

EE23BTECH11217 - Prajwal M*

EXERCISE 9.1

The given figure shows a series LCR circuit connected to a sinusoidal 230 V source.
 $L = 5.0 \text{ H}$, $C = 80 \mu\text{F}$, $R = 40 \Omega$.

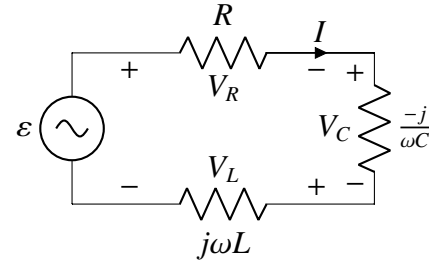
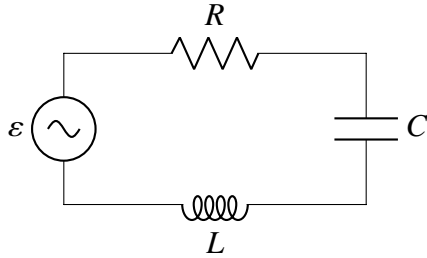


Fig. 3. circuit diagram

- 1) Determine the source frequency which drives the circuit in resonance.
- 2) Obtain the impedance of the circuit at the resonating frequency.
- 3) Determine the rms potential drops across the three elements of the circuit. Show that the potential drop across the LC combination is zero at the resonating frequency.

Solution:

Paramater	Description	Value
ε	Voltage power supply	$Re\{230\sqrt{2}e^{j\omega t}\} \text{ V}$
L	Inductance	5.0 H
C	Capacitance	80 μF
R	Resistance	40 Ω
$\frac{\omega}{2\pi}$	Frequency of voltage source	?
Z	Impedance of circuit	?
V_R	Potential drop across Resistor	?
V_C	Potential drop across Capacitor	?
V_L	Potential drop across Inductor	?

TABLE 3
PARAMETER DESCRIPTION

from Fig. 3,

$$Z = R + j\left(\omega L - \frac{1}{\omega C}\right) \quad (1)$$

$$\min(|Z|) = R \text{ at } \omega = \frac{1}{\sqrt{LC}} \quad (2)$$

$$f_{res} = \frac{\omega_{res}}{2\pi} = \frac{1}{2\pi\sqrt{LC}} = 7.958 \text{ Hz} \quad (3)$$

$$Z_{res} = R = 40 \Omega \quad (4)$$

$$I_{res} = \frac{\varepsilon}{Z_{res}} \quad (5)$$

$$= \left(\frac{230\sqrt{2}e^{j\omega_{res}t}}{R} \right) \quad (6)$$

$$I_{res} = (8.132)e^{j50t} \quad (7)$$

$$V_R = Re\{RI_{res}\} \quad (8)$$

$$= Re\{325.28e^{j50t}\} \quad \{\text{using (7)}\} \quad (9)$$

$$= 325.28 \cos(50t) \quad (10)$$

$$V_C = Re\left\{\frac{-j}{\omega_{res}C}I_{res}\right\} \quad (11)$$

$$= Re\{2032.93e^{j(50t - \frac{\pi}{2})}\} \quad \{\text{using (7)}\} \quad (12)$$

$$= 2031.93 \sin(50t) \quad (13)$$

$$V_L = Re\{j\omega_{res}LI_{res}\} \quad (14)$$

$$= Re\{2032.93e^{j(50t + \frac{\pi}{2})}\} \quad \{\text{using (7)}\} \quad (15)$$

$$= -2031.93 \sin(50t) \quad (16)$$

from (13) and (16), voltage across LC combination is $V_C + V_L = 0 \text{ V}$

Paramater	Description	Value
f_{res}	resonant source frequency	7.958 Hz
Z_{res}	resonant impedance	40 Ω
$rms(V_R)$	rms value of V_R	230 V
$rms(V_C)$	rms value of V_C	1437.5 V
$rms(V_L)$	rms value of V_L	1437.5 V

TABLE 3
SOLUTION VALUES

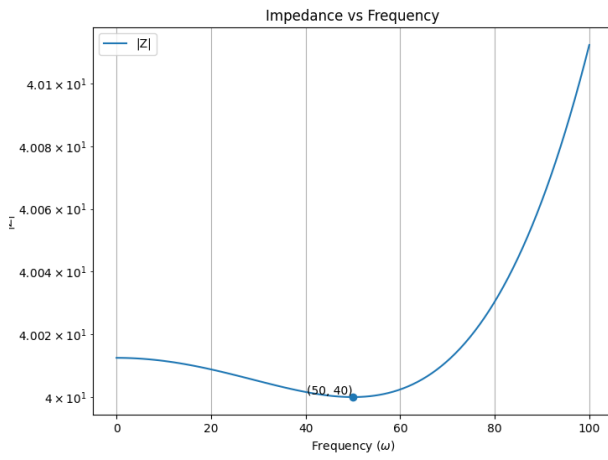


Fig. 3. Impedance vs frequency