Diag. Bloques

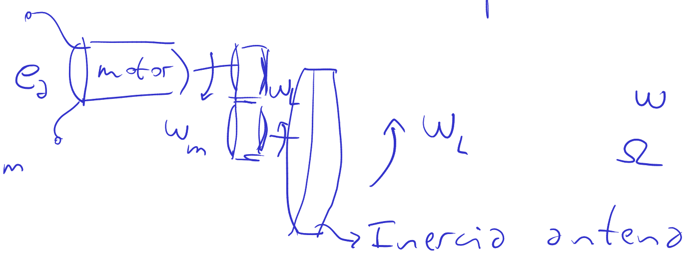
Manera gráfica de expresar ecs.

1.1 Actividad 4.1

Se desea controlar la posición angular de una antena. Para ello, se ha implementado un control proporcional-integral a lazo cerrado.

Obtenga la respuesta a lazo cerrado considerando $k_p = k_i = 1$

Ecuaciones de la antena



(1) $L_a \dfrac{di_a}{dt} + R_a i_a = e_a - e_b$

(2) $e_b = k_b \omega_m$

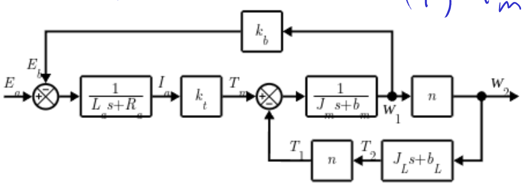
(3) $T_m - T_1 - b_m \omega_m = J_m \dot{\omega}_m$

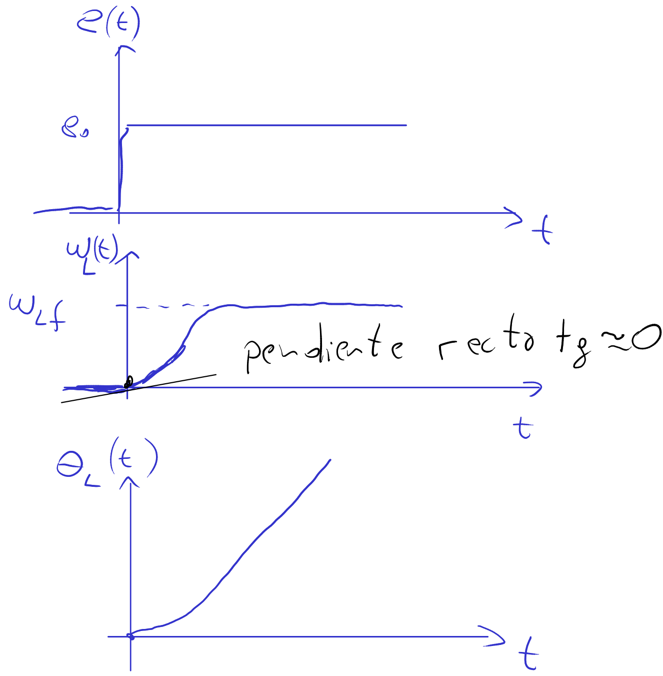
(4) $T_2 - b_L \omega_L = J_L \dot{\omega}_L$

(5) $\omega_L = n\omega_m$

(6) $nT_2 = T_1$

(7) $T_m = k_t i_a$





$$G(s) = \frac{\Theta(s)}{E_a(s)} = \frac{1}{s}\frac{nk_t}{(L_a s + R)(J_{eq}s + b_{eq}) + k_t k_b}$$

Suponiendo que un controlador PI tiene una función transferencia $G_{PI}(s)$, a lazo cerrado la función transferencia total puede hallarse así:

$$M(s) = \frac{\Theta(s)}{R(s)} = \frac{G_{PI}(s)G(s)}{1 + G_{PI}(s)G(s)}$$

La función transferencia del controlador se define como

$$G_{PI}(s) = k_p + \frac{k_i}{s} = \frac{k_p s + k_i}{s}$$

$\mathcal{L} \rightarrow$

(1) $L_a s I_a + R_a I_a = E_a - E_b$

(2) $E_b = k_b \Omega_m$

(3) $T_m - T_1 - b_m \Omega_m = J_m s \Omega_m$

(4) $T_2 - b_L \Omega_L = J_L s \Omega_L$

(5) $\Omega_L = n \Omega_m$

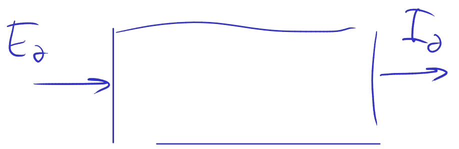
(6) $nT_2 = T_1$

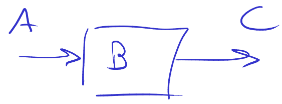
(7) $T_m = k_t I_a$

(1) Despejo I_a :

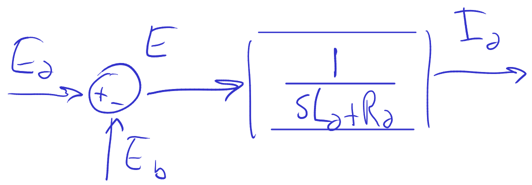
$$(sL_a + R_a)\, I_a = E_a - E_b$$

$$I_a = \frac{1}{sL_a + R_a} \underbrace{(E_a - E_b)}_{E}$$

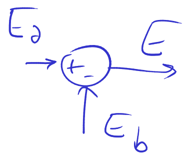




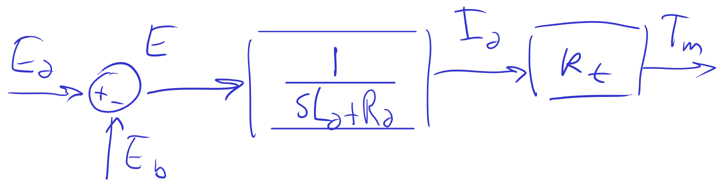
$A \cdot B = C$



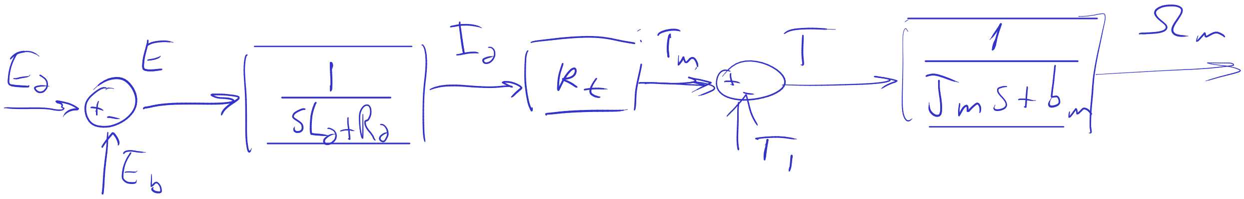
$E = E_a - E_b$



¿Qué ecuación uso? 7 (es la única que tiene I_a)



¿Y ahora? 3 (es la que tiene T_m, y elijo)



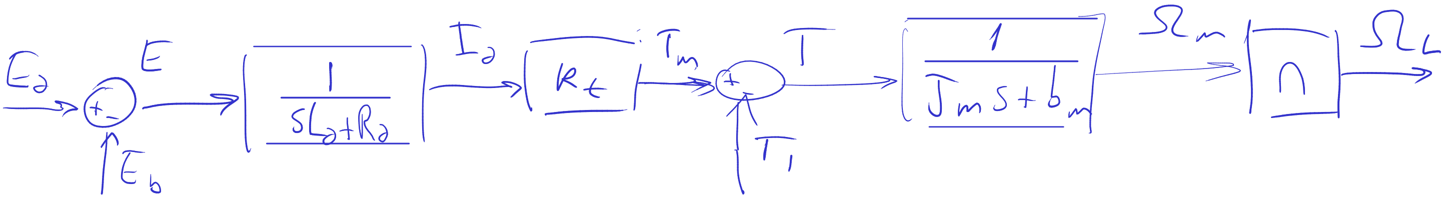
$$T_m - T_1 = (J_m s + b_m)\, \Omega_m$$

$$\Omega_m = \frac{1}{J_m s + b_m} \underbrace{(T_m - T_1)}_{T}$$

¿Y... ahora? Hay llegar a Ω_L

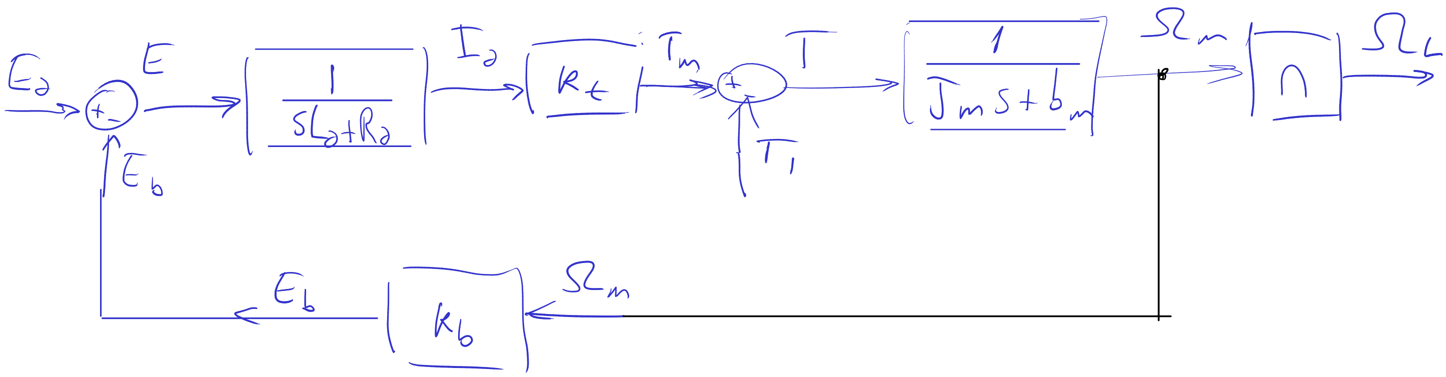
Ec 5

$$\Omega_L = n\, \Omega_m$$

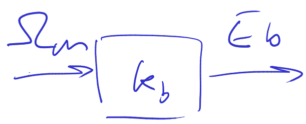


Cerrar lazos

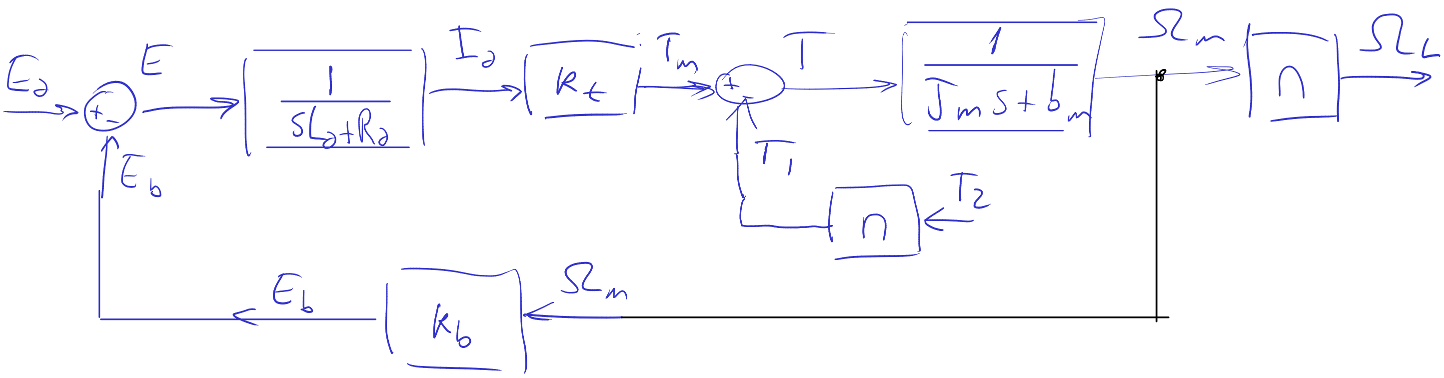
$E_b \longrightarrow$ Ec 2



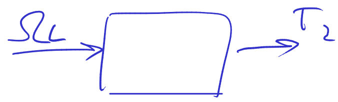
$$E_b = k_b \Omega_m$$



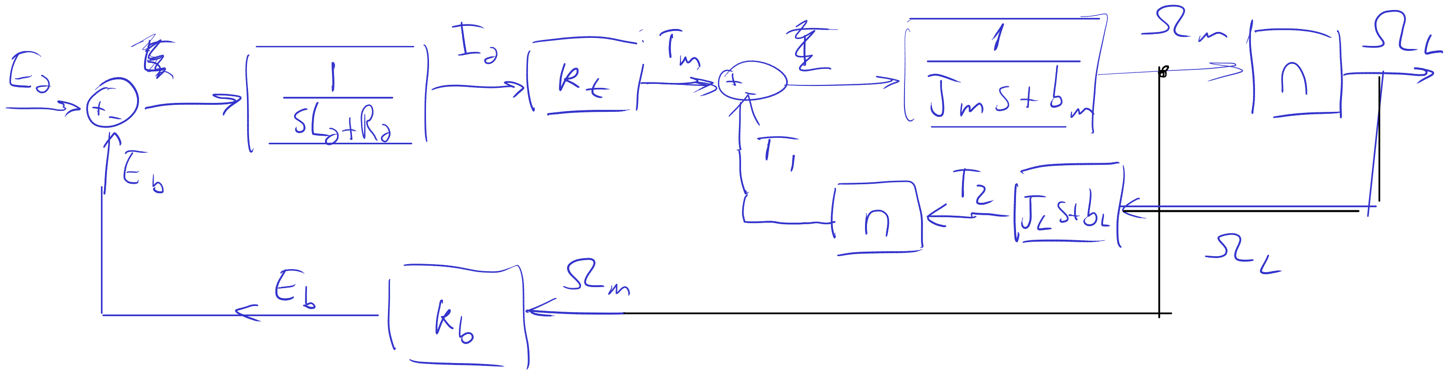
Sigo cerrando lazos ¿T_1? Ec 6 $\quad nT_2 = T_1$

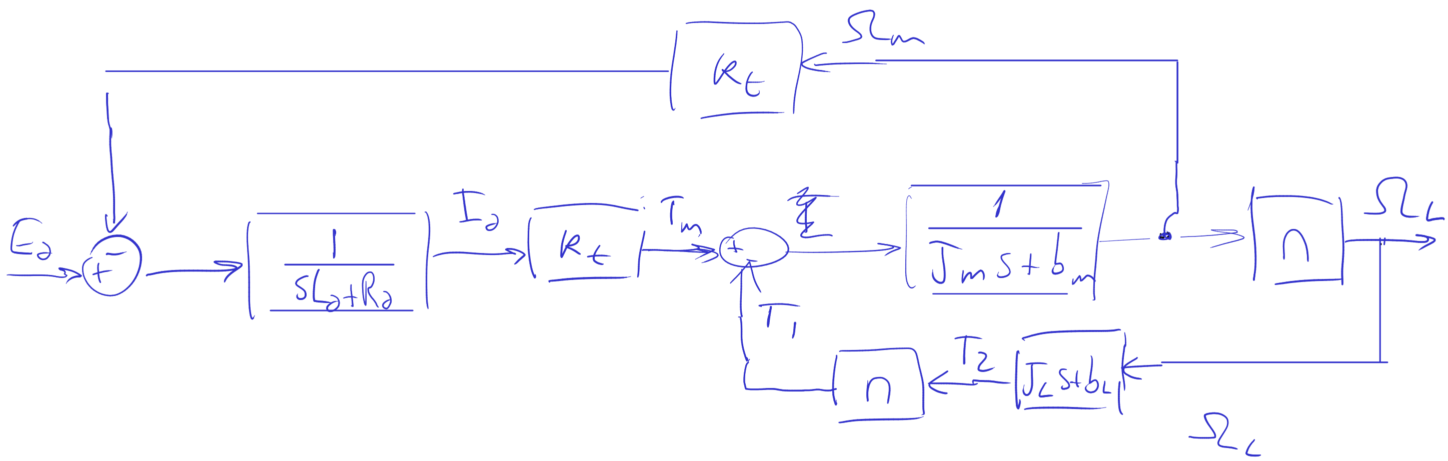


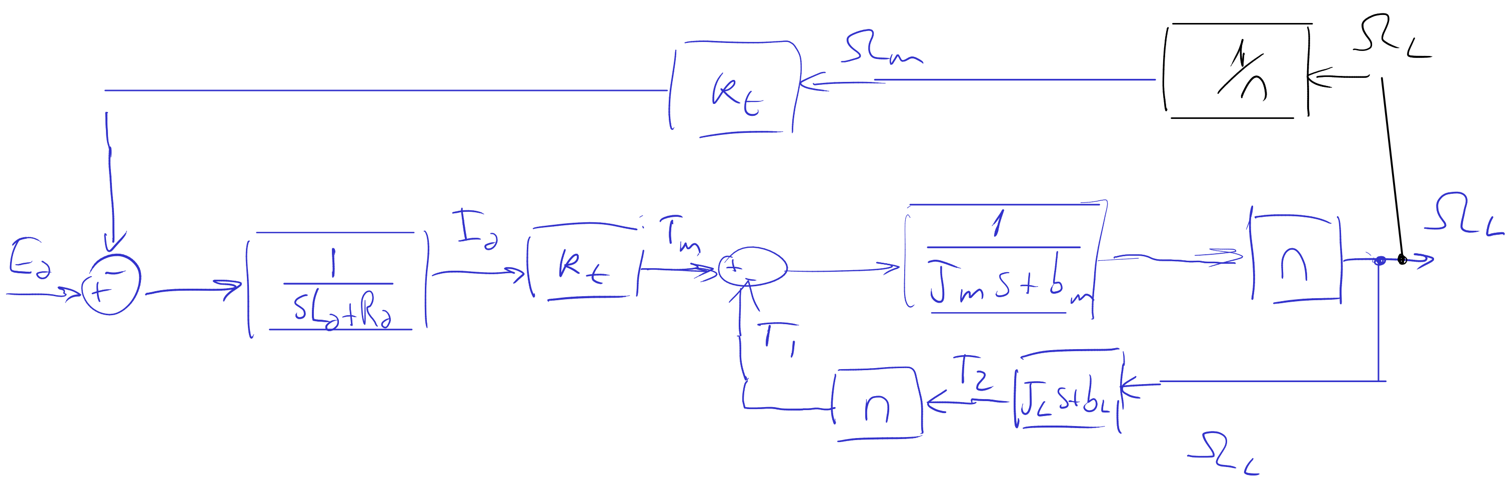
Uso última ecuación 4 $\longrightarrow$ $T_2 - b_L \Omega_L = J_L s \Omega_L$



$$T_2 = \Omega_L (J_L s + b_L)$$



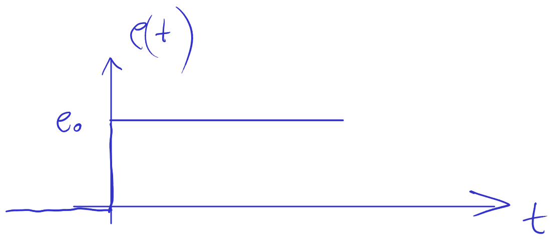


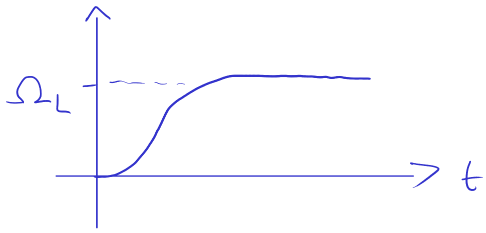


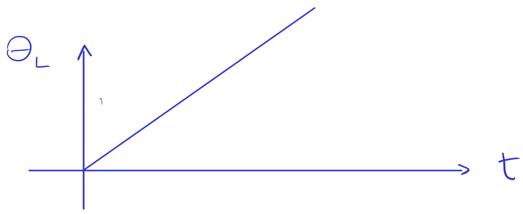
$$G(s) = \frac{\Theta(s)}{E_a(s)} = \frac{1}{s}\frac{nk_t}{[(L_a s + R)(J_{eq}s + b_{eq}) + k_t k_b]}$$

Respuesta temporal $G(s)$

$s = tf("s")$ permite usar s como una cte más

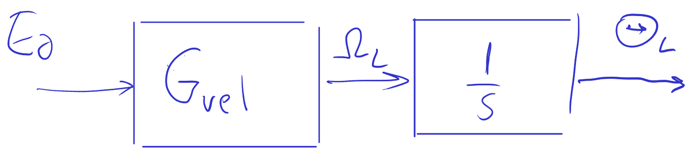






Derivar → S

Integrar → $\frac{1}{S}$



$$G(s)=\frac{\Theta(s)}{E_a(s)}=\frac{1}{s}\underbrace{\left[\frac{nk_t}{(L_a s+R)(J_{eq}s+b_{eq})+k_tk_b}\right]}_{\Omega_L}$$

velc → $\Omega_L = \frac{nk_t}{(sL_a+R_a)(\quad)+k_tk_b}\cdot E_a$

$$\Theta_L = \frac{1}{s}\underbrace{\left(\frac{nk_t}{(sL_a+R_a)(\quad)+k_tk_b}\cdot E_a\right)}_{\Omega_L}$$

$$\Theta_L = \frac{1}{s}\left(\frac{n k_t}{(sL_a+R_a)(\quad)+k_t k_b}\cdot E_a\right)$$

$$\Omega_L = \Theta_L \cdot s = \cancel{s}\left[\frac{1}{\cancel{s}}\left(\frac{n k_t}{(sL_a+R_a)(\quad)+k_t k_b}\cdot E_a\right)\right]$$