GATE:2022 - BM 54

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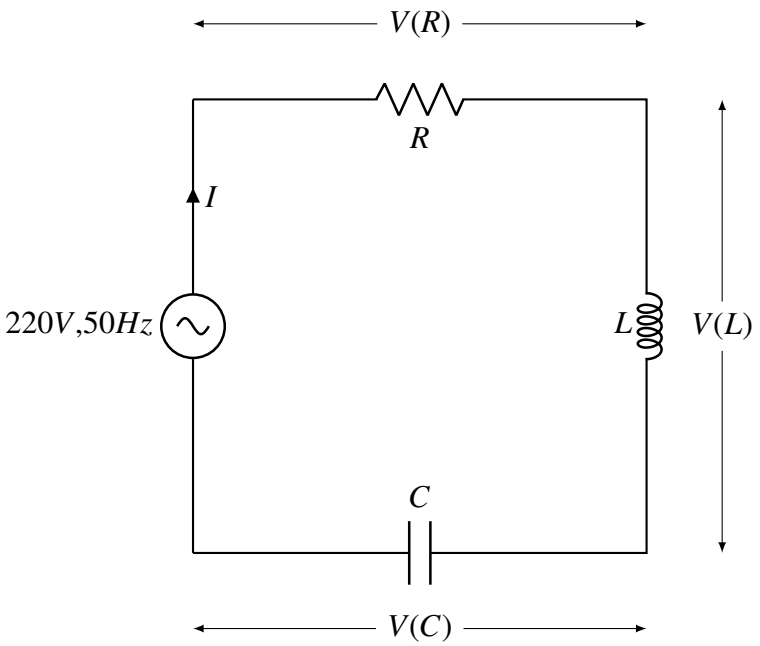
I. QUESTION

A series RLC circuit is connected to 220 V, 50 Hz supply. For a fixed a value of R and C, the inductor L is varied to deliver the maximum current. This value 0.4A and the corresponding potential drop across the capacitor is 330 V. The value of the inductor L is ? (Rounded off to two decimal places).

Solutions :

Symbols	Description
$X_1(s)$	Laplace transform of $x_1(t)$
$X_2(s)$	Laplace transform of $x_2(t)$
$u(t)$	Unit step function

TABLE I
PARAMETERS, DESCRIPTIONS



During maximum current $|Z_{net}|$ is minimum .

$$I = \frac{V_s}{Z_{net}} \tag{1}$$

$$= \frac{V_s}{R + \chi_L + \chi_C} \tag{2}$$

$$|I| = \left| \frac{V_s}{R + j\omega L + \frac{1}{j\omega C}} \right| \tag{3}$$

$$= \frac{|V_s|}{\sqrt{R + \left(\omega L - \frac{1}{\omega C}^2\right)}} \tag{4}$$

Varying L for maximum value of I :

$$\omega L = \frac{1}{\omega C} \tag{5}$$

Putting in (4):

$$I_{max} = \frac{V_s}{R} \tag{6}$$

I_{max} has same phase as V_s (Assume $\angle\phi$). For impedance across the capacitor :

$$V_C|_{I=I_{max}} = I_{max}\chi_C \tag{7}$$
$$-330\angle(90+\phi) = (0.4\angle\phi)\chi_C \tag{8}$$
$$-330\angle 90 = 0.4\chi_C \tag{9}$$
$$\implies \chi_C = -825\,j\Omega \tag{10}$$

For value of inductor, using (5) :

$$L = \frac{825}{100\pi}H \tag{11}$$
$$\approx 2.63H \tag{12}$$

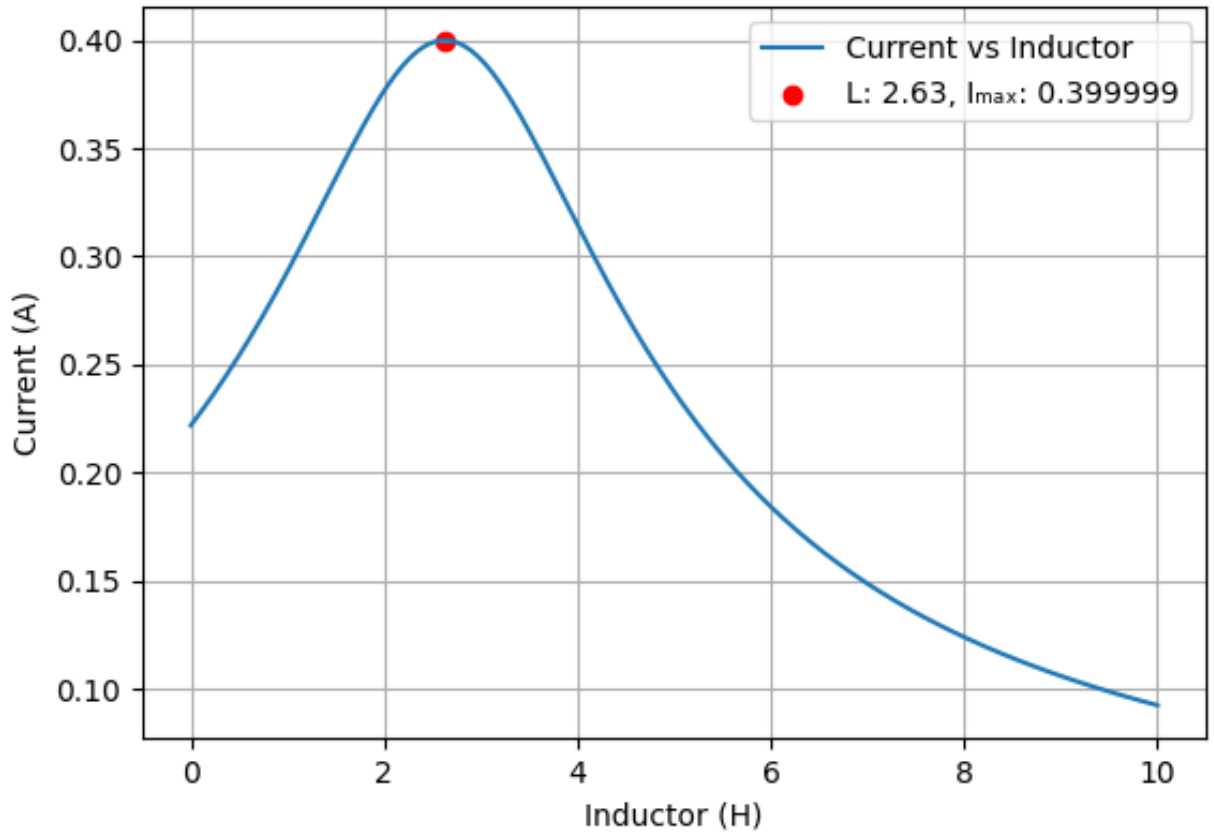


Fig. 1. I vs L