GATE 2022 IN Q52

EE23BTECH11009 - AROSHISH PRADHAN*

Question: In the circuit shown, the load is driven by a sinusoidal A.C. voltage source $V_1 = 100\angle 0°V$ at $50Hz$. Given $R_1 = 20\Omega$, $C_1 = \left(\frac{1000}{\pi}\right)\mu F$, $L_1 = \left(\frac{20}{\pi}\right)mH$ and $R_2 = 4\Omega$, the power factor is _ _ _ _ _ (round off to one decimal place) (GATE 2022 IN Q52)

∴ Power Factor:

$$\cos(\phi) = \frac{\text{Re}(Z_{\text{eff}})}{|Z_{\text{eff}}|} \tag{4}$$

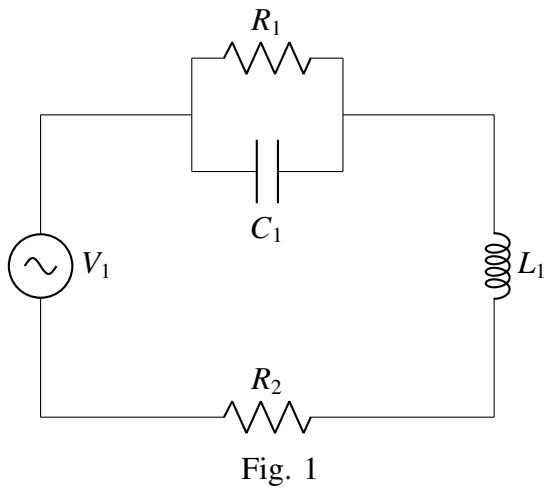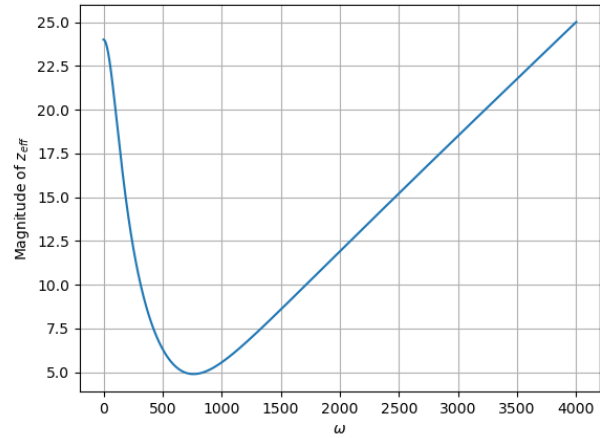$$= \frac{8}{\sqrt{8^2 + 6^2}} \tag{5}$$

$$= 0.8 \tag{6}$$

Fig. 1

Fig. 2: Plot of Z_{eff} vs ω

Solution:

Symbol	Value	Description
V_1	$100\angle 0°V$	Input Voltage
f	$50Hz$	Frequency
ω	$2\pi f$	Angular Frequency
R_1	20Ω	Resistance
R_2	4Ω	Resistance
C_1	$\left(\frac{1000}{\pi}\right)\mu F$	Capacitance
L_1	$\left(\frac{20}{\pi}\right)mH$	Inductance
Z_{eff}		Impedance
$\cos(\phi)$	$\frac{\text{Re}(Z_{\text{eff}})}{|Z_{\text{eff}}|}$	Power Factor

TABLE I: Given Parameters

$$Z_{\text{eff}} = R_2 + j\omega L_1 + \frac{\frac{R_1}{j\omega C_1}}{R_1 + \frac{1}{j\omega C_1}} \tag{1}$$

$$= 4 + 2j + \frac{-200j}{20 - 10j} \tag{2}$$

$$= 8 - 6j \tag{3}$$