

D) what will be the reading of the voltmeter connected across the resistance and ammeter in the circuit shown in the figure.

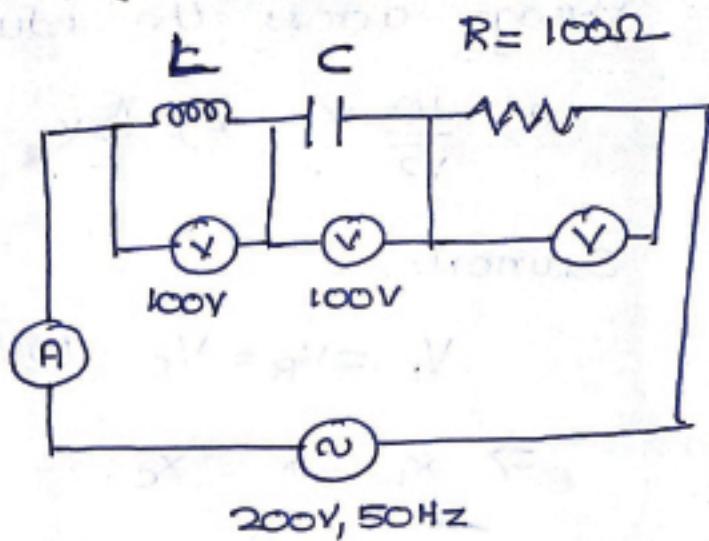
a) 300V, 2A

b) 800V, 2A

c) 200V, 2A

d) Insufficient data

as we need L, C values.



$$V^2 = V_R^2 + (V_L - V_C)^2$$

$$V = V_R \quad (\because V_L = V_C)$$

$$V_R = 200V. \quad I = V_R/R = \frac{200}{100} = 2A$$

2) In the circuit shown, the steady state currents i_1 and i_2 in the coils

2) In an ~~series~~ LCR circuit, the

2) In a series LCR, the voltage across R, C, L is 10V each. If the capacitance is short-circuited, the voltage across the inductance will be.

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

SOLUTION:

$$V_L = V_R = V_C = 10 \text{ V} \quad (\text{given})$$

$$\Rightarrow X_L = R = X_C.$$

$$V_R = iR$$

$$V_L = iX_L$$

$$V_C = iX_C$$

When capacitance is short-circuited,

$$\begin{aligned} V_L &= I X_L = I R & I &= \frac{V}{\sqrt{R^2 + X_L^2}} \\ &= \frac{V}{\sqrt{2} R} \times R = \frac{V}{\sqrt{2}} = \frac{10}{\sqrt{2}} \text{ V.} & &= \frac{V}{\sqrt{2} R} \end{aligned}$$

3) An alternating current is given by

$i = (3 \sin \omega t + 4 \cos \omega t)$ A. The rms current will be

- a) $\frac{7}{\sqrt{2}}$ A b) $\frac{5}{\sqrt{2}}$ A c) $\frac{\sqrt{5}}{\sqrt{2}}$ A d) zero.

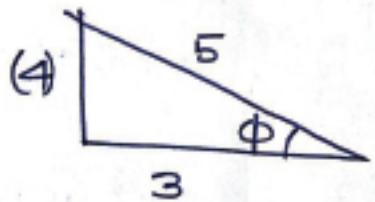
$$\hat{i} = \hat{i}_0 \sin(\omega t + \phi)$$

$$i = 5 \left[\frac{3}{5} \sin \omega t + \frac{4}{5} \cos \omega t \right]$$

$$= 5 [\sin \omega t \cos \phi + \cos \omega t \sin \phi]$$

$$i = 5 \sin(\omega t + \phi)$$

$$\hat{i}_0 = 5 \quad \frac{\hat{i}_0}{\sqrt{2}} = 5\sqrt{2}$$



$$\underline{\phi = 53^\circ}$$

- 4) A coil, a capacitor and an AC source of 24V (rms) are connected in series. By varying the frequency of the source, a maximum rms current of 6A was observed. If this coil is connected to a battery of emf 12V and $R=4\Omega$, current through it will be
- a) 2A b) 1.5A c) 3A d) 2.5A

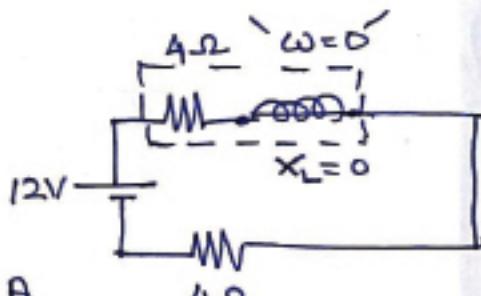
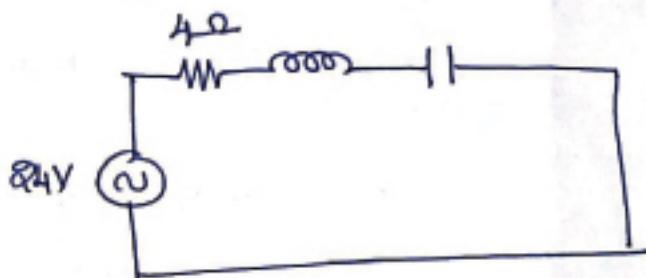
$$I_{\text{rms (max)}} = 6 \text{A}$$

~~Given~~ $X_L = X_C$

$$V_{\text{rms}} = 24 \text{V}$$

$$\frac{V_{\text{rms}}}{I_{\text{rms}}} = R = \frac{24}{6} = 4 \Omega$$

$$i = \frac{12}{8} = \frac{3}{2} = 1.5 \text{ A}$$



when

- 5) An emf, $e = e_0 \sin(100t)$ is connected across a circuit, the current 'i' leads the 'emf' \bar{e} by $\frac{\pi}{4}$. If the circuit consists only of R-C or R-L ~~or~~ L-C in series, find the relationship between the two elements.

~~a)~~ a) $R = 1\text{k}\Omega, C = 10\text{nF}$ b) $R = 1\text{k}\Omega, C = 1\mu\text{F}$

c) $R = 1\text{k}\Omega, L = 10\text{H}$ d) $R = 1\text{k}\Omega, L = 1\text{H}$

Solution.

Since 'i' leads ' \bar{V} ' by $\frac{\pi}{4}$, it must be a combination of R and C.

$$\text{a)} 10^3 \times 10 \times 10^{-6} = 10^2 \text{ s}^{-1}$$

$$\tan\phi = \frac{X_C}{R} \quad \tan\frac{\pi}{4} = \frac{1/C\omega}{R}$$

$$\omega RC = 1$$

$$\text{b)} 10^3 \times 1 \times 10^{-6} = 10^3 \text{ s}^{-1}$$

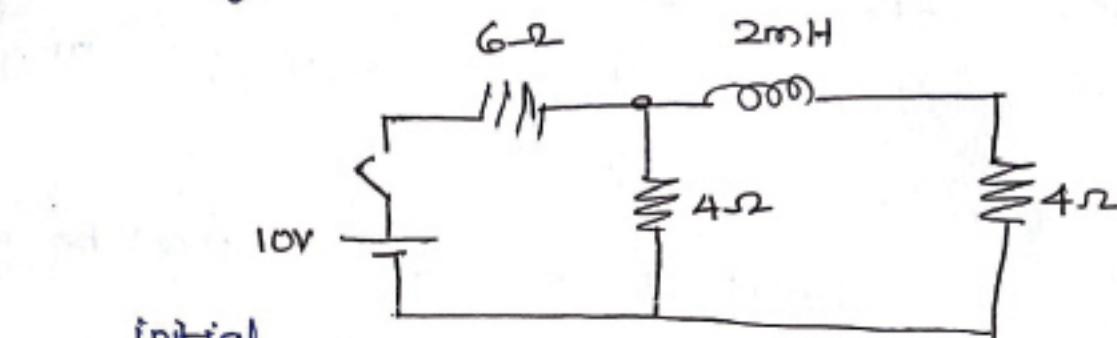
$$RC = \frac{1}{\omega} = \frac{1}{100} \text{ s}^{-1}$$

~~c) $10^3 \times 1$~~

Product of R and C is $\frac{1}{100} \text{ s}^{-1}$

6) In the given circuit, find the ratio of i_1 to i_2 , where i_1 is the initial current (at $t=0$) and i_2 is the steady state current (at $t=\infty$) through the battery.

- a) 1 b) $\checkmark 0.8$ c) 1.2 d) 1.5



Initial state
At steady current, $t=0$

$i_1 = 0$. (Inductor open circuit)

$$i_1 = \frac{10}{10\Omega} = 1A$$

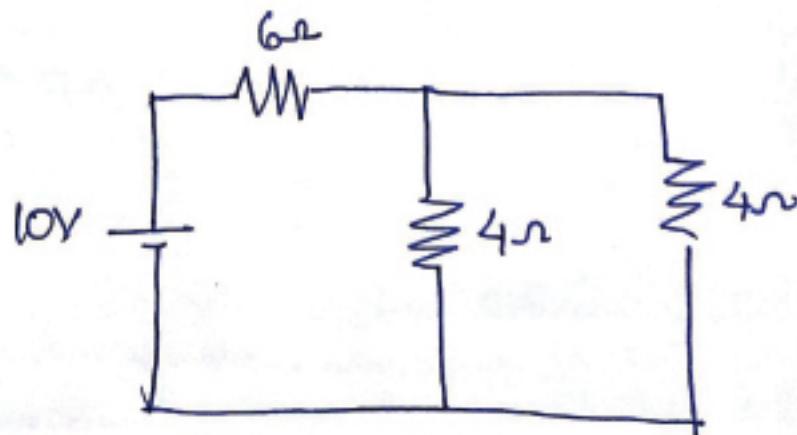
At steady state, $t=\infty$,

Inductor \rightarrow "close circuit"

$$i_1 = \frac{10}{8} A$$

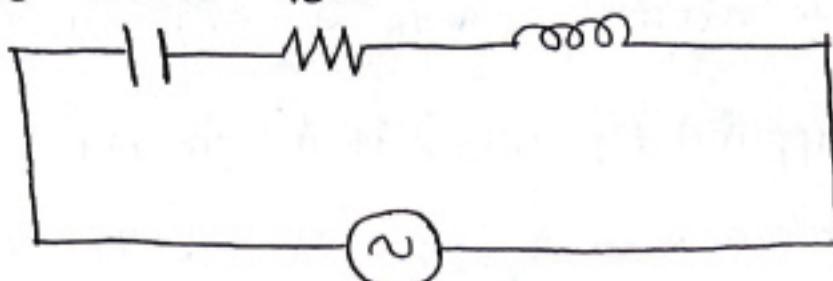
$$\frac{i_1}{i_2} = \frac{1}{10/8} = \frac{8}{10}$$

$$= 0.8$$



7) In LCR circuit shown

$$X_C = 20\Omega \quad 10\Omega \quad X_L = 10\Omega$$



$$V = 200\sqrt{2} \sin \omega t$$

- a) i will lead the voltage
- b) $i_{rms} = 20\text{A} \quad 10\sqrt{2} \text{ A}$
- c) power factor = $\frac{1}{\sqrt{2}}$ at
- d) all the above

Solution:

$X_C > X_L \Rightarrow$ capacitive

a) i leads V

b) $V = 200\sqrt{2} \sin \omega t$

$$= V_0 \sin \omega t$$

$$V_0 = 200\sqrt{2}$$

$$i_{rms} = \frac{i_0}{\sqrt{2}}$$

$$= \frac{20}{\sqrt{2}} = 10\sqrt{2} \text{ A}$$

$$\cos \phi = \frac{R}{Z} = \frac{10}{\sqrt{2}(10)} = \frac{1}{\sqrt{2}}$$

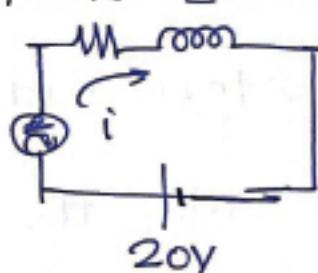
$$i_0 = \frac{V_0}{Z} = \frac{V_0}{\sqrt{R^2 + (X_L - X_C)^2}} = \frac{200\sqrt{2}}{\sqrt{100 + 100}} = \frac{200\sqrt{2}}{20\sqrt{2}} = \frac{200}{20} = 10 \text{ A}$$

8] In LR circuit, $V_R = 4V$ at some instant. Then

- i is increasing at rate of $8A/s$ at that instant
 - power supplied by battery at this instant is $20W$
 - power stored in magnetic field at this instant is $16W$
 - current in the circuit at that instant is $1A$
- i) which of above statements is / are correct
 i) & only a ii) only a,b iii) only a,b,c \checkmark (by all)

$4\Omega \text{ } R \text{ } L = 2H$

a) $\mathcal{E} = L \cdot \frac{di}{dt} \Rightarrow \frac{di}{dt} = \frac{\mathcal{E}}{L} = \frac{16}{2} = 8$



$V_R = 4V$

$V_L = 16V$

b) $P = Vi = 20 \times 1 = 20W$ $V_R = 4V$
 $R = 4\Omega$

c) ~~$\frac{1}{2}L\dot{i}^2 = P \neq \frac{1}{2} \times 2 \times 1^2 = 1W$~~

$P_R = i^2 R = 1 \times 4 = 4W$

$P_L = 20 - 4 = \underline{\underline{16W}}$

d) $\underline{\underline{i = 1A = \frac{V}{R}}}$