DPP – 2 (Alternating Current)

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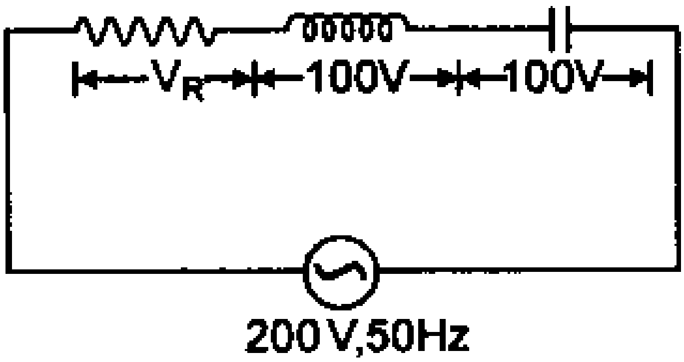
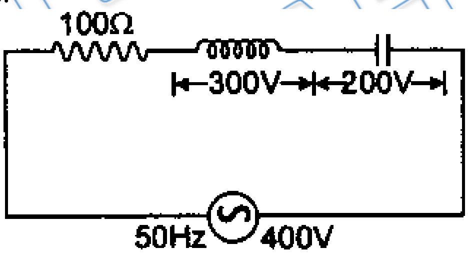
Q 1. In the circuit shown in figure current in the circuit is:



(a) 1.27A (b) 2.23 A (c) 4.26 A (d) 3.87 A

Q 2. 110 V (rms) is applied across a series circuit having resistance 11 Ω and impendence 22 Ω. The power consumed is:



(a) 275 W (b) 366 W (c) 550 W (d) 1100 W

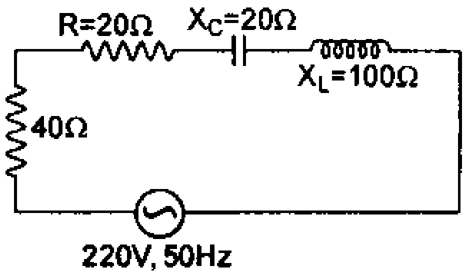
Q 3. At a frequency ω_0 the reactance of a certain capacitor equals that of a certain inductor. If the frequency is changed to 2 ω_0, what is the ratio of the reactance of the inductor to that of the capacitor?

(a) 4 : 1 (b) $\sqrt{2}$: 1 (c) 1 : $2\sqrt{2}$ (d) 1 : 2

Q 4. An alternating voltage given by V = 300 $\sqrt{2}$ sin (50t) (in volts) is connected across a 1μF capacitor through an AC ammeter. The reading of the ammeter will be:

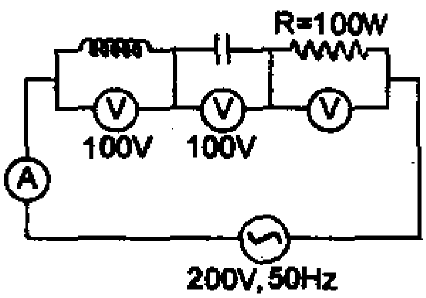
(a) 10 mA (b) 40 mA (c) 100 mA (d) 15 mA

Q 5. The power factor of the circuit shown in the figure is:



(a) 0.4 (b) 0.2 (c) 0.8 (d) 0.6

Q 6. What will be the reading of the voltmeter across the resistance and ammeter in the circuit shown in the figure?



(a)300 V, 2A (b) 800 V, 2 A (c) 100 V. 2 A (d) 200 V, 2 A

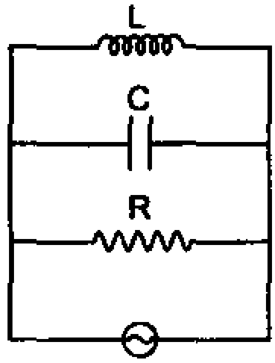
Q 7. When 100 V. DC is applied across a solenoid a current of 1 A flows in it. When 100 V, AC is applied across the same coil, the current drops to 0.5 A. The frequency of the AC is 50 Hz. The impedance and inductance of the solenoid are:
(a) 100 0, 0.75 H (b) 1000, 0.60H
(c) 2000,0.55H (d) 2000,0.75H

Q 8. In a series LCR the voltage across resistance, capacitance and inductance is 10 V each. If the capacitance is short circuited, the voltage across the inductance will be:
(a) $\frac{10}{\sqrt{2}}$ V (b) 10 V (c) $10\sqrt{2}$ V (d) 20 V

Q 9. Choose the wrong statement:
(a) The peak voltage across the inductor can be greater than the peak voltage of the source in an LCR circuit.
(b) In a circuit containing a capacitor and an AC source the current is zero at the instant the source voltage is maximum.
(c) An AC source is connected to a capacitor. The rms current In the circuit gets increased if a dielectric slab is inserted into the capacitor.
(d) None of the above

Q 10. An AC source producing emf $V = V_0 [\sin \omega t + \sin 2\omega t]$ is connected in series with a capacitor and a resistor. The current found in the circuit is $i = i_1 \sin(\omega t + \phi_1) + i_2 \sin(2\omega t + \phi_2)$. Then :
(a) $i_1 = i_2$
(b) $i_1 < i_2$
(c) $i_1 > i_2$
(d) i_1 may be less than, equal to or greater than i_2

Q 11. Figure shows a parallel LCR circuit connected to a 200 V, AC source. L = 5H, C = 80 μF and R = 40 Ω at resonance let i_1 and i_2 be the rms current through L, C and R. Then:

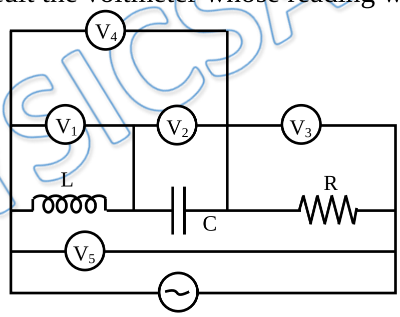


(a) $i_1 = i_2$ and $i_1 > i_2$
(b) $i_1 = 0 = i_2$
(c) $i_1 = i_2$ and $i_1 < i_3$
(d) $i_1 = i_2$ and $i_3 > 0$

Q 12. A 120 V, 60 W lamp is run from a 240V, 50 Hz mains supply using a capacitor connected in series with the lamp and supply. What is theoretical value of the capacitor required to operate the lamp at its normal rating?
(a) 3.8 μF
(b) 6.6 μF
(c) 7.7 μF
(d) 13.3μF

Q 13. A series circuit has an impedence of 50.0Ω and a power factor of 0.63 at 60 Hz. The voltage lags the current. To raise the power factor of the circuit:
(a) an inductor should be placed in series
(b) a capacitor should be placed in series
(c) a resistance should be placed in series
(d) an inductor or a resistance should be placed in series

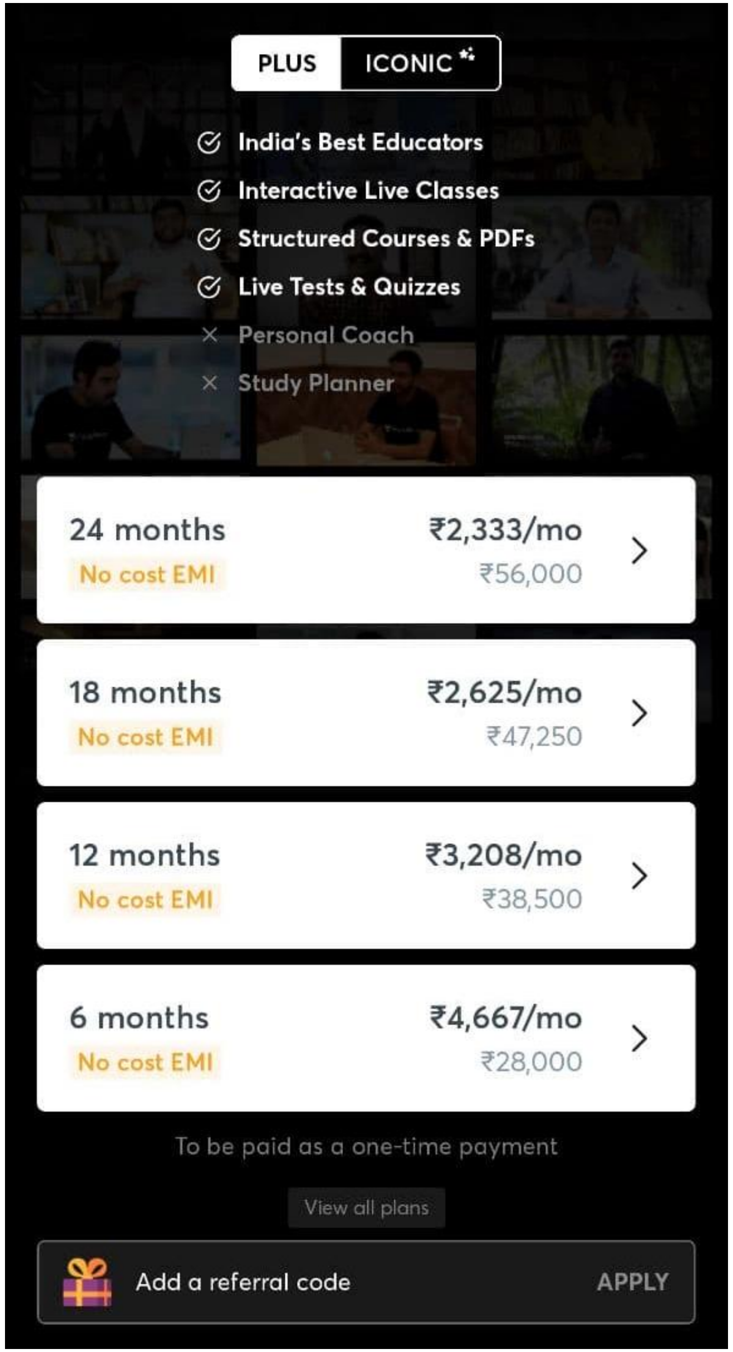
Q 14. In the adjoining A.C. circuit the voltmeter whose reading will be zero at resonance is-



(a) V_1
(b) V_2
(c) V_3
(d) V_4

Answer Key

Q.1 d	Q.2 a	Q.3 a	Q.4 d	Q.5 d
Q.6 d	Q.7 c	Q.8 a	Q.9 d	Q.10 b
Q.11 c	Q.12 c	Q.13 d	Q.14 d	



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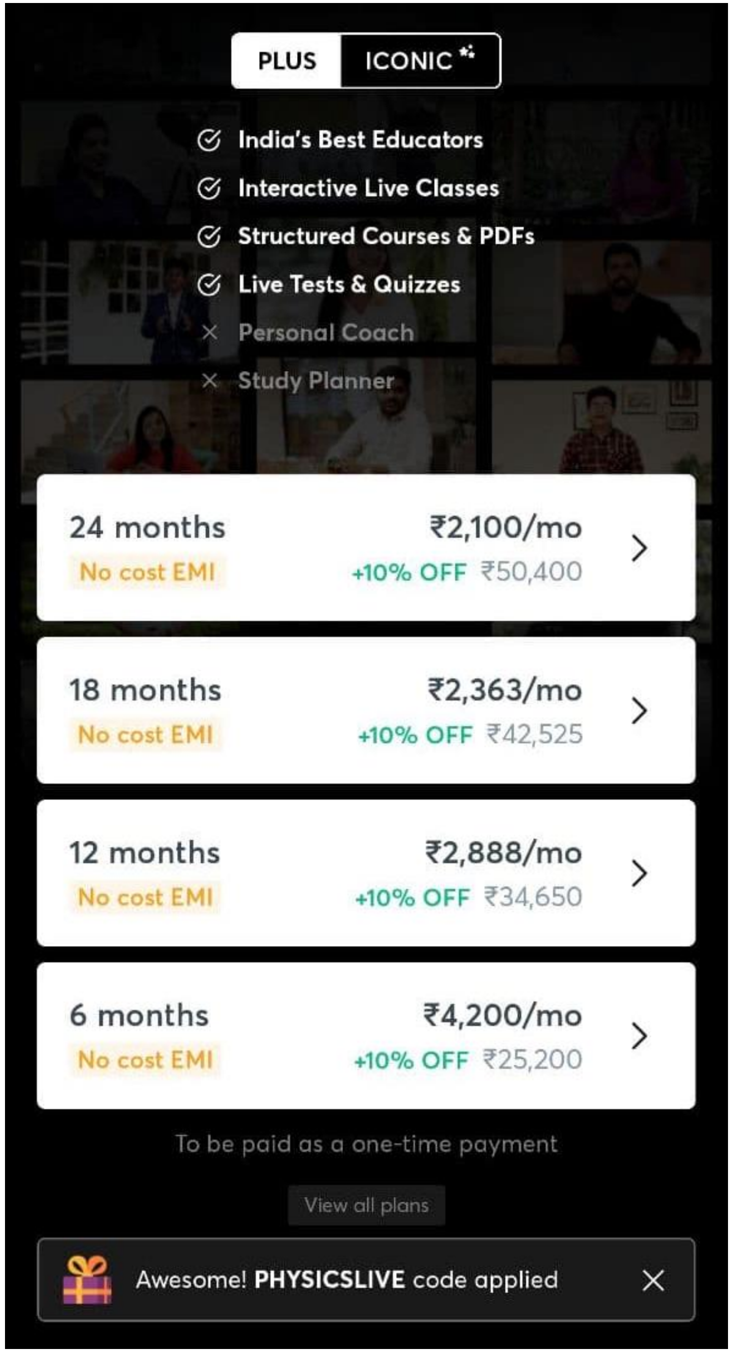
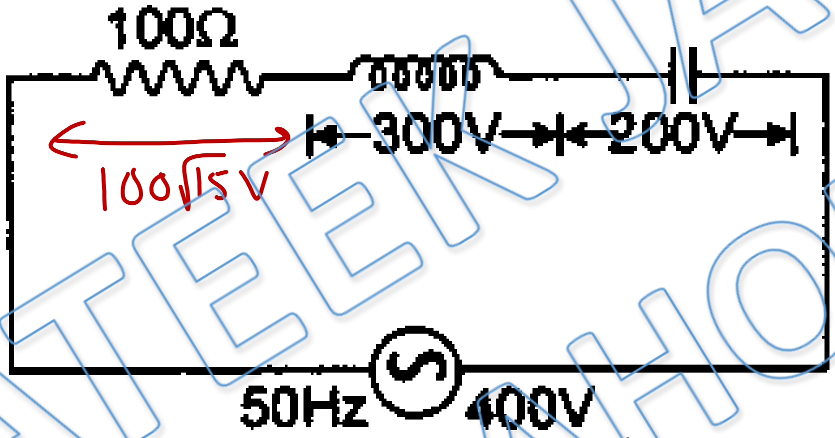


Written Solution

DPP-2 AC: Pure Resistive, Pure Inductive & Pure Capacitive AC circuit, R-L AC Circuit, R-L-C AC circuit, Power Dissipation in AC Circuit

By Physicsaholics Team

Q.1) In the circuit shown in figure current in the circuit is:



$$V_{rms}^2 = V_{R_{rms}}^2 + (V_{C_{rms}} - V_{L_{rms}})^2$$

$$(400)^2 = V_{R_{rms}}^2 + (200-300)^2$$

$$V_{R_{rms}} = \sqrt{(400)^2 - (100)^2} = 100\sqrt{15}$$

(a) Zero (b) 2.23 A (c) 4.26 A (d) 3.87 A ✓

$$i_{rms} = \frac{V_{R_{rms}}}{R} = \frac{100\sqrt{15}}{100} = 3.87\,A$$

Q.2) 110 V (rms) is applied across a series circuit having resistance 11 Ω and impendence 22 Ω. The power consumed is:

Z

$$P = V_{rms} I_{rms} \cos\phi$$

$$= \frac{V_{rms}^2}{Z} \times \frac{R}{Z} = \frac{V_{rms}^2 R}{Z^2} = \frac{110 \times 110 \times 11}{22 \times 22}$$

$= 275$ Watt

(a) 275 W (b) 366 W (c) 550 W (d) 1100 W

Q.3) At a frequency ω_0 the reactance of a certain capacitor equals that of a certain inductor. If the frequency is changed to $2\omega_0$, what is the ratio of the reactance of the inductor to that of the capacitor?

$$X_C = X_L$$

$$\frac{1}{\omega_0 C} = \omega_0 L$$

$\omega_0 \rightarrow 2\omega_0$

$\Rightarrow X_L$ increases to 2 times

X_C decreases to $\frac{1}{2}$ times

$\frac{X_L}{X_C}$ increases to 4 times

(a) 4 : 1 (b) $\sqrt{2}$: 1 (c) 1 : $2\sqrt{2}$ (d) 1 : 2

Q.4) An alternating voltage given by V = 300 $\sqrt{2}$ sin (50t) (in volts) is connected across a 1μF capacitor through an AC ammeter. The reading of the ammeter will be:

$V_0 = 300\sqrt{2}$

$V_{rms} = \frac{V_0}{\sqrt{2}} = 300$

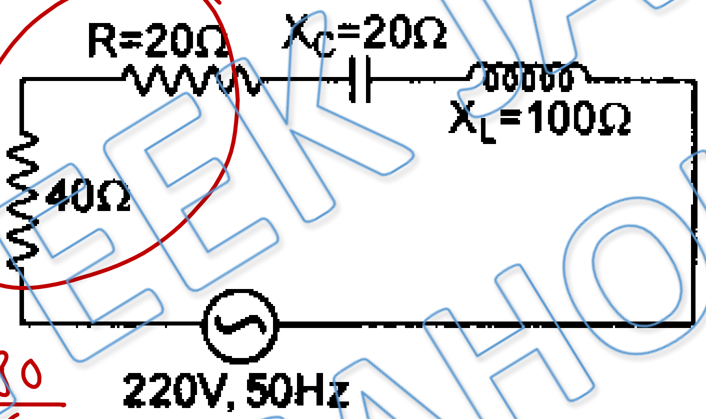
$X_c = \frac{1}{\omega C} = \frac{10^6}{50} = \frac{100 \times 10^4}{50}$

$= 2 \times 10^4 \ \Omega$

$I_{rms} = \frac{V_{rms}}{X_c} = \frac{300}{2 \times 10^4} = \frac{15}{10} \times 10^{-3} = 15 \text{ mA}$

(a) 10 mA (b) 40 mA (c) 100 mA (d) ~~30 mA~~ 15mA

Q.5) The power factor of the circuit shown in the figure is:



(a) 0.4 (b) 0.2 (c) 0.8 (d) 0.6

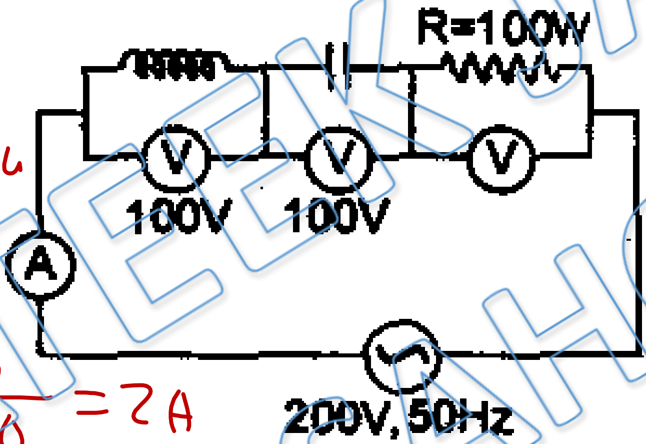
Q.6) What will be the reading of the voltmeter across the resistance and ammeter in the circuit shown in the figure?

Since $V_{C_{rms}} = V_{L_{rms}}$

$\Rightarrow$ Circuit is in resonance

$V_{R_{rms}} = 200V$

$i_{rms} = \frac{V_{rms}}{R} = \frac{200}{100} = 2A$



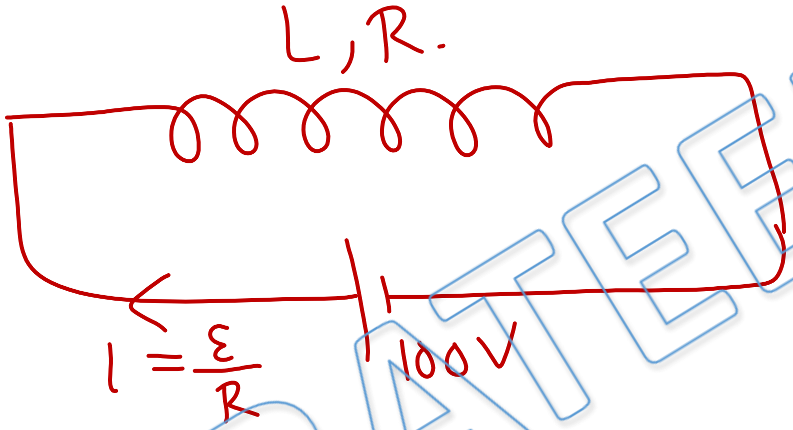
$V_{rms}^2 = V_{R_{rms}}^2 + (V_{C_{rms}} - V_{L_{rms}})^2$

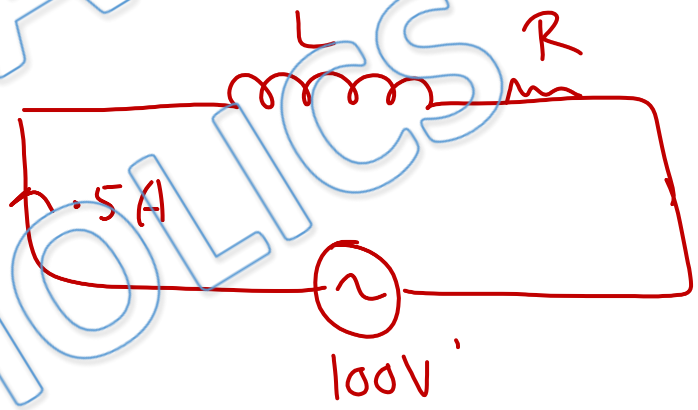
$(200)^2 = V_{R_{rms}}^2 + (100-100)^2$

$V_{R_{rms}} = 200\,V$

(a) 300 V, 2A (b) 800 V, 2 A (c) 100 V. 2 A (d) 200 V, 2 A ✓

Q.7) When 100 V. DC is applied across a solenoid a current of 1 A flows in it. When 100 V, AC is applied across the same coil, the current drops to 0.5 A. The frequency of the AC is 50 Hz. The impedance and inductance of the solenoid are:





(a) 1000, 0.75 H

$\frac{100}{R} = 1A$

(b) 1000, 0.60H

$Z = \frac{100}{.5} = 200\Omega$

(c) 200,0.55H ✓

$R = 100\Omega$

(d) 200,0.75H

$Z^2 = R^2 + X_L^2$

$X_L = \sqrt{(200)^2 - (100)^2}$

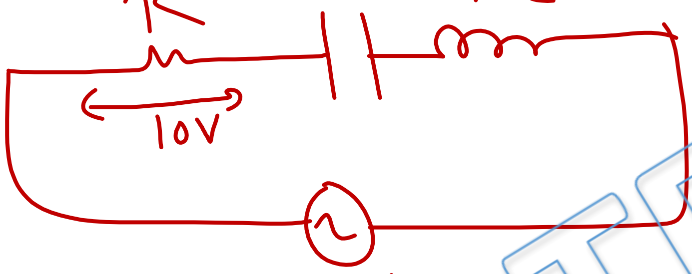
$= 100\sqrt{3}$

$\omega L = 100\sqrt{3} \Rightarrow L = \frac{100\sqrt{3}}{100\pi} = \frac{1.73}{3.14}$

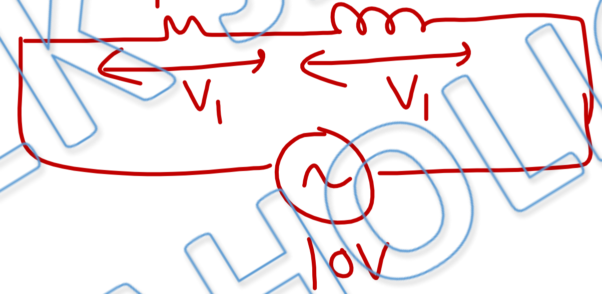
$V_C = V_L \Rightarrow$ Resonance

Q.8) In a series LCR the voltage across resistance, capacitance and inductance is 10 V each. If the capacitance is short circuited, the voltage across the inductance will be:

$R = X_C = X_L$



$\Rightarrow$



$V^2 = V_R^2 + V_C^2$

$100 = V_1^2 + V_1^2$

$V_1^2 = \frac{100}{2}$

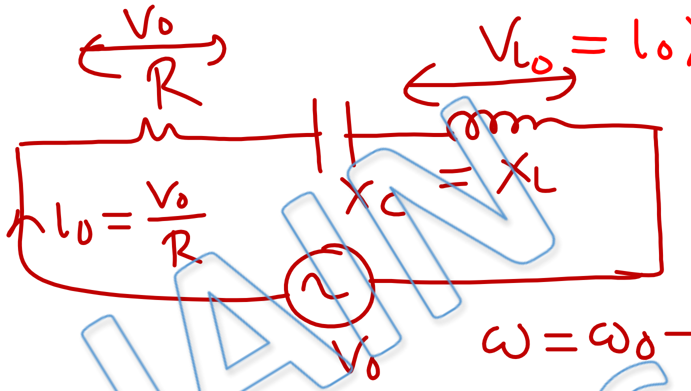
$V_1 = \frac{10}{\sqrt{2}}$ V

(a) $\frac{10}{\sqrt{2}}$ V (b) 10 V (c) $10\sqrt{2}$ V (d) 20 V

$V_R = V_L = V_C$

$\Rightarrow iR = iX_L = iX_C$

Q.9) Choose the wrong statement:



$V_{L0} = I_0 X_L = \frac{V_0}{R} X_L$ — may be greater than V_0

$\omega = \omega_0 \rightarrow$ resonance

(a) The peak voltage across the inductor can be greater than the peak voltage of the source in an LCR circuit.

(b) In a circuit containing a capacitor and an AC source the current is zero at the instant the source voltage is maximum. (Since there is a phase difference of $\pi/2$)

(c) An AC source is connected to a capacitor. The rms current in the circuit gets increased if a dielectric slab is inserted into the capacitor.

$C\uparrow \Rightarrow X_C\downarrow \Rightarrow I_{rms} = \frac{V_{rms}}{X_C}$ increases

(d) ~~None~~ of the above

Q.10) An AC source producing emf $V = V_0$ [sin ωt + sin 2ωt] is connected in series with a capacitor and a resistor. The current found in the circuit is
$i = i_1 \sin(\omega t + \phi_1) + i_2 \sin(2\omega t + \phi_2)$. Then :

$$Z = \sqrt{R^2 + \frac{1}{\omega^2 C^2}}$$

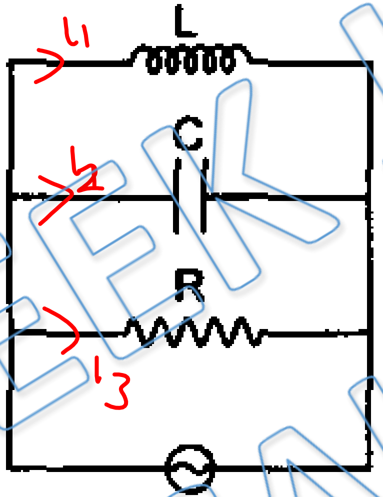
$$V = V_0 \sin \omega t + V_0 \sin 2\omega t$$

$$i = i_1 \sin(\omega t + \phi_1) + i_2 \sin(2\omega t + \phi_2)$$

$$i_1 = \frac{V_0}{\sqrt{R^2 + \frac{1}{\omega^2 C^2}}} \qquad i_2 = \frac{V_0}{\sqrt{R^2 + \frac{1}{4\omega^2 C^2}}}$$

(a) $i_1 = i_2$
✓ (b) $i_1 < i_2$
(c) $i_1 > i_2$
(d) i_1 may be less than, equal to orgreater than i_2

Q.11) Figure shows a parallel LCR circuit connected to a 200 V, AC source. L = 5H, C = 80 μF and R = 40 Ω at resonance let i_1 , i_2 and i_3 be the rms current through L, C and R. Then: $X_C = X_L = 250\Omega$



$V = V_0 \sin\omega t$

Current in induction

$i_1 = \frac{V_0}{X_L}\sin(\omega t - \pi/2)$

Current in Capacitor

$i_2 = \frac{V_0}{X_C}\sin(\omega t + \pi/2)$

$i_3 = \frac{V_0}{R}\sin\omega t$

$i_{3,rms} = \frac{V_0}{\sqrt{2}R} = \frac{200}{40\sqrt{2}} = \frac{5}{\sqrt{2}}$

$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{5 \times 80 \times 10^{-6}}} = \frac{1000}{20} = 50$

$X_L = \omega L = 50 \times 5 = 250\Omega$

(a) $i_1 = i_2$ and $i_1 > i_2$

(b) $i_1 = 0 = i_2$

(c) $i_1 = i_2$ and $i_1 < i_3$

(d) $i_1 = i_2$ and $i_3 < i_1$

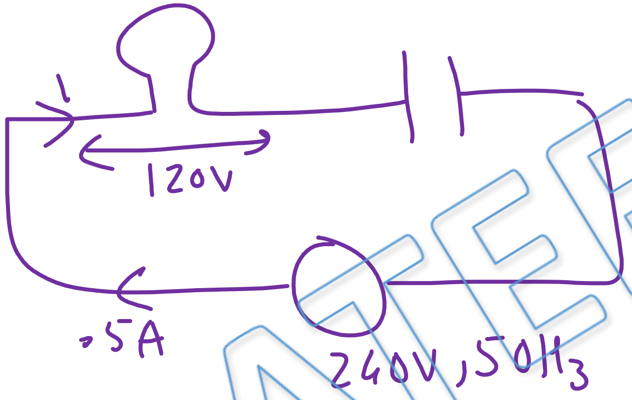
$i_1 = -\left(\frac{V_0}{X_L}\right)\cos\omega t$

$i_2 = \left(\frac{V_0}{X_C}\right)\cos\omega t$

$i_{1,rms} = i_{2,rms} = \frac{V_0}{\sqrt{2}X_L} = \frac{200}{\sqrt{2} \times 250} = \frac{4}{5\sqrt{2}}$

$\omega = 100\pi$

Q.12) A 120 V, 60 W lamp is run from a 240V, 50 Hz mains supply using a capacitor connected in series with the lamp and supply. What is value of the capacitor required to operate the lamp at its normal rating?



$Z = \frac{V_{rms}}{I_{rms}} = \frac{240}{.5} = 480\Omega$

$Z^2 = R^2 + X_c^2$

(a) 3.8 μF (b) 6.6 μF (c) 7.7 μF (d) 13.3μF

$P = VI$

$I = \frac{P}{V} = \frac{60}{120} = \frac{1}{2}A$

$R = \frac{V}{i} = \frac{120}{1/2} = 240$

$X_c = \sqrt{(480)^2 - (240)^2}$

$X_c = 240\sqrt{3}$

$\frac{1}{100\pi C} = 240\sqrt{3}$

$C = \frac{1}{100\pi \times 240\sqrt{3}} F$

$$C = \frac{1000000}{100\pi \times 240\sqrt{3}}\ \mu F$$

$$= \frac{125}{3\sqrt{3}\,\pi}\ \mu F$$

$$= \frac{125}{3 \times 3.14 \times 1.73}$$

$$= \frac{125}{16.2}$$

$$= 7.7\ \mu F$$

314×173

942

21980

31400

$5.4322 = 5.4$

Ans. c

Q.13) A series circuit has an impedence of 50.0Ω and a power factor of 0.63 at 60 Hz. The voltage lags the current. To raise the power factor of the circuit:

$X_C > X_L$

$\tan\phi = \frac{X_C - X_L}{R}$

(a) an inductor should be placed in series

(b) a capacitor should be placed in series

(c) a resistance should be placed in series

✓ (d) an inductor or a resistance should be placed in series

Power factor = $\cos\phi \uparrow$

$\Rightarrow \phi \downarrow$

$\Rightarrow \tan\phi \downarrow$

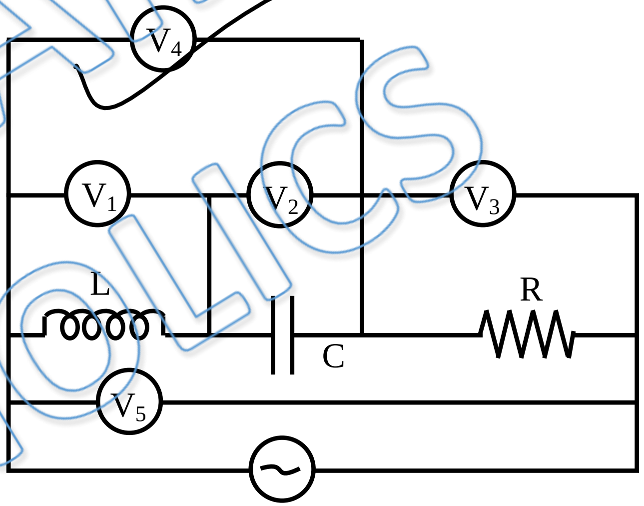
$X_C \downarrow$ or $X_L \uparrow$ or $R \uparrow$

$X_L \uparrow$ ⇒ add L in Series

$R \uparrow$ ⇒ add R in Series

Q.14) In the adjoining A.C. circuit the voltmeter whose reading will be zero at resonance is-

In resonance
rms Voltage across Combination
of L & C = 0



(a) V_1 (b) V_2

(c) V_3 (d) V_4

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