Answer on Question #40547, Electric Circuits

A series resistance-capacitance (R-C) circuit is connected to a 230V, 60Hz source. If the power taken by the circuit is 4,800W and the voltage drop across the resistor is 115V, calculate the capacitance of the capacitor.

Solution

$U = 230\ V$ – total voltage, $U_R = 115\ V$ – voltage drop across the resistor, $f = 60\ Hz$ – frequency, $P = 4800\ W$ - power taken by the circuit.

Voltage across the capacitor:

$$U_C = \sqrt{U^2 - U_R^2}.$$

In this circuit only the resistor can dissipate power:

$$P = \frac{{U_R}^2}{R} \to R = \frac{{U_R}^2}{P}.$$

The ratio of the impedances will be the same as the voltages (currents are equal for series connection):

$$\frac{X_C}{R} = \frac{U_c}{U_R} \to X_C = \frac{U_c}{U_R} R = \frac{\sqrt{U^2 - U_R^2}}{U_R} \cdot \frac{{U_R}^2}{P} = \frac{U_R}{P}\sqrt{U^2 - U_R^2}.$$

But

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

The capacitance of the capacitor:

$$C = \frac{P}{2\pi f U_R \sqrt{U^2 - U_R^2}} = \frac{4800}{2\pi \cdot 60 \cdot 115 \cdot \sqrt{230^2 - 115^2}} = 556\ \mu F.$$

Answer: $556\ \mu F$.