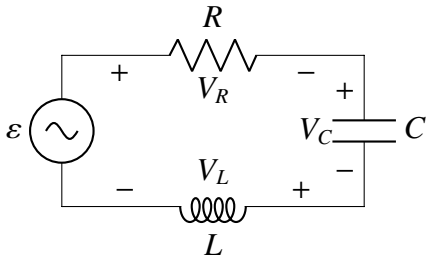
EE23BTECH11217 - Prajwal M*

Exercise 9.1

The given figure shows a series LCR circuit connected to a variable frequency 230 V source. L = 5.0 H, C = 80 μF, R = 40 Ω.



1) Determine the source frequency which drives the circuit in resonance.
2) Obtain the impedance of the circuit and the amplitude of current 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
L	Inductance	5.0 H
C	Capacitance	80 μF
R	Resistance	40 Ω
ω_{res}	resonance frequency	50 rad/s
Z_{res}	Resonance impedance	40 Ω
I_{res}	Amplitude of current at resonance	8.1 A
V_R	Potential drop across Resistor	230 V
V_L	Potential drop across Resistor	1437.5 V
V_C	Potential drop across Resistor	1437.5 V
V_{LC}	Potential drop across LC combination	0 V

TABLE 3
Parameter description

1)

$$\omega_{\text{res}} = \frac{1}{\sqrt{LC}} \tag{1}$$

$$\omega_{\text{res}} = \frac{1}{\sqrt{(5.0\,\text{H})(80\times10^{-6}\,\text{F})}} \tag{2}$$

$$\omega_{\text{res}} \approx 50\,\text{rad/s} \tag{3}$$

$$\tag{4}$$

2)

$$Z_{\text{res}} = R = 40\,\Omega \tag{5}$$

$$I_{\text{res}} = \frac{\sqrt{2}\varepsilon}{Z_{\text{res}}} \tag{6}$$

$$= \frac{\sqrt{2}(230)}{40} \tag{7}$$

$$= 8.1\,\text{A} \tag{8}$$

3)

$$I_{\text{rms}} = \frac{I_{\text{res}}}{\sqrt{2}} \tag{9}$$

$$= \frac{8.1}{\sqrt{2}} \tag{10}$$

$$\approx 5.75\,\text{A} \tag{11}$$

$$V_R = I_{\text{rms}}R \tag{12}$$

$$= 5.75\,\text{A}\times40\,\Omega \tag{13}$$

$$\approx 230\,\text{V} \tag{14}$$

$$V_L = I_{\text{rms}}\omega_{\text{res}}L \tag{15}$$

$$= 5.75\,\text{A}\times50\,\text{rad/s}\times5.0\,\text{H} \tag{16}$$

$$\approx 1437.5\,\text{V} \tag{17}$$

$$V_C = I_{\text{rms}}\frac{1}{\omega_{\text{res}}C} \tag{18}$$

$$= 5.75\,\text{A}\times\frac{1}{50\,\text{rad/s}\times80\times10^{-6}\,\text{F}} \tag{19}$$

$$\approx 1437.5\,\text{V} \tag{20}$$

$$V_{LC} = I_{\text{rms}}\omega_{\text{res}}L - I_{\text{rms}}\frac{1}{\omega_{\text{res}}C} \tag{21}$$

$$= V_L - V_C \tag{22}$$

$$= 1437.5\,\text{V} - 1437.5\,\text{V} = 0\,\text{V} \tag{23}$$