(AC 2-1) Determination of AC- Source Frequency

Aim of experiment

Determination of the frequency of an AC source.

Apparatus

Capacitors – AC Source –AC Ammeter.

Theory of experiment

Consider a circuit consists of a capacitor and AC source connected in series. The relation between current and voltage is given by:

$$I_C = C\frac{dV_C}{dt} \qquad (1)$$

Now we are applying an ac voltage to the capacitor. Therefore, V_c is a sine wave of some frequency, not a fixed dc voltage. Technically:

$$V_c = V_p \sin(2\pi ft) = V_p \sin(\omega t) \qquad (2)$$

where $\omega = 2\pi f$. V_p is the amplitude of the AC generator or other source.

Substitute from (2) to (1) about V_c

$$I_C = C\frac{d}{dt}\left(V_p \sin(2\pi ft)\right) \qquad (3)$$

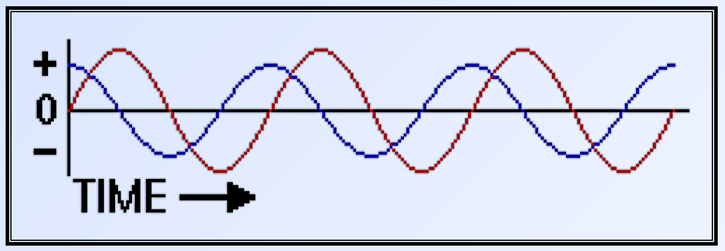
$$I_C = 2\pi fCV_p \cos(2\pi ft)$$

In general,

$$\frac{I}{C} = 2\pi f V \qquad (4)$$

The factor ωC, or $2\pi fC$, amounts to a "constant of proportionality" that relates the voltage and current in the capacitor. Note that it depends on both the value of the capacitance and the frequency of the sine wave. As either factor is increased, the capacitor current will increase for the same applied voltage.

The derived equation above for the alternating current in a capacitor tells us several important things. One of these is that when the applied AC voltage is a sine wave, as shown in red in the graph below, the resulting current is actually shifted in phase by 90° - it is a cosine wave, as shown in blue in the graph.

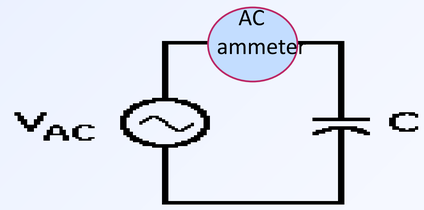


The current actually leads the applied voltage by *¼ cycles*. This actually fits what we know about the capacitor, which is that it will draw current in its attempt to oppose any change in voltage across its terminals. Thus, the capacitor reacts to the applied ac voltage by drawing current ahead by 90° of the applied voltage changes. As to that factor of ωC (or $2\pi fC$), if we invert it and use the factor $1/C$ or $1/2\pi fC$, it will behave like the capacitive equivalent of resistance

Procedures

1. Connect the circuit shown in the figure below and set AC source at a voltage V.
2. Change the capacitance of the capacitor and determine the corresponding current.
3. Draw a graph between the capacitance on x-axis and current on y-axis.
4. Determine the frequency of the AC source from the relation:

f=Slope/2πV



Results

V= v

C (F)	I (A)
0.1	
0.2	
0.3	
0.4	
0.5	
0.6	
0.7	
0.8	

$f = slope/2\pi V$

f = Hz