Kap 3 Elektromek. sys

04.02.16

Motor Equations of Motion (EoM)

$$J_m \dot{\omega}_m = T - T_L$$

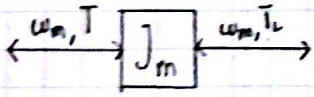
Akseleffekt (motor → rotor)

$$P_m = \omega_m T$$

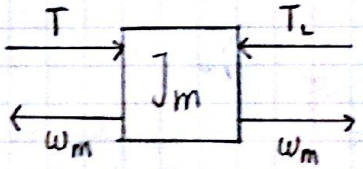
Lasteffekt (rotor → last)

$$P_L = T_L \omega_m$$

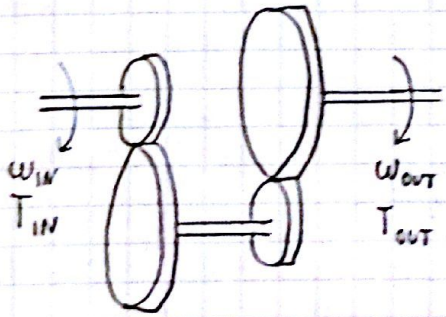
Nettverksmodell:



Signalflytmodell:



Gir



1 : n

$$\omega_{out} = n \cdot \omega_{in}$$

n: gir overselting

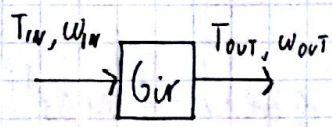
Tapsfritt gir:

Effekt inn = Effekt ut

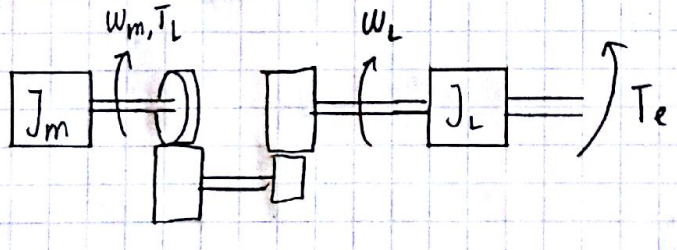
$$T_{IN} \cdot \omega_{IN} = T_{OUT}\, \omega_{OUT}$$

$$= T_{OUT}\, n\, \omega_{IN}$$

$$T_{OUT} = \frac{1}{n} T_{IN}$$

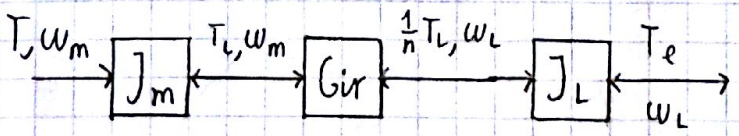


Motor og gir



$$J_m \dot{\omega}_m = T - T_L \qquad (1)$$

$$J_L \dot{\omega}_L = \frac{1}{n} T_L - T_e \qquad (2)$$



Algebraisk kobling $\omega_L = n\, \omega_m$

$\Rightarrow$

(2): $J_L n \dot{\omega}_n = \frac{1}{n} T_L - T_e$ (3)

(1) + (3)

$$\boxed{(J_m + J_L n^2)\dot{\omega}_m = T - nT_e}$$

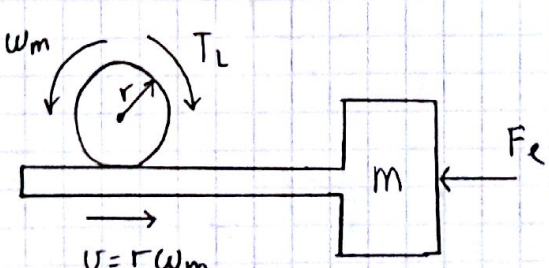
(motorside)

eller:

$$\boxed{\left(\frac{1}{n^2}J_m + J_L\right)\dot{\omega}_L = \frac{1}{n}T - T_e}$$

(lastside)

Rotasjon til translasjon



$F = \frac{1}{r}T_L$

Tapsfritt:

$$\omega_m T_L = F \cdot v = F r \omega_m$$

E.o.M:

$$\delta_m \dot{\omega}_m = T - T_L$$

$$m\dot{v} = F - F_e$$

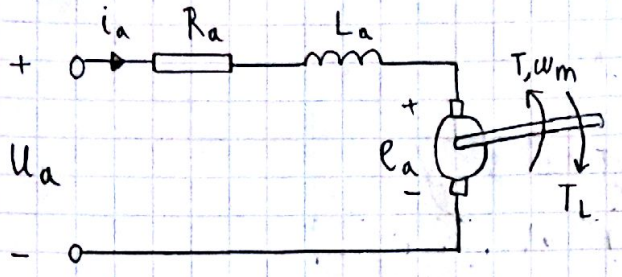
Kan slås sammen:

$$(J_m + mr^2)\dot{\omega}_m = T - rF_e$$

evt. $\left(\frac{1}{r^2}J_m + m\right)\dot{v} = \frac{1}{r}T - F_e$

3.3 Likestrømsmotor m/konstant felt

Ankerkrets ("armature")



Karakteristikk: $T = K_T i_a$

Kirchhoffs spenningslov

$$u_a = R_a i_a + L_a \frac{di_a}{dt} + e_a$$

Motor EoM:

$$J_m \dot{\omega}_m = T - T_L$$

Ingen tap/lagring i energiomforming

$$P_e = P_m$$

$$i_a e_a = T \omega_m = K_T i_a \omega_m$$

$$e_a = K_E \omega_m \quad , \quad K_E = K_T$$

Energifunktion:

$$V = \frac{1}{2} L_a i_a^2 + \frac{1}{2} J_m \omega_m^2$$

$$\dot{V} = i_a L_a \frac{di_a}{dt} + \omega_m J_m \frac{d\omega_m}{dt}$$

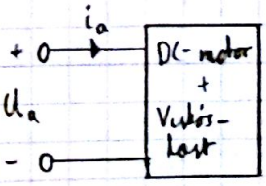
$$= i_a \left(-R_a i_a - \cancel{K_E \omega_m} + u_a\right) + \omega_m \left(\cancel{K_T i_a} - T_L\right)$$

$$= -R_a i_a^2 + i_a u_a - \omega_m T_L$$

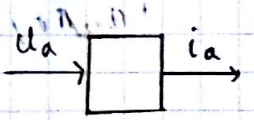
Anta last er "viskös friksjon": $T_L = D\omega_m$

$$\Rightarrow \dot{V} = i_a u_a - \underbrace{R_a i_a^2 - D\omega_m^2}_{T_{ap} \leq 0}$$

$$\int_{t_0}^{t} i_a u_a \, d\tau \geqslant \int_{t_0}^{t} \dot{V} \, d\tau = V(t) - V(0) \geqslant -V(0)$$



Passivt



Generelt:

Passiv last ($\omega_m \rightarrow T_L$)

$\Rightarrow$ motor + last passiv

($u_a \rightarrow i_a$)

Transferfunksjon:

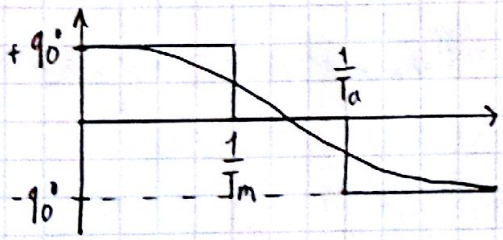
$$\frac{i_a}{u_a}(s) = \frac{J_m}{K_T K_E} \cdot \frac{s}{1 + T_m s + T_m T_a s^2}$$

$$T_m = \frac{J_m R_a}{K_E K_T}$$

$$T_a = \frac{L_a}{R_a}$$

$$\approx \frac{J_m}{K_T K_E} \cdot \frac{s}{(1+T_m s)(1+T_a s)}, \quad T_a \ll T_m$$

Positiv reell?



Implisitte R-K metoder

$$k_1 = f(y_n + h(a_{11}k_1 + a_{12}k_2 + \ldots + a_{1\sigma}k_\sigma), t_n + c_1 h)$$

$$k_2 = f(y_n + h(a_{21}k_1 + \ldots + a_{2\sigma}k_\sigma), t_n + c_2 h) \ldots$$

$$\vdots$$

$$k_\sigma = f(y_n + h(a_{\sigma 1}k_1 + \ldots + a_{\sigma\sigma}k_\sigma), t_n + c_\sigma h)$$

$$y_{n+1} = y_n + h(b_1 k_1 + \ldots + b_\sigma k_\sigma)$$

$$\begin{array}{c|c} c & A \\ \hline & b \end{array} \qquad A = \begin{bmatrix} a_{11} & a_{12} & \cdots \\ a_{21} & a_{22} & \\ \vdots & & \ddots \end{bmatrix}$$