Induction Machine Model

- Rotor Angle ?
- Torque Equation
- Motor / Generator Convention
- Mechanical Torque Speed Dependence

d-axis equations 1.1 model

$$\frac{d\psi_F}{dt} = \frac{1}{T'}(-\psi_F + \psi_d)$$

$$\psi_d = x' i_d + \frac{(x - x')}{x}\psi_F$$

$$\frac{d\psi_d}{dt} = -\omega\psi_q - \omega_B R_a i_d - \omega_B v_d$$

q-axis equations: 1.1 model

$$\frac{d\psi_G}{dt} = \frac{1}{T'}(-\psi_G + \psi_q)$$

$$\psi_q = x' i_q + \frac{(x - x')}{x}\psi_G$$

$$\frac{d\psi_q}{dt} = \omega\psi_d - \omega_B R_a i_q - \omega_B v_q$$

$$x = x_s + X_m$$

$$x' = x_s + \frac{X_m x_r}{X_m + x_r}$$

$$T' = \frac{x'}{x}\frac{x_r + X_m}{\omega_B R_r}$$

$$Te = \psi_d i_q - \psi_q i_d$$

$$[C_P] = \sqrt{\frac{2}{3}} \begin{bmatrix} \cos\theta & \sin\theta & \sqrt{\frac{1}{2}} \\ \cos(\theta - 2\pi/3) & \sin(\theta - 2\pi/3) & \sqrt{\frac{1}{2}} \\ \cos(\theta + 2\pi/3) & \sin(\theta + 2\pi/3) & \sqrt{\frac{1}{2}} \end{bmatrix}$$

$$\theta = \omega t = \omega_O t + \delta$$

Alternative Transformation

$$[C_K] =$$

$$\sqrt{\frac{2}{3}} \begin{bmatrix} \cos\omega_o t & \sin\omega_o t & \sqrt{\frac{1}{2}} \\ \cos(\omega_o t - 2\pi/3) & \sin(\omega_o t - 2\pi/3) & \sqrt{\frac{1}{2}} \\ \cos(\omega_o t + 2\pi/3) & \sin(\omega_o t + 2\pi/3) & \sqrt{\frac{1}{2}} \end{bmatrix}$$

Alternative Transformation

$$\begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix} = [C_P] \begin{bmatrix} f_d \\ f_q \\ f_o \end{bmatrix} = [C_K] \begin{bmatrix} f_D \\ f_Q \\ f_o \end{bmatrix}$$

$$(f_Q + j f_D) = (f_q + j f_d) e^{j\delta}$$

d-axis equations 1.1 model

$$\frac{d\psi_{FK}}{dt} = \frac{1}{T'}(-\psi_{FK} + \psi_D) - (\omega_o - \omega)\psi_{GK}$$

$$\psi_D = x' i_D + \frac{(x - x')}{x}\psi_{FK}$$

$$\frac{d\psi_D}{dt} = -\omega_o \psi_Q - \omega_B R_a i_D - \omega_B v_D$$

$$(\psi_{GK} + j\psi_{FK}) = (\psi_G + j\psi_F)e^{j\delta}$$

q-axis equations: 1.1 model

$$\frac{d\psi_{GK}}{dt} = \frac{1}{T'}(-\psi_{GK} + \psi_Q) + (\omega_o - \omega)\psi_{FK}$$

$$\psi_Q = x' i_Q + \frac{(x - x')}{x}\psi_{GK}$$

$$\frac{d\psi_Q}{dt} = \omega_o \psi_D - \omega_B R a i_Q - \omega_B v_Q$$

$$T_e = \psi_d i_q - \psi_q i_d = \psi_D i_Q - \psi_Q i_D$$

Torque is independent of δ

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