COPPIA INERZIALE

$$m_d = J\frac{d\omega}{dt}$$

$$m_d\omega = J\frac{d\omega}{dt}\cdot\omega = \frac{d}{dt}\left(\frac{1}{2}J\omega^2\right) = \frac{d}{dt}E_c$$

$$E_c = \frac{1}{2}J\omega^2 \qquad J = \frac{2E_c}{\omega^2}$$

Esempio:

J_m [$kg\,m^2$] J del motore

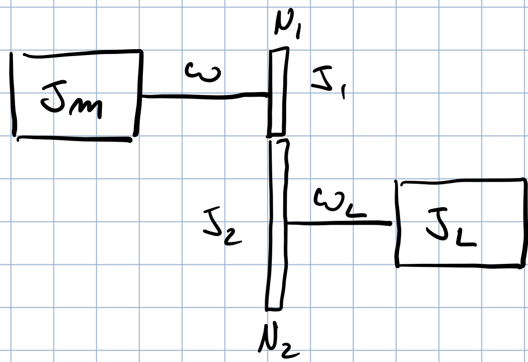
M [kg]

$$E_c = \frac{1}{2}J_m\omega^2 + \frac{1}{2}J_p\omega^2 + \frac{1}{2}M v^2 \qquad v = \omega\frac{\phi_p}{2}$$

$$= \frac{1}{2}J_m\omega^2 + \frac{1}{2}J_p\omega^2 + \frac{1}{2}M\omega^2\frac{\phi_p^2}{4}$$

$$J_{eq} = J_m + J_p + \frac{M\phi_p^2}{4}$$

ESEMPIO



$$\omega N_1 = \omega_L N_2$$

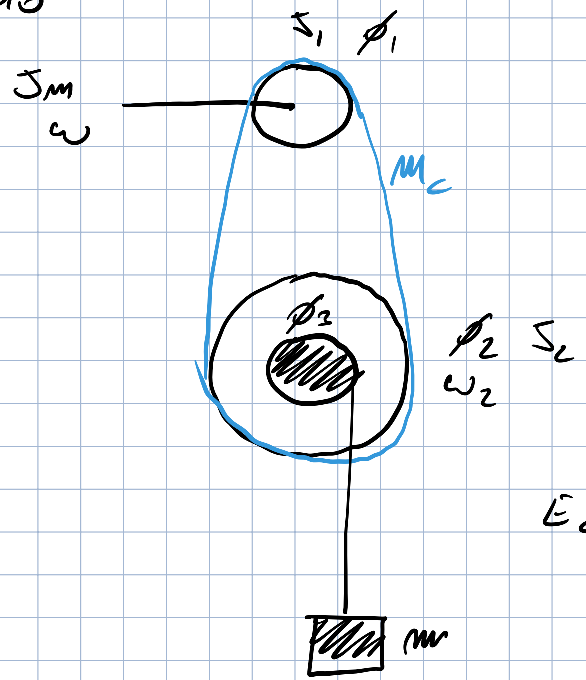
$$\frac{N_1}{N_2} = \frac{\omega_L}{\omega}$$

$$E_c = \frac{1}{2}J_m\omega^2 + \frac{1}{2}J_1\omega^2 + \frac{1}{2}(J_2 + J_L)\omega_L^2$$

$$= \frac{1}{2}(J_m + J_1)\omega^2 + \frac{1}{2}(J_2 + J_L)\left(\omega\frac{N_1}{N_2}\right)^2$$

$$J_{eq} = J_m + J_1 + (J_2 + J_L)\left(\frac{N_1}{N_2}\right)^2$$

ESEMPIO



$$E_c = \frac{1}{2} J_m \omega^2 + \frac{1}{2} J_1 \omega^2 + \frac{1}{2} m_c \left(\omega \frac{\phi_1}{2}\right)^2 +$$

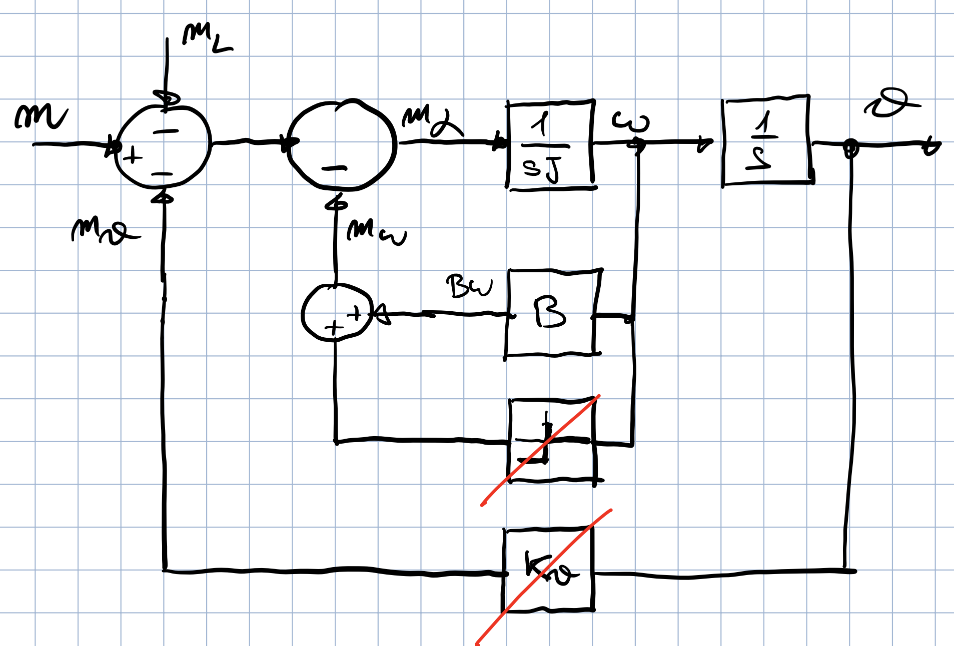
$$+ \frac{1}{2} J_2 \omega_2^2 + \frac{1}{2} m \left(\omega_2 \frac{\phi_3}{2}\right)^2$$

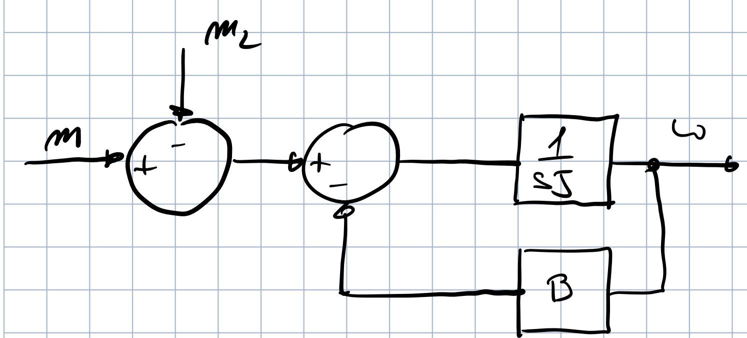
$$\omega \phi_1 = \omega_2 \phi_2$$

$$\omega_2 = \omega \frac{\phi_1}{\phi_2}$$

$$E_c = \frac{1}{2} \omega^2 \underbrace{\left[J_m + J_1 + m_c \frac{\phi_1^2}{4} + J_2 \left(\frac{\phi_1}{\phi_2}\right)^2 + m \frac{\phi_1^2}{\phi_2^2} \frac{\phi_3^2}{4} \right]}_{J_{eq}}$$

$$\underbrace{m_L + m_\vartheta + m_\omega + m_J}_{\text{CARICO}} = \underset{\hookrightarrow \text{AZIONAMENTO}}{m}$$

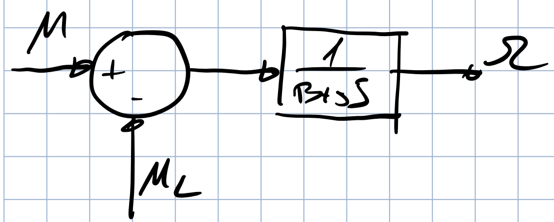


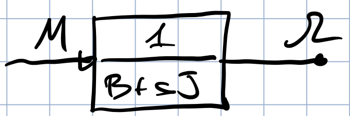


$$m = m_L + J \frac{d\omega}{dt} + B\omega$$

$$M = M_L + J s \Omega + B \Omega$$

$$\overset{!}{=} M_L + \Omega (B + sJ)$$



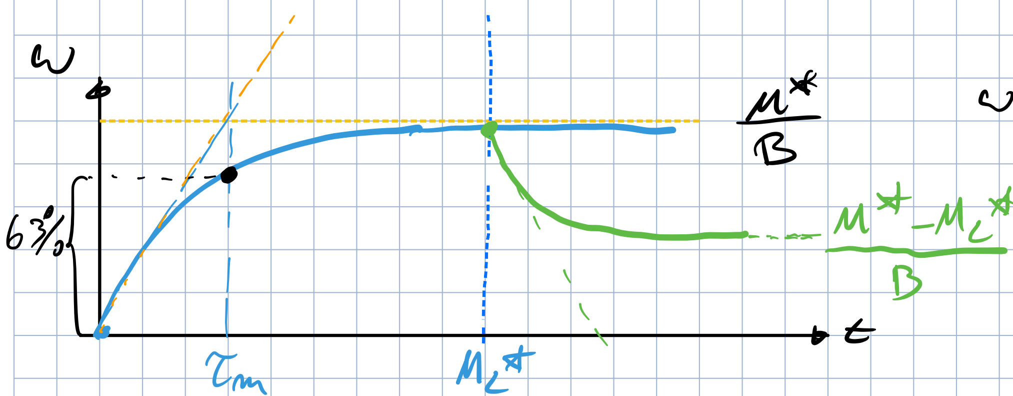


$$\frac{\Omega}{M} = \frac{1}{B+sJ} = \frac{1}{B\left(1+s\frac{J}{B}\right)} = \frac{1/B}{1+s\tau_m}$$

$\tau_m = \frac{J}{B}$ [s] cost. di tempo meccanica

Risposta al gradino

$$\Omega = \frac{1/B}{1+s\tau_m}\,\frac{M^*}{s} \xrightarrow{\mathcal{L}^{-1}} \frac{M^*}{B}\left(1-e^{-t/\tau_m}\right)$$



$$\omega(\tau_m) = \frac{M^*}{B}\left(1-e^{-1}\right) = \frac{M^*}{B}\,0{,}63$$

Se visto nel dominio del tempo

$$m = B\omega + J\frac{d\omega}{dt} \qquad \omega = \omega_o + \omega_f$$

Se $m = M^*$ $\quad \omega_f = \frac{M^*}{B} \quad \omega_o = A\,e^{-t/\tau_m}$

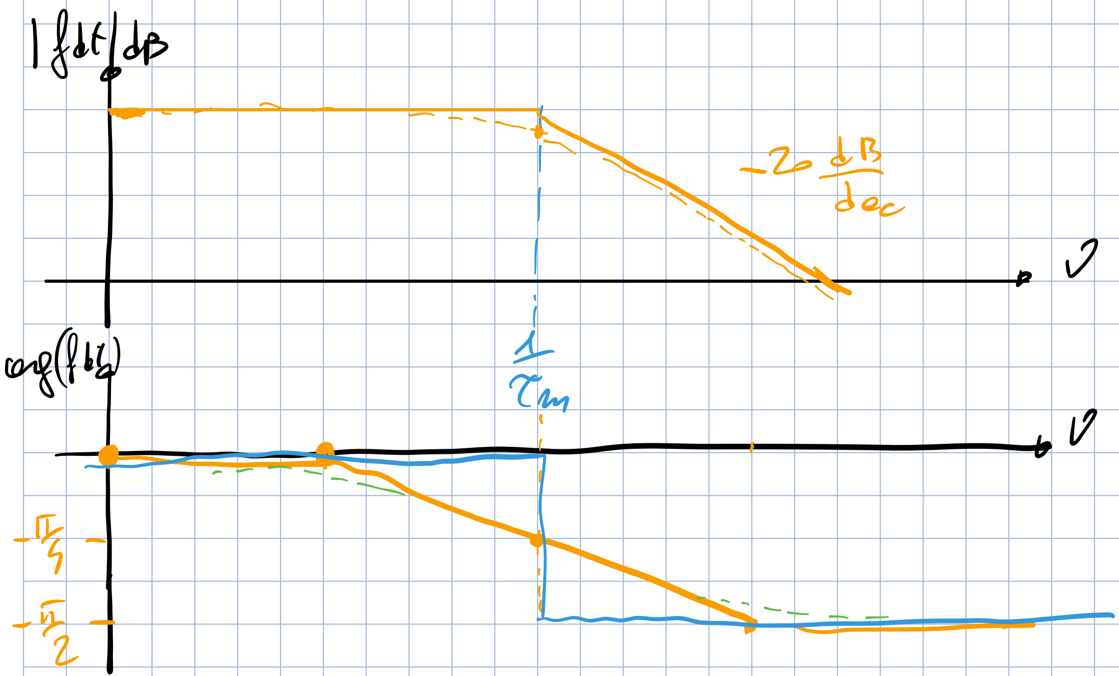
$$\omega = \frac{M^*}{B} + A\,e^{-t/\tau_m}$$

$$\dots \quad \omega = \frac{M^*}{B}\left(1-e^{-t/\tau_m}\right)$$

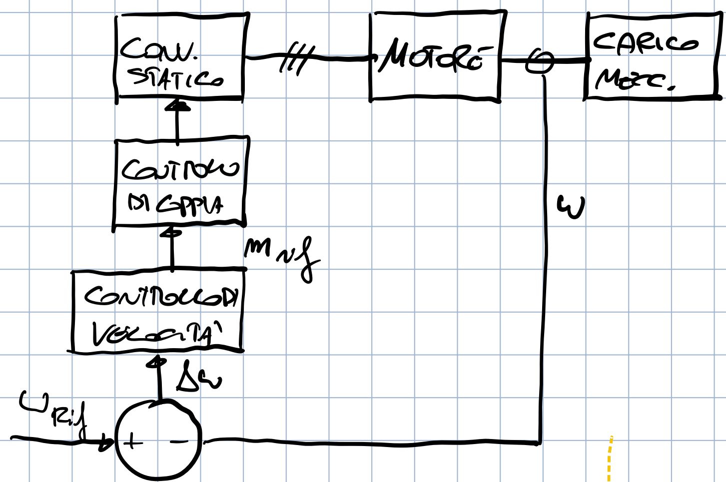
fdt $\left.\frac{\Omega}{M}\right|_{dB} = 20\log\frac{\Omega}{M} \overset{s=j\nu}{=} 20\log\left|\frac{1/B}{1+j\nu\tau_m}\right| = 20\log\frac{1/B}{\sqrt{1+(\nu\tau_m)^2}}$

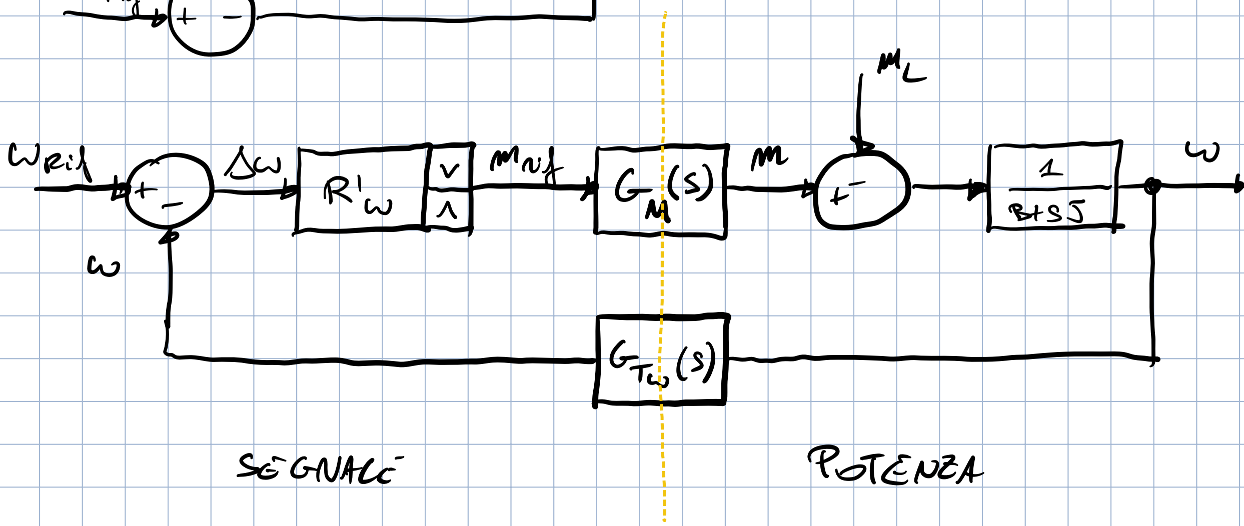
$$\nu \begin{cases} \nu \ll 1/\tau_m & 20\log\frac{1}{B} & \text{cost dB} \\ \nu = 1/\tau_m & 20\log\left(\frac{1}{B}\frac{1}{\sqrt{2}}\right) & -3\,dB \\ \nu \gg \frac{1}{\tau_m} & 20\log\left(\frac{1}{B}\frac{1}{\nu\tau_m}\right) & -20\,dB/dec \end{cases}$$

$$\arg\left(\frac{1/B}{1+j\nu\tau_m}\right) = \arg\frac{1}{B} - \arg(1+j\nu\tau_m) = 0 - \operatorname{atan}\frac{\nu\tau_m}{1}$$
$$= -\operatorname{atan}\nu\tau_m$$

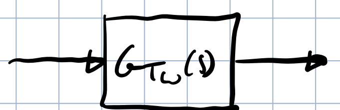


CONTROLLO DI VELOCITÀ

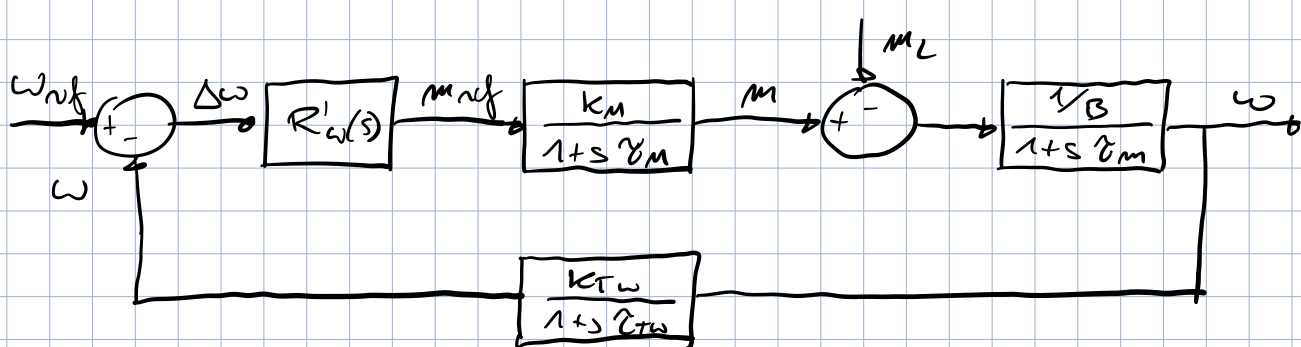




$$G_M(s) = \frac{K_M}{1 + s\tau_M}$$



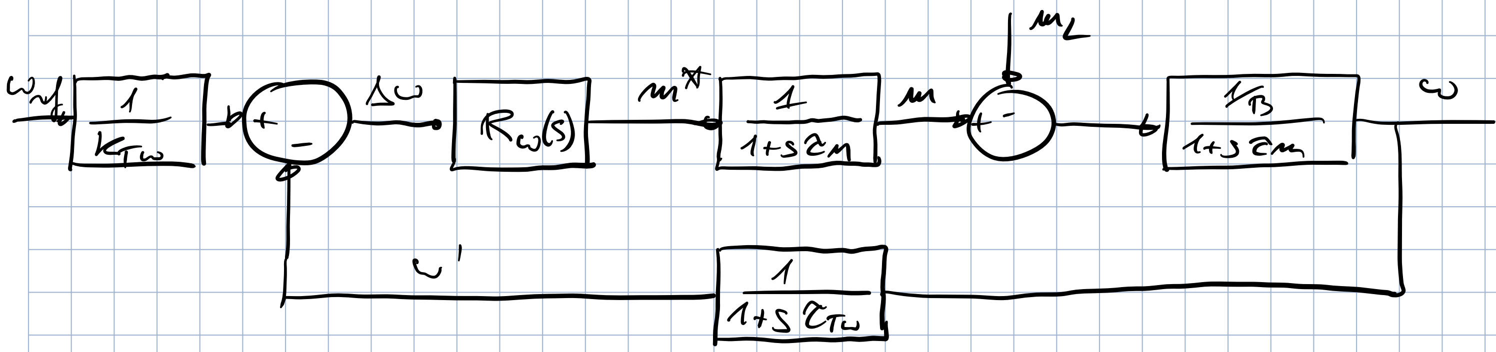
$$G_{T\omega}(s) = \frac{K_{T\omega}}{1 + s\tau_{T\omega}}$$



τ_m CARICO 10 – 100 s $\qquad \tau_m = \frac{J}{B}$

τ_M MOTORE 1 – 10 ms

$\tau_{T\omega}$ TRASDUTTORE è la più piccola di tutte (TRASCURIAMO)



$$R_\omega = R'_\omega \cdot K_{T\omega} \cdot K_M$$