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ASSIGNMENT

The Permanent Magnet Synchronous Machine (PMSM) consists of conventional three phase windings in the stator and permanent magnets in the rotor. The purpose of the field windings in the conventional synchronous machine is done by permanent magnets in PMSM. The conventional synchronous machine requires AC and DC supply, whereas the PMSM requires only AC supply for its operation. One of the greatest advantages of PMSM over its counterpart is the removal of dc supply for field excitation. The permanent-magnet synchronous machine (PMSM) drive is one of best choices for a full range of motion control applications. For example, the PMSM is widely used in robotics, machine tools, actuators, and it is being considered in highpower applications such as industrial drives and vehicular propulsion. It is also used for residential/commercial applications. The PMSM is known for having low torque ripple, superior dynamic performance, high efficiency and high power density.

MODELLING OF A PMSM

The required assumptions are obtained for the modelling of the PMSM without damper windings.

1. Saturation is neglected.
2. Induced EMF is sinusoidal in nature.
3. Hysteresis losses and Eddy current losses are negligible.
4. No field current dynamics.

Voltage equations from the model are given by,

$$V_q = R_s\, i_q + \omega_r \lambda_d + \rho \lambda_q \qquad (1)$$

$$V_d = R_s\, i_d + \omega_r \lambda_q + \rho \lambda_d \qquad (2)$$

Flux linkages are given by,

$$\lambda_q = L_q i_q \qquad (3)$$

$$\lambda_q = L_q i_q + \lambda_f \qquad (4)$$

Substituting Eq. (3) and Eq. (4) into Eq. (1) and Eq. (2)

$$V_q = R_s i_q + \omega_r(L_d i_d + \lambda_f) + \rho L_d i_d \qquad (5)$$

$$V_d = R_s i_d - \omega_r L_q i_q + \rho(L_d i_d + \lambda_f) \qquad (6)$$

Arranging Eq. (5) and Eq. (6) in matrix form,

$$\begin{pmatrix} Vq \\ Vd \end{pmatrix} = \begin{pmatrix} Rs + \rho Lq & \omega rLd \\ -\omega rLq & Rs + \rho Ld \end{pmatrix} \begin{pmatrix} iq \\ id \end{pmatrix} + \begin{pmatrix} \omega r\lambda f \\ \rho\lambda f \end{pmatrix} \qquad (7)$$

The developed torque motor is being given by,

$$T_e = \frac{3}{2}\left(\frac{P}{2}\right)(\lambda_d i_q \ \lambda_q i_d) \qquad (8)$$

The mechanical torque equation is,

$$T_e = T_L + B\omega_m + J\frac{d\omega m}{dt} \qquad (9)$$

Solving for the rotor mechanical speed form Eq. (9)

$$\omega_m = \int\left(\frac{Te - TL - B\omega m}{J}\right)dt \qquad (10)$$

and

$$\omega_m = \omega_r\left(\frac{2}{P}\right) \qquad (11)$$

In the above equations ω_r is the rotor electrical speed, ω_m is the rotor mechanical speed.