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NOTES CLUB

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Trend Writers

CHAPTER- 7

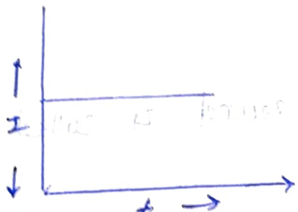
Current - The rate of flow of charges is call electric current

Electric current mainly have two type.

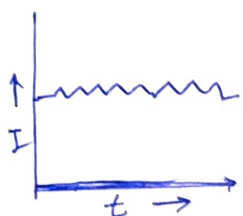
* Direct current - Direct current is that electric current whose direction does not change with time wether its magnitude changes or not.

DC current - Current can be classified into two type

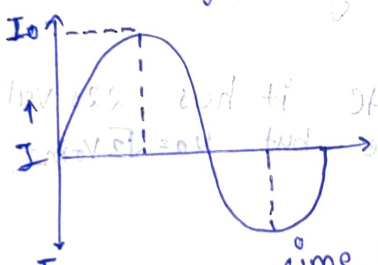
• Steady DC - Steady DC is that DC which remains constant both in magnitude and direction.



• Varying DC - The dc whose magnitude always changes with time but direction remain constant.



• Alternatic current - That current whose direction and magnitude both changes proper with time



It is denoted by $I = I_0 \sin\omega t$

Alternating EMF - An Alternating voltage that voltage whose magnitude and direction change with time periodically

It is denoted by $e = e_0 \sin\omega t$

Same

I - Initial current

I_0 - Peak value

ω - Angular ~~frquncy~~ frequency.

- **Voltage** - The potential difference betw any two points is called voltage.
  It is denoted by $V = V_0 \sin \omega t$
- **Amplitude peak** - The maximum value of alternating current in any direction is called its amplitude, or peak value.
  $I = I_0 \sin \omega t$ where, I_0 is amplitude or peak value.
- **time periode or perodic time** - The time taking by alternating current to complete its one cycle is called time periode or perodic time

$$T = \frac{2\pi}{\omega}$$

- **frequency** - Number of cycles completed by AC in one second is called frequency.
  It is denoted by υ.

$$\upsilon = \frac{1}{T}$$

$$= \frac{1}{\frac{2\pi}{\omega}}$$

$$\upsilon = \frac{\omega}{2\pi}$$

$$\omega = 2\pi\upsilon$$

~~The~~ AC of same voltage is mare dangerious then DC.
Why?

The current supplied in houses is AC it has 220 voltage it is the RMS value of AC voltage but $V_0 = \sqrt{2} V_{rms}$

$$V_0 = \sqrt{2}\, V_{rms}$$

$$= \sqrt{2} \times 220$$

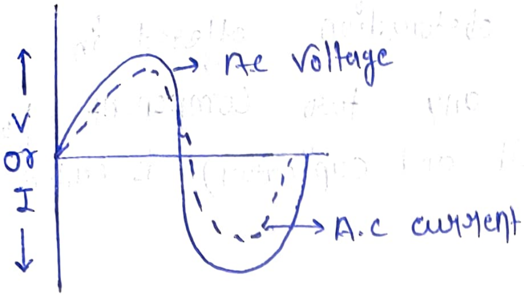
$$= 1.41 \times 220$$

$$= 3.11 \text{ voltage}$$

Thus the peak value of AC voltage 220 volt is ~~380~~ 311 volt if the voltage value of DC 220 V then it will remaine same so it is clear that the AC of same voltage is mare dangerious than DC.

Phase different betw voltage and current.

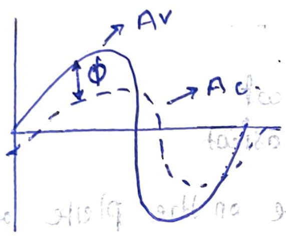
(I) When both current voltage is same phases.



$V = V_0 \sin\omega t$

$I = I_0 \sin\omega t$

(II) when voltage is Leading (आगे)



$V = V_0 \sin(\omega t + \phi)$

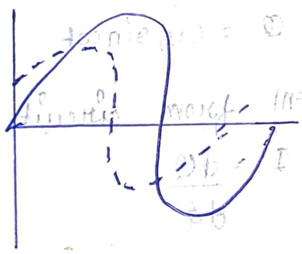
$I = I_0 \sin\omega t$

$V = V_0 \sin\omega t$

$I = I_0 \sin(\omega t - \phi)$

or

(III) when current is leading.



$V = V_0 \sin\omega t$

$I = I_0 \sin(\omega t + \phi)$

$V = V_0 \sin(\omega t + \phi)$

$I = I_0 \sin\omega t$

Define resistance, reactance, and impedance,

- **Resistance** - The obstruction offered by the conductor in the path of ~~AC~~ AC alternating current is called resistance of the conductor it is denote by R and is unit Ω.
- **Reactance** - In a AC circuit the opposition offered by induction coil or capacitor in the path of AC is called ~~reactance~~ reactance is is denoted by X its unit is Ω the reciprocal of reactance is called susceptance its unit is Ω^{-1}.

Reactance is in two types

(i) Inductive Reactance:

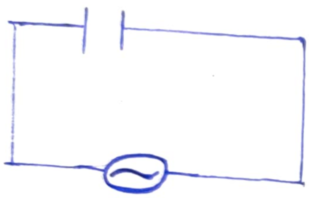
The obstruction offered in the path of AC by Inductance coil is called inductive reactant It is denoted by X_L

• Capacitive reactance - The obstruction offered in the path of AC by capacitor is called capacitive reactance. it is denoted by X_c

• Impedance - In AC circuit the obstruction offered in the path of ac by any two component from the group (resistance, inductance coil and capacitor) is called Impedance - it is denoted by Z
Its unit Ω

The reciprocal of Impedance admittance is unit is Ω^{-1}

• AC circuit containing only pure capacitance -



$V = V_0 \sin \omega t$

$V = V_0 \sin \omega t$

Consider a capacitor capacitance C. is connected with in AC source applied voltage is given by

$V = V_0 \sin \omega t$

Charge on the plate of capacitor

$Q = CV$

$Q = CV_0 \sin \omega t$

current from circuit

$I = \frac{dQ}{dt}$

$= \frac{d}{dt}(CV_0 \cdot \sin \omega t)$

$= CV_0 \frac{d}{dt} \sin \omega t$

$= \omega C V_0 \cos \omega t$

$I = \omega C V_0 \sin\left(\frac{\pi}{2} + \omega t\right)$

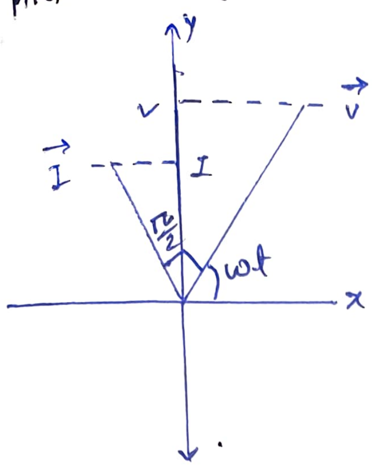
but

than $I = I_0 \sin\left(\frac{\pi}{2} + \omega t\right)$

$I_0 = \omega C V_0$

Peak value of current.

• Phasor diagram



$I_0 = \omega C V_0$

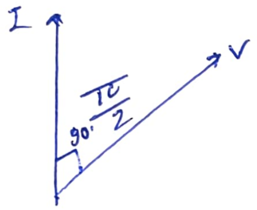
$\frac{1}{\omega C} = \frac{V_0}{I_0}$

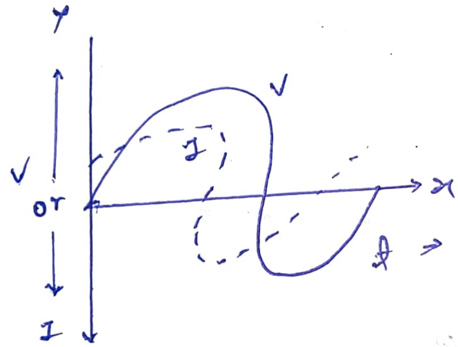
but $\frac{V}{I} = R$

$R = \frac{1}{\omega C}$

$X_c = \frac{1}{\omega C}$

$X_c = \frac{1}{2\pi \nu C}$





- AC circuit containing only pure inductance -

Consider a capacitor of capacitance C is connected with an A.C source applied voltage is given by.

$V = V_0 \sin \omega t$

Charge on the plate of capacitors

$Q = CV$

$Q = CV_0 \sin \omega t$

current from circuit

$I = \frac{dQ}{dt}$

$= \frac{d}{dt}(CV_0 \sin \omega t)$

$\frac{CV_0 d}{dt} \sin \omega t$

$\omega C V_0 \cos \omega t$

$$I = \omega C V_0 \sin\left(\frac{\pi}{2} + \omega t\right)$$

but $I = I_0 \sin\left(\frac{\pi}{2} + \omega t\right)$

then $I_0 = \omega C V_0$

Peak value of current

Phasor digram -

$I_0 = \omega C V_0$

$$\frac{I}{\omega C} = \frac{V_0}{I_0}$$

but $\frac{V}{I} = R$

$$R = \frac{1}{\omega C}$$

$$X_c = \frac{1}{\omega C}$$

$$X_c = \frac{1}{2\pi v C}$$

Ac circuit containing only pure inductance -

let a coil of inductance L has been connected with Ac source.

voltage applied on inductance coil is given by

$V = V_0 \sin \omega t$ - (1)

then E.m.f is generated on coil

is $= -L \frac{dI}{dt}$

So instantaneous voltage

$$V - L\frac{dI}{dt}$$

Since Resistance $= 0$

$$V = -L\frac{dI}{dt} = 0$$

$$V = L\frac{dI}{dt}$$

$$V_0 \sin \omega t = L\frac{dI}{dt}$$

$$\frac{dI}{dt} = \frac{V_0}{L}\sin\omega t$$

$$\int \frac{dI}{dt} = \frac{V_0}{l}\int \sin\omega t$$

$$I = \frac{V_0}{L}\left(-\frac{\cos\omega t}{\omega}\right)$$

$$= \frac{-V_0}{\omega t}\cos\omega t$$

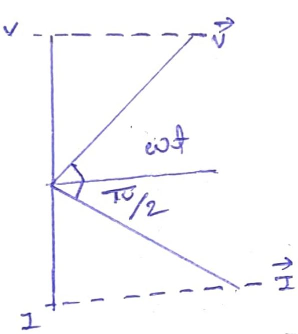
$$I = \frac{-V_0}{\omega t}\sin\left(-\frac{\pi}{2}\ \omega t\right)$$

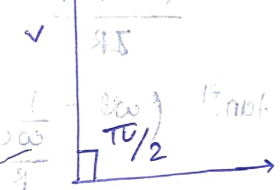
$$I = \frac{V_0}{\omega t}\sin\left(\frac{\pi}{2}-\omega t\right)$$

$$I = \frac{V_0}{\omega t}\sin\left(\omega t-\frac{\pi}{2}\right)$$

$$I = I_0\sin\left(\omega t-\frac{\pi}{2}\right)$$

- phasor - digram -





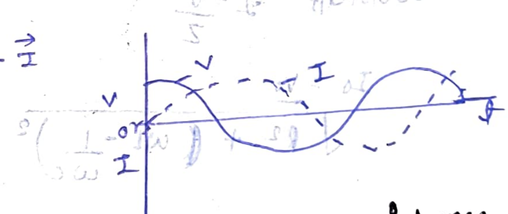
$$I_0 = \frac{V_0}{\omega L}$$

$$\frac{V_0}{I_0} = \omega l$$

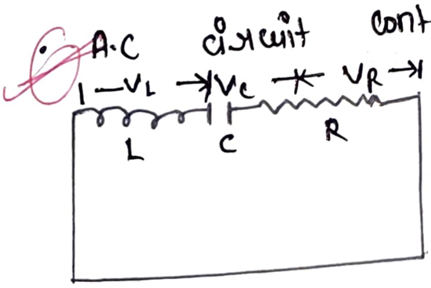
but $\frac{V}{I} = R$

$$X_L = \omega l$$

$$X_L = 2\pi\nu L$$



- A.C circuit containing inductance capacitance and Resistance -



Let inductance L capacitance C and Resistance R connected in series in A.C circuit

Voltage in given by
$V = V_0 \sin\omega t$

Resultent voltage

$$V_c = IX_L$$

$$V_c = IX_c$$

$$V_R = IR$$

$V_2 = V_R{}^2 + (V_L - V_C)^2$

$V = \sqrt{V_R{}^2 + (V_L - V_C)^2}$

Squaring both sides and substituting the values

$V^2 = I^2R^2 + (IX_L - IX_C)$

$V^2 = I^2 [R^2 + (X_L - X_C)^2]$

$V = I \sqrt{R^2 + (X_L - X_C)^2}$

$V = I \sqrt{R + (\omega L - \frac{1}{\omega C})^2}$

$\frac{V}{I} = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}$

Impedence $Z = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}$

* Phase difference -

$\tan \phi = \frac{V_L - V_C}{V_R}$

$= \frac{IX_L - IX_C}{IR}$

$\tan \phi = \frac{I(X_L - X_C)}{IR}$

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

current $I = \frac{V}{Z}$

$I_0 = \frac{V_0}{\sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}}$

• ~~Rep~~ Resonant Condition -

$X_L = X_C$

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

$\omega^2 = \frac{1}{LC}$

$\omega = \frac{1}{\sqrt{LC}}$

$2\pi \nu = \frac{1}{\sqrt{LC}}$

$2\pi\sqrt{LC}$ frequency

The current flowing through LCR circuit attance maximum value for a specific frequency this is called the state of resistant and this frequency is known as resonant frequency.

Power in alternating current circuit -

The value of energy spend in any circuit is called its power in alternating current circuit the value of voltage and current change with time so, the instantaneous power is define as.

instantaneous power = instantaneous voltage

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

$$I = I_0 \sin(\omega t - \phi)$$

ϕ is phase difference betw v and I

$$P = VI$$

$$= V_0 \sin \omega t \cdot I_0 \sin \cancel{\omega t} (\omega t - \phi)$$

$$= \frac{1}{2} V_0 I_0 \, 2 \times \sin \omega t \sin(\omega t - \phi)$$

$$[2 \sin A \sin B = \cos(A-B) - \cos(A+B)$$

$$\cos(\omega t - \omega t - \phi) - \cos(\omega t + \omega t + \phi)$$

$$\frac{1}{2} V_0 I_0 \cos(\omega t$$

$$\frac{1}{2} V_0 I_0 [\cos \phi - \cos(2\omega t - \phi)]$$

$$\frac{1}{2} V_0 I_0 \cos \phi - \frac{1}{2} V_0 I_0 \cos(2\omega t - \phi)$$

In complete cycle Average value of $\cos(2\omega t - \phi)$ is 0.

$$= \frac{1}{2} V_0 I_0 \cos \phi$$

$$P = \frac{V_0}{\sqrt{2}} \cdot \frac{I_0}{\sqrt{2}} \cos \phi$$

$$P_{ov} = V_{rms} \cdot I_{rms} \cos \phi$$

- **Special cause -**

I - AC circuit contains only atomic resistance than phase difference $= 0$

$$P_{ov} = V_{rms} \times I_{rms} \times \cos \phi$$

$$= V_{rms} \times I_{rms} \times \cos 0$$

$P_{av} = V_{rms} \times I_{rms}$ - (1)

Thus maximum energy B consumed

$I_{rms} = \frac{V_{rms}}{R}$

by eq - (1)

$P_{av} = V_{rms} \times \frac{V_{rms}}{R}$

$P_{av} = \frac{V^2_{rms}}{R}$

$= \frac{(I_{rms} R)^2}{R}$

$P_{av} = I^2_{rms} R$

$= \left(\frac{I_0}{\sqrt{2}}\right)^2 R$

$= \frac{I_0^2}{2} R$

$I_0 = I_{rms} \sqrt{2}$

$I_{rms} = \frac{I_0}{\sqrt{2}}$

II Special case

II ac circuit contains only Inductor capacitor

$\cos(-\theta) = \cos\theta$

$\theta = \frac{\pi}{2}$ $\qquad \phi = -\frac{\pi}{2}$

$P_{av} = V_{rms} \times I_{rms} \times \cos\phi$

$= V_{rms} \times I_{rms} \times \cos\frac{\pi}{2}$

$= 0$

II Special case - a-c circuit contains L, C and R in series -

$\tan\phi = \frac{\omega L - \frac{1}{\omega C}}{R}$

By · P.G.T

$H^2 = A^2 + B^2$

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

$\cos\phi = \frac{B}{H}$

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

$\frac{R}{Z}$

$V_{rms} = I_{rms} Z$

$P_{av} = V_{rms} \times I_{rms} \times \cos\phi$

$= I_{rms} Z \times I_{rms} \times \frac{R}{Z}$

$I^2_{rms} R$

$\left(\frac{I_0}{\sqrt{2}}\right)^2 R = \frac{I_0^2}{2} R$

Q factor - The ratio of resonance frequency and bond with of a series LBR circuit is known as Q factor of the circuit.

Q factor $= \frac{\text{resonance frequency}}{\text{Band with}}$

$Q = \frac{\omega_0}{2\Delta\omega}$

Expression of Q factor current in LCR circuit

$I_0 = \frac{V_0}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} = \frac{V_0}{Z}$

for resonance frequency $\omega_0 \cdot I_{max} = \frac{V_0}{R}$

$I_0 = \frac{1}{\sqrt{2}} I_{max}$

thus for resonance frequency ω_1, ω_2

$Z = \sqrt{2}R$

$\sqrt{R^2 (\omega L - \frac{1}{\omega c})^2} = \sqrt{2}R$

squaring both side.

$R^2 + (\omega L - \frac{1}{\omega c})^2 = 2R^2$

$(\omega L - \frac{1}{\omega c})^2 = R^2$

$(\omega L - \frac{1}{\omega c}) = \sqrt{R^2}$

$\omega L = \frac{1}{\omega c} = \pm R$

taking $\omega_L - \frac{1}{\omega c} = R$

$(\omega_2 > \omega)$

$\omega_2 L - \frac{1}{\omega_2 c} - R$ — (1)

taking

$-\omega_1 L - \frac{1}{\omega_1 c} = +R$

$\omega_1 < \omega$ — (ii)

Substracting — (i) -(ii)

$(\omega_2 - \omega_1) L + \frac{1}{c} \left(\frac{\omega_2 - \omega_1}{\omega_1 - \omega_2}\right) = 2R$

$(\omega_2 - \omega_1) \left[L + \frac{1}{c\omega_1 \omega_2}\right] = 2R$

But in case of resonance

$\omega_1 = \omega_2 = \omega_0$

$\omega_1 \omega_2 = \omega_0^2 = \frac{1}{LC}$

$(\omega_2 - \omega_1) \left[L + \frac{1}{(\omega_1 \omega_2)}\right] = 2R$

$(\omega_2 - \omega_1) \left[L + \frac{1}{\frac{c_1}{Lc}}\right] = 2R$

$(\omega_2 - \omega_1) \left[L + \frac{Lc}{c}\right] = 2R$

$(\omega_2 - \omega_1)\ 2L = 2R$

$\omega_2 - \omega_1 = \frac{R}{L}$

But

$\omega_2 - \omega_0 + \Delta\omega$

$\omega_1 = \omega_0 - \Delta\omega$

$2\Delta\omega = RL$

there for Q factor

$Q = \frac{\omega_0}{2\Delta\omega}$ — (1)

$= \frac{\omega_0 L}{R}$

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

$= Q = \frac{1}{\omega_0 C R}$

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

by eq (1)

$Q = \frac{1}{\sqrt{LC}} \times \frac{L}{R}$

$\frac{1}{R} \times \frac{L}{\sqrt{L} \times \sqrt{C}}$

$\frac{1}{R} \frac{\sqrt{L} \times \sqrt{L}}{\sqrt{L} \times \sqrt{C}}$

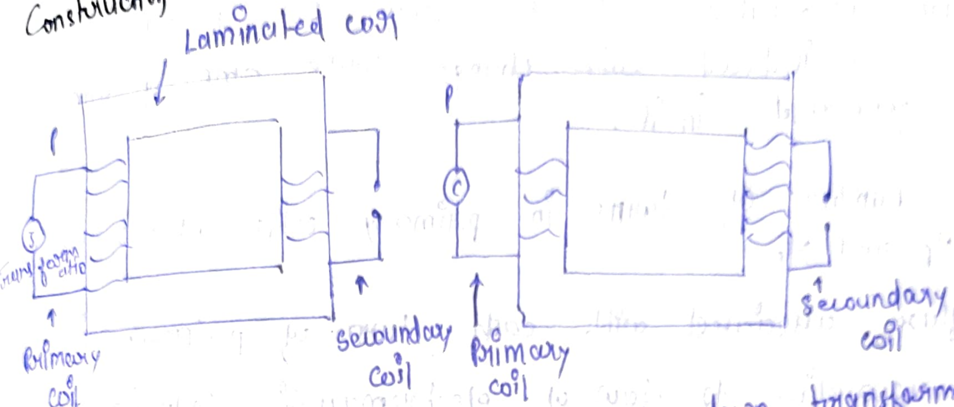
$Q = \frac{1}{R} \cdot \sqrt{\frac{L}{C}}$

Transformer - Transformer ... decrease alternating voltage its working is waste on mutual induction transformer are of two type.

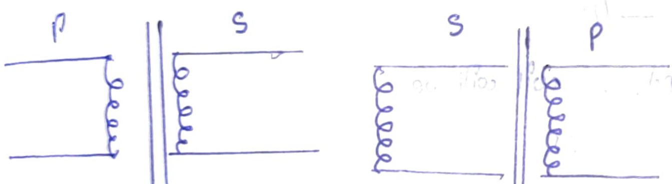
(1) Step - down transformer - This transformer decrease the A.C voltage but increase the value of current.

(2) Step- ~~down~~ up transformer - This transformer increase the A.C voltage but decrease the value of current.

Construction -



(1) Set-up transformer (2) Set - down transformer



Step- down transformer Step - up transformer

Construction - There are mainly three part of transformer
(1) Laminated Core. (II) Primary coil
(III) secondary coil.

* ~~lies~~ Laminated Core - It made up of rectangular or circular strips of pure Iron (which are called for middle in the shape of rectangle or circle) these strips are made up of required thickness by giving sufficient layers of warnish. It is called laminated core.

The coil on which alternating voltage is applied is called primary coil and the coil at whose terminal induced emf is obtained is called secondary coil.

In step down transformer. The no of turns in primary coil are larger and wire is thin. In secondary coil no. of turns are less and wire is thick, turns are less and wire is thick.

In primary coil, of step up transformer of turns are loss but wire is thick and in secondary coil of set up transformer the no. of turns are greater but the wire is thin.

Working - when alternating voltage is applied betw terminal of primary coil then an alternating current flow in the coil. This alternating current produce in coil this alternati. magnetic flux associated with secondary coil changes consequently is the induced ~~volt~~ ~~change~~ w.r.t. emf of same frequency is generated in it.

Theory - let the number of turns in primary coils and secondary coils are Np and Ns

If magnetic flux associated with each turn of primary coil is ϕ then according to law of electromagnetic induction induced in primary coil will be

$$Ep = -Np \cdot \frac{d\phi}{dt} \quad -(1)$$

then induced emf in secondary coil will be

$$Es = -Np \frac{d\phi}{dt} \quad -(2)$$

dividing eq (2) by eq (1)

$$\frac{Es}{Ep} = \frac{Ns}{Np} \quad \text{by eq (1)}$$

If resistance of primary coil is negligible than induced emf coil Ep will be equal to applied alternating voltage Vp similarly, Es in it will be equal to potential difference Vs betw its terminals.

So from eq - (3)

$$\frac{Vs}{Vp} = \frac{Ns}{Np} \quad -(4)$$

$$\frac{Ns}{Np} = r = \text{transformer ratio} \quad -(5)$$

Then input power (Power in primary coil) = $Vp \times Ip$

& output power (power in second, coil) = $Vs \times Is$

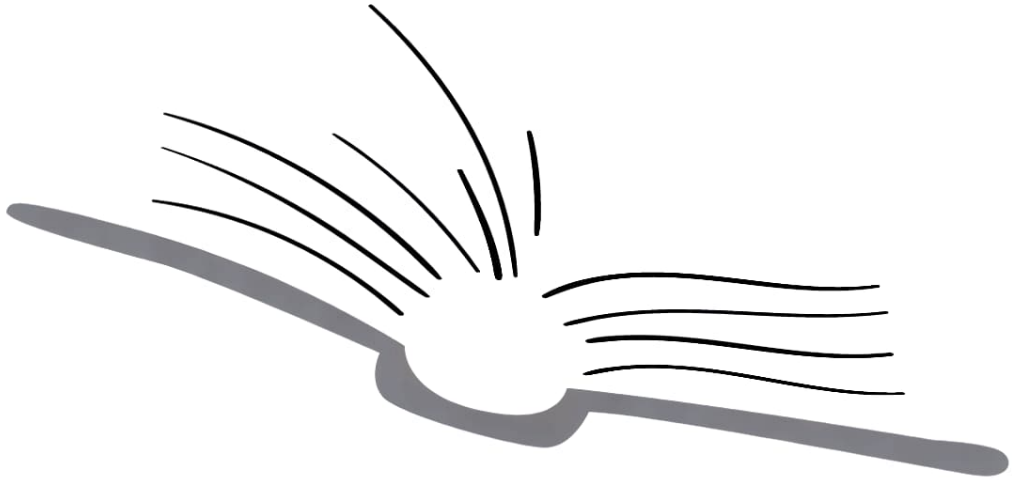
$\therefore \quad V_p \times I_p = V_s \times I_s$

or $\quad \dfrac{V_s}{V_p} = \dfrac{I_p}{I_s} \quad — (1)$

or $\quad V \propto \dfrac{1}{I}$

So, from eq 4, 5, 6,

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s} = r$$



THANKYOU

FOR

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