Day-20

→ **Transformer efficiency:**

$$\eta = \frac{P_{out}}{P_{in}} = \frac{P_o}{P_o + P_{loss}} = \frac{V_2 I_2 \cos\phi_2}{V_2 I_2 \cos\phi_2 + P_c + I_2^2 R_2 + I_1^2 R_1}$$

(V_2, I_2: RMS values)

P_c: core loss (from O.C. Test)

$I_2^2 R_2 + I_1^2 R_1$: copper loss (from S.C. Test)

$$I_2^2 R_2 + I_1^2 R_1 = I_2^2 R_{eq}$$

→ **Plot of η vs load (I_2):**

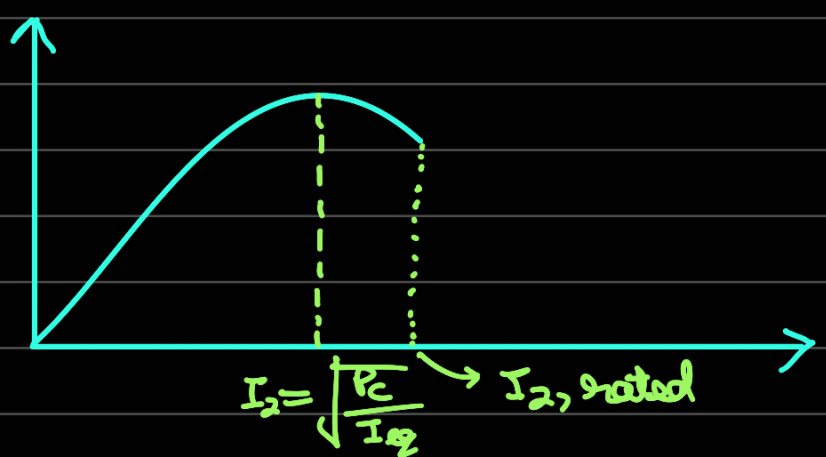
Peak efficiency point $\Rightarrow \frac{d\eta}{dI_2} = 0$

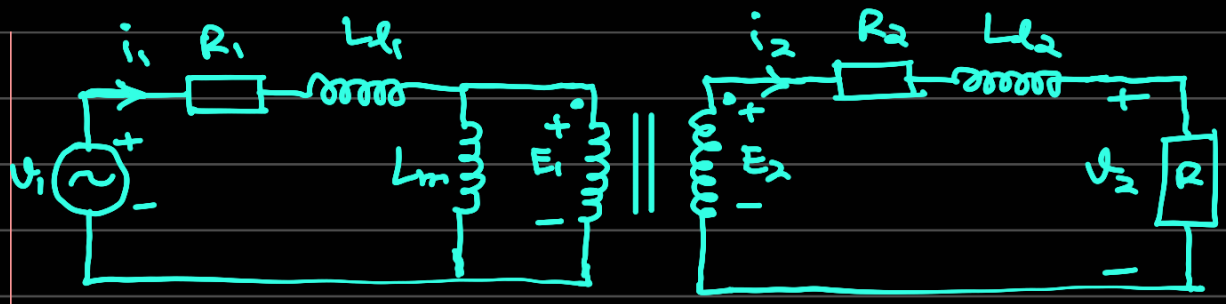
$$\therefore \frac{d}{dI_2}\left[1 + \frac{P_c}{V_2 I_2 \cos\phi_2} + \frac{I_2^2 R_{eq}}{V_2 I_2 \cos\phi_2}\right] = 0$$

$$\Rightarrow \frac{P_c}{V_2 \cos\phi_2}\left(\frac{-1}{I_2^2}\right) + \frac{R_{eq}}{V_2 \cos\phi_2} = 0$$

$$\Rightarrow \boxed{I_2^2 R_{eq} = P_c}$$ → Peak efficiency point

P_c → Assumed constant



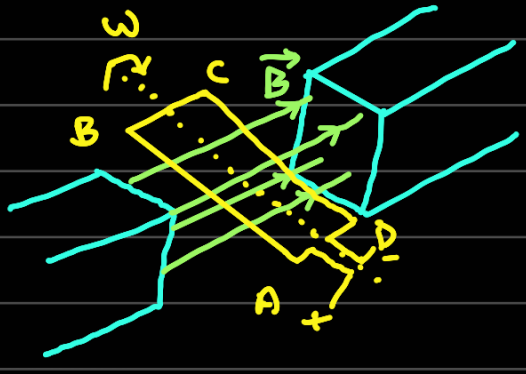


Voltage regulation

$$= \frac{V_{2,\text{no load}} - V_{2,\text{load}}}{V_{2,\text{load}}}$$

$$= \frac{E_2 - V_{2,\text{load}}}{V_{2,\text{load}}}$$

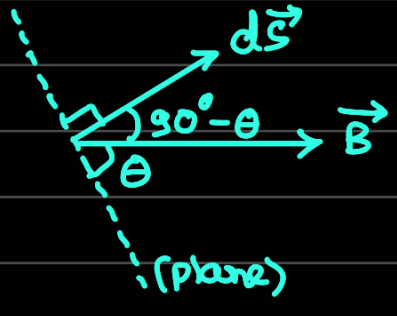
→ **Revisiting basics of generator :-**



$$e = (\vec{v} \times \vec{B}) \cdot \vec{l}$$

$$e(t) = N \frac{d\phi}{dt}$$

$$\phi = \iint_S \vec{B} \cdot d\vec{s}$$



$$= \int_S |\vec{B}|\,|d\vec{s}| \cos(90° - \theta)$$

$$= l_b B \sin\theta$$

l_b: l_{AB}, B_C

$$\Rightarrow \phi(t) = B A_c \sin\omega t$$

(A_c → Area of coil)

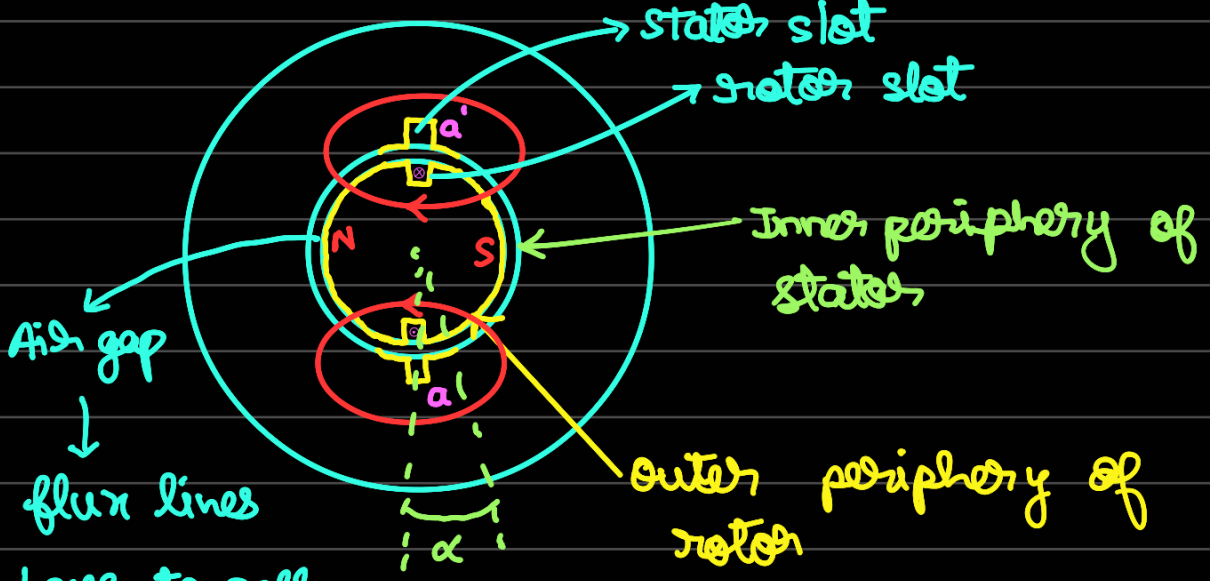
$$\text{EMF} = e(t) = N\frac{d\phi(t)}{dt} = BA_c \frac{d}{dt}(\sin\omega t)$$

($N = 1$)

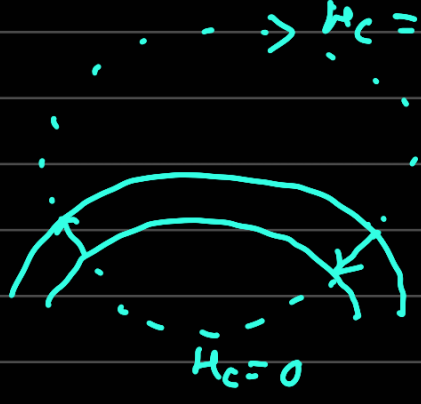
$$= BA_c \omega \cos\omega t$$

ϕ lags emf by 90°

→



They flow radially



$$\oint \vec{H} \cdot d\vec{l} = NI$$

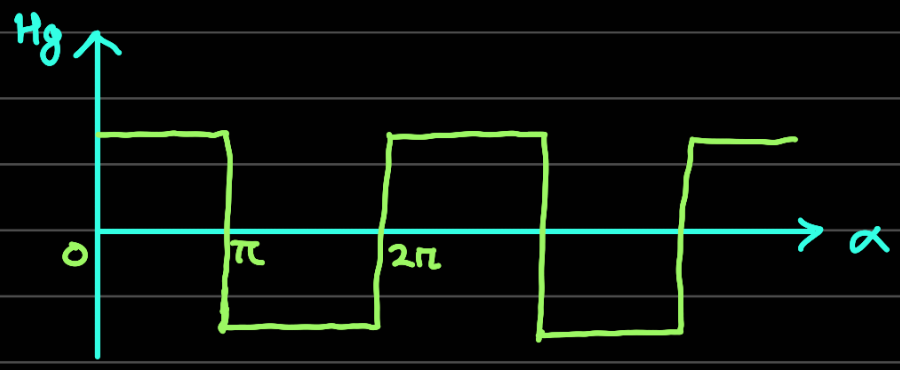
$$H_c l_c + H_g l_g$$

$H_c \sim 0$ ($\mu_{r_c} \to \infty$)

$$\Rightarrow H_g l_g + H_g l_g = NI$$

$$\Rightarrow H_g = \frac{NI}{2 l_g}$$

(H_g is same irrespective of contours → assumed)


Hg
0
π
2π
α