



# SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore - 641 107



AN AUTONOMOUS INSTITUTION

Accredited by NBA - AICTE and Accredited by NAAC - UGC with 'A' Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

### UNIT - 2

#### PERMANENT MAGNET SYNCHRONOUS MOTOR

##### EMF EQUATION

*EMF equation of PMSM*

The armature windings and shape of the permanent magnet are so designed that the flux density distribution in the airgap is sinusoidal.

i. magnetic field by the PM is sinusoidal.

It is derived from emf produced due to the magnet.

where  $B =$  flux density

$P =$  no. of pole

$\theta =$  angle ( $\omega$ ) position of rotor

let us consider a small angle  $d\theta$

flux density of the strip  $B = B_{max} \sin p\theta$

flux in  $d\phi = B \times$  area swept by the conductor

$$= B_{max} \sin p\theta \times l r d\theta \quad \text{--- (2)}$$

where

$l =$  length of the armature

$r =$  radius of the armature

$$d\phi = B_{max} l r \sin p\theta \cdot d\theta \quad \text{--- (3)}$$

The flux enclosed by the coil after  $t$  sec is

$$\phi = \int_0^{\omega_m t + \frac{\pi}{p}} B_{max} l r \sin p\theta \cdot d\theta \quad \text{--- (4)}$$

$$= B_{max} l r \left[ -\frac{\cos p\theta}{p} \right]_0^{\omega_m t + \frac{\pi}{p}}$$

$$= \frac{B_{max} l r}{p} \left[ -\cos p\left(\omega_m t + \frac{\pi}{p}\right) + \cos 0 \right]$$

$$= \frac{B_{max} r l}{\rho} \left[ -\cos \left( \frac{\omega_m t \rho + \pi}{\rho} \right) + \cos 0 \right]$$

$$= \frac{B_{max} r l}{\rho} \left[ -\cos \rho \omega_m t + \cos \pi + \cos 0 \right]$$

$$= \frac{B_{max} r l}{\rho} \left[ -\cos \rho \omega_m t + 1 + 1 \right]$$

$$\phi = 2 \frac{B_{max} r l}{\rho} (-\cos \rho \omega_m t) \quad \text{--- (5)}$$

Faradays law of electromagnetic induction

$$e = -\frac{d\phi}{dt} = -\frac{d}{dt} \left[ \frac{B_{max} r l}{\rho} (\cos \rho \omega_m t) \right] \quad \text{--- (6)}$$

$$= 2 \frac{B_{max} r l}{\rho} \times \rho \omega_m \sin \rho \omega_m t$$

$$e = 2 B_{max} r l \omega_m \sin \rho \omega_m t \quad \text{--- (7)}$$

$$E_{ph} = (2 B_{max} r l \omega_m \sin \rho \omega_m t) T_{ph}$$

$$= E_{ph} \sin \rho \omega_m t \quad \left[ \because E_{ph} = 2 B_{max} r l \omega_m \right] \quad \text{--- (8)}$$