Gate Assignment

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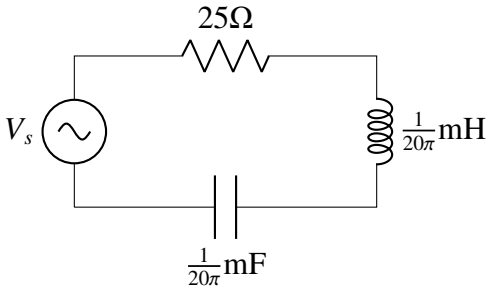
Question

The voltage source $V_s = 10\sqrt{2}\sin(20000\pi t)$ V has an internal resistance of 50 ohms. The RMS value of the current through R is ___ (in mA) (rounded off to one decimal place).



(GATE IN 2023)

Solution:

Parameter	Value
V_s	$10\sqrt{2}\sin(20000\pi t)$ V
R	??
R_{internal}	50 ohms
R_{net}	$R + R_{\text{internal}}$

TABLE I
INPUT PARAMETERS

$$V(s) = ZI(s) \tag{1}$$

$$I_{\text{RMS}} = \frac{V_{\text{RMS}}}{|Z|} \cdot e^{-\angle Z} \tag{2}$$

$$\frac{V_{\text{RMS}}}{I_{\text{RMS}}} = Z = R + R_{\text{internal}} + Ls + \frac{1}{Cs} \tag{3}$$

$$= 50 + 25 + \frac{s}{20000\pi} + \frac{20000\pi}{s} \tag{4}$$

$$V_{\text{RMS}} = \frac{10\sqrt{2}}{\sqrt{2}} = 10\,\text{V} \tag{5}$$

$$\text{Putting } s = j\omega \tag{6}$$

$$\frac{V(j\omega)}{I(j\omega)} = |Z| \tag{7}$$

$$= 75 + \frac{20000\pi j}{20000\pi} + \frac{20000\pi}{20000\pi j} \tag{8}$$

$$= 75 + j - j \tag{9}$$

$$= 75 \tag{10}$$

$$I_{\text{RMS}} = \frac{10}{75} \times 1000 = \frac{2000}{15} \approx 133.3\,\text{mA} \tag{11}$$