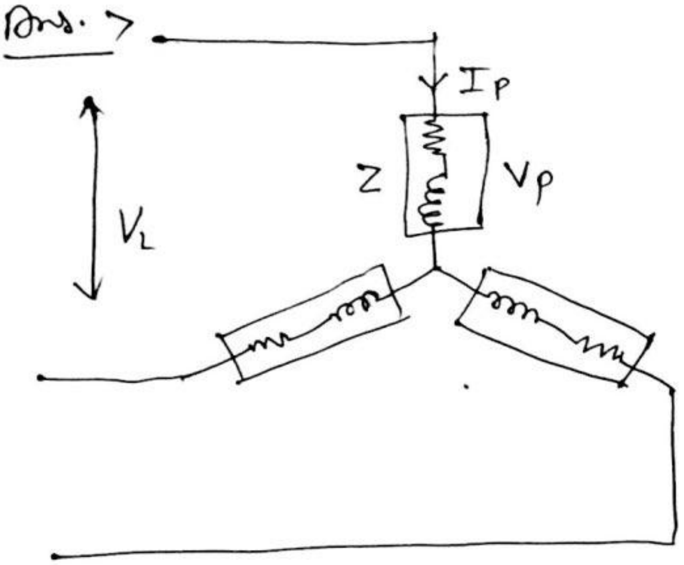
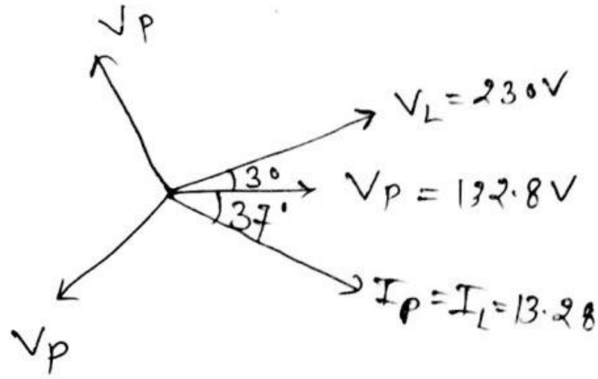
Que.5> A balance star Connected load of $(8+j6)\Omega$ per phase is Connected to 3 phase, 230V, 50Hz. Supply. find the line current, power factor, Volt ampere reactive Draw the phasor Diagram for cht.

Ans.>





now given → $V_L = 230V$ $\quad Z = \sqrt{8^2+6^2} = 10\Omega$

$Z = 8+j6\Omega$ $\quad V_p = V_L/\sqrt{3} = 132.8\ V$

now

$$I_p = \frac{V_p}{Z} = \frac{132.8}{10} = 13.28\ A$$

(i) $I_L = I_p = 13.28\ A$

(II) $\cos\phi = R/Z = 0.8$ and $\phi = 36.87$

(III) $P = 3V_pI_p\cos\phi = 3\times 132.8\times 13.28\times 0.8 = 4.232\ KW$

(IV) $P_R = 3V_pI_p\sin\phi = 3\times 132.8\times 13.28\times 0.6 = 3.179\ KVAR$

Que.6> A 3ϕ balance load draw 10KW Power from a 400V, 3phase, supply at 0.8 logging power factor. determine (i) line Current (II)

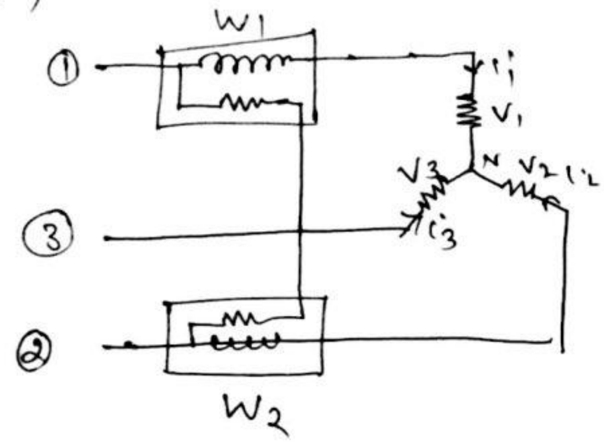
Ans.> $P = 10KW$ $\quad V_L = 400V$ $\quad \cos\phi = 0.8$

$P = 3V_pI_p\cos\phi = \sqrt{3}V_LI_L\cos\phi$

$\boxed{I_L = 18.04A}$ Ans

Que.7> Prove that Power Can be measured by two wattmeter method for Star & Delta Connected System.

(i) Star Connected System>



Total Power in cht is given by

$$P = V_1 i_1 + V_2 i_2 + V_3 i_3 \quad -(i)$$

apply KCL at node N

$$i_1 + i_2 + i_3 = 0$$

$$i_3 = (-i_1 - i_2)$$

Put the value of i_3 in eq. (i)

$$P = V_1 i_1 + V_2 i_2 - V_3(i_1 + i_2)$$

$$P = i_1(V_1 - V_3) + i_2(V_2 - V_3) \quad \text{—— (ii)}$$

* Now for Wattmeter reading.

$(W_1) \rightarrow$ the Current Coil having Current i_1 & Pressure Coil Voltage is $V_{13} = (V_1 - V_3)$ So Wattmeter reading is

$$W_1 = i_1(V_1 - V_3)$$

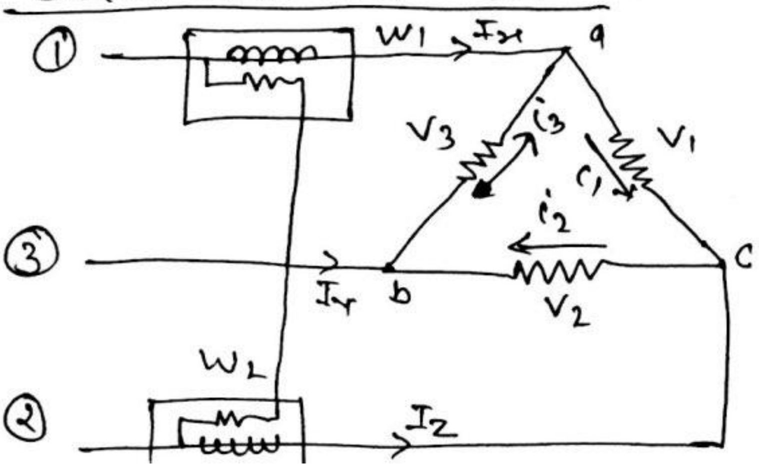
Similarly $W_2 = i_2(V_2 - V_3)$

by eq. (ii) total Power is now

$$\boxed{P = W_1 + W_2}$$

So total Power Can be measured by two wattmeter Method

(ii) Delta Connected System>



Total power in Delta Connected System is

$$P = V_1 i_1 + V_2 i_2 + V_3 i_3 \quad (i)$$

apply KVL in loop abcb →

$$V_1 + V_2 + V_3 = 0$$

$$V_1 = -(V_2 + V_3)$$

Put the value of V_1 in eq. (1')

$$P = V_1 i_1' + V_2 i_2' + V_3 i_3'$$

$$= -(V_2+V_3) i_1' + V_2 i_2' + V_3 i_3'$$

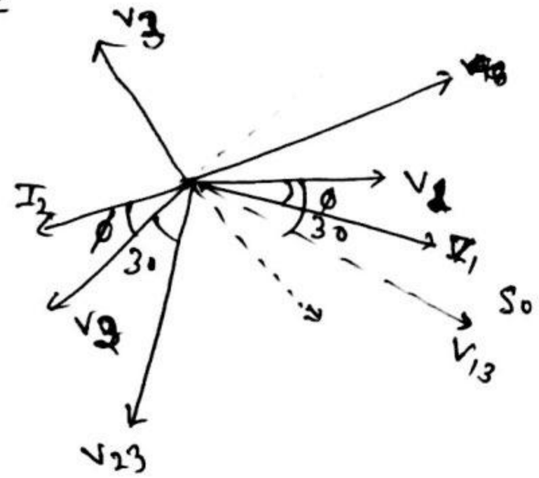
$$P = -V_3(i_1' - i_3') + V_2(i_2' - i_1')$$

Compairing with wattmeter reading →

$$\boxed{P = W_1 + W_2}$$

Que. 8> Derive the Expression for power Factor by wattmeter reading.

Ans. >



Wattmeter readings are

$$W_1 = i_1 (V_1 - V_3)$$

$$W_2 = i_2' (V_2 - V_3)$$

for Inductive load →

$$W_1 = V_L I_L \cos(30 - \phi)$$

$$W_2 = V_L I_L \cos(30 + \phi)$$

now $W_1 + W_2 = V_L I_L \cos(30 - \phi) + V_L I_L \cos(30 + \phi)$

$$= \sqrt{3} V_L I_L \cos\phi$$

$$W_1 - W_2 = V_L I_L \cos(30 - \phi) - V_L I_L \cos(30 - \phi)$$

$$= V_L I_L [2 \sin 30 \sin\phi]$$

$$= V_L I_L \sin\phi$$

$$\frac{W_1 - W_2}{W_1 + W_2} = \frac{1}{\sqrt{3}} \tan\phi$$

$$\tan\phi = \sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)$$

$$\boxed{\cos\phi = \cos \tan^{-1} \sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)}$$

Qus.1 > Explain Different type of Magnetic Material

Ans.> Magnetic Materials are basically three types

(i) Paramagnetic Material

(II) Diamagnetic Material

(III) Ferromagnetic Material

(i) Paramagnetic Materials.> The materials which are not strongly attracted by a magnet are known as Paramagnetic material.

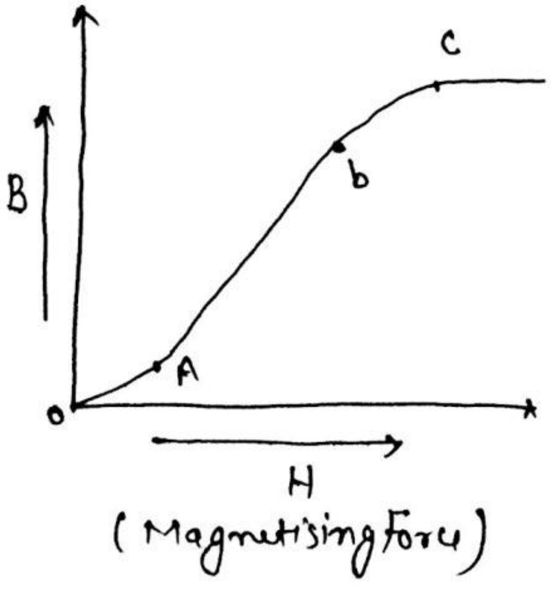
Ex.> aluminium, platinum, magnesium.

(II) Diamagnetic Materials> The materials which are repelled by a magnet such as Zinc, mercury, lead are known as Diamagnetic materials.

(III) Ferromagnetic Materials> The material which are strongly attracted by a magnet such as Iron, steel, Nickel are known as ferromagnetic materials.

Qus.2> Explain B-H curve in detail >

Ans.> The Curve Drawn b/w Induction density B and Magnetising Force H is known as B-H curve or Magnetising curve.



* in region OA Increase in flux density is very small
* in region ab flux density is Directly proportional to Magnetising Force
* in Region bc again Increase in flux density is very small.
* beyond c there is no change in flux density on Increasing the Magnetising Force this Region is known as Magnetic Saturation.

Que.3 > Explain Ideal & Practical Transformer.

Ans. > For a Ideal Transformer we take following assumption's →

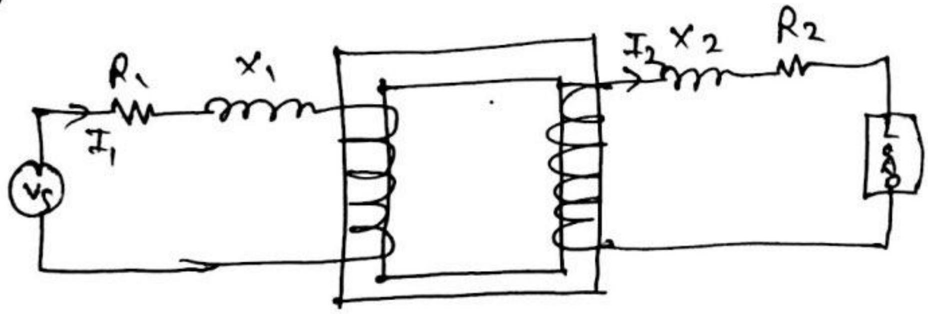
(i) No winding resistance → The primary & Secondary winding's have No resistance.

(ii) No magnetic leakage → There is No leakage Flux all the flux setup is confined to the core.

(iii) No Iron loss → There is No Hysteresis and eddy current loss

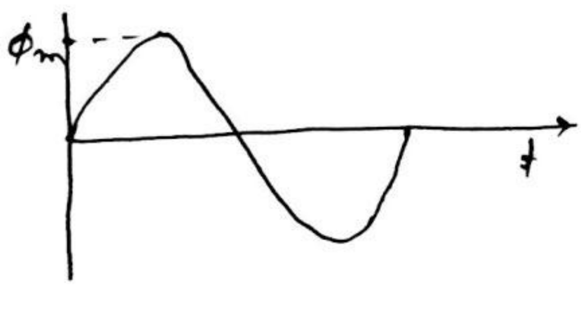
(iv) Zero magnetising current → The Core has Infinite Permeability and zero reluctance.

Practical Transformer > The Transformer which Not follow the assumption of Ideal Transformer is known as practical Transformer



Que-4 > Write down E.m.f. Equation of transformer

Ans. >



* let flux associated with the Core is

$$\phi = \phi_m \sin \omega t$$

* N_1 & N_2 no of turn in Primary and Secondary winding.

* Now Induced e.m.f in Primary winding

$$e_1 = -N_1 \frac{d\phi}{dt} = -N_1 \omega \phi_m \cos \omega t$$

$$= N_1 \omega \phi_m \sin(\omega t - \pi/2)$$

Similarely

$$\mathcal{E}_2 = -N_2\frac{d\phi}{dt}$$

$$= -N_2\frac{d}{dt}(\phi_m \sin \omega t)$$

$$= N_2 \omega \phi_m \sin(\omega t - \pi/2)$$

Now ~~average~~ r.m.s. value of Induced e.m.f

$$\mathcal{E}_1 = \frac{N_1 \phi_m \omega}{\sqrt{2}}$$

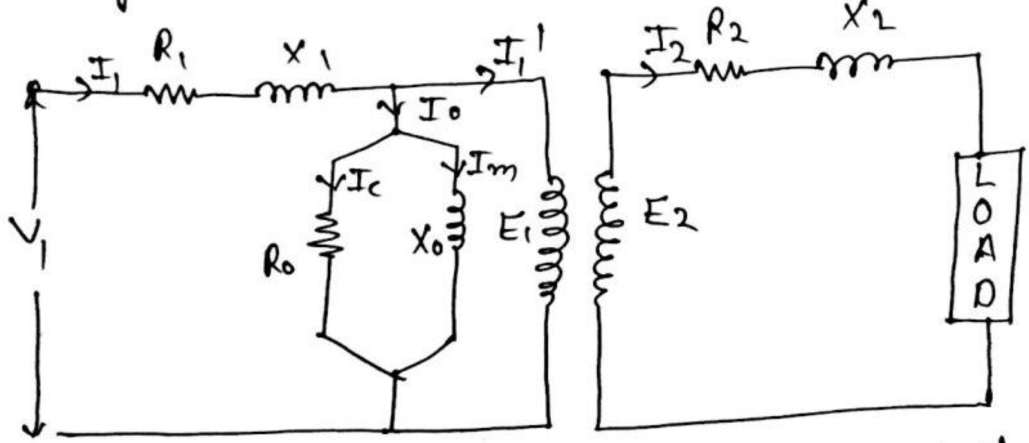
$$= \frac{N_1 \phi_m 2\pi f}{\sqrt{2}}$$

$$\boxed{\mathcal{E}_1 = 4.44 f \phi_m N_1 \text{ Volt}}$$

$$\boxed{\mathcal{E}_2 = 4.44 f \phi_m N_2 \text{ Volt}}$$

Que 5> Draw and Explain Equivalent Circuit of Transformer.

Ans.>



Equivalent ckt of any device can be quit helpful in Predetermination of the behavior of the device under Various Condition of operation.

$R_1, X_1 \rightarrow$ Primary Resistance and Reactance

$R_2, X_2 \rightarrow$ Secondary Resistance and Reactance.

$I_1, I_2 \rightarrow$ Primary & Secondary current

$R_0, X_0 \rightarrow$ No-load Parameter of Transformer.

$I_0 \rightarrow$ No load Current

$I_1' \rightarrow$ Counter balancing current which Neutralized the flux producted by Secondary current.

$$I_1 = I_0 + I_1'$$

$$\boxed{N_1 I_1 = N_2 I_2}$$

Que. 6 → Explain Different type of losses Present in Transformer.

Ans. → There are two type of losses present in Transformer

(i) Copper loss

(ii) Iron loss

Copper loss → Copper loss is basically due to Resistance and It takes place in primary & Secondary winding.

$$\boxed{P_c = I_1^2 R_1 + I_2^2 R_2}$$

Iron loss → Iron loss is also two types.

(i) Hysteresis loss

(ii) Eddy current loss.

(i) Hysteresis loss > When alternating flux Setup in the Core the Hysteresis loop is Traced out and area under Hysteresis loop represent Hysteresis loss. and it is given by

$$\boxed{P_h = \eta (B_{max})^x f V \text{ Joule}}$$

where $\eta \rightarrow$ Hysteresis Cofficient

$B_{max} \rightarrow$ Max. flux density

$f \rightarrow$ Supply frequency

$V \rightarrow$ Volume of core.

(ii) Eddy current loss > When Variable flux Setup in the Core the flux linkage with Iron core is change due to which a current is

Induced in the core this current is known as Eddy Current and result heating loss which is known as Eddy current loss. and is given by

$$\boxed{P_e = K_e (B_{max})^2 f^2 t^2 V \text{ Watt}}$$

Ques. 7 → What is the efficiency of Transformer. Derive the expression for Max. efficiency.

Ans. 7 The efficiency of any Machine is given by

$$\boxed{\eta = \frac{\text{output}}{\text{Input}}} = \frac{\text{output}}{\text{output} + \text{losses}}$$

for a fixed Input Voltage Iron loss is constant but Copper loss is depend upon Load current

$$\eta = \frac{\text{output}}{\text{output} + \text{Copper loss} + \text{Iron loss}}$$

let $P_o \rightarrow$ output Power at full load

$P_i \rightarrow$ Iron loss

$P_c \rightarrow$ Copper loss at full load

then efficiency at x load where x is fraction of full load →

$$\eta = \frac{x P_o}{x P_o + P_i + x^2 P_c}$$

for max. efficiency

$$\frac{d\eta}{dx} = 0 \quad \text{now} \quad \frac{d\eta}{dx} = \frac{(xP + x^2 P_c + P_i)P - xP(P + 2xP_c)}{(xP + P_i + x^2 P_c)^2}$$

$$P_i - x^2 P_c = 0$$

$$\boxed{x = \sqrt{\frac{P_i}{P_c}}}$$

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Que. 8 → In a 25 KVA 2000V/200V Transformer The Iron and Copper losses are 200 W and 400 W respectively calculate the efficiency at half load 0.8 Power Factor lagging. also determine max. efficiency and corresponding load.

Ans. > $P_c = 400\,W = 0.4\,KW$

$P_i = 200\,W$

$$P_o = \tfrac{1}{2} \times V \times I \times \cos\phi$$
$$= \tfrac{1}{2} \times 25 \times 0.8$$
$$= 10\,KW$$

* Copper loss at half load $= \left(\tfrac{1}{2}\right)^2 \times 400 = 0.1\,KW$

* efficiency at half load →

$$\%\eta = \frac{10}{10 + 0.1 + 0.2} \times 100 = 97.08\%$$

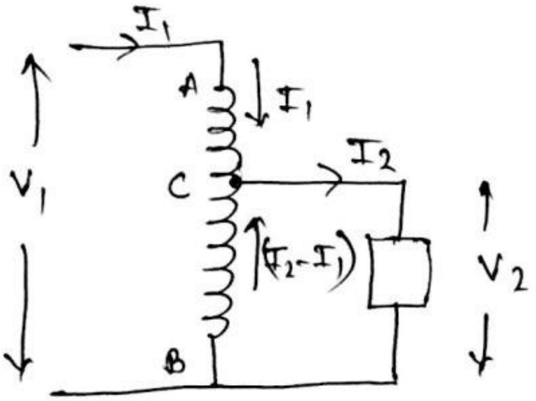
* for max efficiency $x = \sqrt{\frac{P_i}{P_c}}$ ⇒

$$\text{Corresponding load} = 25 \times \sqrt{\frac{P_i}{P_c}} = 17.68\,KVA$$

$$\text{So max. efficiency} = \frac{17.68}{17.68 + 0.2 + 0.2} = 97.788\%$$

Que. 9 > What is Auto Transformer. How Conducting Material saved in Auto Transformer.

Ans. > The Auto Transformer has same principal as like conventional two winding transformer the only difference is that in auto transformer primary and secondary windings are Interrelated.



$$\frac{V_2}{V_1} = \frac{E_{BC}}{E_{AB}} = \frac{N_2}{N_1} = \frac{I_1}{I_2} = K$$

<u>Conducting Material</u> → Conducting Material required is Directly proportional to cross sectional area and length of conductor so.

Conducting Material in ordinary Transformer

$$C_0 \propto (N_1 I_1 + N_2 I_2)$$

$$C_0 \propto 2N_1 I_1 \quad \text{because } N_1 I_1 = N_2 I_2$$

In auto Transformer

$$C_A \propto I_1 (N_1 - N_2) + N_2 (I_2 - I_1)$$

$$C_A \propto 2(N_1 - N_2) I_1$$

now $$\frac{C_A}{C_0} = \frac{2(N_1 - N_2) I_1}{2 N_1 I_1} = 1 - \frac{N_2}{N_1} = 1 - K$$

$$\boxed{C_A = C_0(1-K)}$$

Conducting Material Saved.

$$C_0 - C_A = C_0 - C_0(1-K)$$

$$= C_0 K$$

$$\boxed{\text{Saving} = K \times \text{Conducting Material in Ordinary}}$$

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Ques.10 > Explain Different type of Three phase Transformer Inter Connection.

Ans. > The Winding of Three phase Transformer are either Connected in Star or Delta. According To Primary & Secondary Winding Inter Connection there are four Method of Interconnection.

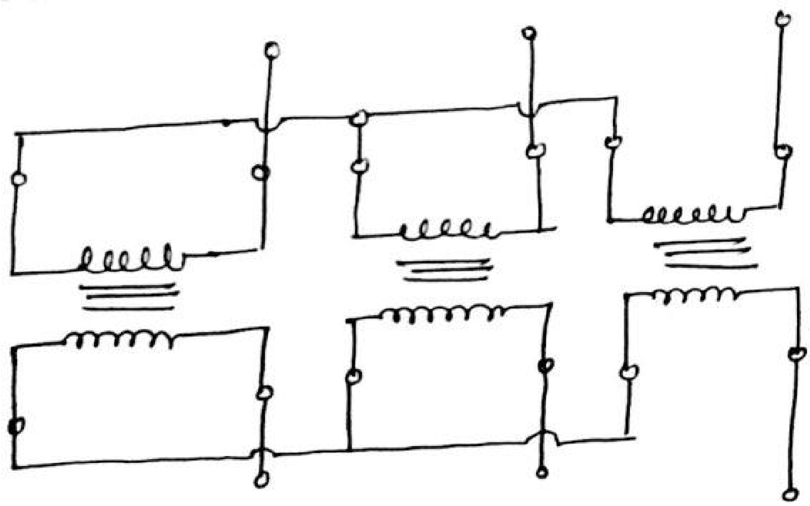
(i) Y-Y (Star-Star) Connection

(ii) Δ-Δ (Delta-Delta) Connection

(iii) Y-Δ (Star-Delta) Connection

(iv) Δ-Y (Delta-Star) Connection

(i). Y-Y (Star-star) Connection:

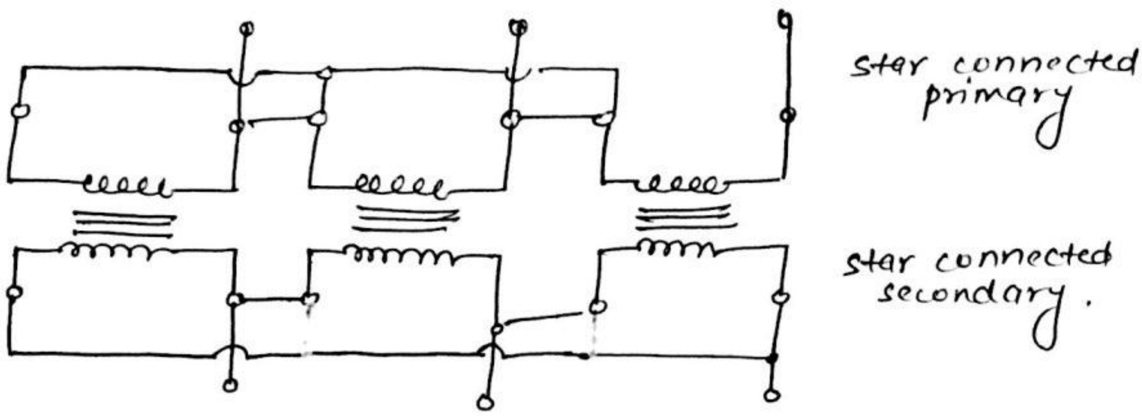


It gives line voltage $\sqrt{3}$ times phase voltage. It is economical for small rating, high voltage transformers as the number of turns per phase and the amount of insulation required is less.

$$\text{Voltage ratio} = \frac{V_{L2}}{V_{L1}} = \frac{\sqrt{3}\,V_{P2}}{\sqrt{3}\,V_{P1}} = \frac{N_2}{N_1}$$

$$\text{Current ratio} = \frac{I_{L2}}{I_{L1}} = \frac{I_{P2}}{I_{P1}} = \frac{N_1}{N_2}$$

(ii). Δ – Δ (Delta Delta Connections)

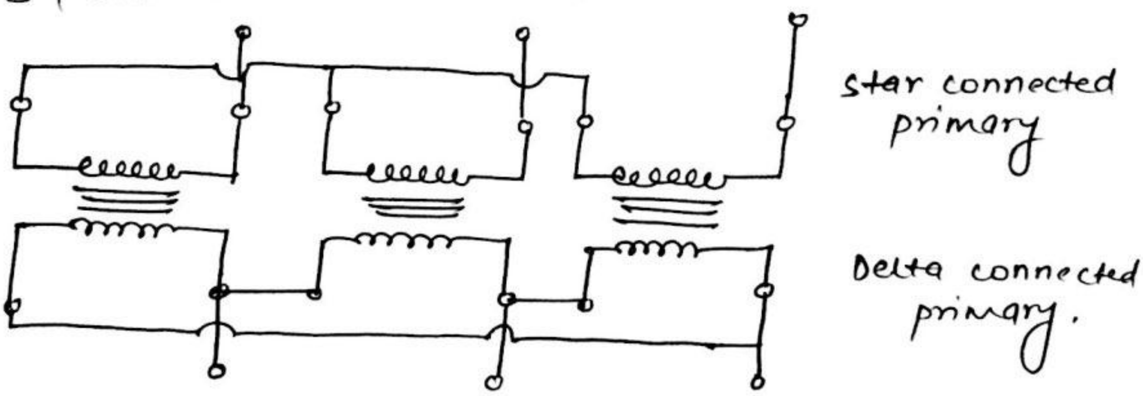


This arrangement is generally used in systems which carry large currents on low voltages. The conductor is required of smaller cross section as the phase current is $\frac{1}{\sqrt{3}}$ times the line current.

$$\text{Voltage ratio} = \frac{V_{L2}}{V_{L1}} = \frac{V_{P2}}{V_{P1}} = \frac{N_2}{N_1}$$

$$\text{Current ratio} = \frac{I_{L2}}{I_{L1}} = \frac{\sqrt{3}\, I_{P2}}{\sqrt{3}\, I_{P1}} = \frac{N_1}{N_2}$$

(iii). Y – Δ (star Delta Connection):

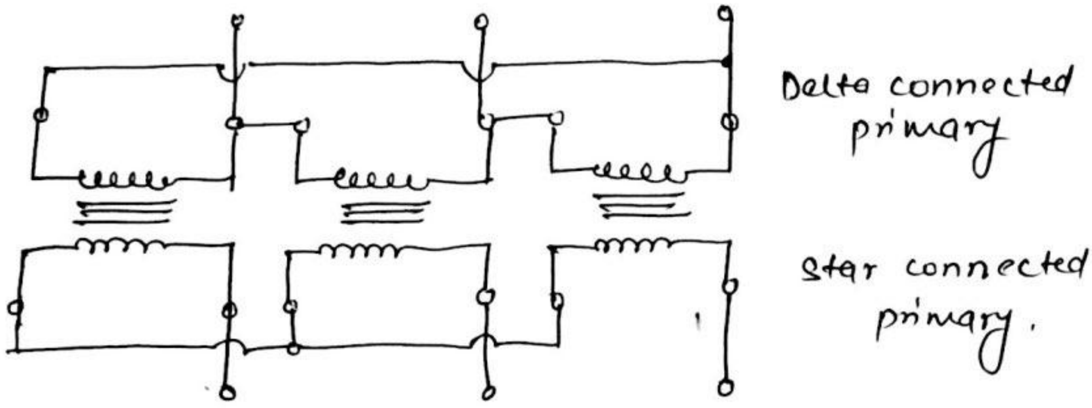


Such connections are used principally where the voltage is to be stepped down. The neutral of the primary winding is earthed.

$$\text{Voltage ratio} = \frac{V_{L2}}{V_{L1}} = \frac{V_{P2}}{\sqrt{3}\, V_{P1}} = \frac{1}{\sqrt{3}} \frac{N_2}{N_1}$$

$$\text{Current ratio} = \frac{I_{L2}}{I_{L1}} = \frac{\sqrt{3}\, I_{P2}}{I_{P1}} = \sqrt{3} \frac{N_1}{N_2}$$

(iv). Δ-Y (Delta star) Connections:



Such connections are used when it is necessary to step up the voltage.

$$\text{Voltage ratio} = \frac{V_{L2}}{V_{L1}} = \frac{\sqrt{3}\,V_{p2}}{V_{p1}} = \sqrt{3}\,\frac{N_2}{N_1}$$

$$\text{Current ratio} = \frac{I_{L2}}{I_{L1}} = \frac{I_{p2}}{\sqrt{3}\,I_{p1}} = \frac{N_1}{\sqrt{3}\,N_2}$$