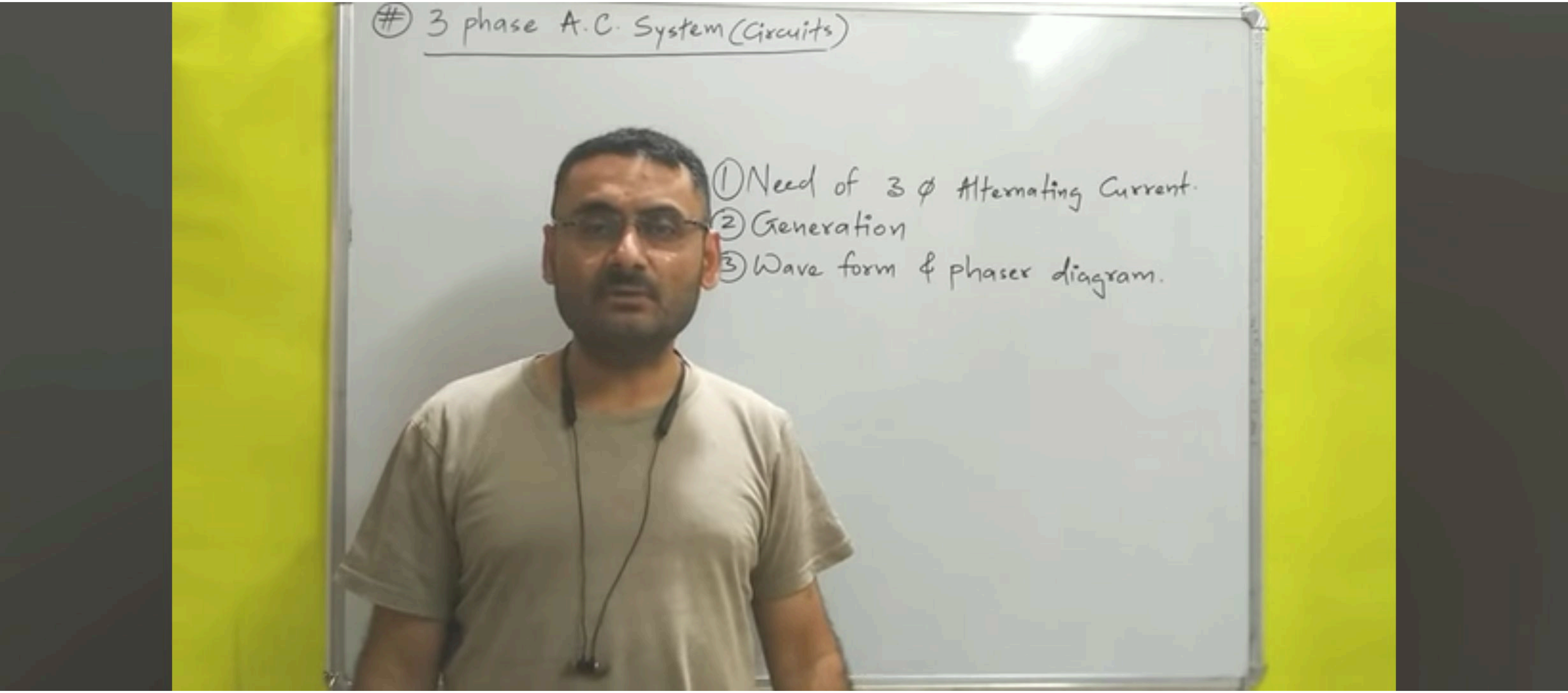
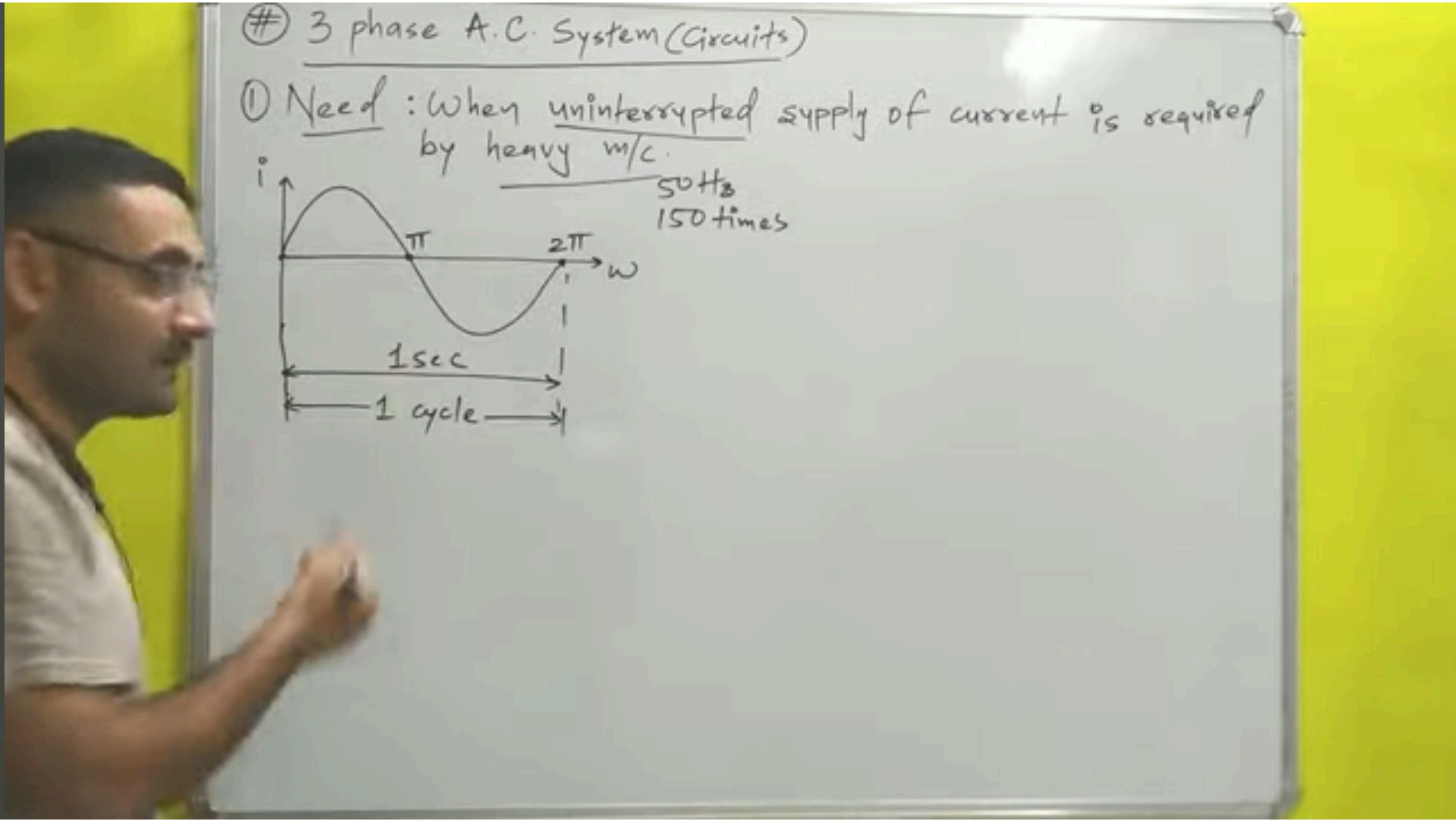


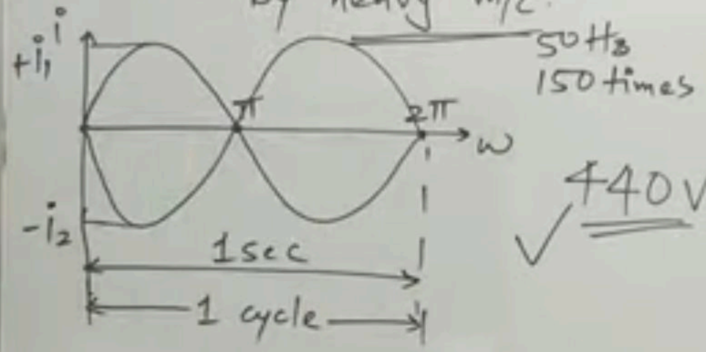
3 phase A.C. System (Circuits)
① Need of 3 φ Alternating Current.
② Generation
③ Wave form & phaser diagram.



3 phase A.C. System (Circuits)
① Need : When uninterrupted supply of current is required by heavy m/c.
50 Hz
150 times
i
π
2π
ω
1 sec
1 cycle

3 phase A.C. System (Circuits)

① **Need**: When uninterrupted supply of current is required by heavy m/c.



440V ✓

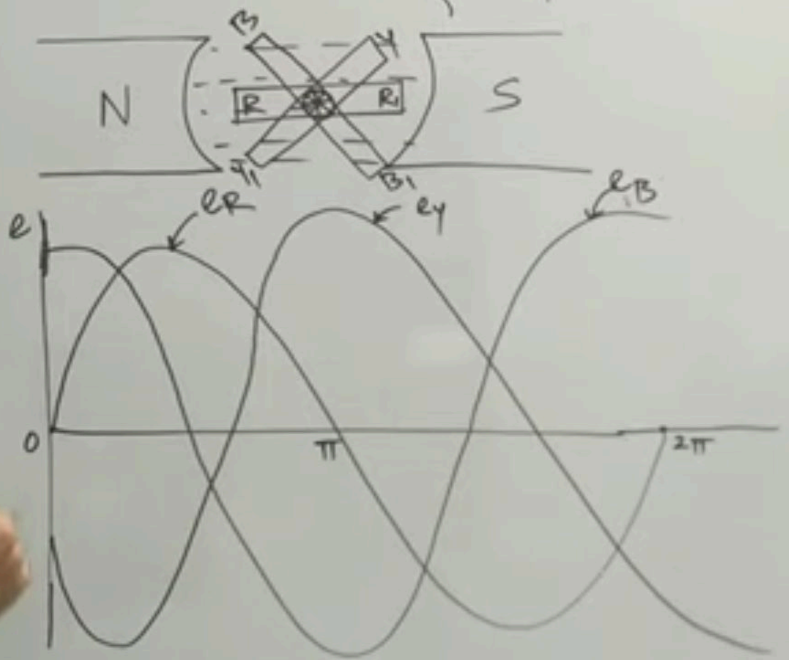
e = emf

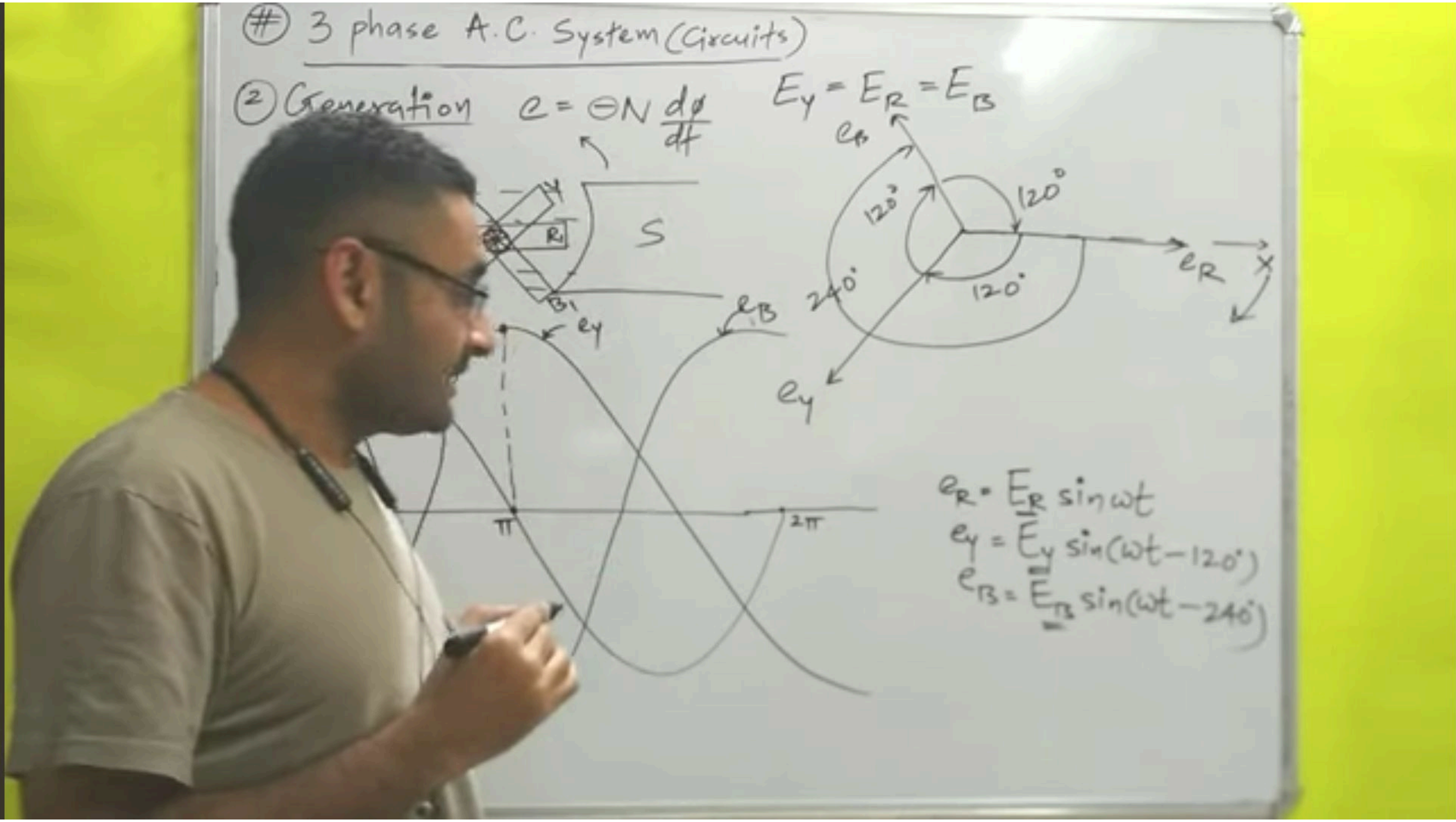
N = no. of turns

d¢/dt = rate of change of magnetic flux

3 phase A.C. System (Circuits)

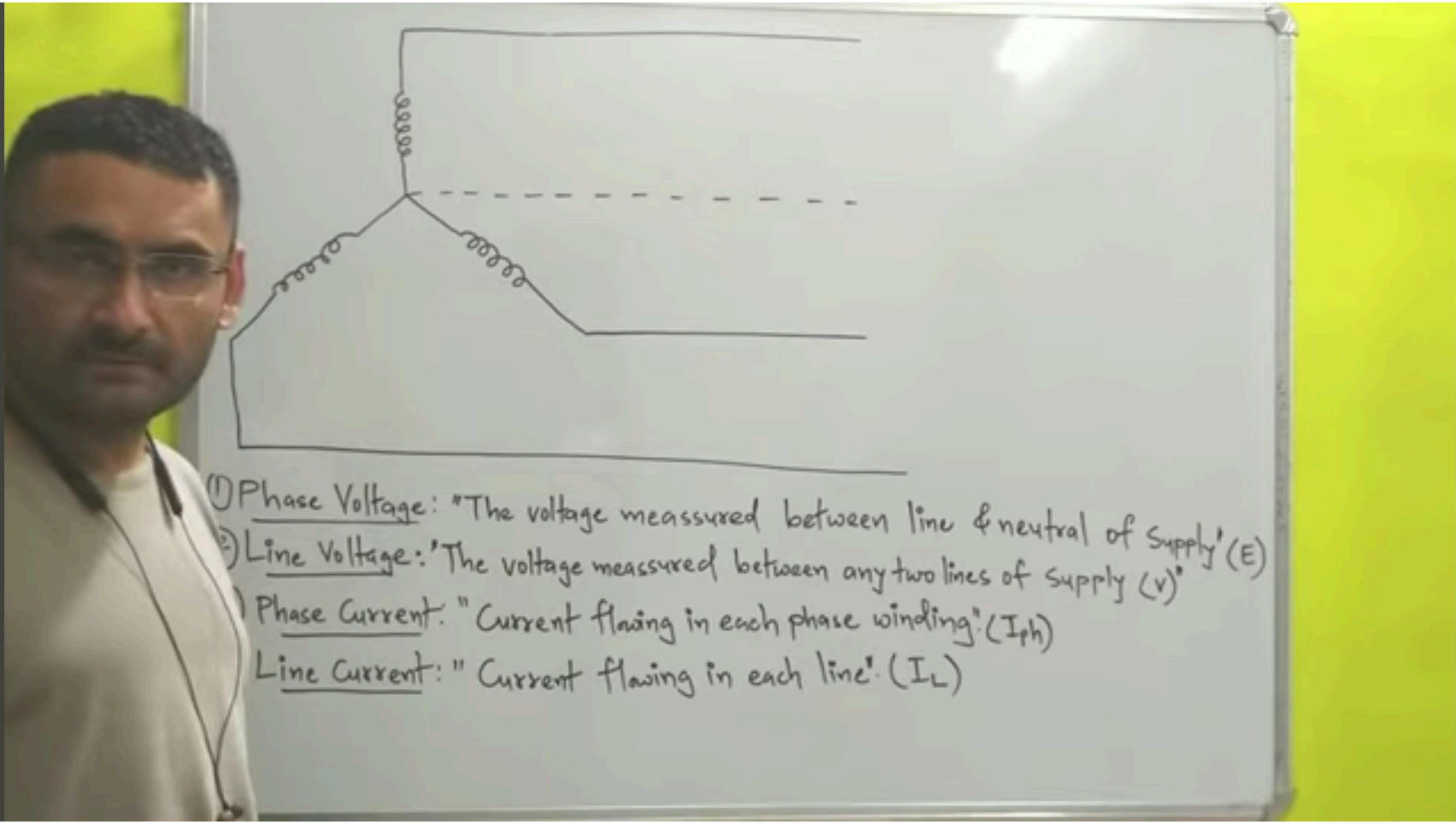
(2) Generation $e = \ominus N \frac{d\phi}{dt}$ $E_Y = E_R = E_B$

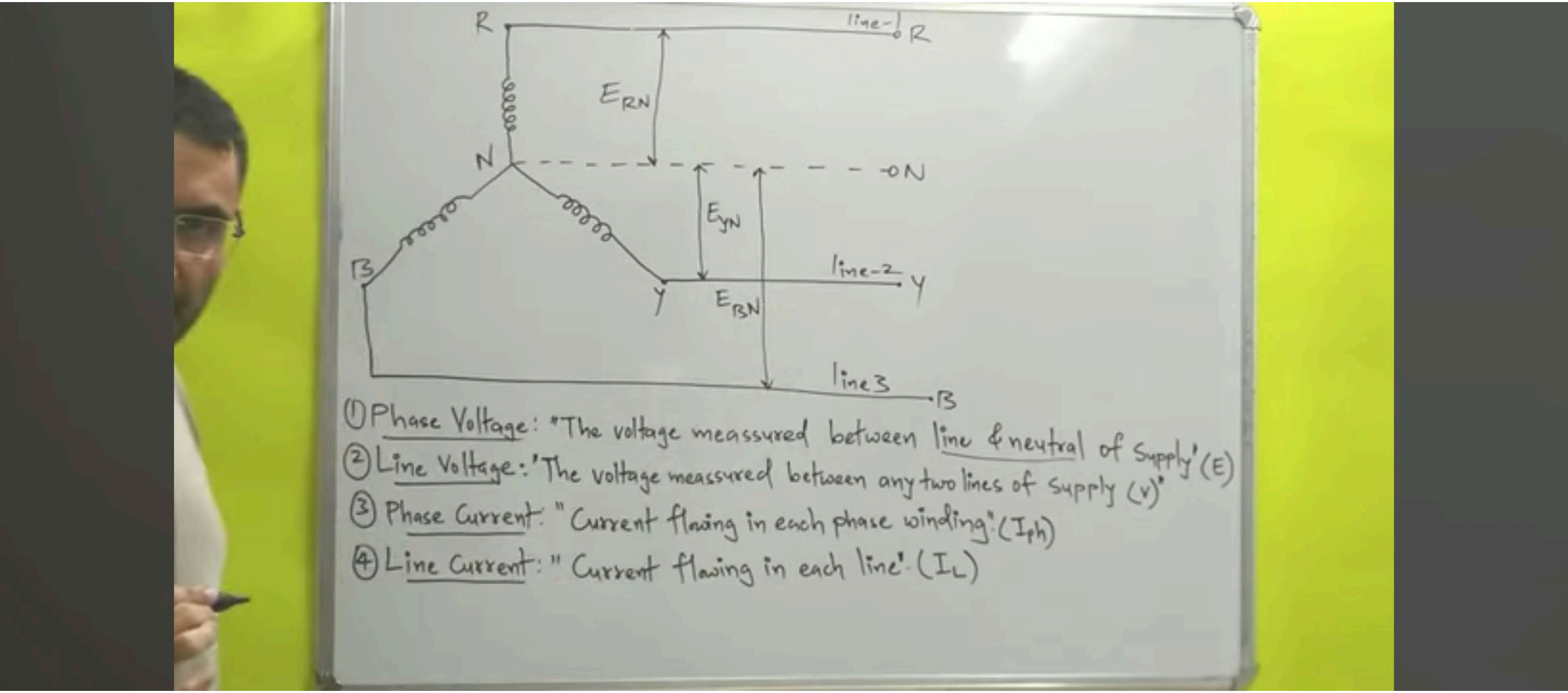


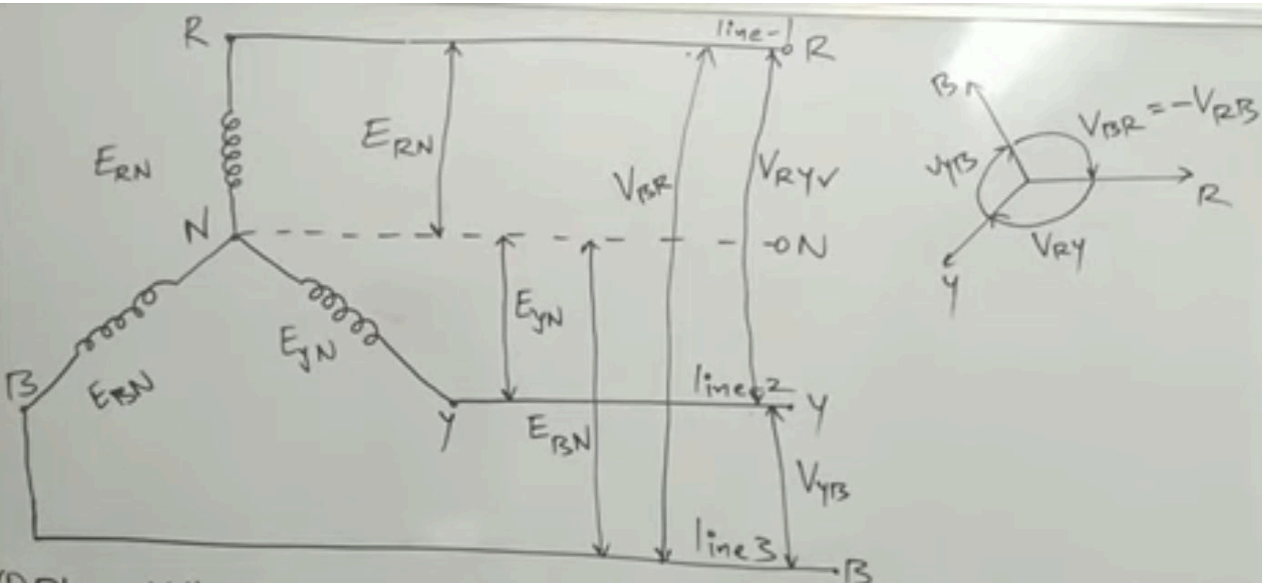


3 phase A.C. System (Circuits)
(2) Generation
e = ⊖N dφ/dt
E_Y = E_R = E_B
S
e_B
e_Y
e_R
X
120°
120°
120°
240°
π
2π
e_R = E_R sin ωt
e_Y = E_Y sin(ωt − 120°)
e_B = E_B sin(ωt − 240°)

Important terms in Three phase AC circuit


(1) Phase Voltage: "The voltage meassured between line & neutral of Supply" (E)
2) Line Voltage: 'The voltage measured between any two lines of supply (V)'
Phase Current: "Current flowing in each phase winding" (Iph)
Line Current: "Current flowing in each line". (IL)


R
line-1 R
E_{RN}
N
N
E_{YN}
B
Y
line-2 Y
E_{BN}
line 3 B
① Phase Voltage: "The voltage meassured between line & neutral of Supply" (E)
② Line Voltage: "The voltage measured between any two lines of supply (V)"
③ Phase Current: "Current flowing in each phase winding" (I_{ph})
④ Line Current: "Current flowing in each line" (I_L)

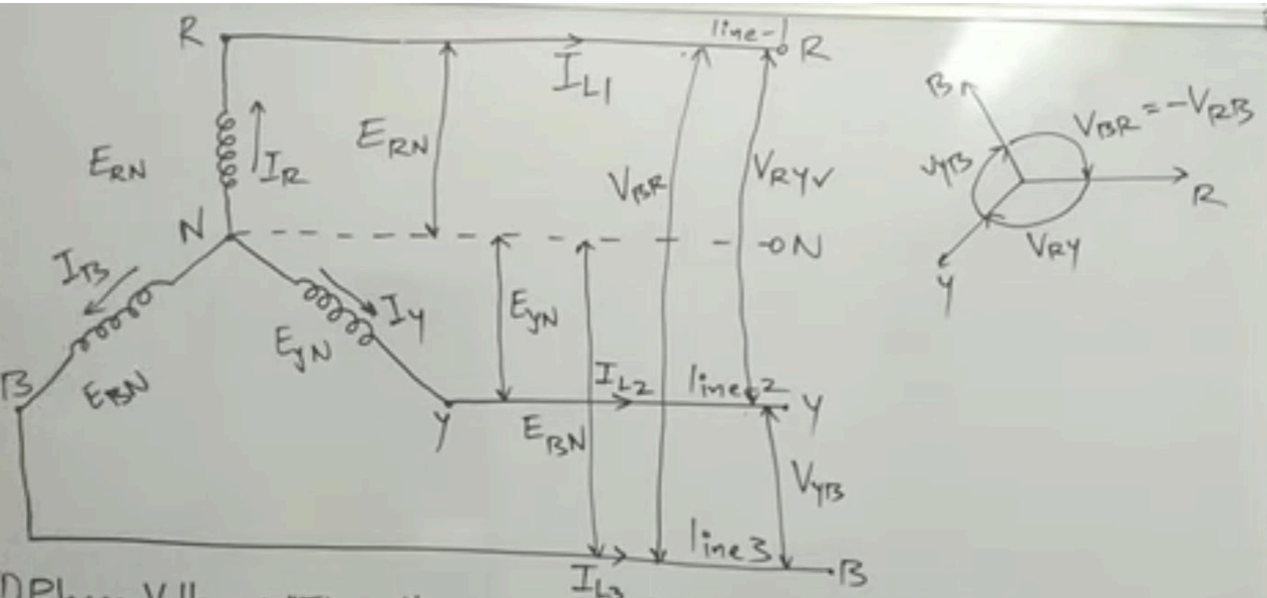


① **Phase Voltage**: "The voltage meassured between line & neutral of supply" (E)

② **Line Voltage**: "The voltage measured between any two lines of supply (V)"

③ **Phase Current**: "Current flowing in each phase winding" (I_{ph})

④ **Line Current**: "Current flowing in each line" (I_L)



① <u>Phase Voltage</u>: "The voltage meassured between <u>line & neutral</u> of Supply" (E)

② <u>Line Voltage</u>: "The voltage measured between any two lines of supply (V)"

③ <u>Phase Current</u>: "Current flowing in each phase winding" (I_{ph})

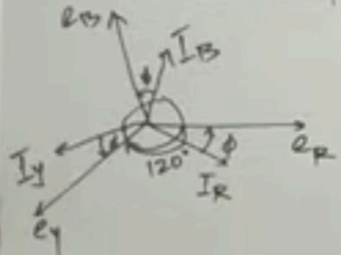
④ <u>Line Current</u>: "Current flowing in each line". (I_L)

(5) Balanced system: It is one in which voltages in all phases are equal in magnitude ($e_R = e_Y = e_B$) and are displaced from one another by equal angles (120°), Also currents in these phases are equal in magnitude ($i_R = i_Y = i_B$) and are displaced by equal angle.

(6) Balanced load: It is one in which the loads in all phases are equal in magnitude & having equal phases.

(7) Unbalanced load: It is one in which the loads in all phases are different in magnitude & having different phase.

(5) **Balanced system**: It is one in which voltages in all phases are equal in magnitude ($e_R = e_Y = e_B$) and are displaced from one another by equal angles (120°)] Also currents in these phases are equal in magnitude ($i_R = i_Y = i_B$) and are displaced by equal angle.



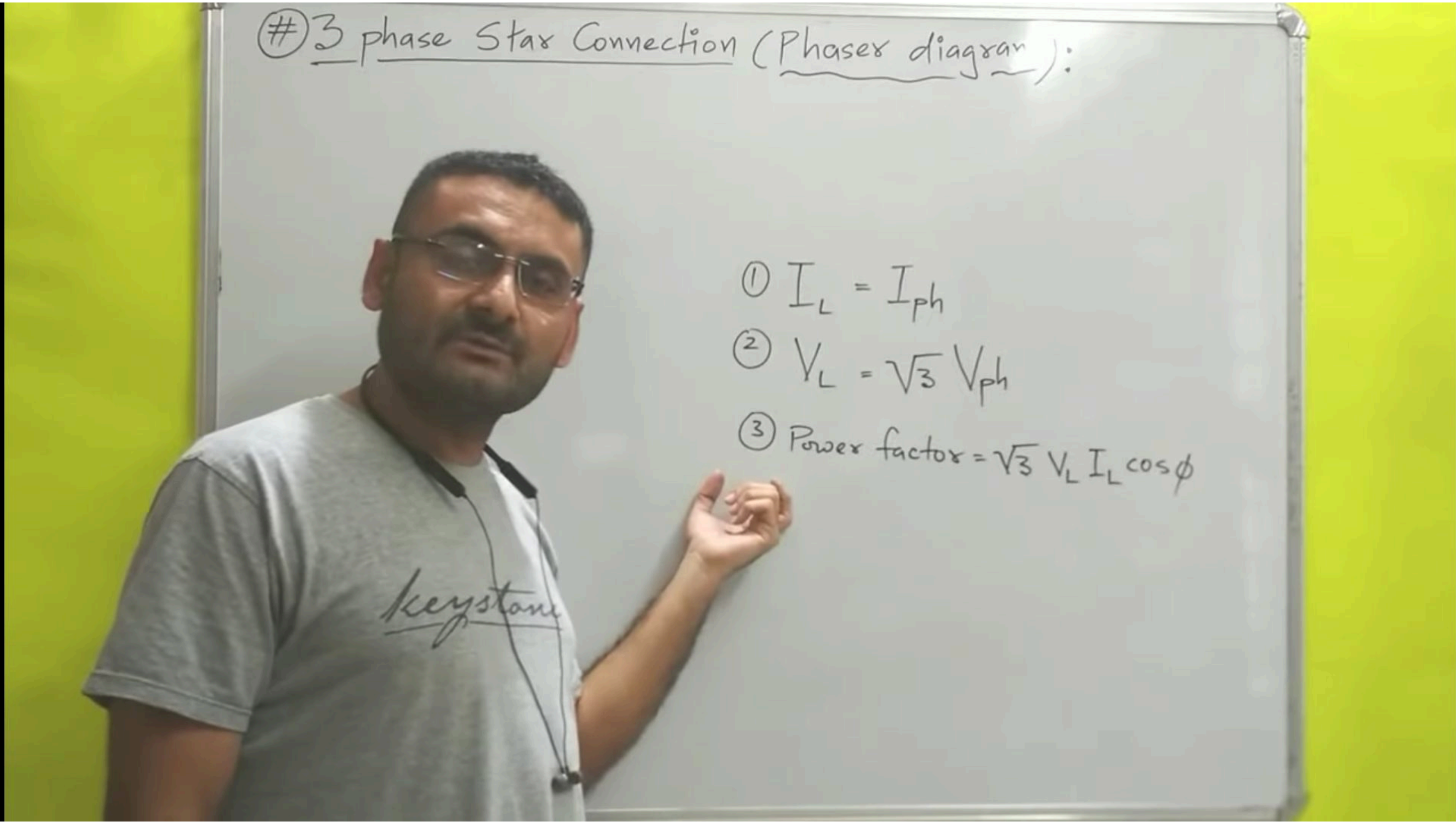
120° 3ϕ motor

(6) **Balanced load**: It is one in which the loads in all phases are equal in magnitude & having equal phases.

3ϕ motor

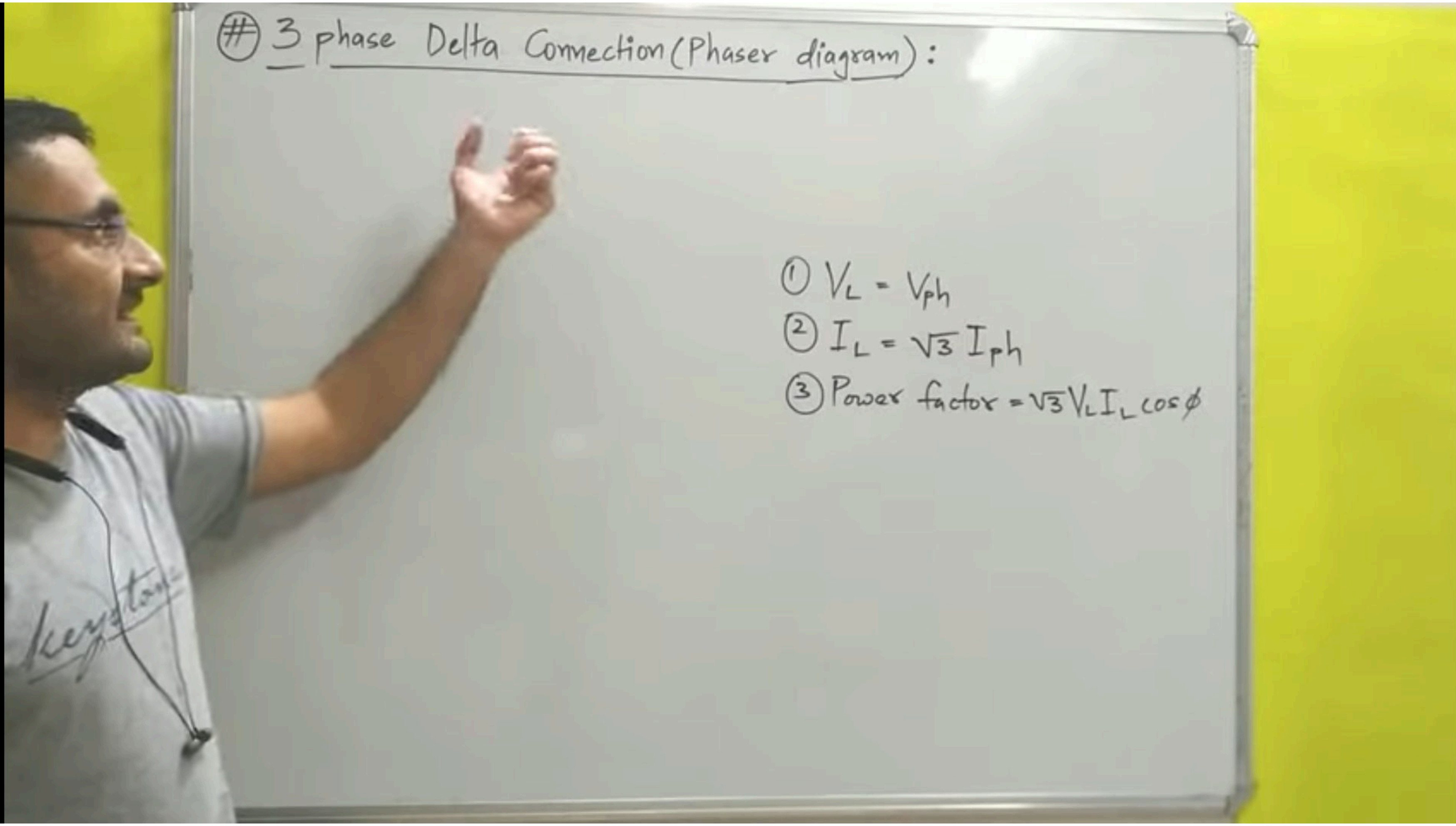
(7) **Unbalanced load**: It is one in which the loads in all phases are different in magnitude & having different phase.

Three phase star
connection :
Line current phase
current
Line voltage phase
voltage
Power factor equation

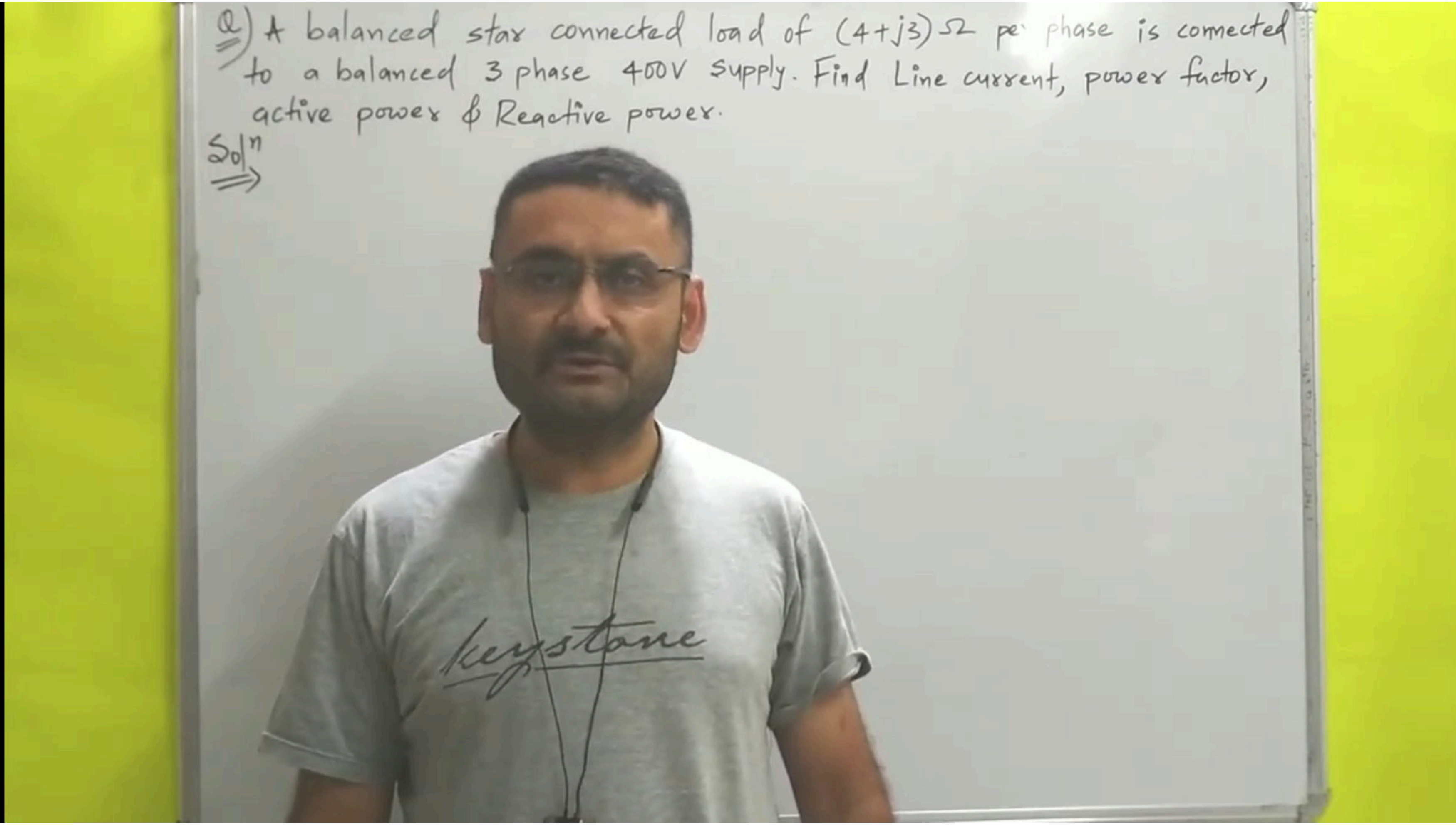


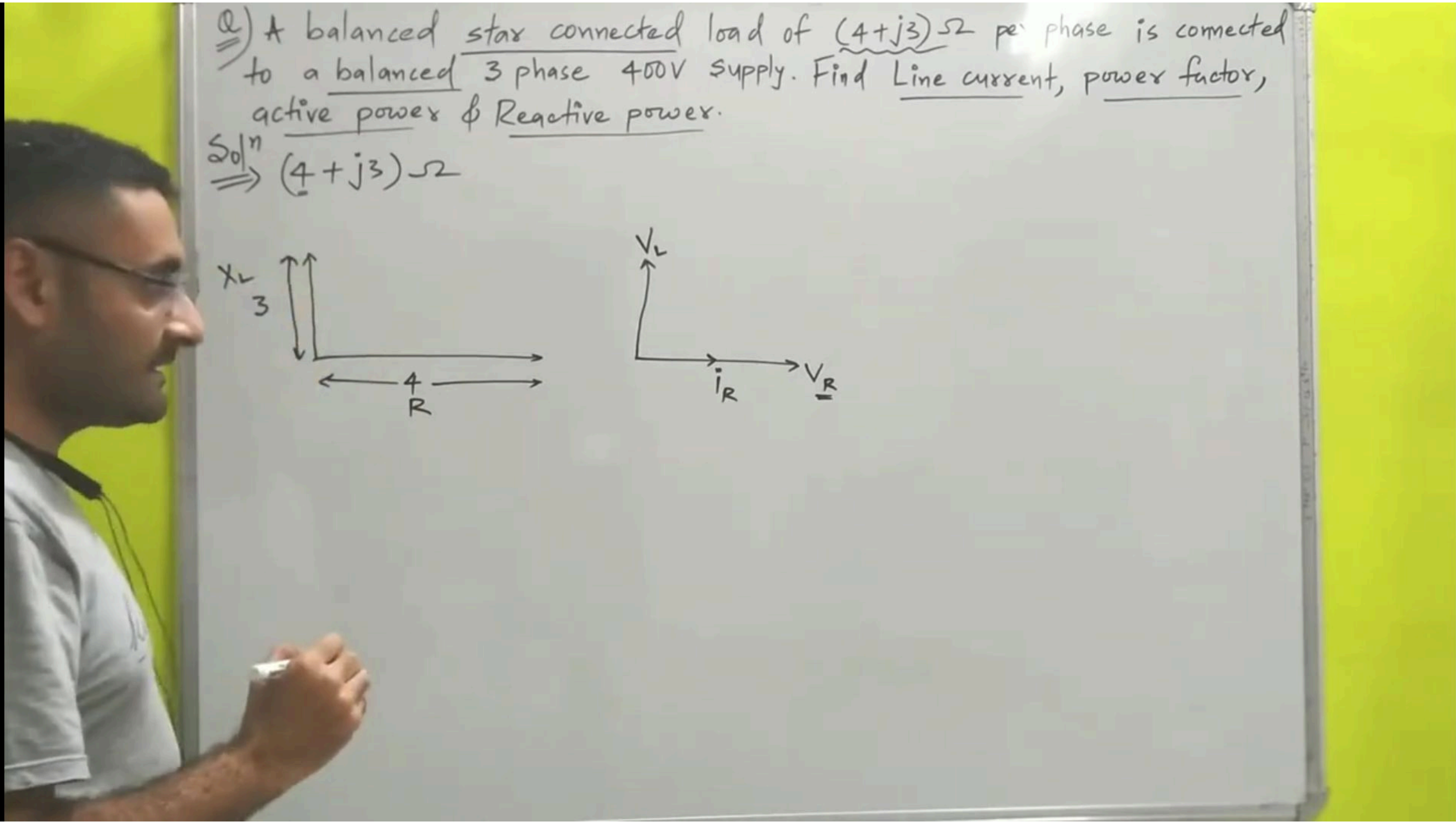
#3 phase Star Connection (Phaser diagram):
① $I_L = I_{ph}$
② $V_L = \sqrt{3}\, V_{ph}$
③ Power factor = $\sqrt{3}\, V_L I_L \cos\phi$

Three phase delta connection



3 phase Delta Connection (Phaser diagram):
① $V_L = V_{ph}$
② $I_L = \sqrt{3}\, I_{ph}$
③ Power factor $= \sqrt{3}\, V_L I_L \cos\phi$


Q) A balanced star connected load of (4+j3) Ω per phase is connected to a balanced 3 phase 400V supply. Find Line current, power factor, active power & Reactive power.
Soln ⟹
keystone

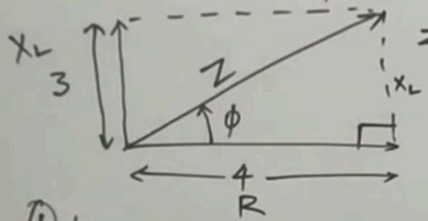

Q) A balanced star connected load of (4+j3)Ω per phase is connected to a balanced 3 phase 400V supply. Find Line current, power factor, active power & Reactive power.
Sol^n ⟹ (4+j3)Ω
X_L
3
4
R
V_L
i_R
V_R

Q) A balanced star connected load of $(4+j3)\,\Omega$ per phase is connected to a balanced 3 phase 400V supply. Find Line current, power factor, active power & Reactive power.

Sol^n $\Rightarrow$ $(4+j3)\,\Omega$

$X_L = 3\,\Omega$ $\quad V_L = 400\,V$

$R = 4\,\Omega$



$$Z = \sqrt{R^2 + X_L^2}$$
$$= \sqrt{16+9} = \sqrt{25}$$
$$Z = 5\,\Omega$$

① Line current (I_L)

$$I_L = I_{ph}$$

$$V_L = \sqrt{3}\,V_{ph}$$
$$V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}}$$
$$V_{ph} = 230.94\,V$$

$$V_{ph} = I_{ph} Z$$
$$I_{ph} = \frac{V_{ph}}{Z} = \frac{230.94}{5}$$

$$\boxed{I_{ph} = 46.19\,A = I_L}$$ Ans

Q) A balanced star connected load of $(4+j3)\,\Omega$ per phase is connected to a balanced 3 phase 400V supply. Find Line current, power factor, active power & Reactive power.

Sol^n ⟹ $(4+j3)\,\Omega$

$X_L = 3\,\Omega$ $V_L = 400\,V$

$R = 4\,\Omega$

$Z = \sqrt{R^2 + X_L^2}$

$= \sqrt{16+9} = \sqrt{25}$

$Z = 5\,\Omega$

$\sin\phi = \frac{X_L}{R} = \frac{3}{4}$

$\phi = \sin^{-1}\left(\frac{3}{4}\right)$

$\phi = 36.86$

...ent (I_L)

$V_L = \sqrt{3} V_{ph}$

$V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{400}{\sqrt{3}}$

$V_{ph} = 230.94\,V$

$I_{ph} = \frac{V_{ph}}{Z} = \frac{230.94}{5}$

$\boxed{I_{ph} = 46.19\,A = I_L}$ Ans

② Power factor $(\cos\phi)$

$\cos\phi = \frac{R}{Z} = \frac{4}{5}$

$\boxed{\cos\phi = 0.8}$ Ans

③ Active Power (cos) W

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

$= \sqrt{3} \times 400 \times 46.19 \times 0.8$

$P = 25601.09\,W$

$\boxed{P = 25.601\,kW}$ Ans

④ Reactive (sin) VAR

$P = \sqrt{3} V_L I_L \sin\phi$

$= \sqrt{3} \times 400 \times 46.19 \times \sin(36.86)$

$P = 19196.39\,VAR$

$\boxed{P = 19.196\,kVAR}$ Ans

Q) A delta connected balanced 3 phase load is supplied from 400V, 3 phase mains. The line current is 20A and Power taken by load is 10kW. Find,

(i) Impedance in each branch.

(ii) Power factor of load.

Sol^n $\Longrightarrow$

$V_L = V_{ph}$

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

$V_L = 400V = V_{ph}$

$I_L = 20A$

$I_{ph} = \frac{I_L}{\sqrt{3}} = \frac{20}{\sqrt{3}}$

$I_{ph} = 11.55A$

$P = 10\,kW$

$= 10\times10^3\,W$

Q) A delta connected balanced 3 phase load is supplied from 400 V, 3 phase mains. The line current is 20 A and Power taken by load is 10 kW. Find,

(i) Impedance in each branch.

(ii) Power factor of load.

$V_L = V_{ph}$

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

$V_L = 400\,V = V_{ph}$

$I_L = 20\,A$

$I_{ph} = \frac{I_L}{\sqrt{3}} = \frac{20}{\sqrt{3}}$

$I_{ph} = 11.55\,A$

$P = 10\,kW$

$= 10 \times 10^3\,W$

Sol^n $\Rightarrow$ (i) Z

$V = I R$

$V_{ph} = I_{ph} Z$

$Z = \frac{V_{ph}}{I_{ph}} = \frac{400}{11.55}$

$\boxed{Z = 34.63\,\Omega}$ Ans

Q) A delta connected balanced 3 phase load is supplied from 400 V, 3 phase mains. The line current is 20 A and Power taken by load is 10 kW. Find,

(i) Impedance in each branch.

(ii) Power factor of load.

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

Sol^n ⇒ (i) Z

$$V = I R$$

$$V_{ph} = I_{ph} Z$$

$$Z = \frac{V_{ph}}{I_{ph}} = \frac{400}{11.55}$$

$$\boxed{Z = 34.63\,\Omega}$$ Ans

$$V_L = V_{ph}$$

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

$$V_L = 400V = V_{ph}$$

$$I_L = 20A$$

$$I_{ph} = \frac{I_L}{\sqrt{3}} = \frac{20}{\sqrt{3}}$$

$$I_{ph} = 11.55A$$

$$P = 10\,kW = 10\times10^3\,W$$

(ii) $P = \sqrt{3} V_L I_L \cos\phi$

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

$$\cos\phi = \frac{10\times10^3}{\sqrt{3}\times400\times20}$$

$$\boxed{\cos\phi = 0.7217}$$