Objectives

- To examined the Capacitive reactance.
- To analyze its relationship between capacitance and frequency
- To observe the plot of capacitive reactance versus frequency.

Theory Overview

On contrary to resistance of a resistor which shows a constant resistor over a wide range of frequencies, the equivalent ohmic value for a capacitor known as reactance of capacitor is changed with change in frequency. The reactance of capacitor is inversely proportional to the frequency and measured through the formula:

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

Where:

Xc = Capacitive Reactance in Ohms, (Ω)

π (pi) = 3.142 (decimal) or as 22÷7 (fraction)

ƒ = Frequency in Hertz, (Hz)

C = Capacitance in Farads, (F)

To get more accurate results and plot a better frequency vs capacitive reactance, feeding a capacitor a known current, measuring the resulting voltage, and dividing the two, following Ohm's Law may be repeated across a range of frequencies.

Equipment

- AC Function Generator
- Oscilloscope Components

Components

- 100 µF actual: 96 µF
- 2.2 µF actual: 2 µF
- 2 kΩ actual: 1985 Ω

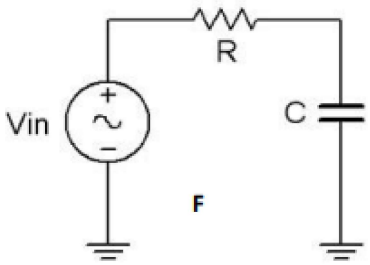


Figure 1: Circuit Schematics

Procedure

Current Source

1. To find current of the source in the circuit, make a circuit as shown in figure 1 with Vin=10Vp-p and R=2kΩ. Reactance of the capacitance can be neglected in the circuit since its reactance value is so small as compared to resistor. Now determine the value of current of current using ohm's law

Measuring Reactance

2. After building the circuit as shown in figure 1, Set voltage on function generator to 10Vp-p and frequency to 200Hz of sine wave. Place one probe of the oscilloscopes across the capacitor and the other across generator.
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 100 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.

$i_{source(p-p)}$	5mA

Table 1

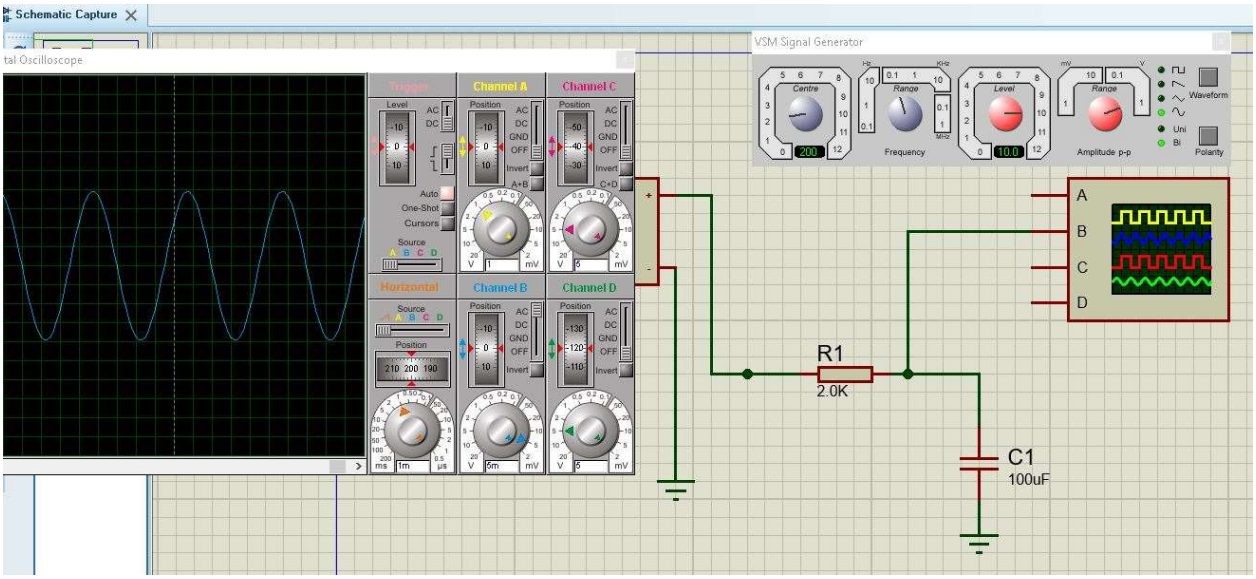


Figure 2: Proteus 100uF Capacitor Reading

Frequency	Xc Theory	$V_{c(p-p)}$ Exp	Xc Exp	% Dev
200	7.95 Ω	42 mA	8.4 Ω	6%
400	3.98 Ω	22	4.4 Ω	11%
600	2.65 Ω	12	2.4 Ω	9%
800	1.99 Ω	9	1.8 Ω	9%
1.0 k	1.59 Ω	7	1.4 Ω	12%
1.2 k	1.33 Ω	6	1.2 Ω	9%
1.6 k	0.99 Ω	4.5	0.9 Ω	9%
2.0 k	0.80 Ω	3.5	0.7 Ω	12%

Table 2

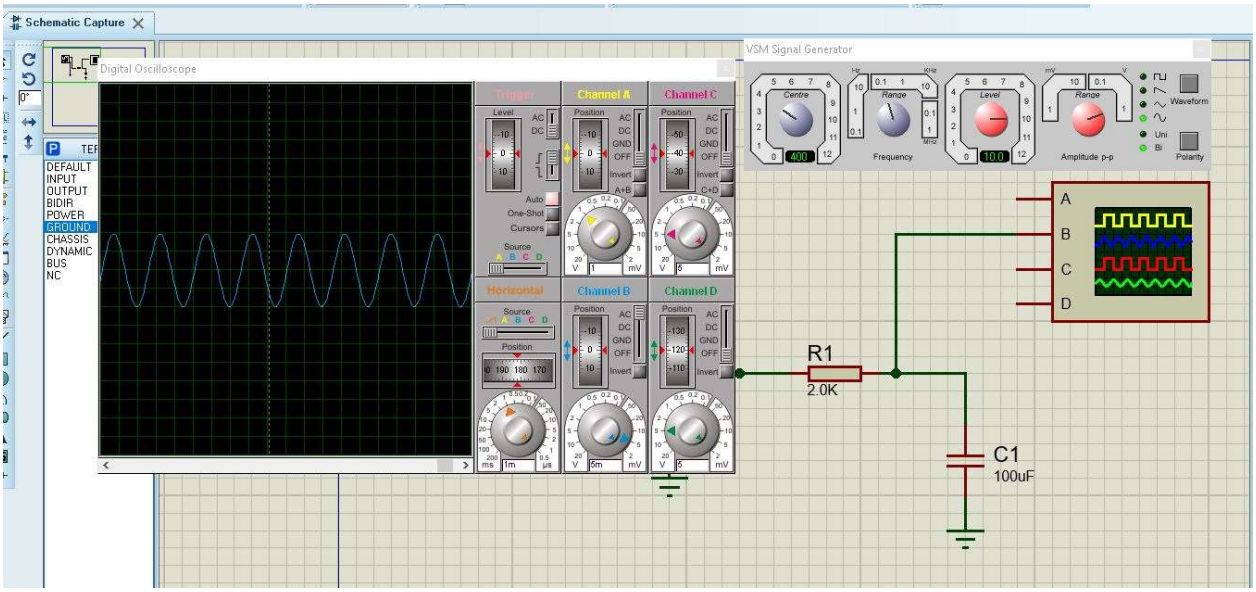


Figure 3 Proteus 100uF Capacitor Reading

Frequency	Xc Theory	$V_{c(p-p)}$ Exp	Xc Exp	% Dev
200	362Ω	1.65 V	400Ω	11%
400	181Ω	0.95 V	200Ω	11 %
600	121Ω	0.65 V	130Ω	8 %
800	90Ω	0.47 V	94Ω	4 %
1.0 k	72Ω	0.4 V	80Ω	11 %
1.2 k	60Ω	0.275 V	55Ω	9 %
1.6 k	45Ω	0.2 V	40Ω	12 %
2.0 k	36Ω	0.16 V	32Ω	12 %

Table 3

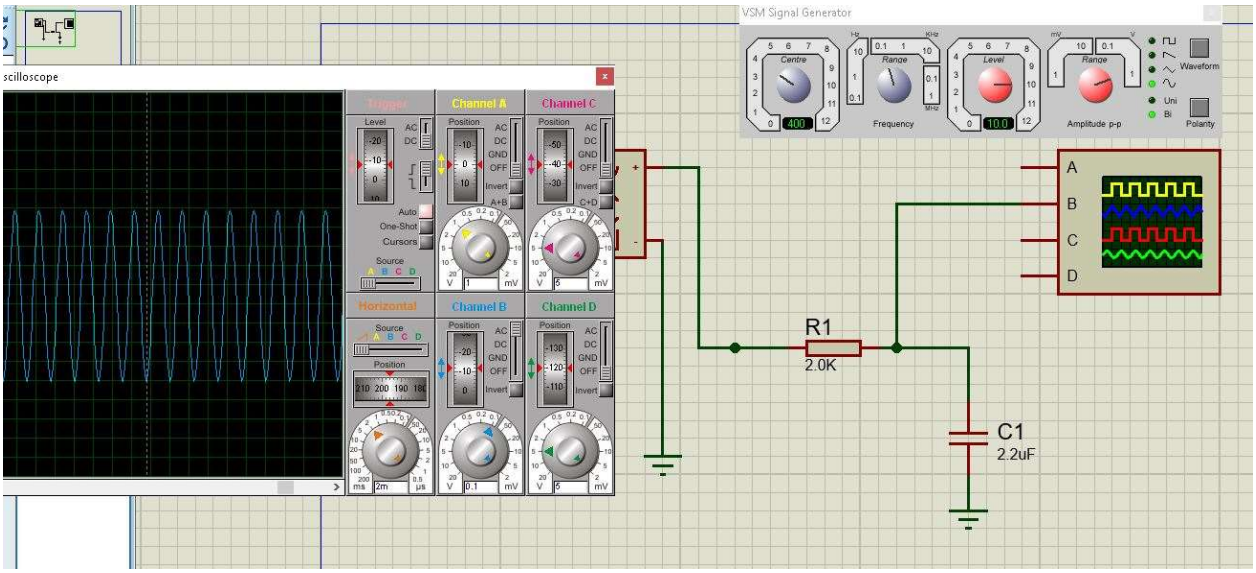
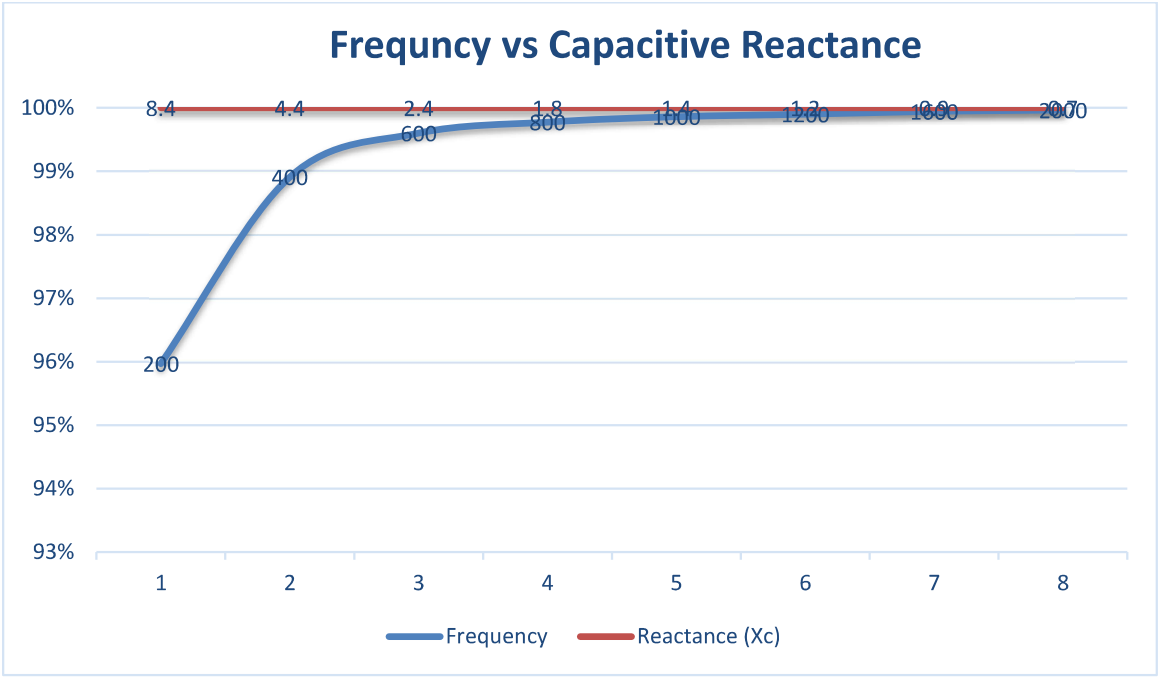


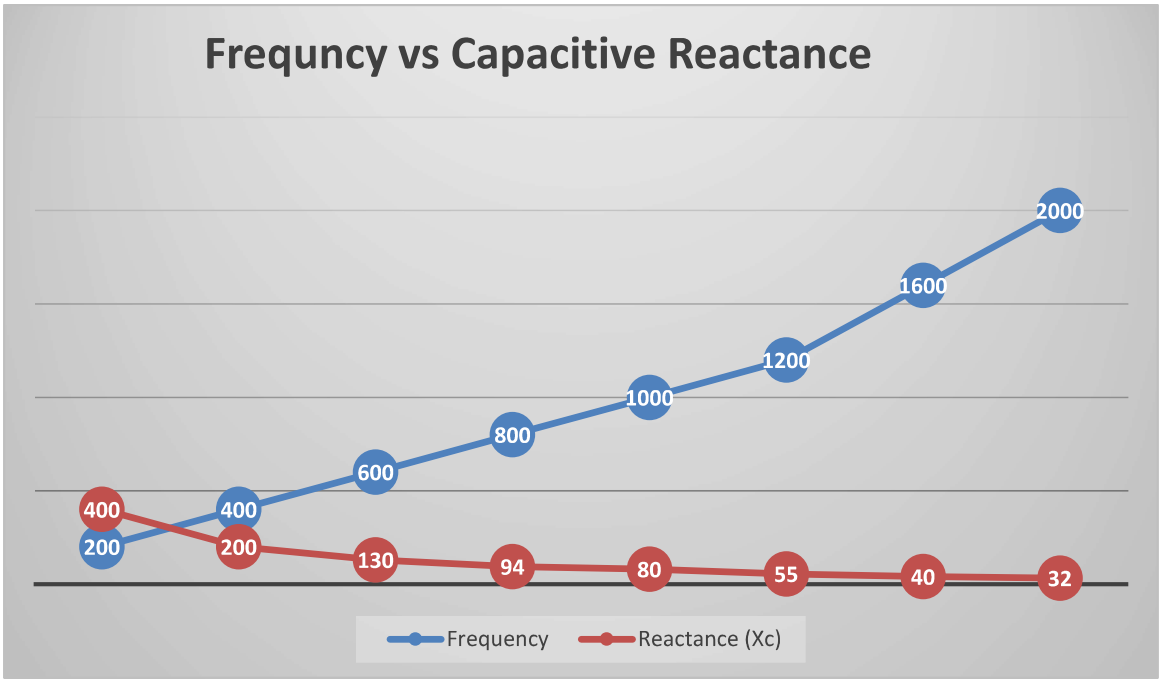
Figure 4 Proteus 2.2uF Capacitor Reading

Graphs

- **From Table 2 Experimental Data**



- **From Table 3 Experimental Data**



Questions

1. What is the relationship between capacitive reactance and frequency?

The capacitive reactance and frequency are **inversely proportional** to each other if capacitance of capacitor is same. The capacitive reactance is computed by formula:

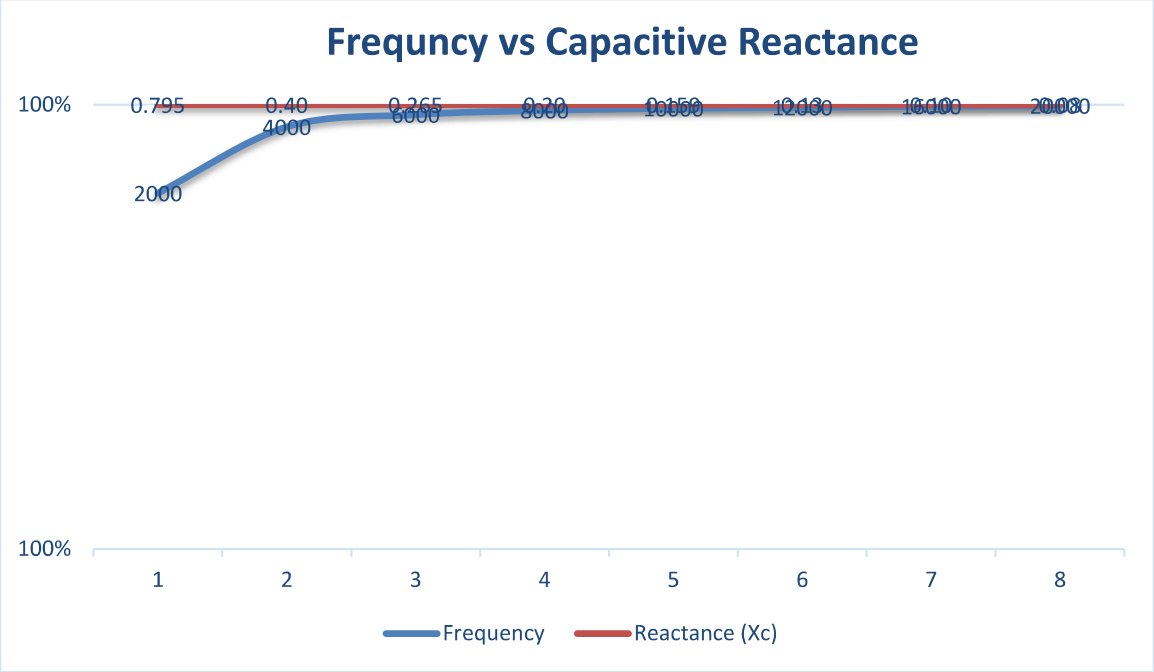
$$X_C = \frac{1}{2\pi f C}$$

2. What is the relationship between capacitive reactance and capacitance?

Capacitive Reactance is inversely proportional to capacitance and frequency. The formula to compute reactance of the capacitor is:

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

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



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