PHYS 1402
General Physics II

EXPERIMENT 7C
AC CIRCUITS

I. OBJECTIVE:
 The objective of this experiment is to study the behavior of an RC series circuit subjected to an AC input. This will be done by measuring the circuit current and the voltages across the various circuits elements. Also the phase angle between the current and the power supply voltage will be measured. The measured quantities will be compared with theoretical predictions.

II. APPARATUS:
 Capacitor, decade resistance box, AC power supply, multimeters and connection wires.

III. EXPERIMENTAL PROCEDURE:

Procedure 1: AC Capacitor Circuit

1. Measure the capacitance of the given capacitor and record its value in the data table.

2. Wire the circuit as shown in figure (1).

3. Set the frequency of the power supply to $f = 500\,\text{Hz}$.

4. Set the amplitude of the power supply until the ammeter reads about $10\,\text{mA}$. This is the rms current, I_{rms}. Record this value in the data table.

5. Using the AC voltmeter, measure the emf of the power supply, $\mathcal{E}_{\text{rms}}$, and record it in the data table.

Procedure 2: Alternating Current RC Circuit

1. Insert the decade resistance box in your circuit and wire it as shown in figure (2).

2. Set the resistance $R = 700\,\Omega$.

3. Set the frequency to $f = 500\,\text{Hz}$.

4. Set the amplitude of the power supply until the ammeter reads about $7\,\text{mA}$. This is the rms current I_{rms}. Record it in your data table.

5. Using the AC voltmeter, measure the emf of the power supply, $\mathcal{E}_{rms}$, the voltage across the capacitor, V_C and the voltage across the resistaor, V_R. Record these values in the data table.

6. Use the oscilloscope to measure the phase angle between the power supply voltage and the current. The instructor or the lab assistant will wire the circuit for this measurement.

IV. ANALYSIS

1. For the first procedure, calculate the capacitive reactance and show your calculation below.
$$X_c = \frac{1}{\omega C} = \frac{1}{2\pi f C} \tag{1}$$

2. Calculate the theoretical rms current in the circuit and show your calculation below.
$$I_{rms,th} = \frac{\mathcal{E}_{rms}}{X_C} \tag{2}$$

3. Calculate the percent difference between the experimental and the theoretical currents.
$$\% \, \text{diff} = \frac{\left| I_{rms,exp} - I_{rms,th} \right|}{\left(\dfrac{I_{rms,exp} + I_{rms,th}}{2} \right)} \tag{3}$$

4. For procedure 2, calculate the circuit impedance
$$Z = \sqrt{R^2 + X_C^2} \tag{4}$$

5. Using the measured value of the current, calculate the power supply emf, and the voltages across the resistor and the capacitor.

$$\mathcal{E}_{rms} = I_{rms}Z \tag{5}$$
$$V_R = I_{rms}R \tag{6}$$
$$V_C = I_{rms}X_C \tag{7}$$

6. Compare the measured and the calculated values by calculating percent differences.

7. Calculate the phase angle between the supply emf and the current (for this circuit $X_L = 0.0$)

$$\tan\phi = \frac{X_L - X_C}{R} \tag{8}$$

The negative sign means that the supply voltage lags behind the current.

8. Calculate the percent difference between the measured and calculated phase angles.