GATE:2022 - BM 54

EE23BTECH11025 - Anantha Krishnan

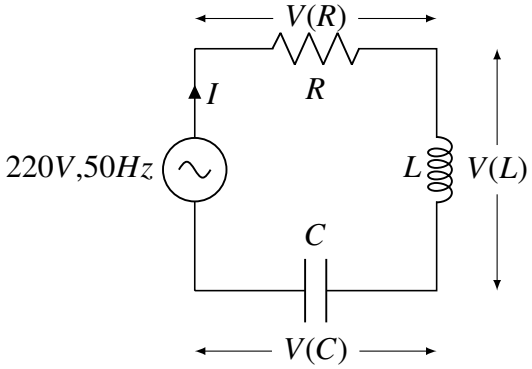
I. QUESTION

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	Values
V_s	Input voltage	220 V and 50Hz
χ_L	Impedance across inductor	$j\omega L$
χ_C	Impedance across capacitor	$\frac{-j}{\omega C}$
Z	Impedance across the entire circuit	$\frac{1}{R+j\omega L+\frac{-j}{\omega C}}$

TABLE I
PARAMETERS, DESCRIPTIONS, AND VALUES



During maximum current $|Z|$ is minimum .

$$I = \frac{V_s}{Z} \tag{1}$$

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

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

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

Varying L for maximum value of I :

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

Putting in (3):

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

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 Capacitor and inductor, using (5) :

$$L = \frac{825}{100\pi}H \tag{11}$$
$$\approx 2.63H \tag{12}$$
$$C = 3.858 * 10^{-6}F \tag{13}$$

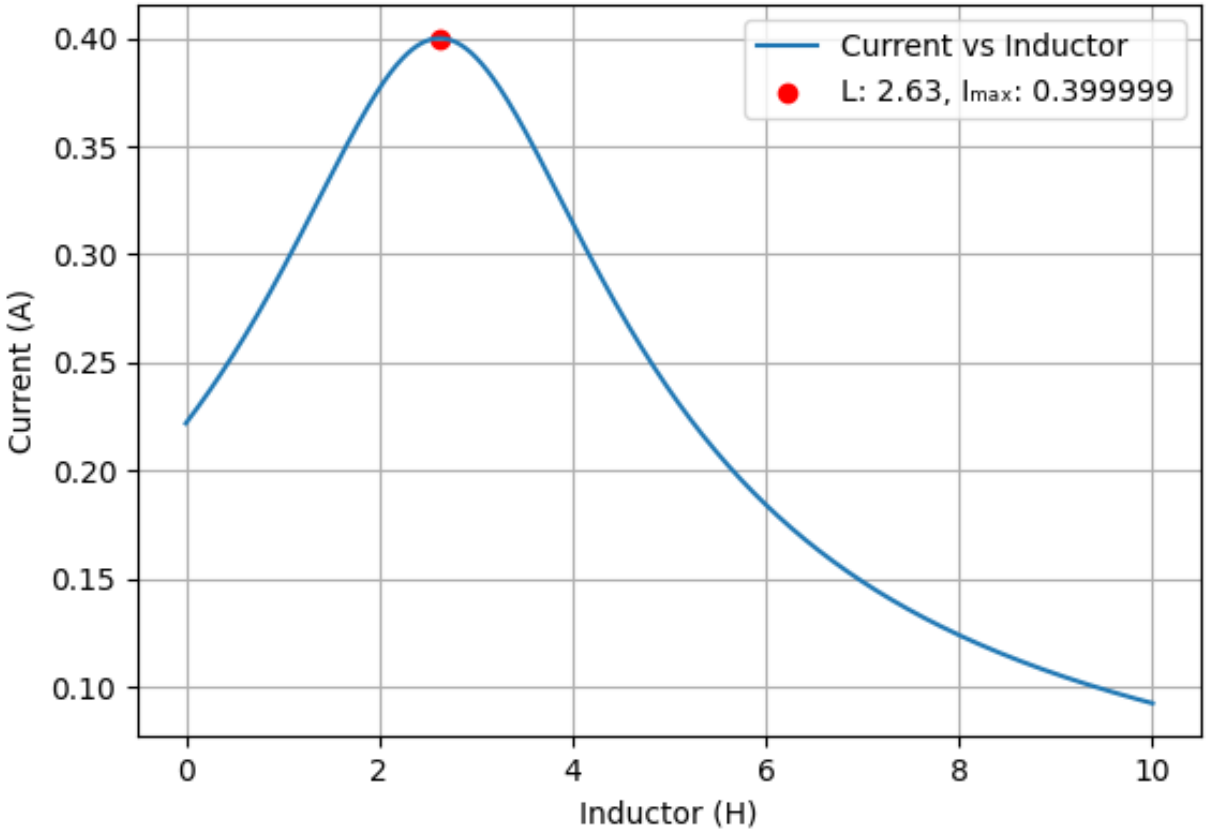


Fig. 1. I vs L