제외

유도 전동기 d-q 변환

→ d-q축 모델

$$V_{abcs} = R_s i_{abcs} + \frac{d}{dt}\lambda_{abcs}$$

$$V_{abcr} = R_r i_{abcr} + \frac{d}{dt}\lambda_{abcr}$$

$$\begin{bmatrix}\lambda_{abcs}\\ \lambda_{abcr}\end{bmatrix} = \begin{bmatrix} L_s & L_{sr} \\ (L_{sr})^T & L_r \end{bmatrix}\begin{bmatrix} i_{abcs} \\ i_{abcr}\end{bmatrix}$$

$$V_{abcs} = R_s i_{abcs} + \frac{d\lambda_{abcs}}{dt}$$

$$T(\theta)\, V_{abcs} = V^{w}_{abcs}$$

$$\int \omega(t)\, dt = \theta$$

$$T(\theta)\, R_s\, T(\theta)^{-1} = R_s$$

θ 측정후 다시 적용

$$\frac{dp(\theta)}{dt} = \omega \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} p(\theta)$$

$$R(\theta) = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$ 로 표현

$$\theta(t) = \int \omega(t)\, dt + p(t)$$

$$\omega(t) = \frac{d\theta(t)}{dt}$$

$$\frac{dp}{d\theta} = J(\theta) = \begin{bmatrix} -\sin\theta & -\cos\theta \\ \cos\theta & -\sin\theta \end{bmatrix}$$

$$J = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} \cos 90 & -\sin 90 \\ \sin 90 & \cos 90 \end{bmatrix}$$

$\Rightarrow 90^\circ$ 회전

$$J\,T(\theta) = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

$$= \begin{bmatrix} -\sin\theta & -\cos\theta \\ \cos\theta & -\sin\theta \end{bmatrix}$$

$$\omega J\,T(\theta) = \begin{bmatrix} -\sin\theta \cdot \omega & -\cos\theta\,\omega \\ \cos\theta\,\omega & -\sin\theta\,\omega \end{bmatrix}$$

$$= \frac{dT(\theta)}{dt}$$

$$T(\theta)\,T^{-1}(\theta) = I$$

$$\frac{d}{dt}\,T(\theta)\,T^{-1}(\theta) = 0 = \frac{dT}{dt}T^{-1} + T\frac{dT^{-1}}{dt}$$

$$T\frac{dT^{-1}}{dt} = -\frac{dT}{dt}T^{-1}$$

$$T\frac{dT^{-1}}{dt} = -\omega J$$

$$V^{\omega}_{abcs} = R_s i^{\omega}_{abcs} + \begin{bmatrix} 0 & -\omega & 0 \\ \omega & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \vec{\lambda}_{dqns}$$

$$+ \frac{d}{dt} \lambda^{\omega}_{dqns}$$

ω에 의하여 전압이 발생

$$\omega \cdot \lambda^{\omega}_{qs} \quad . \quad \omega \lambda^{\omega}_{ds}$$

V^{ω}_{dr} 도 $\omega - \omega_{rm}$ 의 차이 (s만큼의)

전압 발생.

⇒ Torque 식

$$T_e = \frac{P}{2} \frac{3}{2} L_m \left(i^{\omega}_{qs} i^{\omega}_{dr} - i^{\omega}_{ds} i^{\omega}_{qr} \right)$$

여러가지 형태로 표현 가능.