

NCERT Physics 12.7 Q19

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Question: Suppose the circuit in Exercise 7.18 (in Figure 1) has a resistance of 15Ω . Obtain the average power transferred to each element of the circuit, and the total power absorbed.

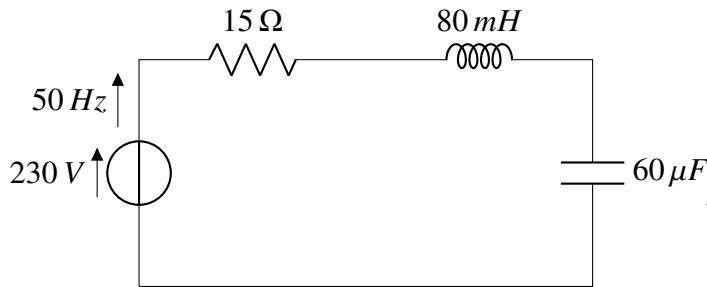


Fig. 1. LCR Circuit

Solution: In in Figure 1 the following information is provided:

Symbol	Value	Description
L	80 mH	Inductance
C	$60 \mu\text{F}$	Capacitance
R	15Ω	Resistance
V	230 V	Voltage
f	50 Hz	Frequency

TABLE I
IMPEDENCES

Angular frequency of signal, $\omega = 2\pi f = 2\pi \cdot (50)$
 $= 100\pi$

The elements are connected in series to each other. Hence the impedance Z is given as :

$$Z = \sqrt{R^2 + \left(\omega \cdot L - \frac{1}{\omega \cdot C}\right)^2} \quad (1)$$

$$= \sqrt{15^2 + \left(100\pi \cdot (80 \times 10^{-3}) - \frac{1}{100\pi \times 60 \times 10^{-6}}\right)^2} \quad (2)$$

$$= \sqrt{15^2 + (25.12 - 53.08)^2} \quad (3)$$

$$= 31.728 \Omega \quad (4)$$

Current flowing through the circuit I is :

$$I = \frac{V}{Z} = \frac{230}{31.728} \quad (5)$$

$$= 7.25 \text{ A} \quad (6)$$

Average power transferred to resistance is given by :

$$P_R = I^2 \cdot R = (7.25)^2 \times 15 \quad (7)$$

$$= 788.44 \text{ W} \quad (8)$$

Average power transferred to the capacitor, $P_C =$
 Average power transferred to the inductor, $P_L = 0$

Total power absorbed by circuit:

$$= P_R + P_C + P_L \quad (9)$$

$$= 788.44 + 0 + 0 \quad (10)$$

$$= 788.44 \text{ W} \quad (11)$$

Total power absorbed by circuit is 788.44W

Function $H(s)$:

$$V(s) = RI(s) + sLI(s) + \frac{1}{sC}I(s) \quad (12)$$

$$\Rightarrow V(s) = I(s) \left(R + Ls + \frac{1}{sC} \right) \quad (13)$$

$$\Rightarrow I(s) = \frac{V(s)}{\left(R + Ls + \frac{1}{sC} \right)} \quad (14)$$

$$H(s) = \frac{V(s)}{I(s)} \quad (15)$$

$$H(s) = R + sL + \frac{1}{sC} \quad (16)$$

$$\Rightarrow H(j\omega) = R + j\omega L + \frac{1}{j\omega C} \quad (17)$$

$$\Rightarrow |H(j\omega)| = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} \quad (18)$$

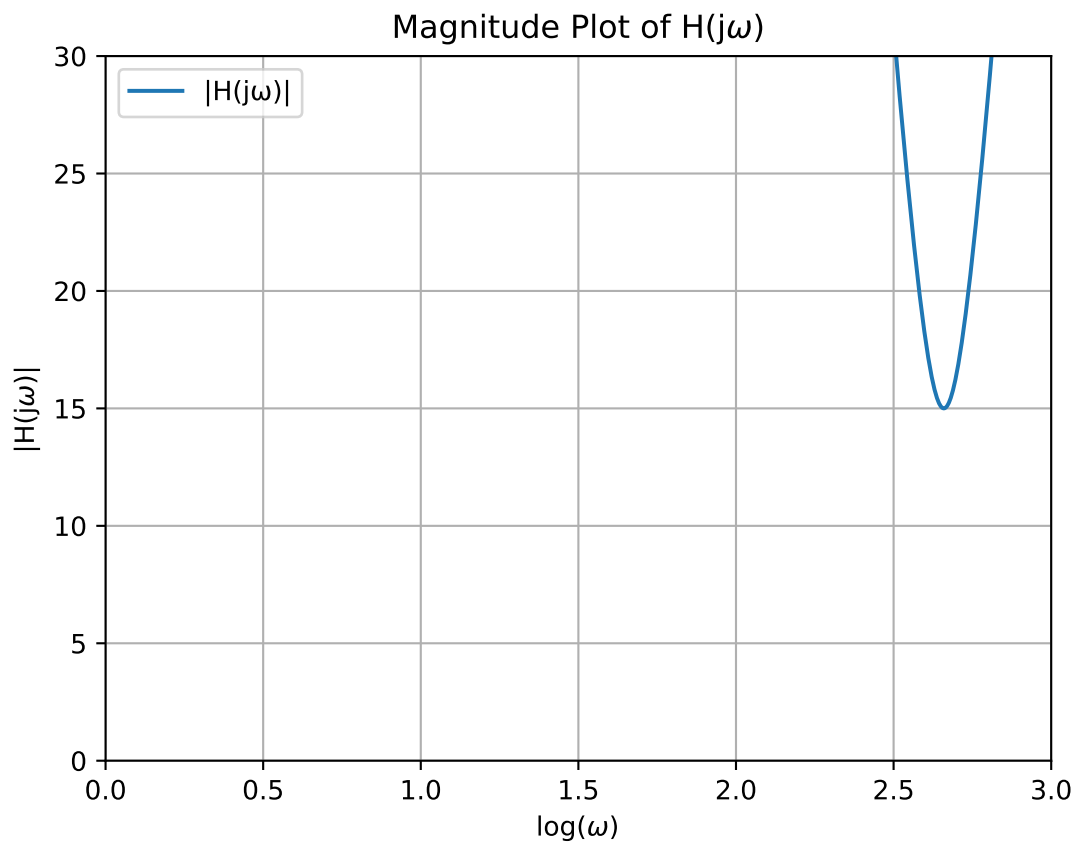


Fig. 2. Absolute value of $H(j\omega)$ for RLC Circuit