacitor connected in series with a resistor and voltage source in Proteus 8 software.