

NCERT Physics 12.7. Q20

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Question A series LCR circuit with $L = 0.12$ H, $C = 480$ nF, $R = 23\Omega$ is connected to a 230 V variable frequency supply.

(a) What is the source frequency for which current amplitude is maximum. Obtain this maximum value.

(b) What is the source frequency for which average power absorbed by the circuit is maximum. Obtain the value of this maximum power.

(c) For which frequencies of the source is the power transferred to the circuit half the power at resonant frequency? What is the current amplitude at these frequencies?

(d) What is the Q-factor of the given circuit?

Solution: Given parameters are:

TABLE 0
GIVEN DATA

Parameter	Symbol	Value
Inductance	L	0.12 H
Capacitance	C	480 nF
Resistance	R	23 Ω
Supply voltage	V	230 V

(a)

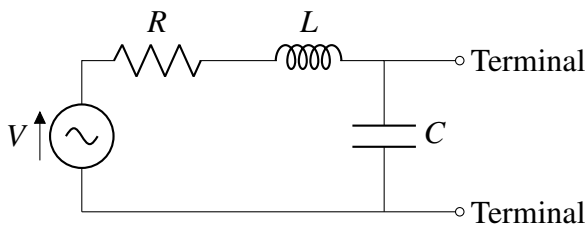
$$V_o = \sqrt{2}V = 325.2 \text{ volts} \quad (1)$$

$$\text{At resonance, } \omega_{RL} = \frac{1}{\omega RC} \quad (2)$$

$$\omega_R = \frac{1}{\sqrt{LC}} = 4166.67 \text{ rad/s} \quad (3)$$

$$\nu_R = \frac{\omega_R}{2\pi} = 663.48 \text{ Hz} \quad (4)$$

$$I_o = \frac{V_o}{R} = 14.14 \text{ A} \quad (5)$$



(b)

$$P = \frac{1}{2} I_o^2 R = \frac{1}{2} (14.14)^2 \times 23 \Rightarrow 2299.3 \text{ W} \quad (6)$$

(c)

$$\Delta\omega = R^2 L = 23^2 \times 0.12 = 95.83 \text{ rad/s} \quad (7)$$

$$\omega'_1 = 4166.67 + 95.83 = 4262.3 \text{ rad/s} \quad (8)$$

$$\omega'_2 = 4166.67 - 95.83 = 4070.87 \text{ rad/s} \quad (9)$$

$$I = I_o \sqrt{2} = \frac{14.14}{1.414} = 10 \text{ A} \quad (10)$$

(d)

$$Q = \frac{1}{R} \sqrt{LC} = \frac{1}{23} \sqrt{0.12480 \times 10^{-9}} = 21.74 \quad (11)$$