10+2 PCM NOTES

BY

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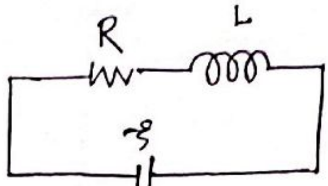
(PDF version handwritten notes of Maths, Physics and Chemistry for 10+2 competitive exams like JEE Main, WBJEE, NEST, IISER Entrance Exam, CUCET, AIPMT, JIPMER, EAMCET etc.)

10+2

Alternating Current

* Growth & Decay of current in a LR circuit :

i) Growth of current :



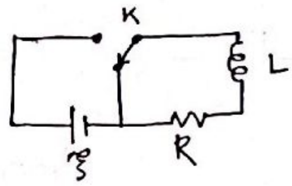
$$i = \frac{\xi}{R}\left(1 - e^{-Rt/L}\right)$$

$$i = i_0\left(1 - e^{-t/\tau}\right) \quad \left[i_0 = \frac{\xi}{R},\ \tau = \frac{L}{R}\right].$$

$\tau \rightarrow$ Time constant

At $t = \tau$, $i = 0.63\, i_0$.

ii) Decay of current :

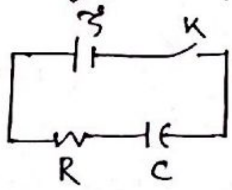


$$i = i_0 e^{-\frac{R}{L}t} = i_0 e^{-t/\tau}.$$

At $t = \tau$, $i = 0.37\, i_0$.

* Charging & Discharging of Capacitor :

i) Charging :



$$q = \xi C\left(1 - e^{\frac{-t}{RC}}\right)$$

$$q = \xi C\left(1 - e^{-t/\tau}\right) \quad [\tau = RC] \quad \tau \rightarrow \text{Time cons.}$$

$$\boxed{q = q_0\left(1 - e^{-t/\tau}\right)} \quad [q_0 = \xi C].$$

At $t = \tau$, $q = 0.63\, q_0$.

$$\boxed{i = \frac{\xi}{R} e^{\frac{-t}{RC}} = i_0 e^{-t/\tau}}.$$

At $t = \tau$, $i = 0.37\, i_0$.

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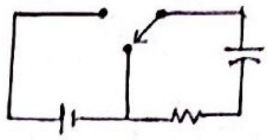
ii) ~~D~~ischarging :



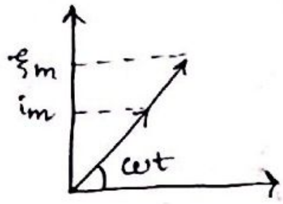
$$q = q_0 e^{-t/\tau}$$

$$[q_0 = C\xi, \ \tau = RC]$$

$$i = i_0 e^{-t/\tau} \quad \left[i_0 = \frac{q_0}{CR} = \frac{\xi}{R} \right]$$

* Pure R circuit with AC :

$$\xi = \xi_m \sin\omega t, \quad i = i_m \sin\omega t \quad \left[i_m = \frac{\xi_m}{R} \right].$$



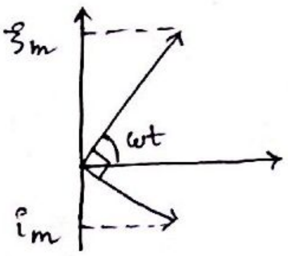
$$\bar{P} = \frac{1}{2} i_m^2 R = i^2 R = iV \left[i = \frac{i_m}{\sqrt{2}} \rightarrow \text{rms current} \right.$$

$$= \frac{\xi_m}{\sqrt{2}} \cdot \frac{i_m}{\sqrt{2}} \qquad \left. V = \frac{\xi_m}{\sqrt{2}} \rightarrow \text{rms voltage} \right].$$

Impedence, $Z = R$

* Pure L circuit with AC :

$$\xi = \xi_m \sin\omega t, \quad i = \frac{\xi_m}{\omega L} \sin(\omega t - \pi/2) = i_m \sin(\omega t - \pi/2).$$



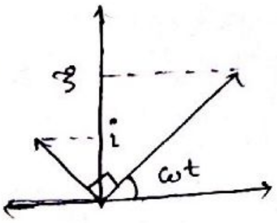
$$\bar{P}_L = 0 \ [\text{Wattless current}]. \qquad \left[i_m = \frac{\xi_m}{\omega L} \right].$$

$$Z = \omega L \qquad \left[i_m = \frac{\xi_m}{Z} \right].$$

* Pure C circuit with AC :

$$\xi = \xi_m \sin\omega t, \quad i = \xi_m \omega C \sin(\omega t + \pi/2) = \frac{\xi_m}{1/\omega C} \sin(\omega t + \pi/2)$$

$$i = \frac{\xi_m}{Z} \sin(\omega t + \pi/2) = i_m \sin(\omega t + \pi/2)$$



$$\bar{P}_C = 0 \ [\text{Wattless}].$$

$$Z = \frac{1}{\omega C}.$$

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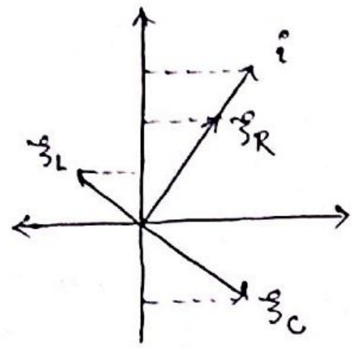
* LCR series circuit with AC:

$$\xi = \xi_m \sin\omega t$$



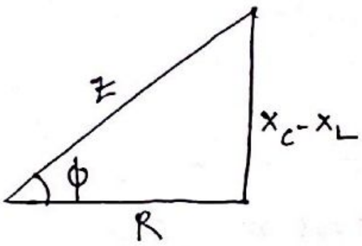
$$i = \frac{\xi_m}{\sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2}} \sin(\omega t - \phi).$$

$$= \frac{\xi_m}{Z} \sin(\omega t - \phi).$$

$$\tan\phi = \frac{X_C - X_L}{R} \quad \Big| \quad X_C = \frac{1}{\omega C}$$

$$X_L = \omega L.$$

$$\frac{R}{Z} = \cos\phi, \quad \frac{X_C - X_L}{Z} = \sin\phi$$



$$P = \frac{1}{2} \frac{\xi_m^2 R}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

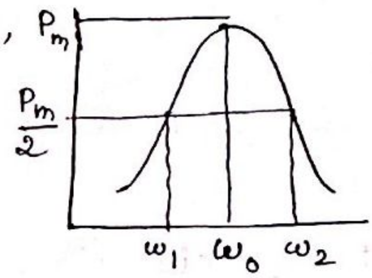
$$\Rightarrow P = P_m \frac{R^2}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}.$$

At half-maximum points,

$$P = \frac{1}{2} P_m. \quad \Big| \quad \omega_1 = \omega_0 - \Delta\omega$$

$$\omega_2 = \omega_0 + \Delta\omega.$$

$$\& \quad 2\Delta\omega = \frac{R}{L}$$



Q-factor:

$$Q = \frac{\omega_0}{2\Delta\omega} = \frac{\omega_0 L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{\omega_0 C R}$$

Higher the value of Q, the sharper resonance occurs.

For resonance, $\omega_0 = 1/\sqrt{LC}$. $[\omega_0 = 2\pi n]$.

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}.$$

$\rightarrow i \rightarrow$ maximum $\Rightarrow i = \frac{\xi_m}{R}$.

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* Power in AC Circuit : The Power Factor :-

$$\bar{P} = iV\cos\phi = Z i^2 \cos\phi .$$

$\cos\phi$ is called the power factor.

* LC Oscillations : $\dfrac{d^2q}{dt^2} + \dfrac{1}{LC} q = 0 .$ | $i = -\dfrac{dq}{dt} .$

$$\omega_0 = \frac{1}{\sqrt{LC}} .$$

$q = q_m \cos\omega_0 t$

$i = \omega_0 q_m \sin\omega_0 t = i_m \sin\omega_0 t$

$(i_m = \omega_0 q_m)$

* LR Circuit : $\xi = \xi_m \sin\omega t .$

$$i = i_m \sin(\omega t - \theta) = \frac{\xi_m}{\sqrt{R^2 + (\omega L)^2}} \sin(\omega t - \theta) .$$

$$\theta = \tan^{-1} \frac{\omega L}{R} .$$

$$\cos\theta = \frac{R}{\sqrt{R^2 + (\omega L)^2}}$$

$$\bar{P} = iV\cos\theta . \quad \left[V = \frac{\xi_m}{\sqrt{2}} , \; i = \frac{i_m}{\sqrt{2}} \right] .$$

* CR circuit :

$$i = i_0 \sin(\omega t + \theta) = \frac{\xi_m}{\sqrt{R^2 + \frac{1}{(\omega C)^2}}} \sin(\omega t + \theta) .$$

$$\theta = \tan^{-1} \left(\frac{1}{C\omega R} \right) .$$

$$\cos\theta = \frac{R}{\sqrt{R^2 + 1/\omega^2 C^2}} .$$

$$\bar{P} = iV\cos\theta .$$

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