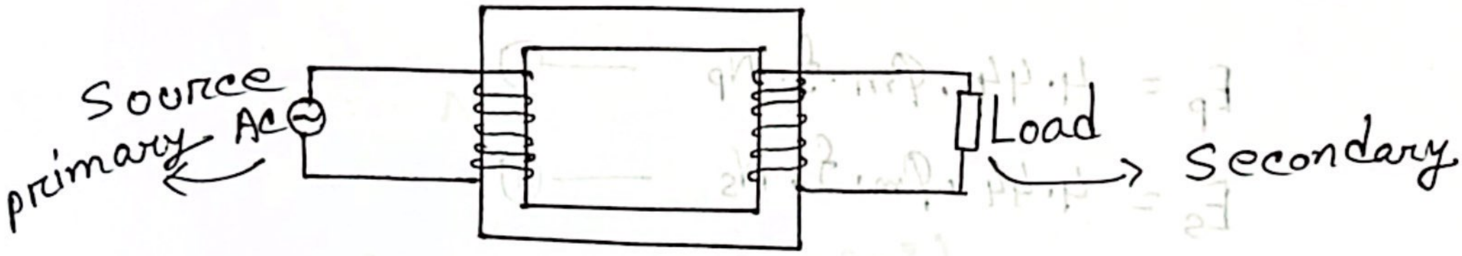
Transfarmar



⇒ The side where the source that is the primary source

power → Primary = Secondary $V_P I_P = V_S I_S$

Frequency → Primary = Secondary

$$\text{EMF or } E = -N \frac{d\phi}{dt}$$

Here, N = Number of turns,

ϕ = magnetic flux

t = time

⇒ The side with a higher number of turns has a higher voltage. If the number of turns is less the voltage is also less

Turns Ratio, $a = \frac{N_P}{N_S}$

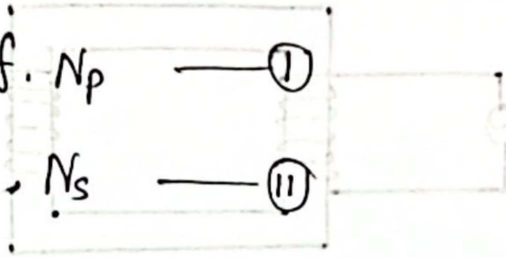
Transformation Ratio, $K = \frac{N_S}{N_P} = \frac{1}{a}$

No-load Condition

RMS Value of EMF Equation

$$E_p = 4.44 \cdot \varphi_m \cdot f \cdot N_p \quad \text{--- (I)}$$

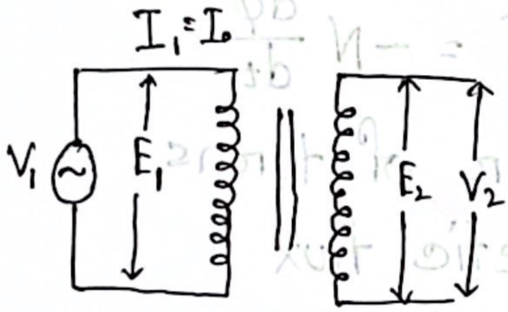
$$E_s = 4.44 \cdot \varphi_m \cdot f \cdot N_s \quad \text{--- (II)}$$



$$\text{(I)} \div \text{(II)} \Rightarrow \frac{E_1}{E_2} = \frac{N_p}{N_s} \Rightarrow \frac{E_1}{N_p} = \frac{E_2}{N_s} = K = 4.44\,\varphi_m f$$

$\Rightarrow K > 1$; $N_s > N_p \longrightarrow$ step-up transformer

$\Rightarrow K < 1$; $N_s < N_p \longrightarrow$ step-down transformer



when in no load condition

$I_1 = I_0$ —
- $\rightarrow I_w \longrightarrow$ Working Component
- $\rightarrow I_\mu / I_m \rightarrow$ Magnetizing Component

Losses

I_w

$\Rightarrow$ Iron loss / Core loss + Copper loss (I^2R)

- eddy Current loss
- Hysteresis loss

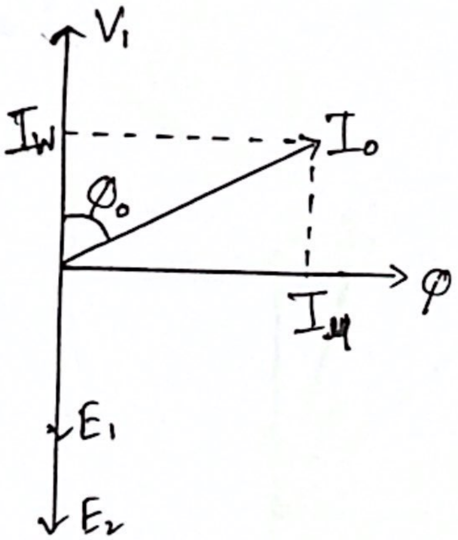
Flux equation

$$E = -N \frac{d\phi}{dt} \quad [\phi = \phi_m \sin \omega t$$

$$\Rightarrow = -N \frac{d(\phi_m \sin \omega t)}{dt}$$

$$= K \sin(\omega t - 90^\circ)$$

No-load transformer phasor diagram



$$\vec{I_0} = \vec{I_\mu} + \vec{I_W}$$

$$I_W = I_0 \cos \phi_0$$

$$I_\mu = I_0 \sin \phi_0$$

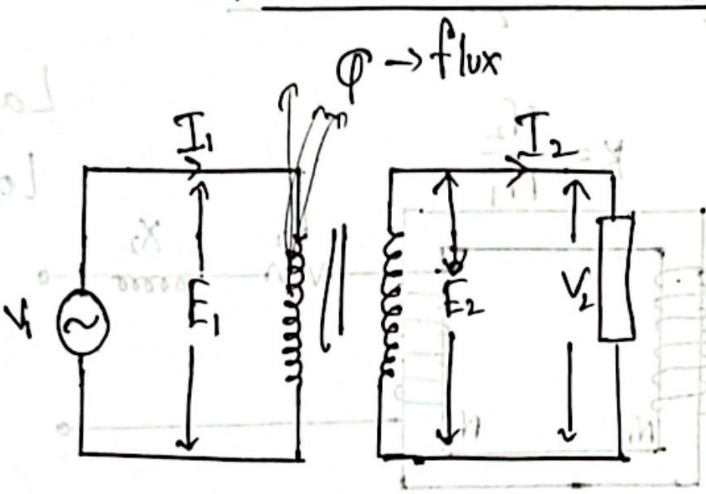
$$I_0 = \sqrt{I_W^2 + I_\mu^2}$$

Ideal Power balance equⁿ

$$KVE = E_1 I_1 = E_2 I_2 \quad [I_2 = 0]$$

$$\Rightarrow E_2 I = 0 = E_1 I_1$$

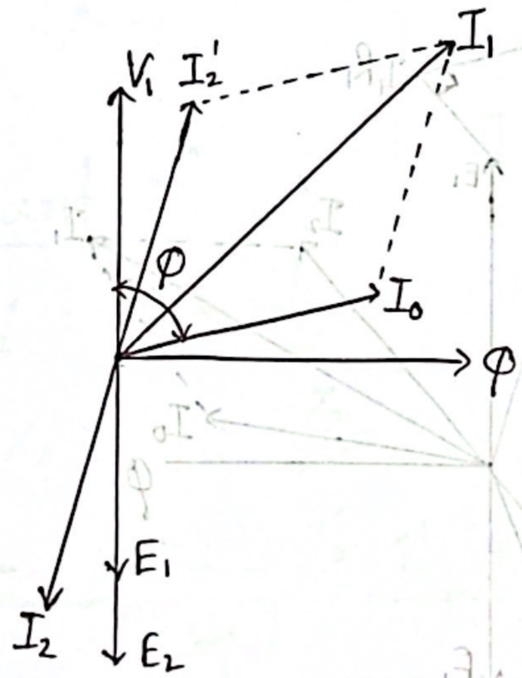
Transformer on Load



[The current will be lead or lag depends on the load.]

$$\vec{I_1} = \vec{I_0} + \vec{I_2'}$$

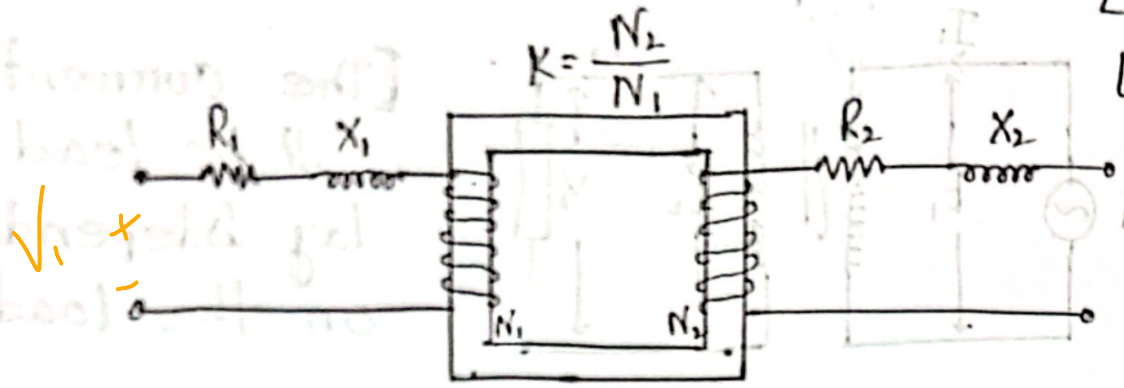
$$I_2' = K I_2$$
$$= \frac{N_2}{N_1} \cdot I_2$$



=> যদি Question এ Load থাকে Loaded transformer

Equivalent Circuit

Laging type load.

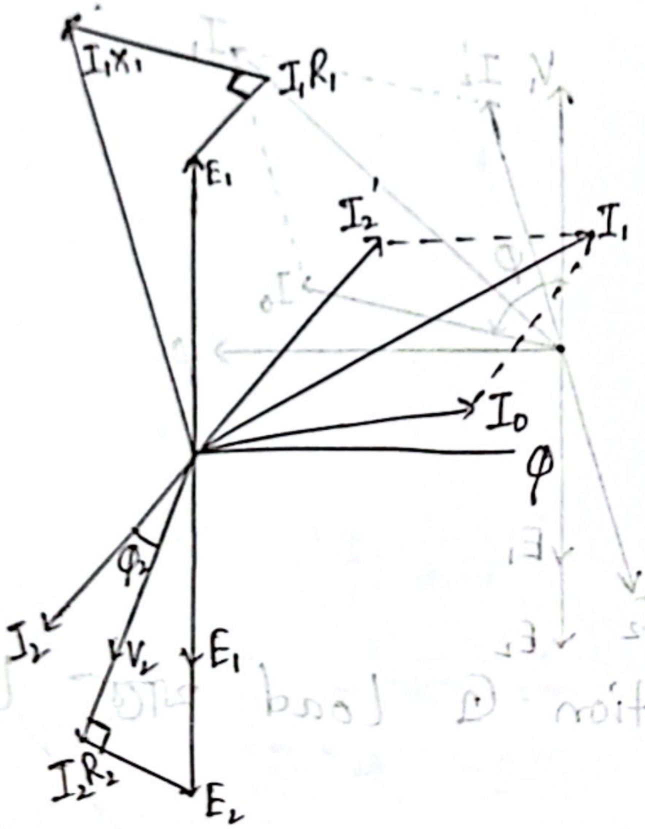


$\#$ $E_1 = -V_1 + I_1 R_1 + j I_1 X_1$

$\Rightarrow V_1 = -E_1 + I_1 (R_1 + jX_1)$

and,

$\#$ $E_2 = V_2 + I_2 (R_2 + jX_2)$



Shifting

Secondary to Primary shift:

$$X_2' = \frac{X_2}{K^2}$$

$$R_2' = \frac{R_2}{K^2}$$

$$Z_2' = \frac{Z_2}{K^2}$$

Primary to secondary shift:

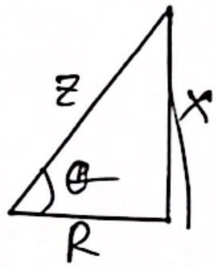
$$X_1' = K^2 X_1$$

$$R_1' = K^2 R_1$$

$$Z_1' = K^2 Z_1$$

Only have Value X_1 and R_1

$$Z_1 = \sqrt{R_1^2 + X^2}$$



$$\tan\theta = \frac{X}{R}$$

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

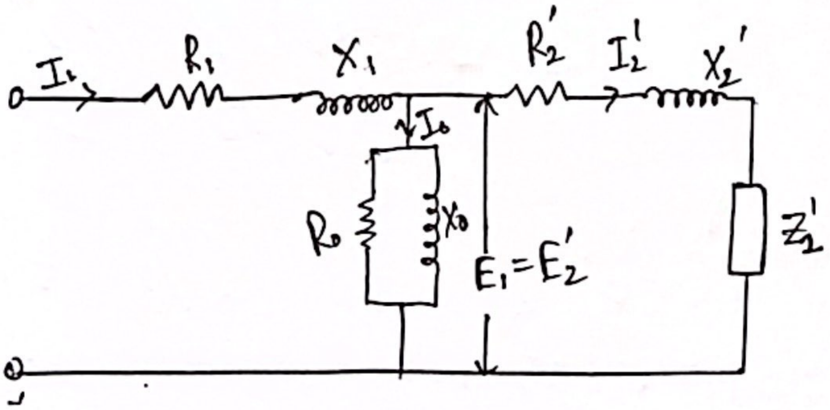
Equevalant

$$R = R_1 + R_2' = R_1 + \frac{R_2}{K^2}$$

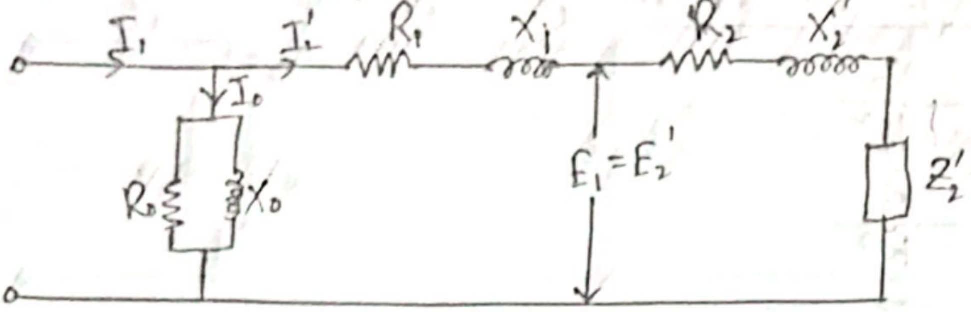
$$X = X_1 + X_2' = X_1 + \frac{X_2}{K^2}$$

$$I_2' = K I_2$$

$$E_2 = K E_2'$$



Symplefy circuit:



$\boxed{32.1}$ The maximum flux density in core of a $\overset{V_1}{250}/\overset{V_2}{3000}$ volts, 50 Hz single phase tranformer is 1.2 wb/m². If the emf per turn is 8 volts, determine.

(i) Primary and secondary turns

(ii) Area of the core.

Soln: (i)

Given that,

$$\text{emf per turn}, E_t = 8\ V$$

$$V_1 = E_1 = 250\ V$$

$$V_2 = E_2 = 3000\ V$$

we know that,

$$E_1 = N_1 \times \text{emf/turn}$$

$$\Rightarrow 250 = N_1 \times 8$$

$$\Rightarrow N_1 = \frac{250}{8} \approx 32$$

and,

$$E_2 = N_2 \times \text{emf/turn}$$

$$\Rightarrow 3000 = N_2 \times 8$$

$$\Rightarrow N_2 = \frac{3000}{8} \approx 375$$

(ii) Given that,

B_m $f = 50$ Hz $E_1 = 250$ V

flux density, $B_m = 1.2$ wb/m^2

we Know that,

$$E_1 = 4.44 f \phi_m N_1$$

$$\Rightarrow 250 = 4.44 \times 50 \times B_m \times A \times 32$$

$$\Rightarrow A = \frac{250}{4.44 \times 50 \times 1.2 \times 32}$$

$$= 0.029 \text{ m}^2$$

32.5 The core of a three phase, 50 Hz, 11000/550 volt delta/star, 300 KVA, Coretype transformer opperate with a flax of 0.05 wb. find

(i) number of H.V and L.V turn per phase

(ii) emf per turn

(iii) full load H.V and L.V phase current.

Soln:

Given that,

$f = 50$ Hz KVA = 300

$\phi_m = 0.05$ wb

$E_1 = 11000$ V

$E_2 = 550$ V

(i) We Know that,

$$E_1 = 4.44\, \phi_m f N_1$$

$$\Rightarrow 11000 = 4.44 \times 0.05 \times 50 \times N_1$$

$$\Rightarrow N_1 = \frac{11000}{4.44 \times 0.05 \times 50} = 990.99 \approx 991.$$

and, $E_2 = 4.44\, \phi_m f N_2$

$$\Rightarrow \frac{550}{\sqrt{3}} = 4.44 \times 0.05 \times 50 \times N_2$$

[E_2 star Connection]

$$\therefore N_2 = 28.60 \approx 30$$

again,

$$\frac{N_2}{N_1} = \frac{E_2}{E_1}$$

$$\Rightarrow N_1 = N_2 \times \frac{E_1}{E_2} = 30 \times \frac{11000}{\frac{550}{\sqrt{3}}}$$

$$= 1040$$

(ii) emf per turn,

$$E_t = \frac{11000}{1040} = 10.57\ V$$

(iii) per phase KVA $= \frac{300}{3} = 100 \times 10^3\ VA.$

we Know that,

$$KVA = E_1 I_1$$

$$\Rightarrow I_1 = \frac{11000}{100 \times 10^3} = 9.1\ A$$

and, $I_2 = \frac{N_1}{N_2} \times I_1 = \frac{1040}{30} \times 9.1$

$$= 315.46\ A$$

$\boxed{32.11}$ A single-phase transformer has 1000 turns on the primary and 200 turns on the secondary. The no load current is 3 amp. at a p.f of 0.2 lagging. Calculate the primary current and power factor when the 2nd current is 280 A at a p.f of 0.8 Lagging.

Soln:

Given that,

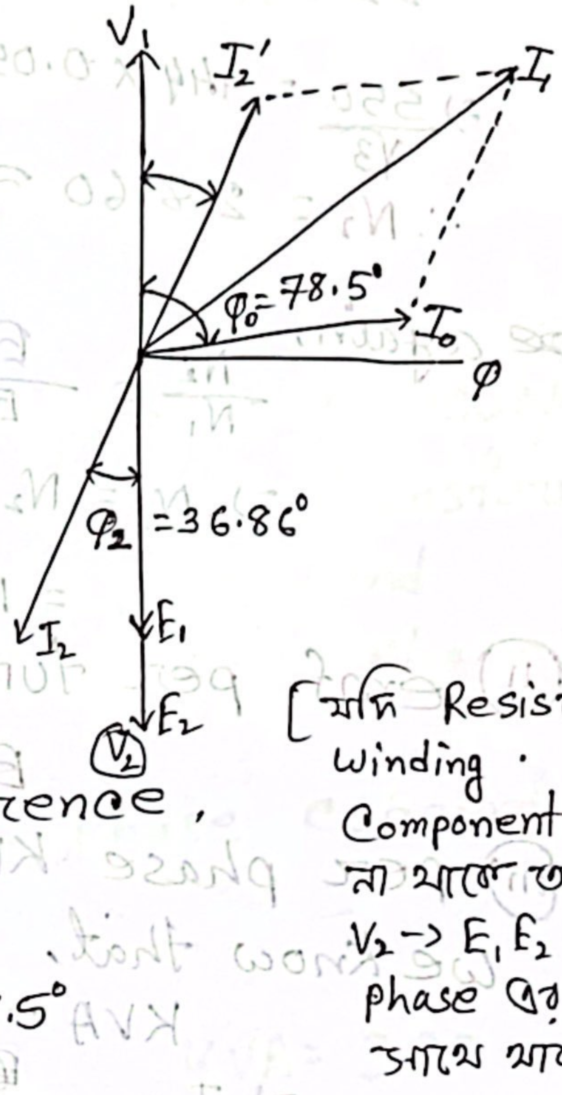
$N_1 = 1000$

$N_2 = 200$

$I_0 = 3\,A$ at a P.f. of 0.2 lagging

$I_1 = ?$

P.f. at Primary when $I_2 = 280\,A$ at a p.f. 0.8 lagging.



[যদি Resistance winding. Component এ না থাকে তাহলে $V_2 \to E_1\, E_2$ phase এর সাথে থাকবে]

Considering V_1 as reference,

so, $\cos\varphi_0 = 0.2$

$\Rightarrow \varphi_0 = \cos^{-1}(0.2) = 78.5^\circ$

and, $\cos\varphi_2 = 0.8$

$\Rightarrow \varphi_2 = \cos^{-1}(0.8) = 36.86^\circ$

$\vec{I_0} = 3\angle -78.5° \ A$

$I_2' = K I_2$

$= \frac{N_2}{N_1} \times I_2 = \frac{200}{1000} \times 280$

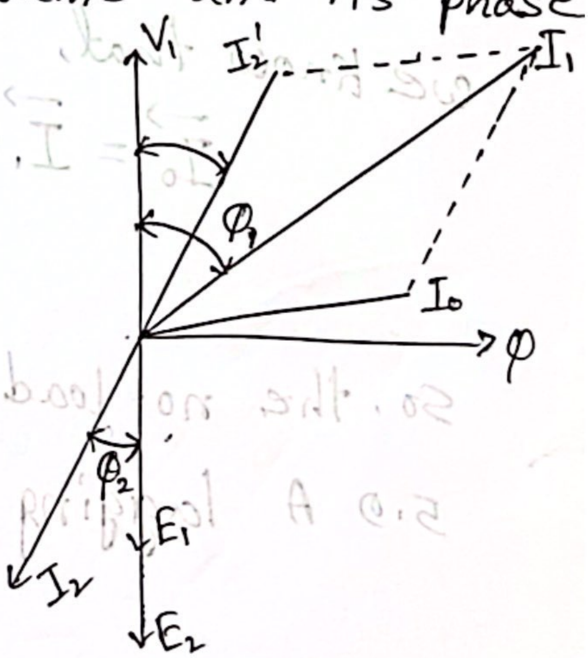
$= 56 \ A$

$\therefore \vec{I_2} = 56 \angle -36.86°$

Now, $\vec{I_1} = \vec{I_0} + \vec{I_2'}$

$= 3\angle -78.5° + 56\angle -36.86°$

$\boxed{32.13}$ A transformer has a primary winding of 800 turns and a secondary winding of 200 turns. when the load current on the secondary is 80 A at 0.8 p.f lagging. the primary current is 25 A at 0.7078 lagging. Determine graphically or otherwise the no-load current of the transformer and its phase with respect to the voltage.



Soln:

Given that,

$N_1 = 800$

$N_2 = 200$

$I_2 = 80 \ A$ at pf 0.8 lagging

$I_1 = 25 A$ at pf 0.7078 "

$I_0 = ?$

Here,

$\cos \varphi_2 = 0.8$

$\therefore \varphi_2 = \cos^{-1}(0.8)$

$= 36.86°$

and, $\cos \varphi_1 = 0.7078$

$\varphi_1 = \cos^{-1}(0.7078)$

$= 44.94°$

Now, $\vec{I_1} = 25 \angle -44.94° \text{ A}$

$I_2' = K I_2$

$= \frac{N_2}{N_1} \cdot I_2 = \frac{200}{800} \times 80 = 20 \text{ A}$

$\therefore \vec{I_2'} = 20 \angle -36.86° \text{ A}$

we know that,

$\vec{I_0} = \vec{I_1} - \vec{I_2'} \Rightarrow 25 \angle -44.94° - 20 \angle -36.86°$

$= 5.9 \angle -73.32° \text{ A}$

So, the no-load current is approximately 5.9 A lagging the applied voltage by 73.32°