SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

AN AUTONOMOUS INSTITUTION

Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai

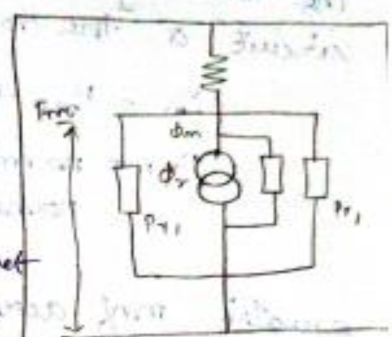
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

POWER SYSTEM ANALYSIS
UNIT – I
PERMANENT MAGNET PMBLDC MOTOR
MAGNETIC CIRCUIT ANALYSIS

MAGNETIC CIRCUIT ANALYSIS

$$\phi_r = B_r A_m$$

$$P_m = \frac{\mu_0 \mu_r A_m}{l_m}$$



where

A_m is the pole area of magnet
l_m is the magnet length
in the direction of magnetization
B_r is flux density
μ_r is relative permeability

Outer pole > inner pole

$$A_m = \frac{2}{3}\pi\left(r_i - g - \frac{l_m}{2}\right)l$$

Most of the magnet flux crosses the airgap via the airgap reluctance R_g.

$$R_g = \frac{g'}{\mu_0 A_g}$$

g' is equivalent air gap length

The slotting by mean of carter's coefficient

$$g' = K_c g$$

The airgap area A_g is the area through which flux passes as it crosses the gap.

$$A_g = \left[\frac{2}{3}\pi\left(r_1 - \frac{g}{2}\right) + 2g\right](l + 2g)$$

The remaining permeance in the magnetic circuit is the rotor leakage permeance

$$P_m = P_{m0} + P_{r1}$$

P_{r1} = normalized rotor leakage permeance. $\approx P_{m0}$

equating mmf across the magnet to mmf across air gap

$$F_m = \frac{\phi_r - \phi_g}{P_m} = \phi_g R_g$$

$$\frac{\phi_r}{P_m} = \phi_g\left(\frac{1}{P_m} + R_g\right)$$

$$\frac{\phi_r}{P_m} = \phi_g\left(\frac{P_m R_g + 1}{P_m}\right)$$

$$\boxed{\phi_g = \frac{\phi_r}{1 + P_m R_g}}$$

magnetic pole area (A_m) of airgap area (

$$C_\phi = \frac{A_m}{A_g}$$

Air gap flux / A_g

$$B_g = \frac{\phi_g}{A_g} = \frac{\phi_r}{(1+P_m R_g) A_g}$$

But $C_\phi = \frac{A_m}{A_g}$

$$A_g = \frac{A_m}{C_\phi}$$

$$B_g = \frac{\phi_g}{A_g} = \frac{\phi_r}{(1+P_m R_g)} \cdot \frac{C_\phi}{A_m}$$

$$B_g = \frac{C_\phi}{(1+P_m R_g)} \cdot \frac{\phi_r}{A_m}$$

$$= \frac{C_\phi}{(1+P_m R_g)} \cdot B_r.$$

where $B_r = \frac{\phi_r}{A_m}$

magnetic flux density B_m

$$B_m = \frac{1 + P_{rl} R_g}{1 + P_m R_g} \alpha \cdot B_r$$

$\frac{B_g}{B_m} < C_\phi$ due to rotor leakage

Performance coefficient

$$P_c = \mu_{rec} \left[\frac{1 + P_{rL} R_g}{P_{mo} R_g} \right]$$