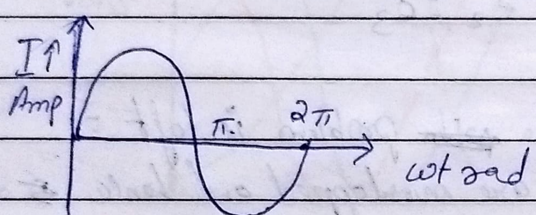
UNIT-3

Three phase AC circuits

Introduction
Phase sequence
Connection of 3ϕ AC
Power in 3ϕ AC
Numericals.

Introduction to $\boxed{3\phi\ AC}$ → Polyphase

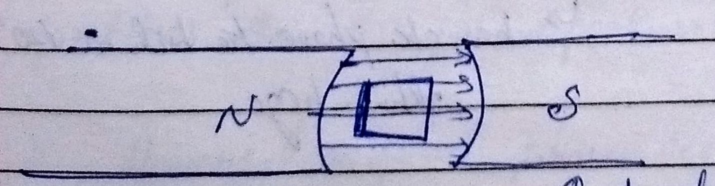


① Device in which we want it to run with an ininterrupted supply = use 3ϕ AC.
coz in in one ϕ it approaches zero 3 times in one cycle.

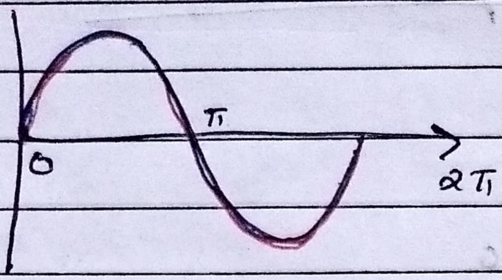
② In that cast only from which we are creating 1ϕ, we can create 3ϕ, it would be more economical.

why not 2ϕ, 4ϕ, 5ϕ?
Bcoz general device don't need this much of supply.
Phase diff of 180° is provided, so it will start cancel outing its own phase system.

Generation of three phase AC



Same as 1ϕ, difference is we have kept 3 conductors on one another.



Condition → ① $N_1 = N_2 = N_3$ $\qquad e = -N\frac{d\phi}{dt}$

~~⇒ $e_1 = e_2 = e_3$~~

② $\omega_1 = \omega_2 = \omega_3$ ③ $\phi_1 = \phi_2 = \phi_3$

⇒ $e_1 = e_2 = e_3$

Problem = only one ~~prob~~ problem is left = conductors are overlapped and hence ~~s~~ sin wave is also overlapped, and this isn't solving the problem of approaching zero 3 times.

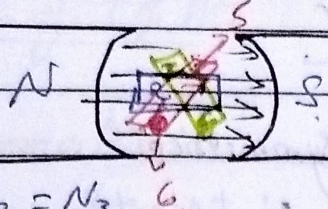
⇒ For this we have to put 3 of them with some ϕ diff., so that if one is at zero, another one isn't.

Phase diff angle = $\frac{360 \text{ Electrical degrees}}{N \text{ (No. of phase)}}$

Eg $\phi = \frac{360}{3}$ → a cycle has 360°
3 → 3ϕ system

$\phi = 120°$

↳ har ek phase ke bich m 120° ka diff rakhna hoga.



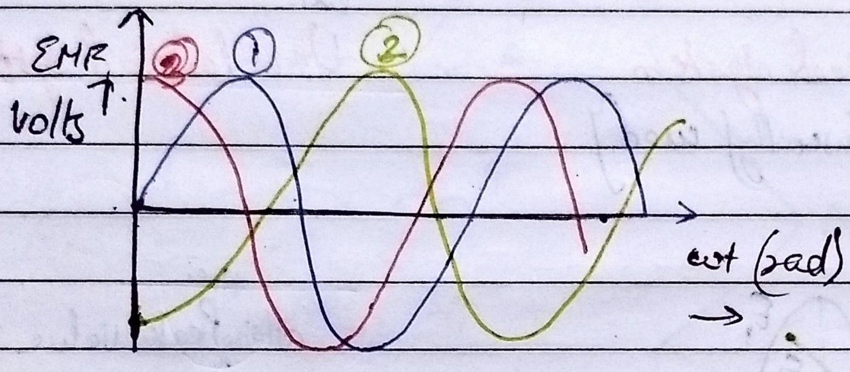
$N_1 = N_2 = N_3$

$\omega_1 = \omega_2 = \omega_3$

$\phi_1 \neq \phi_2 \neq \phi_3$

hence $e_1 \neq e_2 \neq e_3$

magnitude of emf is same but diff is just ϕ diff.

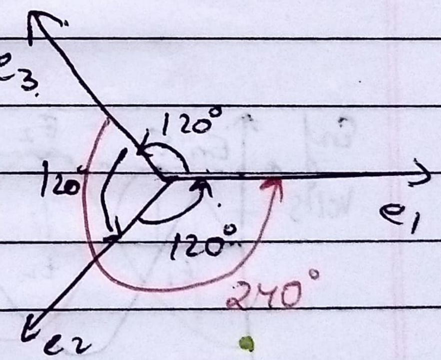


~~Thes~~ ~~B~~ There is not a single time when all 3 will ~~attain~~ approaches zero along with each other.

$e_1 = E_m \sin \omega t$

$e_2 = E_m \sin\left(\omega t - \frac{2\pi}{3}\right)$

$e_3 = E_m \sin\left(\omega t - \frac{4\pi}{3}\right)$



Phase Sequence

It is a sequence or order in which the alternating quantities attein their positive peak values.

Universal accepted phase sequence = R Y B

Red, Yellow, Blue

Types of 3 phase AC

1. Symmetrical.
   - i) Source symmetry
   - ii) Load ,,

   Only phase diff. is here

   Balanced system
   {Mostly (usually) used}

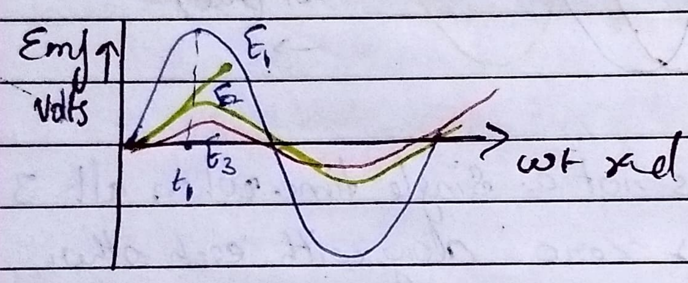
2. Unsymmetrical

   $N_1 \neq N_2 \neq N_3$ or $N_1 \neq N_2 = N_3$

   $\omega_1 = \omega_2 = \omega_3$

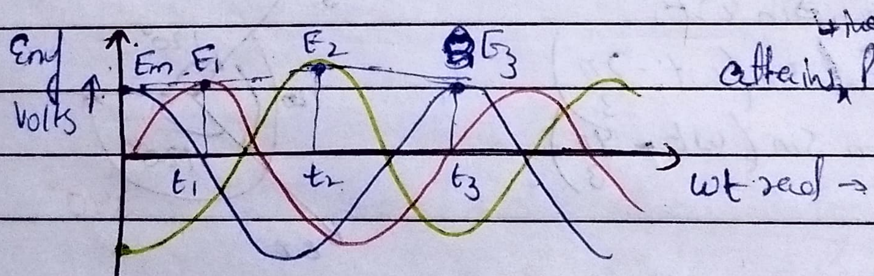
   Phase toh hoga hi hoga sath aur kch bhi.

   Unbalanced system.



attains +ive Peak value = Same instant

magnitude = diff



attains +ive Peak value = diff instant

magnitude = same

The quantity which attains its +ive peak value first (in less time) is said to be leading from others

E_1 is leading from E_2 & E_3

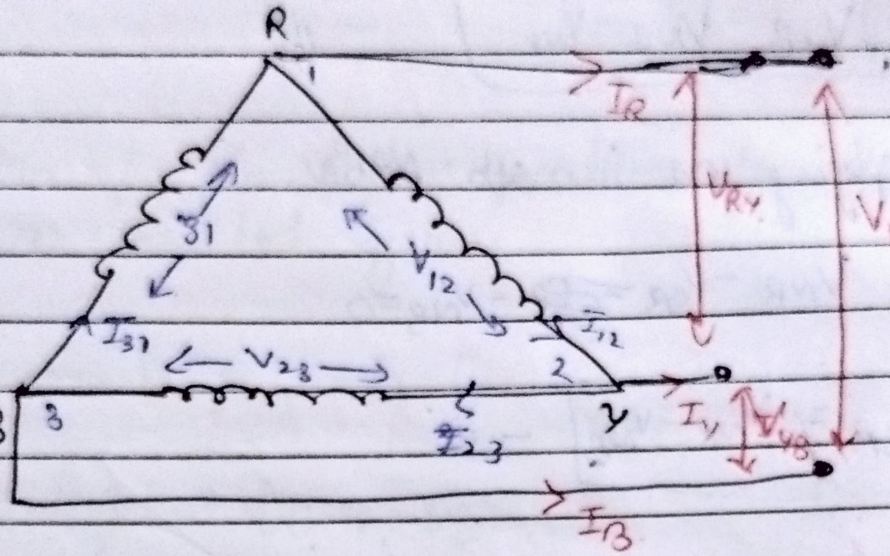
E_2 is leading from E_3.

+ive phase sequence = R Y B

-ive ,, ,, => B Y R

Delta Connection

It is a type of connection of 3ϕ winding where all the coils are connected in a back to back arrangement



Line quantities :-

Line voltage = $V_{RY} = V_{BR} = V_{YB} = V_L$
Line current = $I_R = I_Y = I_B = I_L$

Phase quantities :-

Phase voltages $V_{12} = V_{23} = V_{31} = V_{ph}$
Phase current $I_{12} = I_{23} = I_{31} = I_{ph}$

Relation b/w line & Phase voltage

$\boxed{V_{RY} = V_{12}}$ $\boxed{V_{23} = I_{YB}}$ $\boxed{V_{31} = V_{BR}}$

$$\boxed{V_L = V_{ph}}$$

Relation b/w line & phase current

By KCL at j^n R

$$I_{31} - I_{12} - I_R = 0$$

$$\boxed{I_R = I_{31} - I_{12}} \quad -①$$

By KCL at j^n Y

$$I_{12} - I_{23} - I_Y = 0$$

$$\boxed{I_Y = I_{12} - I_{23}}$$

By KCL at j^n B

$$I_{23} - I_{31} - I_B = 0$$

$$\boxed{I_B = I_{23} - I_{31}}$$

$$I_R = \sqrt{I_{31}^2 + I_{12}^2 + 2 I_{31} I_{12} \cos\phi}$$

$$= \sqrt{I_{ph}^2 + I_{ph}^2 + 2 \times I_{ph}^2 \cos 60^\circ}$$

$$\boxed{I_L = \sqrt{3}\, I_{ph}}$$