NOTES -Class 28

1. A 250-V, 50-Hz voltage is applied to a coil having resistance of 5Ω and an inductance of 9.55 H in series with a capacitor C. If the voltage across the coil is 300 V, find the value of C.

Solution

Solution

Data

$V = 250$ V
$R = 5\ \Omega$
$L = 9.55$ H
$V_{coil} = 300$ V
$X_L = 2\pi fL = 2\pi \times 50 \times 9.55 = 3000\ \Omega$

$$Z_{coil} = \sqrt{R^2 + X_L^2} = \sqrt{(5)^2 + (3000)^2} = 3000\ \Omega$$

$$I = \frac{V_{coil}}{Z_{coil}} = \frac{300}{3000} = 0.1\ \text{A}$$

Total impedance

$$Z = \frac{V}{I} = \frac{250}{0.1} = 2500\ \Omega$$

When $X_L > X_C$,

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$
$$(2500)^2 = (5)^2 + (3000 - X_C)^2$$
$$(3000 - X_C) = 2500$$
$$X_C = 500$$
$$C = \frac{1}{2\pi f X_C} = \frac{1}{2\pi \times 50 \times 500} = 6.37\ \mu\text{F}$$

When $X_C > X_L$,

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$
$$(2500)^2 = (5)^2 + (X_C - 3000)^2$$
$$2500 = X_C - 3000$$
$$X_C = 5500$$
$$C = \frac{1}{2\pi \times 50 \times 5500} = 0.58\ \mu\text{F}.$$

2.An R-L-C series circuit has a current which lags the applied voltage by 45°. The voltage across the inductance has maximum value equal to twice the maximum value of voltage across the capacitor.Voltage across the inductance is 300 sin (1000t) and R = 20 Ω . Find the value of inductance and capacitance

Solution

Data

$$v_L = 300 \sin (1000t)$$
$$R = 20\ \Omega$$
$$\phi = 45^\circ$$
$$V_{L(\max)} = 2V_{C(\max)}$$
$$\sqrt{2}\, V_L = 2\sqrt{2}\, V_C$$
$$I \times X_L = 2I \times X_C$$
$$X_L = 2X_C$$
$$\cos \phi = \frac{R}{Z}$$

$$\cos (45^\circ) = \frac{20}{Z}$$
$$Z = 28.28\ \Omega$$

For a series *R-L-C* circuit,

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$
$$(28.28)^2 = (20)^2 + (2X_C - X_C)^2$$
$$799.76 = 400 + X_C^2$$
$$X_C = 20\ \Omega$$
$$X_L = 2X_C = 40\ \Omega$$
$$X_L = \omega L$$
$$40 = 1000 \times L$$
$$L = \frac{40}{1000} = 0.04\ \text{H}$$
$$X_C = \frac{1}{\omega C}$$
$$20 = \frac{1}{1000 \times C}$$
$$C = 50\ \mu\text{F}$$