Q- An ideal choke takes a current of 5 A when connected to an ac source of 100 volt and 50 Hz. A pure resistor under the same conditions takes a current of 10 A. If the two are connected in series to an ac supply of 120 V and 60 Hz, then what current will flow in series combination of above resistor and inductor?

The oppose to the alternating current in an inductor is called reactance and it is given by

$$X_L = \omega L$$

Here XL is the reactance, L inductance of the coil and w is the angular frequence of the current. The current and the voltage are given in A and V directly this means these are rms values of AC current and voltages respectively. Thus we can write

$$X_L = 2\pi \times 50 \times L = \frac{V_{rms}}{i_{rms}} = \frac{220}{5} = 2\pi \times 50 \times L$$

Gives $$L = \frac{11}{25\pi} Henry$$

In case of resistor the current is 10 A thus the resistance will be

$$R = \frac{V}{I} = \frac{220}{10} = 22\ \Omega$$

Now if a resistor and inductor both are in series in an AC circuit the net oppose offered to the current is called Impedance of the circuit is given by

$$Z = \sqrt{R^2 + X_L^2} = \sqrt{R^2 + (2\pi L)^2}$$

In the series combination the rms voltage is 120V at 60 Hz hence the current will be

$$I = \frac{V}{Z} = \frac{V}{\sqrt{R^2 + (2\pi L)^2}}$$

Or $$I = \frac{120}{\sqrt{22^2 + \left(2\pi * 60 * \frac{11}{25\pi}\right)^2}} \qquad (\omega = 2\pi f)$$

Or $$I = \frac{120}{\sqrt{22^2 + \left(22 * \frac{12}{5}\right)^2}}$$

Or $$I = \frac{120}{22 * \sqrt{1 + \left(\frac{12}{5}\right)^2}} = 2.96\ A$$

So impedance of the series *RC* circuit at a frequency of 40 *Hz* is $Z = \sqrt{\left(\frac{1}{8\pi} \times 2\pi \times 40\right)^2 + 10^2} = 10\sqrt{2}$

Hence current in the *RC* circuit now $i = \frac{E}{Z} = \frac{100}{10\sqrt{2}} = \frac{10}{\sqrt{2}} = 5\sqrt{2}A.$