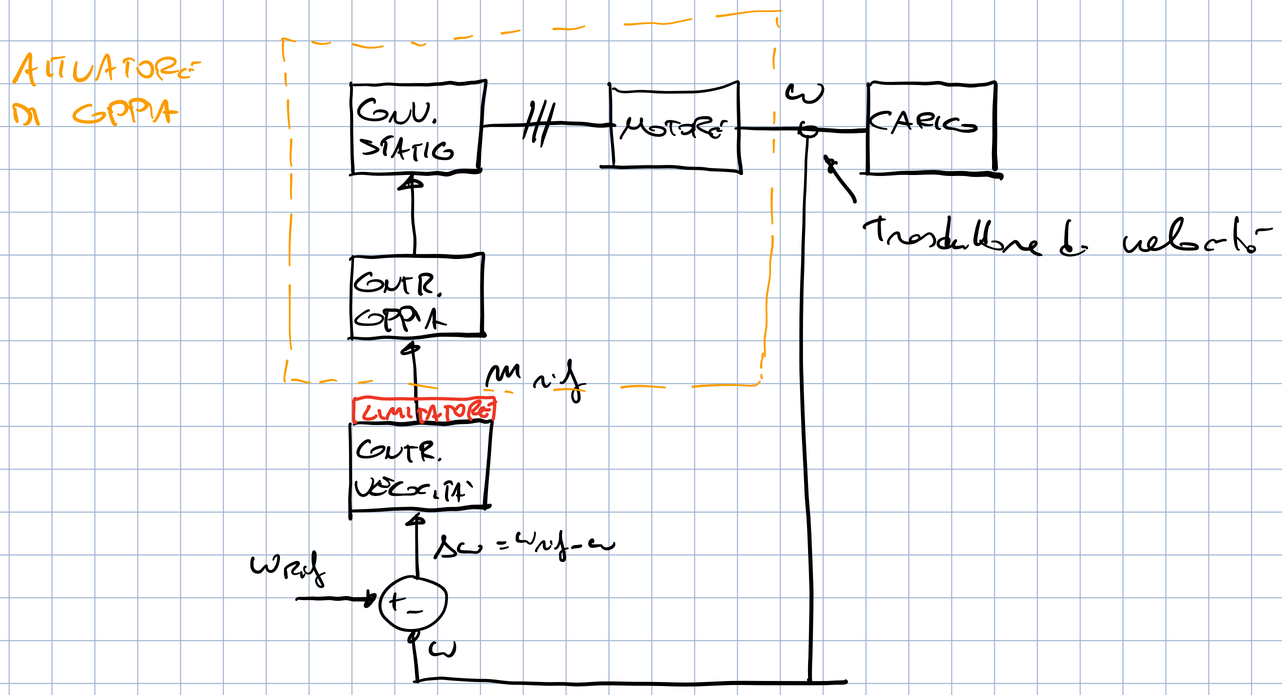
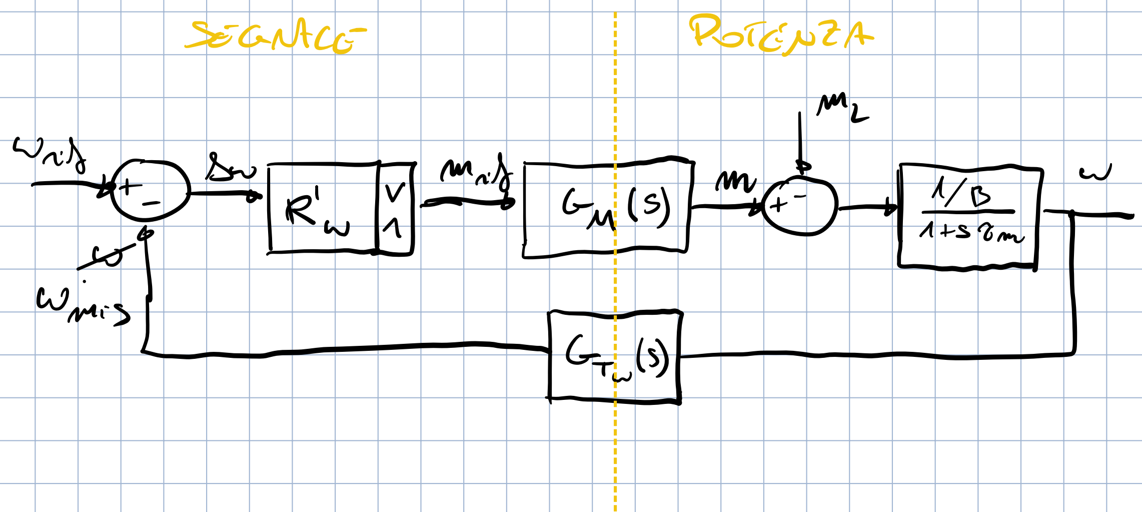
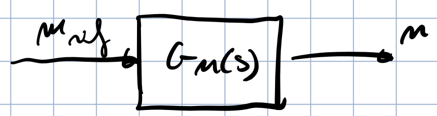
CONTROLLO DI VELOCITÀ A CATENA CHIUSA



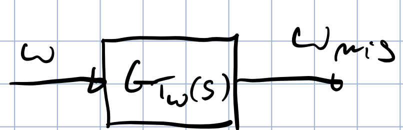


ATTUATORE DI COPPIA

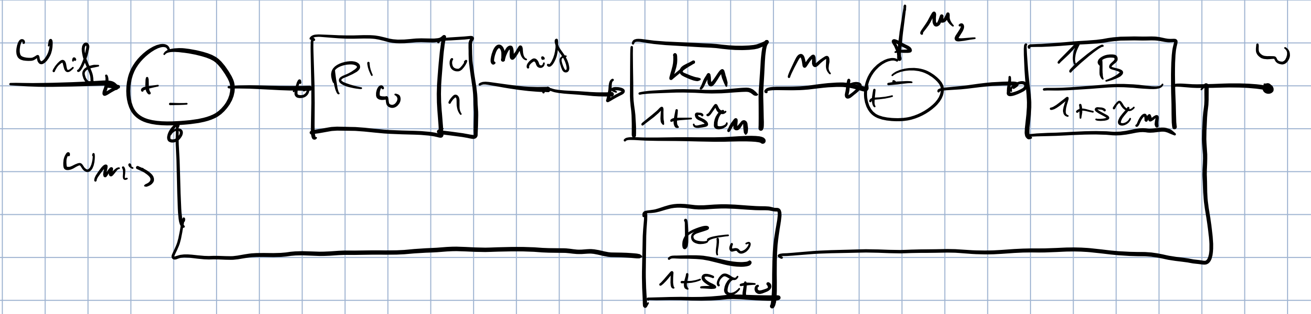


$$G_M(s) = \frac{K_M}{1+s\tau_M}$$

TRASDUTTORE DI VELOCITÀ



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

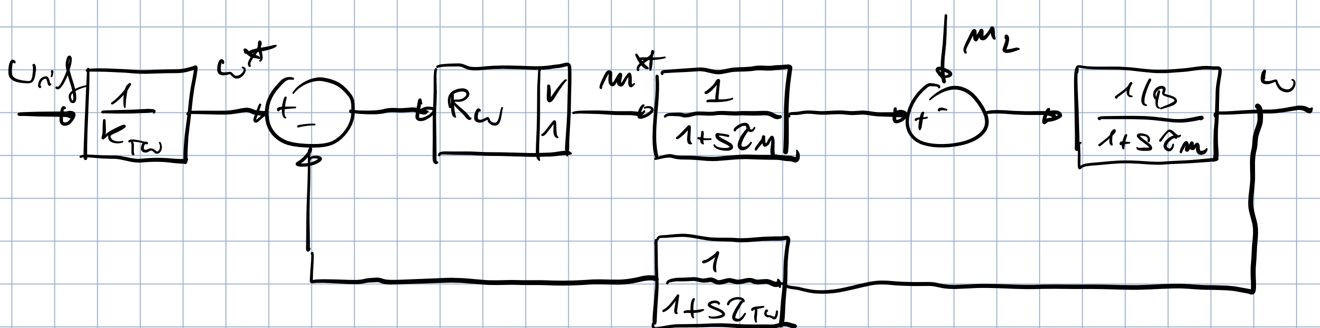


Ho 3 costanti di tempo

τ_m : CARICO $\qquad$ $10 \div 100$ s

τ_M : ATTUATORE $\qquad$ $1 \div 100$ ms

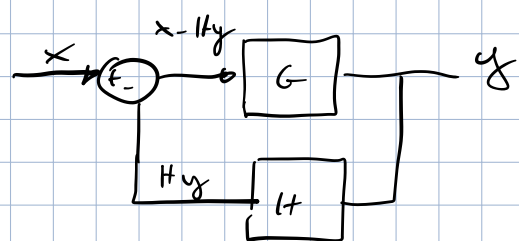
$\tau_{T\omega}$: TRASDUTTORE $\qquad$ 0,1 ms $\qquad$ tipicamente possono trascurare



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

STABILIRE $\quad R_\omega(s)$ / $\begin{cases} \text{STABILITÀ} \\ \text{ERRORE A REGIME} \\ \text{DINAMICA} \end{cases}$

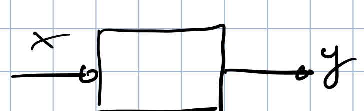
P
PI } DIAGRAMMI DI BODE

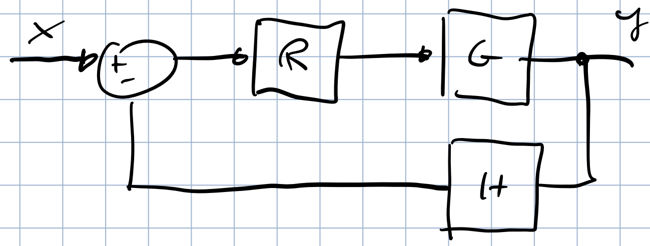


$y = G(x - Hy) = Gx - GHy$

$y(1 + GH) = Gx$

$\frac{y}{x} = \frac{G}{1+GH}$

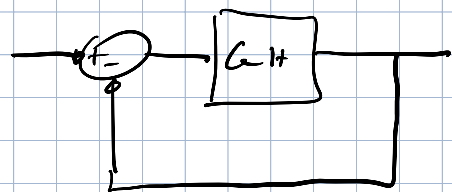




$R = 1$

Si studio GH_R

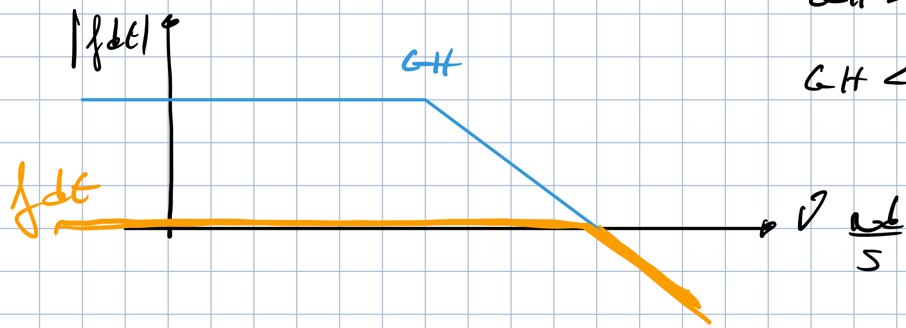
Nota



$$fdt = \frac{GH}{1+GH}$$

$GH \gg 1 \quad fdt \cong 1$

$GH \ll 1 \quad fdt \cong GH$



$$GH_R(s) = \frac{1/B}{1+s\tau_m} \cdot \frac{1}{1+s\tau_M} \cdot \frac{1}{1+s\tau_{Tw}}$$

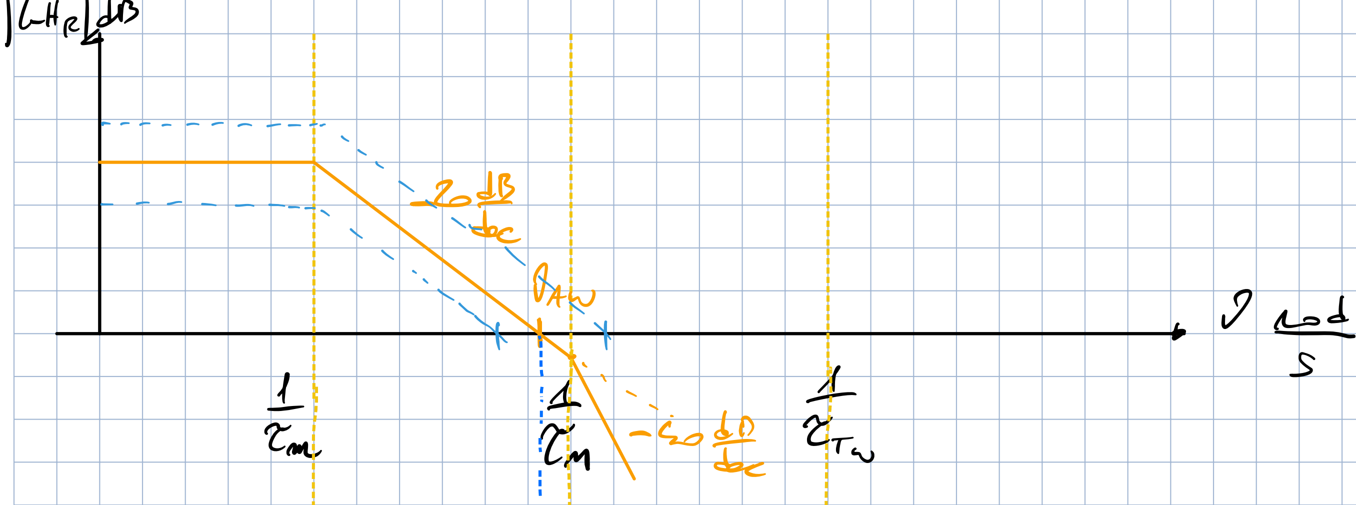
$\tau_m > \tau_M > \tau_{Tw}$

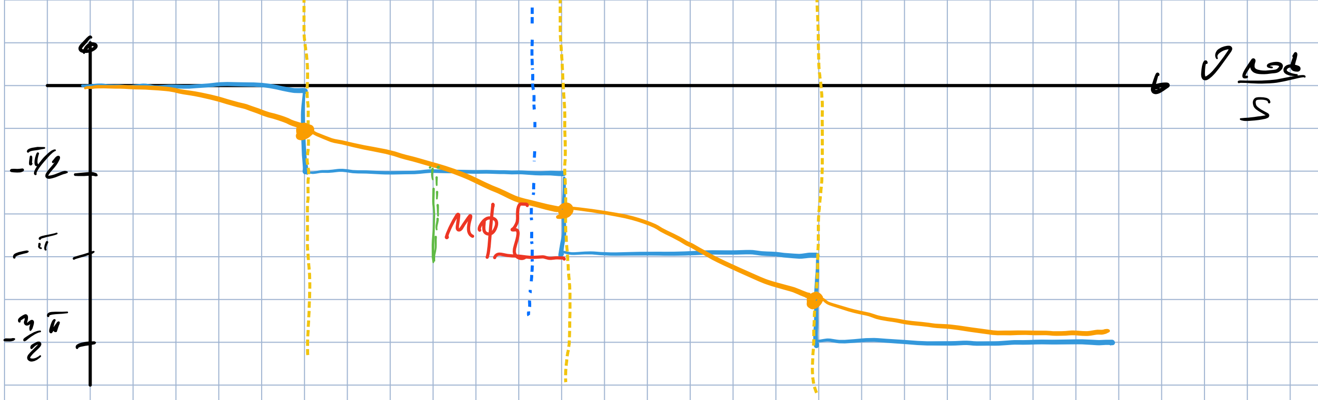
$\frac{1}{\tau_m} < \frac{1}{\tau_M} < \frac{1}{\tau_{Tw}}$

$$|GH_R(j\vartheta)| = \frac{1/B}{\sqrt{1+(\vartheta\tau_m)^2}} \cdot \frac{1}{\sqrt{1+(\vartheta\tau_M)^2}} \cdot \frac{1}{\sqrt{1+(\vartheta\tau_{Tw})^2}}$$

K_p

$$\angle GH_R(j\vartheta) = -\operatorname{atan}(\vartheta\tau_m) - \operatorname{atan}(\vartheta\tau_M) - \operatorname{atan}(\vartheta\tau_{Tw})$$





$R_\omega = K_p$ REGOLATORE PROPORZIONALE

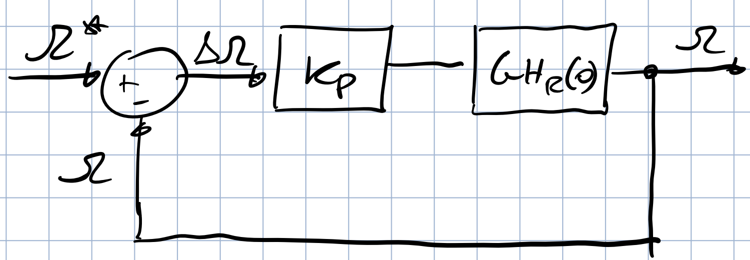
LIMITE PER STABILITÀ $\omega_{A\omega} \le \frac{1}{\tau_M}$

$$|GH(j\omega)| = |GH_R \cdot K_p| \cong K_p \frac{1}{\omega_{A\omega}} \frac{1}{\tau_m} \cdot \frac{1}{B}$$

$$|GH(j\omega)| = 1 = \frac{K_p}{\omega_{A\omega}\tau_m B} \Rightarrow K_p = B\tau_m\omega_{A\omega} = J\omega_{A\omega} \qquad \tau_m = \frac{J}{B}$$

Se scelgo $\omega_{A\omega} = \frac{1}{\tau_M}$ $\qquad K_p \le \boxed{J\frac{1}{\tau_M}}$

ERRORE A REGIME?



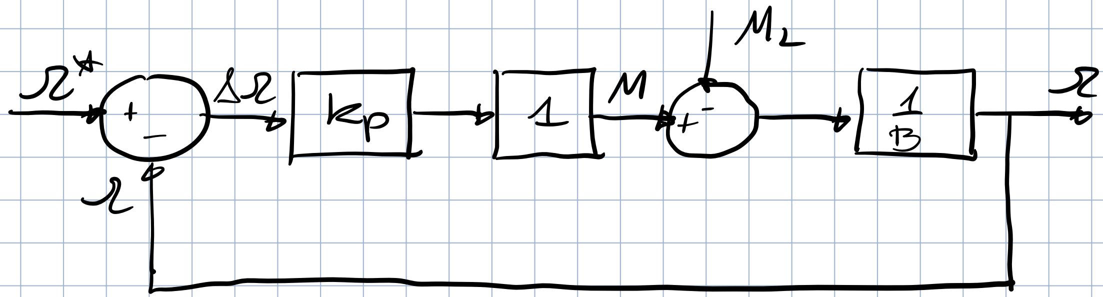
$t \to \infty \qquad s \to 0$

$$GH_R(s=0) = \frac{1}{B}$$

$$\Delta\Omega = \Omega^* - \Omega = \Omega^* - \Delta\Omega \frac{K_p}{B}$$

$$\Delta\Omega\left(1+\frac{k_p}{B}\right)=\Omega^* \qquad \Delta\Omega=\frac{\Omega^*}{1+\frac{k_p}{B}}=\frac{B\Omega^*}{B+k_p}$$

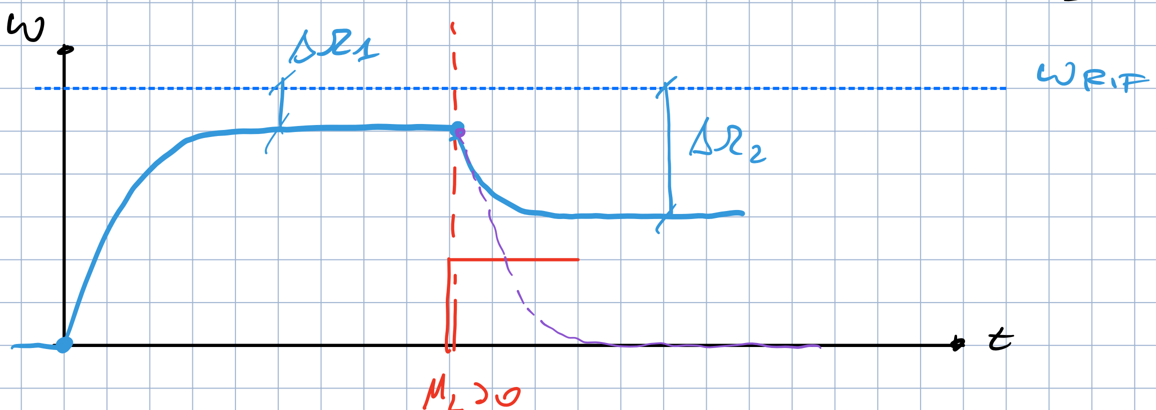
C'È ERRORE A REGIME ANCHE IN PRESENZA DI DISTURBO:



$$\Delta\Omega=\Omega^*-\Omega=\Omega^*-\left[\Delta\Omega\, k_p\frac{1}{B}-\frac{M_L}{B}\right]$$

$$=\Omega^*-\frac{\Delta\Omega\, k_p}{B}+\frac{M_L}{B}$$

$$\Delta\Omega\left(1+\frac{k_p}{B}\right)=\Omega^*+\frac{M_L}{B} \qquad \Delta\Omega=\frac{\Omega^*+\frac{M_L}{B}}{1+\frac{k_p}{B}}=\frac{B\Omega^*+M_L}{B+k_p}$$



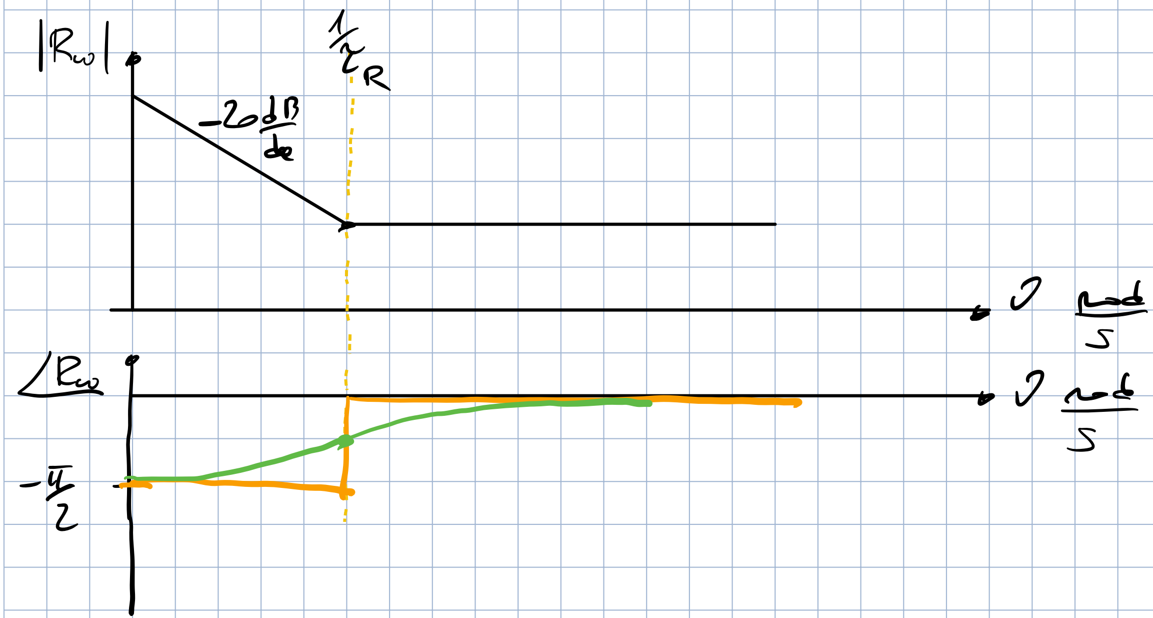
Impongo $\Delta\Omega=\Omega^*$

$$\Omega^*=\frac{B\Omega^*+M_L}{B+k_p} \qquad \ldots \quad M_L=\Omega^* k_p$$

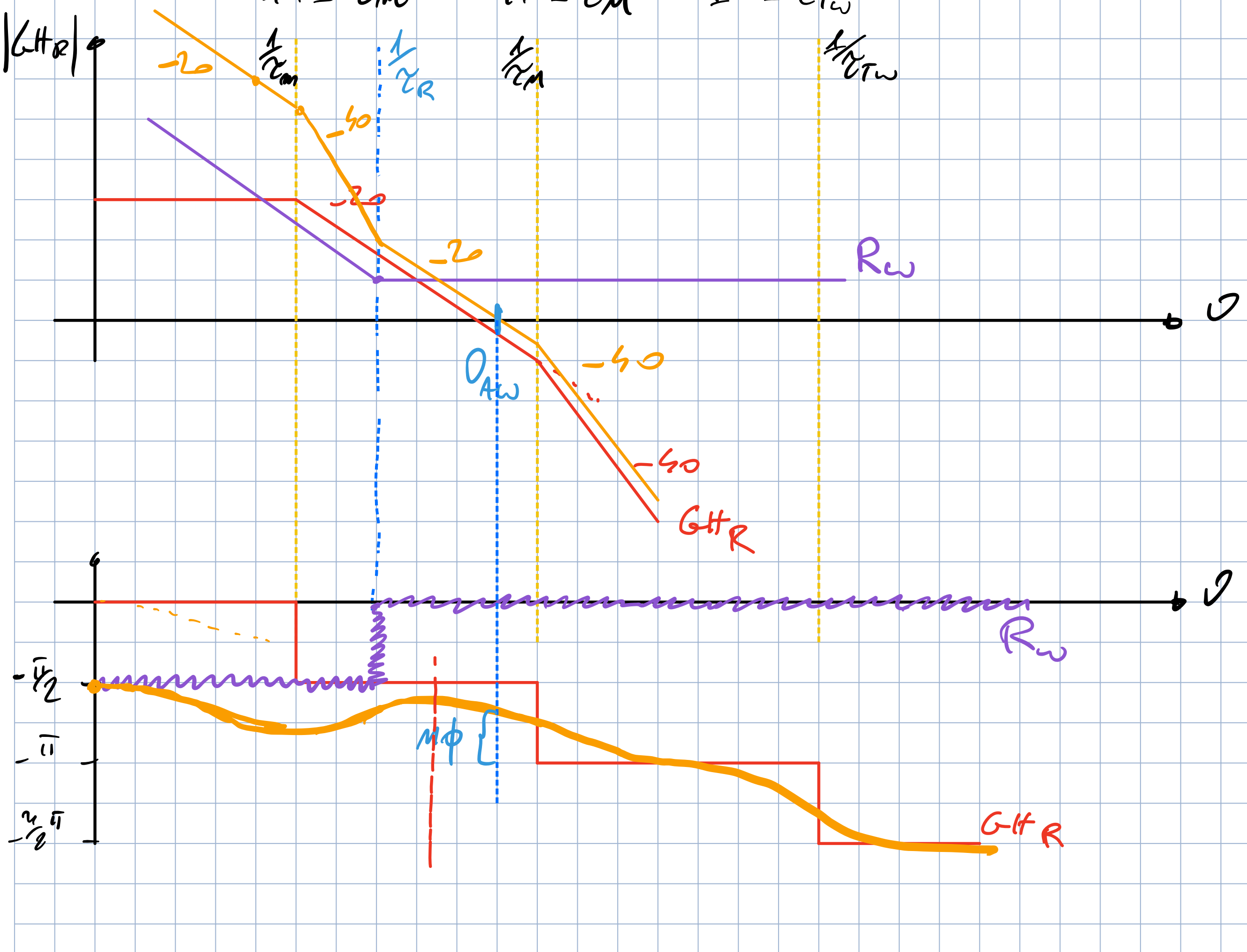
CONTROLLORE PI PER ELIMINARE ERRORE A REGIME

$$R_\omega = K_p + \frac{K_I}{s} = \frac{sK_p + K_I}{s} = K_I \, \frac{1+\frac{K_p}{K_I}s}{s} = K_I \, \frac{1+s\tau_R}{s}$$

$$\tau_R = \frac{K_p}{K_I}$$



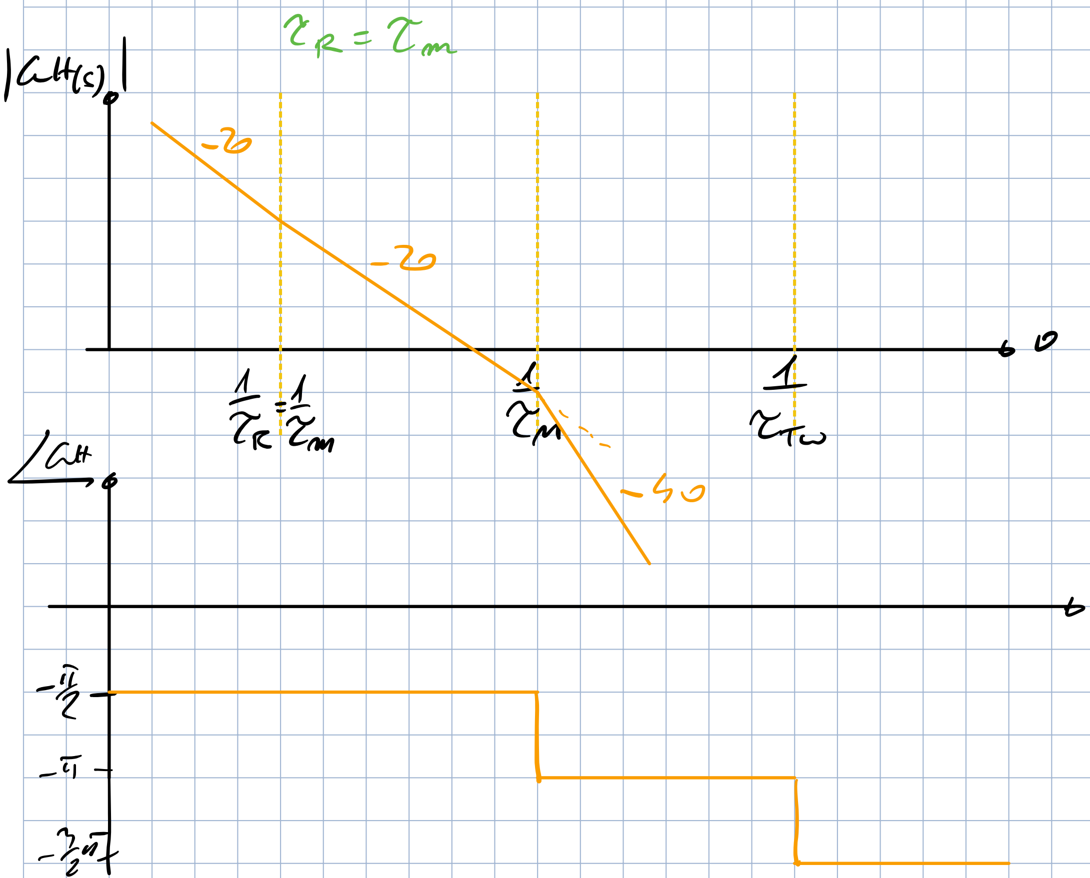
$$GH_R(s) = \frac{1/B}{1+s\tau_m} \cdot \frac{1}{1+s\tau_M} \cdot \frac{1}{1+s\tau_{T\omega}}$$



$$\omega_{A\omega} \le \frac{1}{\tau_M}$$

CANCELLAZIONE ZERO - POLO

$$GH(s) = \underbrace{K_I \, \frac{1+\cancel{s\tau_R}}{s}}_{R_\omega} \cdot \frac{1/B}{1+\cancel{s\tau_m}} \cdot \frac{1}{1+s\tau_M} \cdot \frac{1}{1+s\tau_{T\omega}}$$



Fissato $\tau_R = \frac{K_P}{K_I} = \tau_m$

Posso calcolare K_I scegliendo banda passante $\omega_{A\omega}$

$$|GH(\omega_{A\omega})| = 1$$

$$\omega_{A\omega} = \frac{1}{\tau_M}$$

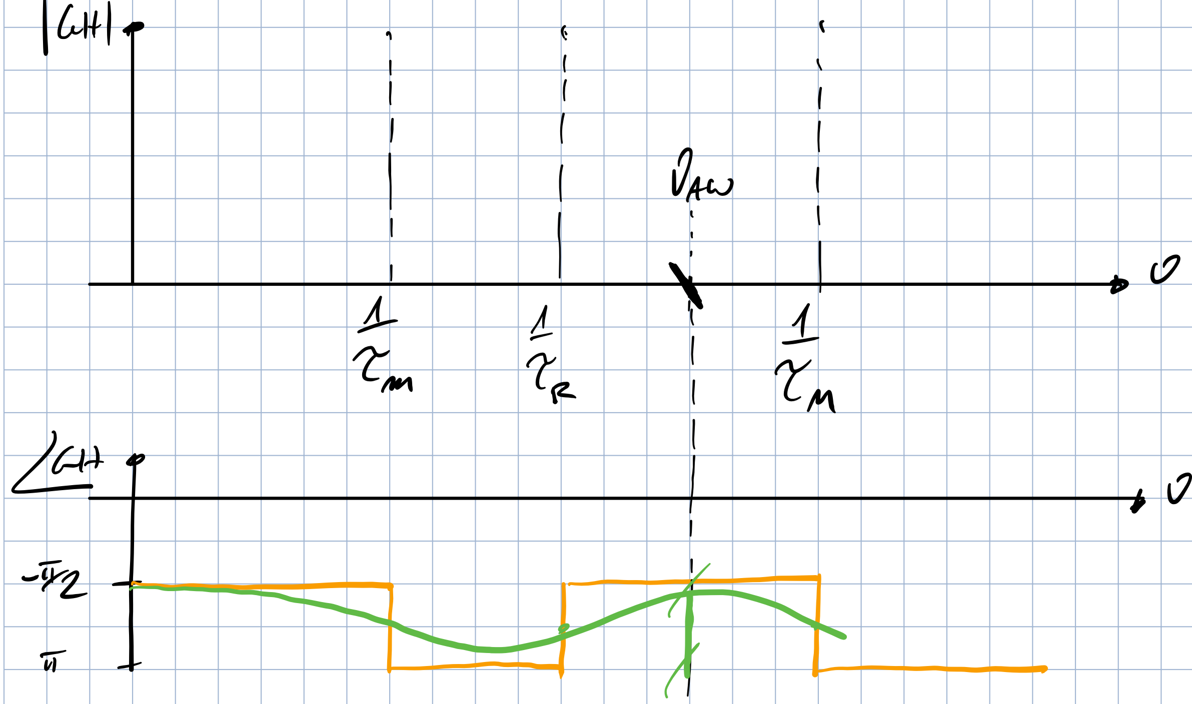
$$K_I = \frac{\sqrt{2}\,B}{\tau_M}$$

$$K_P = K_I \, \tau_R$$

OTTIMO SIMMETRICO

Scelgo τ_R in modo che M_ϕ sia più alto possibile

$$\nu_{AW} = a\frac{1}{\tau_R} \qquad a\nu_{AW} = \frac{1}{\tau_M} \qquad \text{cioè} \qquad \nu_{AW} = \sqrt{\frac{1}{\tau_R}\frac{1}{\tau_M}}$$



Valori di $a \in [2, 4]$