Lab 2

Capacitive Reactance

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

1. AC Function Generator
2. Oscilloscope

Components

1. 1 µF actual:__________________
2. 2.2 µF actual:__________________
3. 10 kΩ actual:__________________

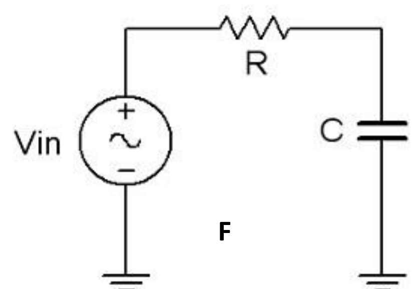

Figure 1

Procedure

Current Source

1. Using Figure 1 with V_{in}=10V_{p-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 $10V_{p-p}$. 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 X_c 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.

$i_{source\ (p-p)}$	

Table 1

Frequency	Xc Theory	$V_{C(p-p)}$ Exp	Xc Exp	% Dev
200				
400				
600				
800				
1.0 k				
1.2 k				
1.6 k				
2.0 k				

Table 2

Frequency	X_C Theory	$V_{C(p-p)}$ Exp	X_C Exp	% Dev
200				
400				
600				
800				
1.0 k				
1.2 k				
1.6 k				
2.0 k				

Table 3

Questions

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