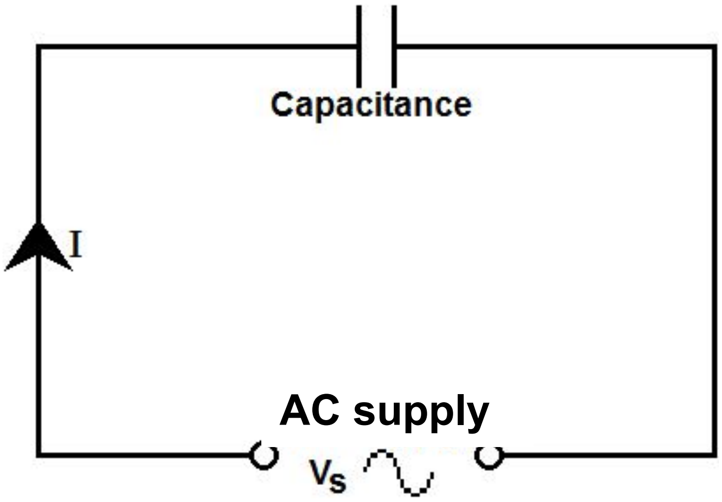
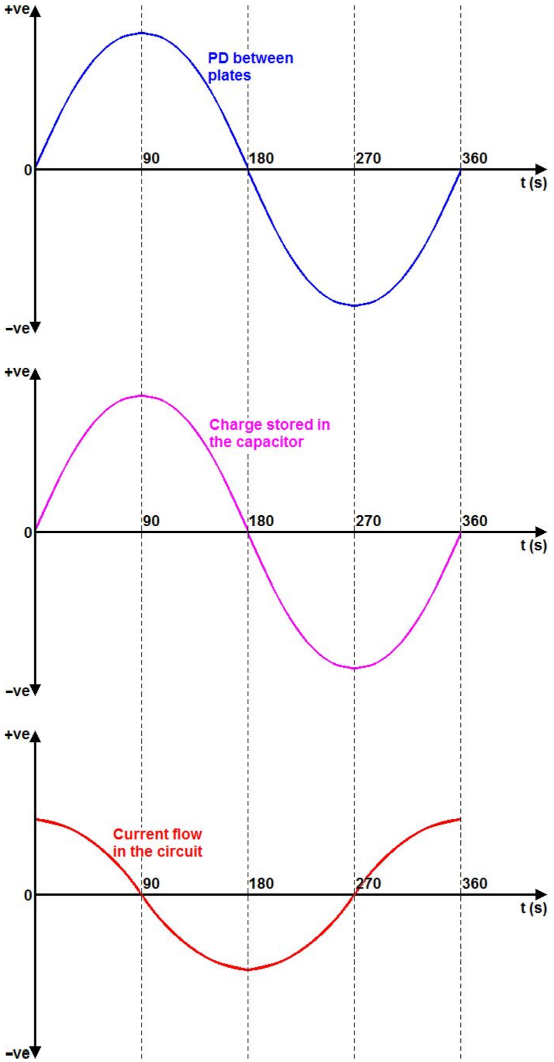
Unit 302: Principles of electrical science

Capacitance in an AC circuit





Q = V.C

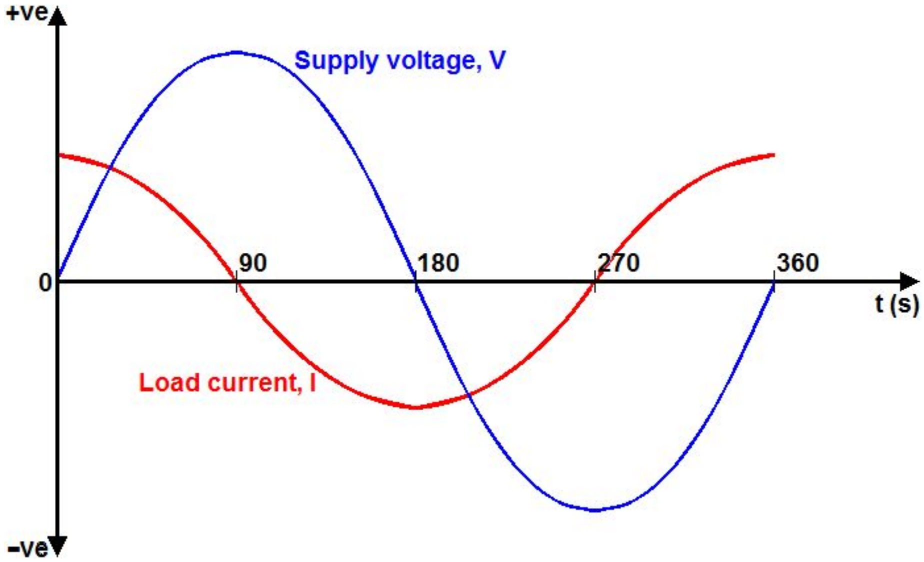
Where:

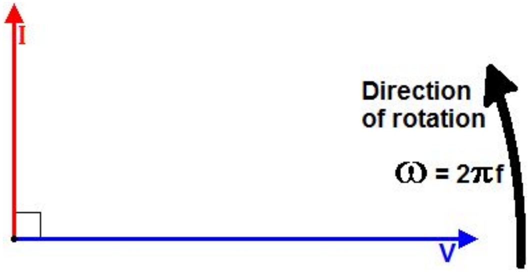
Q = Charge in coulombs

V = Voltage in volts

C = Capacitance in farads

In a purely capacitive circuit, the current must flow before the pd can be established across the capacitor and therefore the current leads the voltage by 90°





In a purely capacitive circuit, the current must flow before the pd can be established across the capacitor and therefore the current leads the voltage by 90°

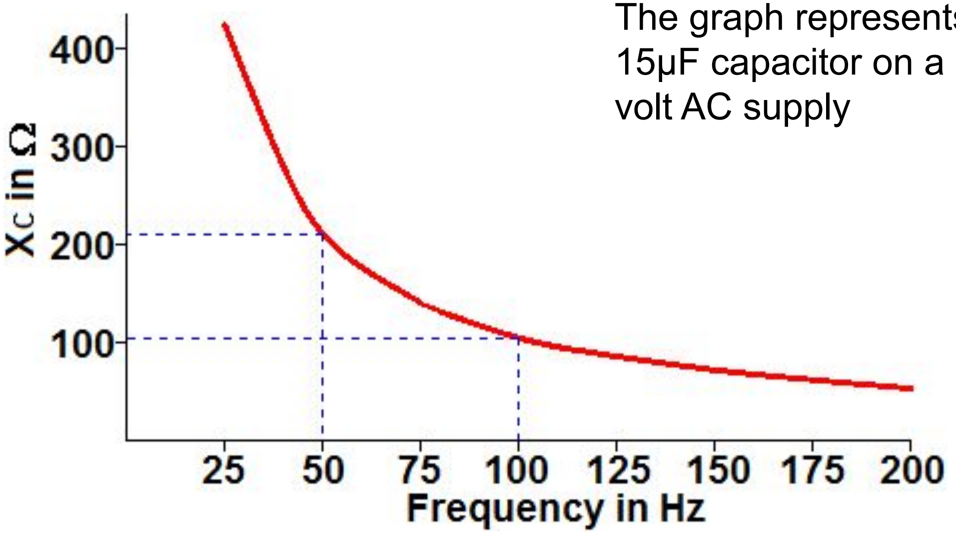
$$X_c = \frac{V}{I}$$

$$X_c = \frac{1}{2\pi fC}$$

$$X_c = \frac{1}{\omega C}$$

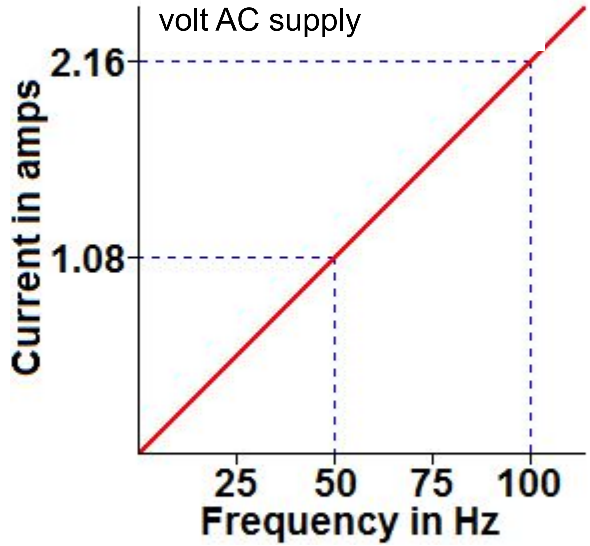
Where:

X_C	=	Reactance of the capacitor in ohms
V	=	Voltage across the capacitor
I	=	Resulting current flow
f	=	Supply frequency in Hz
C	=	Capacitance in Farads
ω	=	$2\pi f$



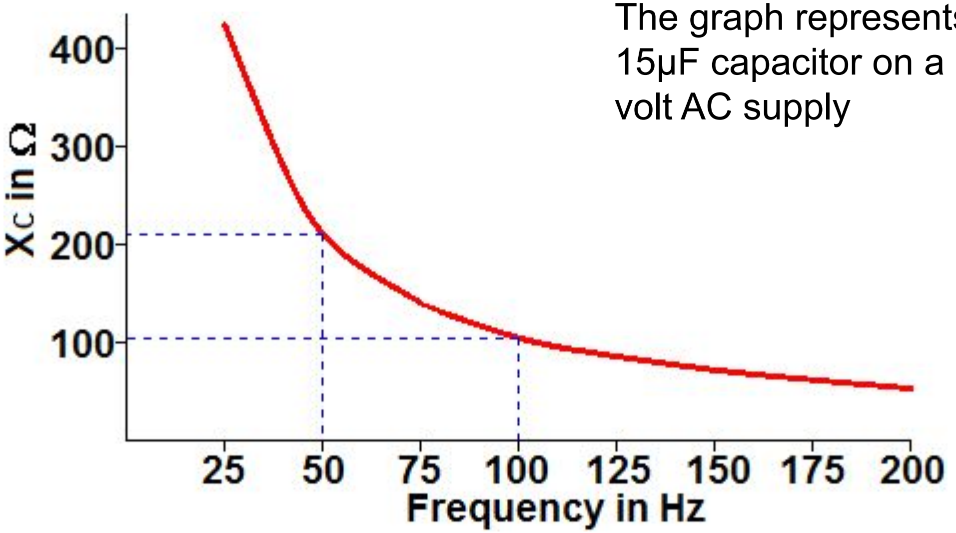
The graph represents a 15µF capacitor on a 230 volt AC supply

The graph represents a 15µF capacitor on a 230 volt AC supply



The current flowing through a capacitor is proportional to:

- size of the capacitor in microfarads (µF)
- the voltage applied to the capacitor (V_C)
- the frequency (f).



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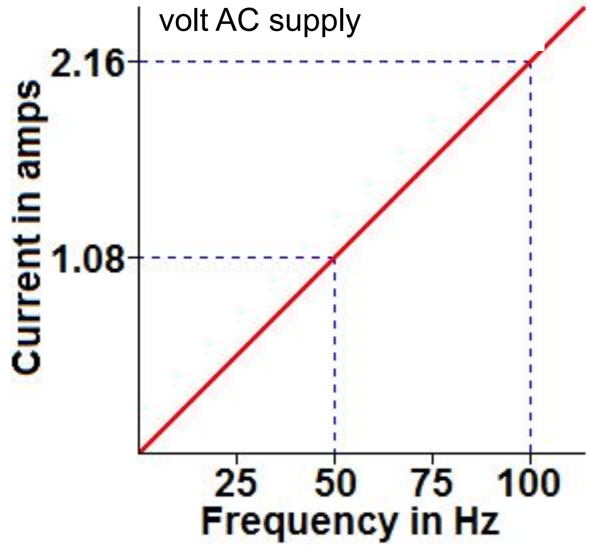

$$W = \frac{1}{2}CV^2 \text{ (joules)}$$

EXAMPLE – Calculate the capacitive reactance and current that will flow to a 2μF capacitor, when connected to a 230 volt supply at:

a) 50Hz.

b) 200Hz.

a)

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

$$X_C = \frac{1}{2\times3.14\times50\times2\times10^{-6}}$$

$$X_C = 1592.4\Omega$$

$$I = \frac{V}{X_c}$$

$$I = \frac{230}{1592.4}$$

$$I = 0.14\text{A}$$

EXAMPLE – Calculate the capacitive reactance and current that will flow to a 2μF capacitor, when connected to a 230 volt supply at:

a) 50Hz.

b) 200Hz.

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

b)

$$X_C = \frac{1}{2\times3.14\times200\times2\times10^{-6}}$$

$$X_C = 398.1\Omega$$

$$I = \frac{V}{X_c}$$

$$I = \frac{230}{398.1}$$

$$I = 0.58\text{A}$$

EXAMPLE – Calculate the capacitive reactance and current that will flow to an 8μF capacitor, when connected to a 230 volt supply at:

a) 50Hz.

b) 200Hz.

a)

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

$$X_C = \frac{1}{2 \times 3.14 \times 50 \times 8 \times 10^{-6}}$$

$$X_C = 398.1\Omega$$

$$I = \frac{V}{X_c}$$

$$I = \frac{230}{398.1}$$

$$I = 0.58\text{A}$$

EXAMPLE – Calculate the capacitive reactance and current that will flow to an 8μF capacitor, when connected to a 230-volt supply at:

a) 50Hz.

b) 200Hz.

b)

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

$$X_C = \frac{1}{2 \times 3.14 \times 200 \times 8 \times 10^{-6}}$$

$$X_C = 99.5\Omega$$

$$I = \frac{V}{X_c}$$

$$I = \frac{230}{99.5}$$

$$I = 2.3\text{A}$$

EXAMPLE – Calculate the capacitive reactance and current that will flow to a 16μF capacitor, when connected to a 230-volt supply at:

a) 50Hz.

b) 200Hz.

a)

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

$$X_C = \frac{1}{2\times 3.14\times 50\times 16\times 10^{-6}}$$

$$X_C = 199\Omega$$

$$I = \frac{V}{X_c}$$

$$I = \frac{230}{199}$$

$$I = 1.16\text{A}$$

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EXAMPLE – Calculate the capacitive reactance and current that will flow to a 16μF capacitor, when connected to a 230-volt supply at:

a) 50Hz.

b) 200Hz.

b)

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

$$X_C = \frac{1}{2\times3.14\times200\times16\times10^{-6}}$$

$$X_C = 49.8\Omega$$

$$I = \frac{V}{X_c}$$

$$I = \frac{230}{49.8}$$

$$I = 4.6\text{A}$$

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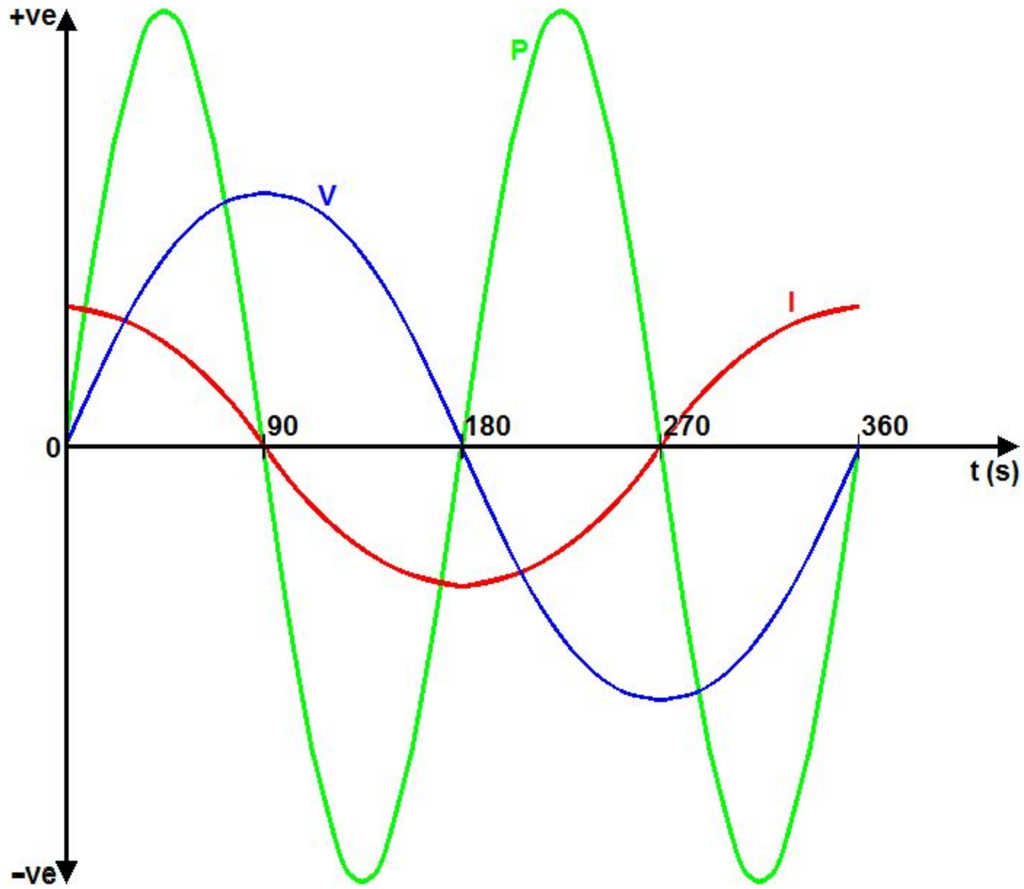
$P = I^2R$ therefore p = zero watts



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Any questions?