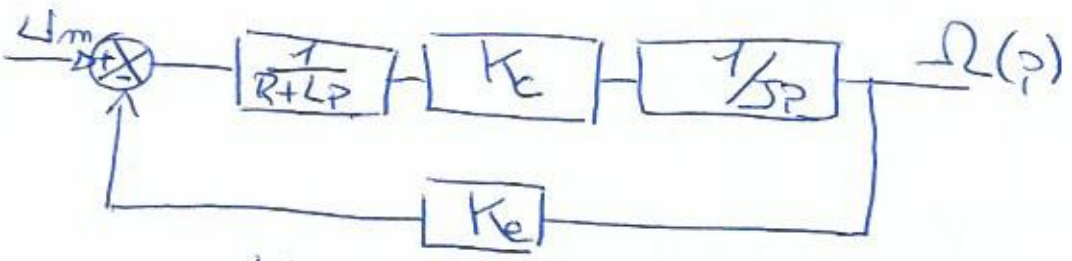
1. $U_m(p) + E_m(p) = (R + Lp) I_m(p)$

$E_m(p) = K_e \Omega_m(p)$

$J_m \times p \times \Omega_m(p) = C_m(p)$

$C_m(p) = K_c I_m(p)$

2.



3. $$H(p) = \frac{\frac{K_c}{Jp(R+Lp)}}{1 + \frac{K_c K_e}{Jp(R+Lp)}} = \frac{K_c}{K_c K_e + Jp(R+Lp)}$$

$$= \frac{\frac{1}{K_e}}{1 + \frac{JR}{K_c K_e} p + \frac{JL}{K_c K_e} p^2}$$

4. $K = 1/K_e$

$$\frac{1}{\omega_0^2} = \frac{JL}{K_c K_e} \Rightarrow \omega_0 = \sqrt{\frac{K_c K_e}{JL}}$$

$$\frac{2z}{\omega_0} = \frac{JL}{K_c K_e} \Rightarrow z = 2 \frac{JL}{K_c K_e} \times \sqrt{\frac{K_c K_e}{JL}} = 2\sqrt{\frac{J}{K_c K_e} \times L}$$

5. $$H(p) = \frac{K}{(1+\tau_e p)(1+\tau_m p)} = \frac{K}{1 + (\tau_e + \tau_m) p + \tau_1 \tau_e p^2}$$

$$(\tau_e + \tau_m) = \frac{JR}{K_c K_e}$$

$$\tau_e \tau_m = \frac{JL}{K_c K_e}$$

6. $\tau_e \ll \tau_m \Rightarrow \tau_e + \tau_m \simeq \tau_m$

$\tau_e \tau_m \simeq 0$

$$\Rightarrow H = \frac{K}{1 + \tau_m p}$$

7. $\omega_m(+\infty) = \lim_{t \to \infty} \omega_m(t)$

$= \lim_{p \to 0} p\,\Omega_m(p)$

$= \lim_{p \to 0} p\,H(p) \times E(p)$

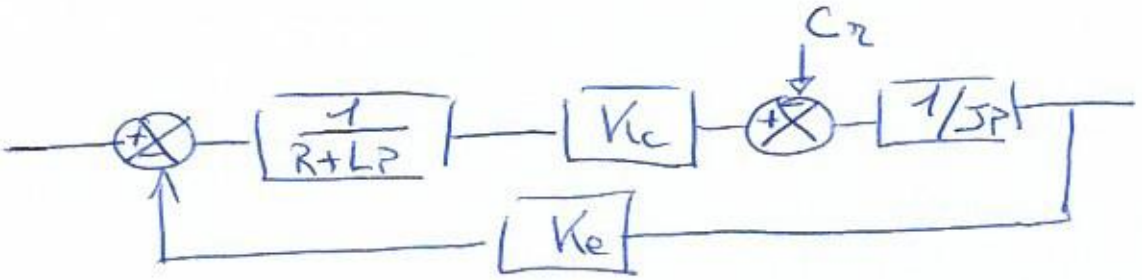
$= \lim_{p \to 0} \frac{18}{p} \times p \times H(p) = \lim_{p \to 0} 18 \times H(p)$

$= 18 \times K$

8. $\omega_m(+\infty) = 18 \times K = 18 \times 45 \text{ rad.s}^{-1}$

$= \frac{18 \times 45}{60 \times 2\pi}$

9.



10. $F_1(p) = \frac{K}{1 + \tau_m p}$

$F_2(p) = \frac{1/Jp}{1 + \frac{K_c K_e}{Jp(R+Lp)}}$

11 On veut ~~$F(p) \times I(p)$~~

$B(p) \cup(p) - C_r(p) = \frac{\Omega_m}{F(p)}$

D'après 10 : $\Omega_m(p) = F_1(p) \cup(p) - F_2(p) C_r(p)$

$\frac{\Omega_m(p)}{F_2(p)} = \frac{F_1(p)}{F_2(p)} \cup(p) - C_r(p)$

$B(p) = \frac{F_1(p)}{F_2(p)}$ et $F(p) = \frac{1}{F_2(p)}$

12. $H(p) = \frac{1}{p}$ car $\theta_a = \int \omega_a(t)\,dt$

$G(p) = \frac{1}{N}$ car $\frac{\omega_a}{\omega_m} = \frac{1}{N}$

13 $H_a(p) = \dfrac{K_a \times \frac{K}{1+\tau_m p} * \frac{1}{N} \times \frac{1}{p}}{1 + \frac{K_a K}{N p (1+\tau_m p)}}$

$= \dfrac{K_a K}{N p (1+\tau_m p) + K_a K}$

14 $\varepsilon = \lim_{t \to \infty} (e(t) - s(t)) = \lim_{p \to 0} p(E(p) - S(p))$

$= \lim_{p \to 0} \frac{E_0}{p} \times p(1 - H(p))$

$= \lim_{p \to 0} E_0 \left(1 - \frac{K_a K}{K_a K + N p (1+\tau_m p)}\right)$

$= E_0 \left(1 - \frac{K_a K}{K_a K}\right) = 0$