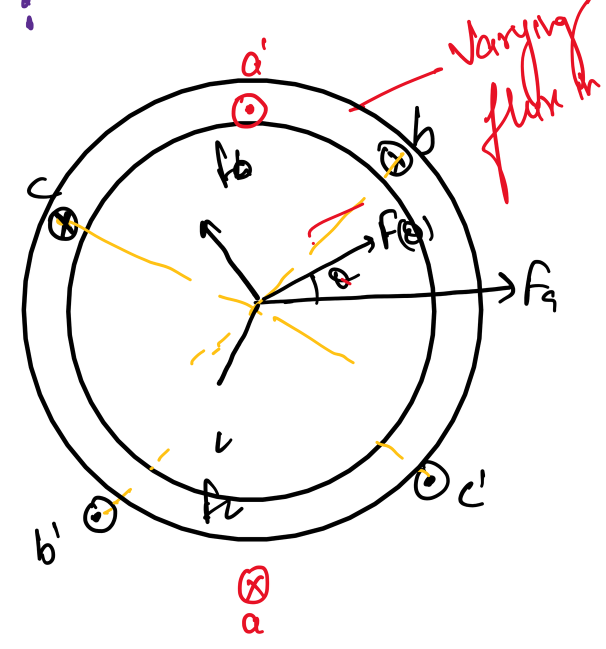
Class notes

Wednesday, 10 April 2024 9:33 AM

Induction motor :

Stator :



Let the balanced 3ϕ current flow through the winding.

- Current in a-phase is $i_a = I_m \cos\omega t$
- MMF due to phase a current $= F_a = N i_a$

The total MMF along θ is $F(\theta)$ given by:

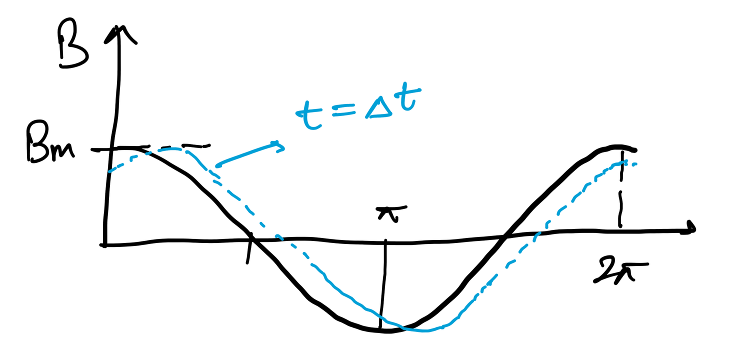
$$\Rightarrow F(\theta) = F_a\cos\theta + F_b\cos(\theta-120) + F_c\cos(\theta-240)$$

$$= \frac{3}{2} N I_m \cos(\omega t-\theta)$$

flux density in the air gap $B_{ag}(\theta,t) = B_m\cos(\omega t-\theta)$

air gap

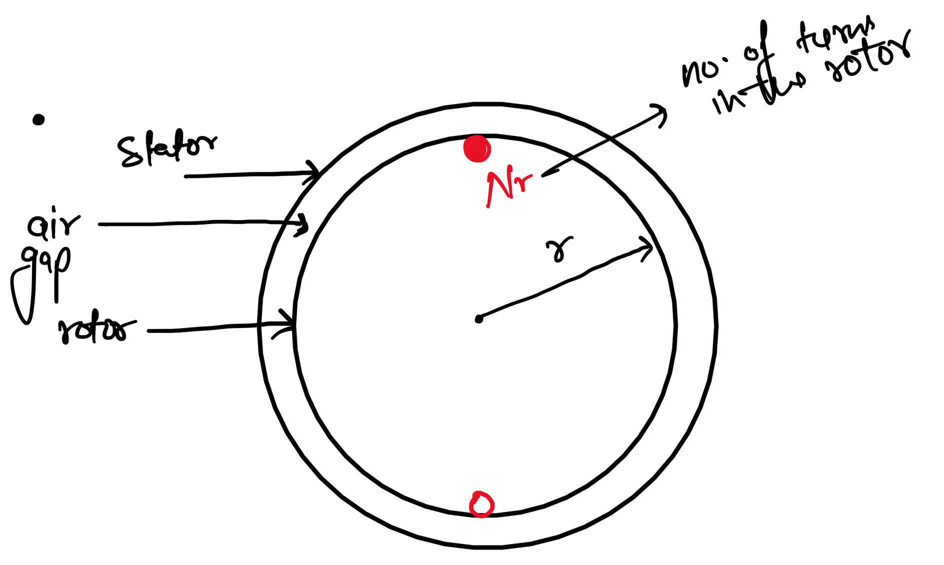
$B @ t=0$



$$\omega = \frac{120F}{P} \text{ rpm}$$

Speed of magnetic field (Synchronous Speed) $= \omega$ rad/sec $= 2\pi f$ $\left\{ \frac{\omega}{2\pi} \times 60 \times \frac{2}{P} \text{ rpm} \right\}$

- No. of poles in the above m/c $\rightarrow$ 2 poles



$$\phi_{linkage} = l\int_{-\pi/2}^{\pi/2} B_{ag}(\theta,t)\, r \cdot d\theta$$

$$= 2rl\,B_m\cos(\omega t)$$

Using Faraday's law :

emf induced in the rotor $= e_{rotor} = N_r\frac{d\phi}{dt}$

$$= -2\omega rl\,B_m N_r \sin(\omega t)$$

$$E_r = \frac{\overset{\phi_m}{2\omega rl B_m} N_r}{\sqrt{2}}$$

2. $\omega_{rad} = \frac{\omega \times 2\pi}{60}$

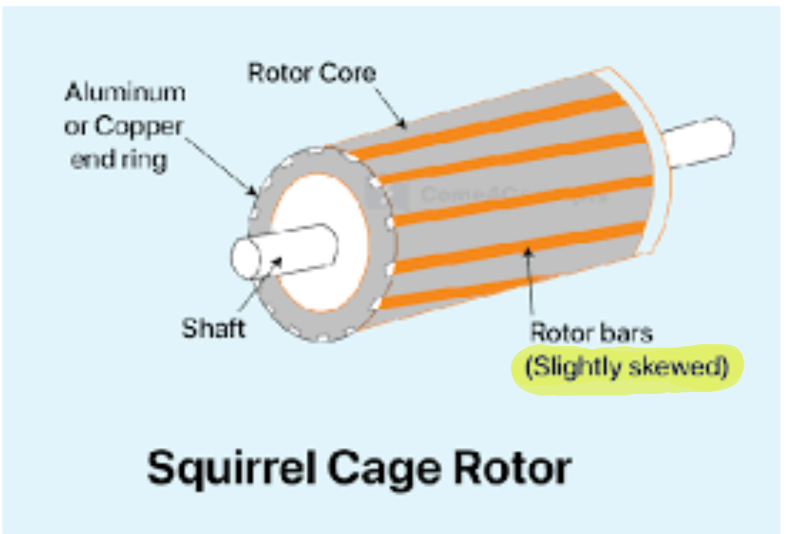
$$\frac{2\times 2\times\pi\times f\cdot B_m\cdot N_r}{\sqrt{2}}$$

putting $\omega = 2\pi f$

$$\boxed{E_r = 4.44\,N_r f\,\phi_m}$$

Similarly voltage induced in the stator $E_s = 4.44\,N_s f\,\phi_m$ (No. of turns in stator)

Rotor :

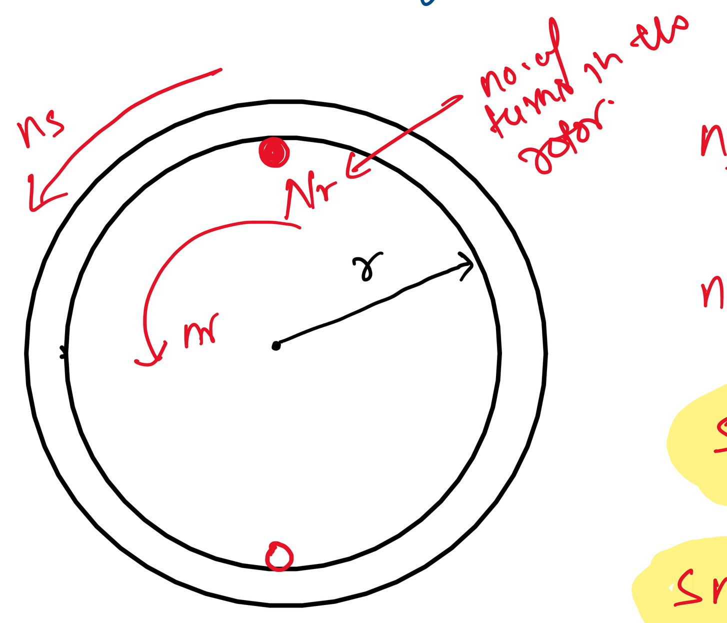


1) the rotor is short circuited, so the E_r causes the current in the rotor $\rightarrow$ current carrying conductor placed in the magnetic field.
↓
it experiences the torque $\rightarrow$ rotor starts rotating

Voltage induced in stator $\rightarrow$ $\frac{E_1}{E_2} = \frac{N_s}{N_r}$ $\leftarrow$ Voltage induced in rotor @ standstill.

Q) In transformer and induction motor, which of these will have higher magnetising current & why ??

Ans Induction motor has higher magnetising current due to the higher reluctance in induction motor {higher air gap}



$n_s = \frac{120f}{P}$ {$n_s \rightarrow$ synchronous speed}

n_r = rotor speed

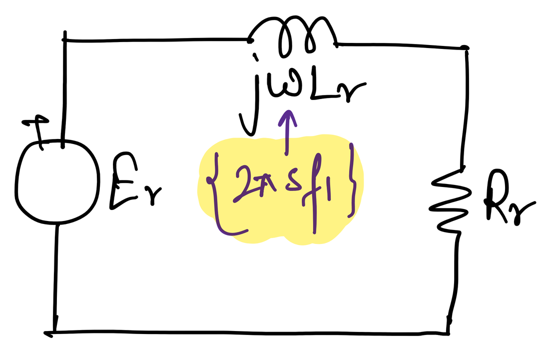
$s = \frac{n_s - n_r}{n_s} \rightarrow$ slip

$sn_s \rightarrow$ slip speed

→ if f_1 is freq. of the stator
→ freq of rotor current $= s\cdot f_1$

- Induction motor rotates below synchronous speed {Speed of rotating magnetic field}
since, at $N_s = N_r$, induced Emf is zero $\rightarrow$ zero current $\rightarrow$ zero torque.

$\Rightarrow$ Voltage induced in the rotor (rotating) $= 4.44\,N_r\,s f_1\,\phi_m$ {induced emf depend on slip freq.}



Induction motor $\longrightarrow$ Sq. cage induction motor
Slip ring " " {Variable resistance using slip rings}