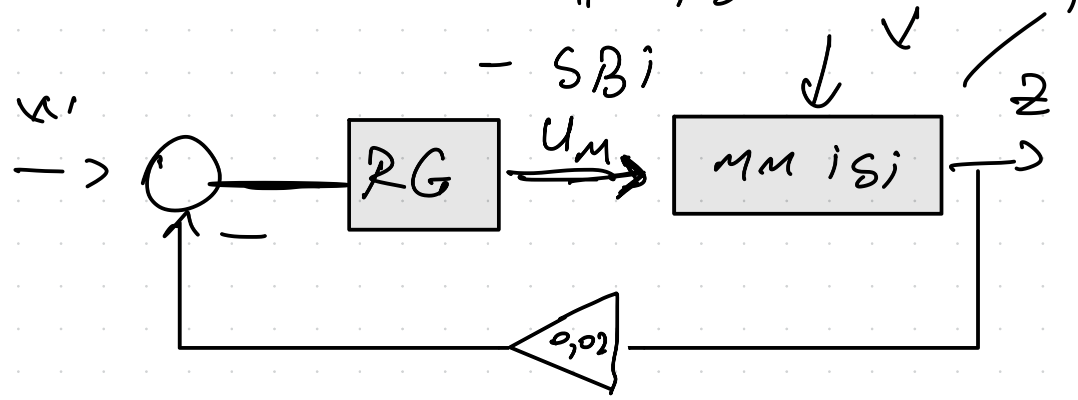
(1) $H_{zw}(s)$ $\quad H_{zv}(s) = ?$

(2) - 3 structuri
- mm ii
- mm isi
- SBi

$\rightarrow A, B, C, D$




$w(t) = 5\sigma(t)$ — Step 0, Final 5

$v(t) = 1\sigma(t-25)$ — Step 25, Final 1

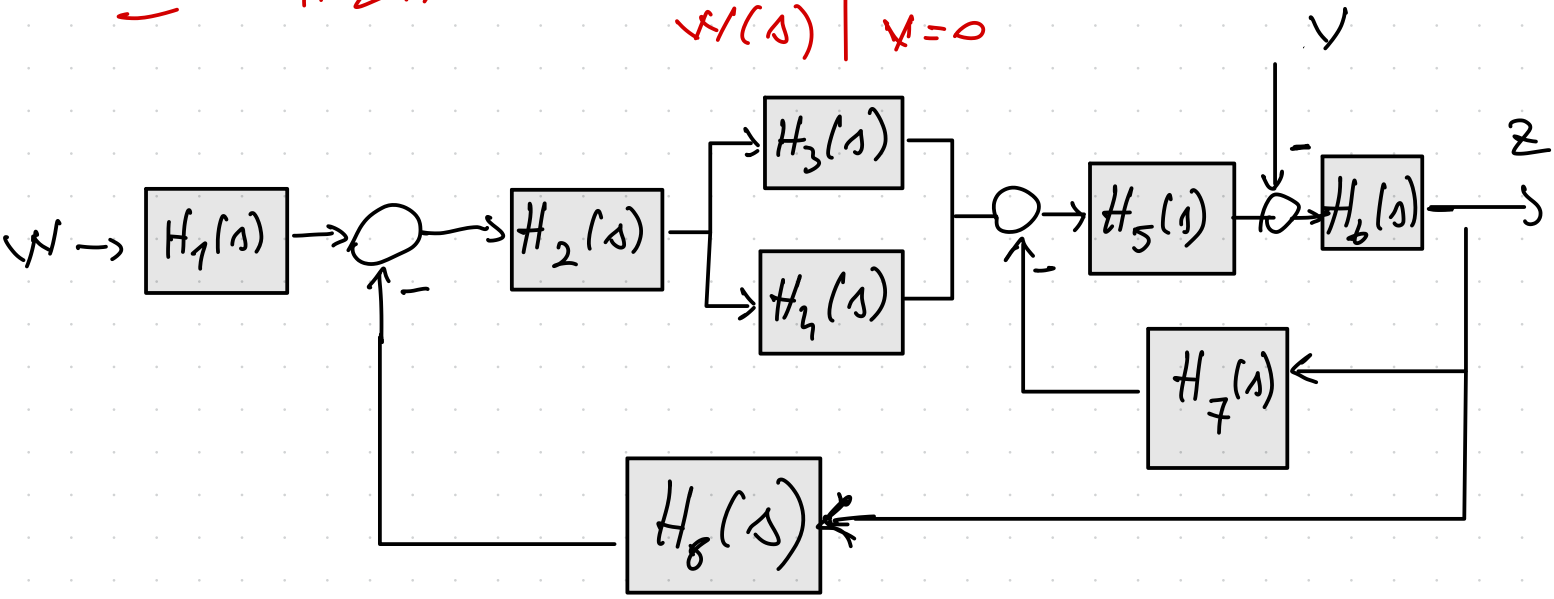
Total 50

$Y(s) = H(s) \cdot U(s)$

ieșire

intrare

I $\quad H_{zw}(s) = \left.\dfrac{Z(s)}{W(s)}\right|_{v=0}$




$$H_1(s) = \frac{1}{s/2+1}$$

$$H_{34}(s) = H_3(s) + H_4(s) = 25$$

$$H_2(s) = \frac{5(s+1)}{s}$$

$$H_3(s) = 10$$

$$H_4(s) = 15$$

$$H_5(s) = \frac{0{,}08}{0{,}05s+1} = \frac{\frac{8}{\cancel{100}}}{\frac{5s+100}{\cancel{100}}} = \frac{8}{5s+100}$$

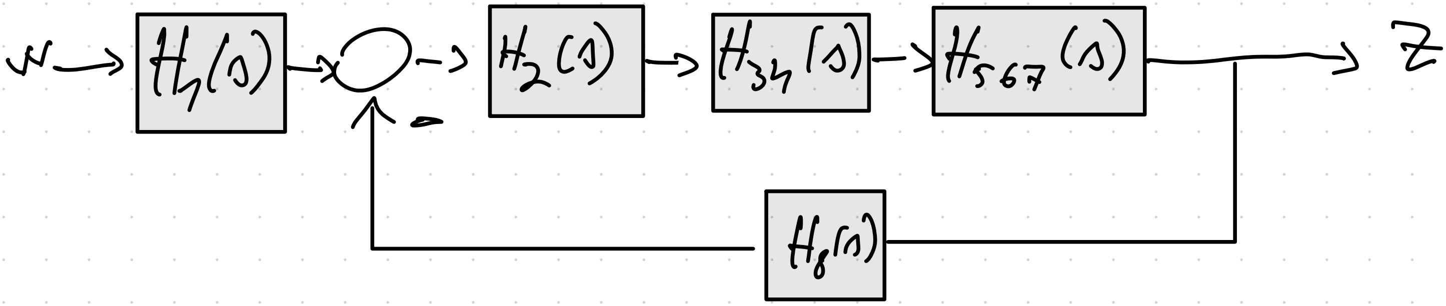
$$H_6(s) = \frac{10}{s}$$

$$H_7(s) = 0{,}8$$

$$H_8(s) = 0{,}02$$

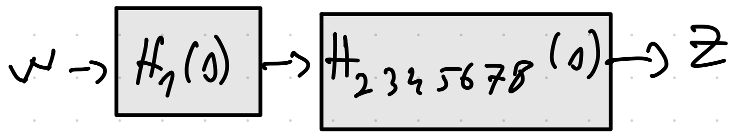
$$H_{567}(s) = \frac{H_5(s)\cdot H_6(s)}{1+H_5(s)H_6(s)H_7(s)} = \frac{\frac{8}{5s+100}\cdot\frac{10}{s}}{1+\frac{8}{5s+100}\cdot\frac{\cancel{10}}{s}\cdot\frac{8}{\cancel{10}}} =$$

$$= \frac{80}{\cancel{s(5s+100)}} \cdot \frac{1}{\frac{s(5s+100)+64}{\cancel{s(5s+100)}}} = \frac{80}{s(5s+100)+64}$$



$$H_{234567}(s) = H_2(s)\cdot H_{34}(s)\cdot H_{567}(s) = \frac{s\,5(s+1)}{s}\cdot 25\cdot \frac{80}{s(5s+100)+64}$$

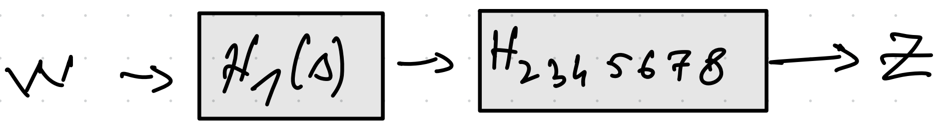
$$= \frac{s\,5(s+1)\cdot 2000}{s^2(5s+100)+64s}$$



$$H_{2345678}(s) = \frac{H_{234567}(s)}{1+H_8(s)\cdot H_{234567}(s)} =$$

$$= \frac{\frac{s\,5(s+1)\cdot 2000}{s^2(5s+1)+64s}}{1+\frac{s\,5(s+1)\cdot 2000}{s^2\,5(s+1)+64s}\cdot\frac{2}{\cancel{100}}} = \frac{\frac{\cancel{s}\,5(s+1)\cdot 2000}{\cancel{s^2(5s+1)+64s}}}{\frac{s^{\cancel{2}}\,5(s+1)+64\cancel{s}+\cancel{s}\,5(s+1)\cdot 40}{\cancel{s^2\,5(s+1)+64s}}}$$

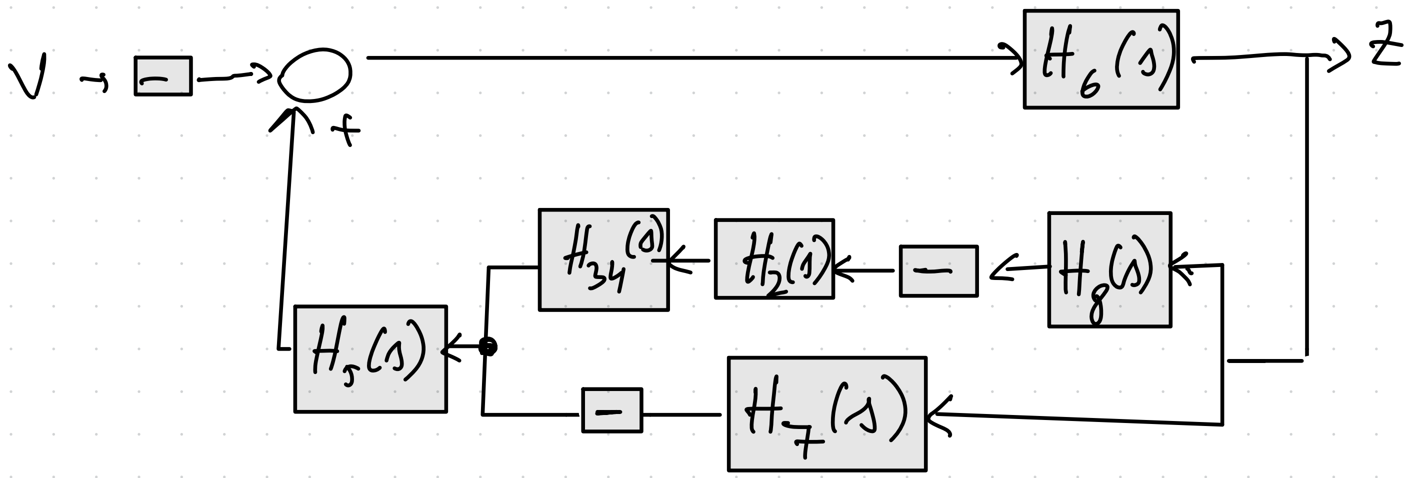
$$= \frac{2000\cdot 5(s+1)}{s\cdot 5(s+1)+64+40\cdot 5(s+1)} = \frac{10000(s+1)}{5(s+1)(s+40)+64}$$



$$H_{ZW}(s) = H_1(s)\cdot H_{2345678}(s)$$

$$= \frac{1}{s/2+1}\cdot\frac{10000\cdot(s+1)}{5(s+1)(s+40)+64}$$

$$\text{II} \quad H_{ZV}(s) = \left.\frac{Z(s)}{V(s)}\right|_{X_1=0}$$




$$H_{23478}(s) = -\left[H_2(s)\cdot H_{34}(s)\cdot H_8(s)\right] + \left[-H_7(s)\right] =$$

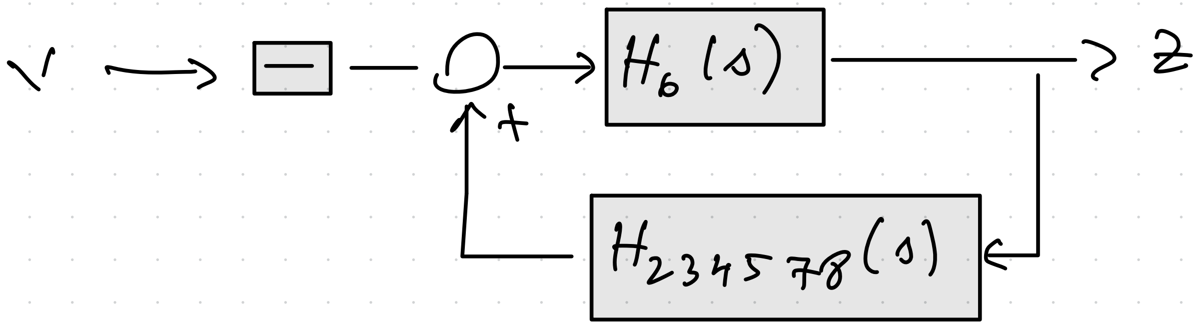
$$= -\left[H_2(s)\cdot H_{34}(s)\cdot H_8(s) + H_7(s)\right]$$

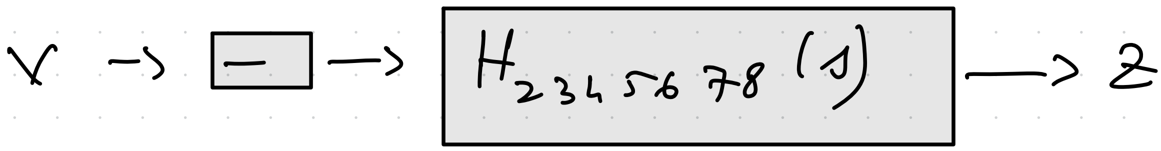
$$= -\left[\frac{\cancel{5}(s+1)}{s}\cdot 25\cdot\frac{\cancel{2}}{1\cancel{00}} + \frac{8}{10}\right] = -\frac{25(s+1)+8s}{10s} =$$

$$= -\frac{33s+25}{10s}$$

$$H_{234578}(s) = H_5(s)\cdot H_{23478}(s) = \frac{8}{5s+100}\cdot -\frac{33s+25}{10s}$$

$$= -\frac{264s+200}{50s^2+1000s}$$




$$H_{2345678}(s) = \frac{H_6(s)}{1 - H_6(s)H_{234578}(s)} =$$

$$= \frac{\frac{10}{s}}{1 - \frac{10}{s}\cdot\left(-\frac{264s+200}{50s^2+1000s}\right)} =$$

$$= \frac{\frac{10}{s}}{1 + \frac{2640s+2000}{50s^3+1000s^2}} = \frac{\frac{10}{s}}{\frac{50s^3+1000s^2+2640s+2000}{50s^3+1000s^2}}$$

$$= \frac{50\cancel{0}s^{\cancel{3}\,2}+1000\cancel{0}s^{\cancel{2}}}{\cancel{s}(5\cancel{0}s^3+100\cancel{0}s^2+264\cancel{0}s+200\cancel{0})} \Rightarrow$$

$$H_{zv}(s) = -H_{2345678}(s)$$

$$= -\frac{50s^2+1000s}{5s^3+100s^2+264s+200}$$

$$H_{zw}(s) = \frac{1}{s/2+1} \cdot \frac{10000 \cdot (s+1)}{5(s+1)(s+40)+64}$$

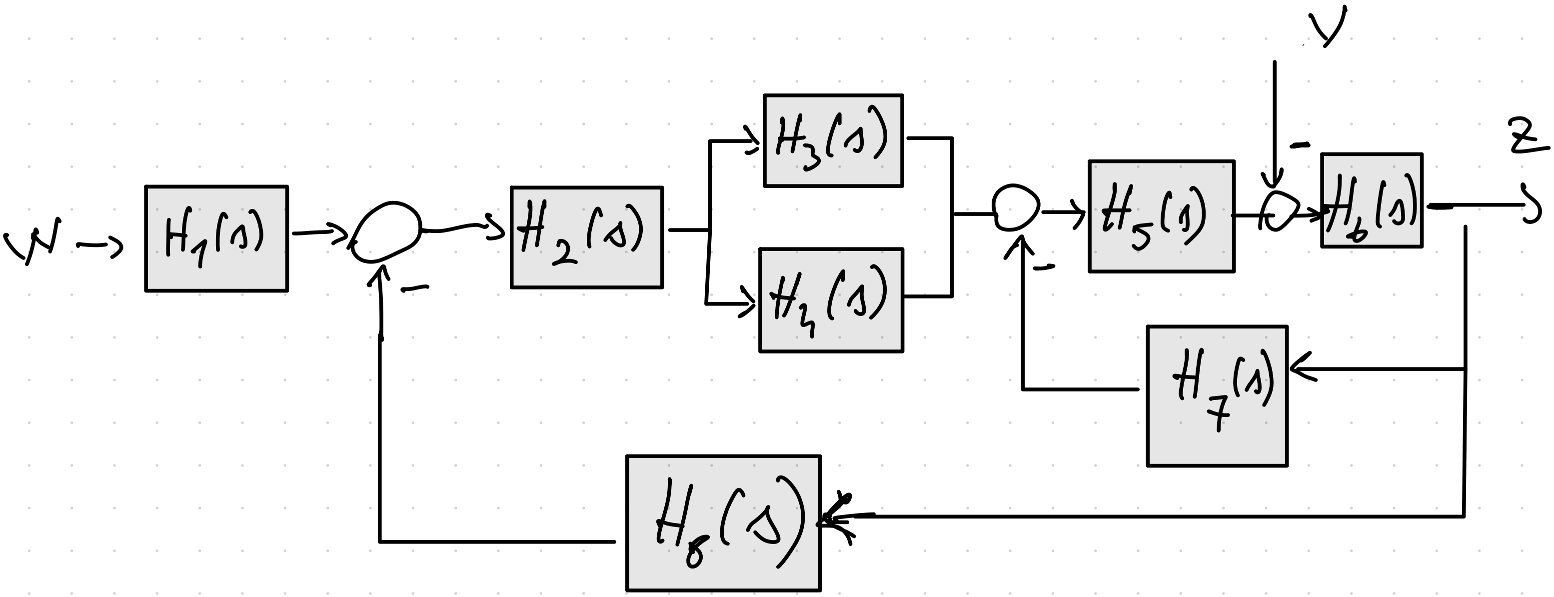
$$(\,) = 10000\,s + 10000$$

$$5(s+1)(s+40)+64 = 5(s^2+41s+40)+64 =$$
$$= 5s^2+205s+264$$

$$(s/2+1)(5s^2+205s+264) =$$
$$= 5s^3/2 + 205s^2/2 + 132s + 5s^2 + 205s + 264$$
$$= 5/2 \cdot s^3 + (205/2 + 5)s^2 + 337s + 264$$
$$= 2.5 \cdot s^3 + 107.5s^2 + 337s + 264$$

$$H_{zw}(s) = \frac{10000\,s + 10000}{2.5\,s^3 + 107.5\,s^2 + 337\,s + 264}$$

$$H_{zv}(s) = -\frac{50\,s^2 + 1000\,s}{5s^3 + 100s^2 + 264\,s + 200}$$




$$H_1(s) = \frac{2}{s+2} = \frac{k_w}{s \cdot T_w + 1}$$

$$H_2(s) = \frac{k_R \cdot T_n \cdot s + k_R}{T_n \cdot s} = \frac{5s+5}{s}$$

$$H_3(s) = k_{E1} = 10$$

$$H_4(s) = k_{E2} = 15$$

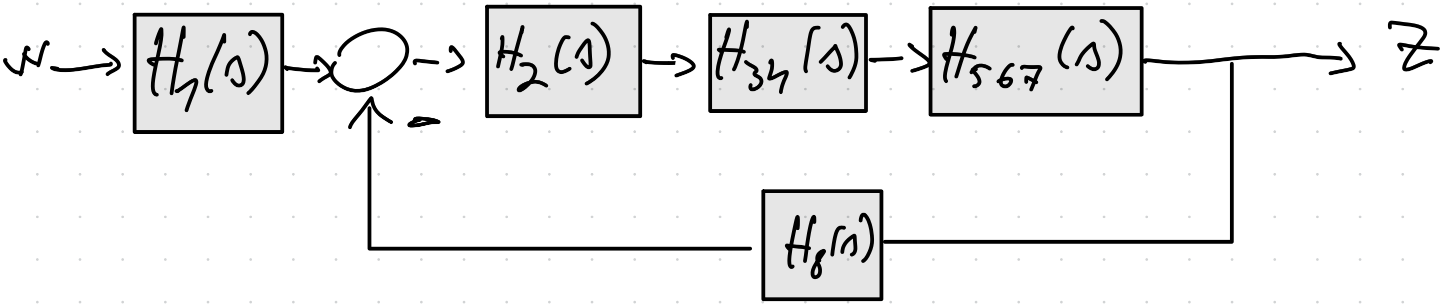
$$H_5(s) = \frac{k_1}{T_1 \cdot s + 1} = \frac{0{,}08}{0{,}05 s + 1}$$

$$H_6(s) = \frac{1/T_i}{s} = \frac{1}{T_i \cdot s}$$

$$H_7(s) = 0{,}8 \quad (K_{em})$$

$$H_8(s) = 0{,}02 \quad (K_{EM})$$

I $\quad H_{zw}(s) = \left. \dfrac{Z(s)}{W(s)} \right|_{v=0}$




$$H_{234567}(s) = H_2(s) \cdot H_{34}(s) \cdot H_{567}(s)$$

$$H_{34}(s) = H_3(s) + H_4(s)$$

$$H_{567}(s) = \frac{H_5(s) \cdot H_6(s)}{1 + H_5(s) H_6(s) H_7(s)}$$

$$H_{2345678}(s) = \frac{H_{234567}(s)}{1 + H_{234567}(s)\, H_8(s)}$$

$$H_{zw}(s) = H_1(s) \cdot H_{2345678}(s) =$$

$$= \frac{H_1(s) \cdot H_{234567}(s)}{1 + H_{234567}(s) H_8(s)} =$$

$$= \frac{\dfrac{H_1(s) \cdot H_2(s) \left[ H_3(s) + H_4(s) \right] H_5(s) H_6(s)}{1 + H_5(s)\, H_6(s)\, H_7(s)}}{1 + \dfrac{H_2(s) \left[ H_3(s) + H_4(s) \right] H_5(s) H_6(s)}{1 + H_5(s)\, H_6(s)\, H_7(s)} \cdot H_8(s)}$$

$$= \frac{\dfrac{H_1(s)\cdot H_2(s)\left[H_3(s)+H_4(s)\right]H_5(s)H_6(s)}{1+H_5(s)\,H_6(s)\,H_7(s)}}{1+\dfrac{H_2(s)\left[H_3(s)+H_4(s)\right]H_5(s)H_6(s)}{1+H_5(s)\,H_6(s)\,H_7(s)}\cdot H_8(s)}$$

$$= \frac{\dfrac{H_1(s)\cdot H_2(s)\left[H_3(s)+H_4(s)\right]H_5(s)H_6(s)}{\cancel{1+H_5(s)\,H_6(s)\,H_7(s)}}}{\dfrac{1+H_5(s)\,H_6(s)H_7(s)+H_2(s)\left[H_3(s)+H_4(s)\right]H_5(s)H_6(s)\,H_8(s)}{\cancel{1+H_5(s)\,H_6(s)\,H_7(s)}}}$$

$$H_{ZW}(s)=\frac{H_1(s)\,H_2(s)\left[H_3(s)+H_4(s)\right]\,H_5(s)\,H_6(s)}{1+H_5(s)\,H_6(s)\,H_7(s)+H_2(s)\left[H_3(s)+H_4(s)\right]H_5(s)\,H_6(s)\,H_8(s)}$$

$$H_3(s)+H_4(s)=25$$

$$H_5(s)\cdot H_6(s)=\frac{\dfrac{8}{\cancel{100}}}{\dfrac{5s+100}{\cancel{100}}}\cdot\frac{1}{T_i\cdot s}=\frac{8}{5T_i\cdot s^2+100\cdot T_i\cdot s}$$

$$H_2(s)\cdot H_{56}(s)=\frac{kR\cdot T_2 s+kR}{T_2\cdot s}\cdot\frac{8}{5T_i\,s^2+100\,T_i\,s}=$$

$$=\frac{8\,kR\cdot T_2\cdot s+8\,kR}{5T_iT_2\,s^3+100\,T_iT_R\,s^2}$$

$$H_{56}(s) \cdot H_7(s) = \frac{8}{5T_i s^2 + 100 T_i s} \cdot \frac{8}{10} = \frac{64}{50 T_i s^2 + 1000 T_i s}$$

$$H_{zur}(s) = \frac{H_1(s) \; H_{256}(s) \; H_{34}(s)}{1 + H_{567}(s) + H_{256}(s) H_{34}(s) H_8(s)}$$

$$\underbrace{H_{256}(s) \cdot H_{34}(s)}_{25} = \frac{5 \cdot 40 kR T_2 s + 5 \cdot 40 kR}{5 T_i T_2 s^3 + 100 T_i T_R s^2} =$$

$$= \frac{40 kR T_2 s + 40 kR}{T_i T_2 s^3 + 20 T_i T_R s^2}$$

$$H_{zv1}(s) = \frac{\frac{2}{s+2} \cdot \frac{40 kR T_2 s + 40 kR}{T_i T_2 s^3 + 20 T_i T_2 s^2}}{1 + \frac{64}{50 T_i s^2 + 1000 T_i s} + \frac{40 kR T_2 s + 40 kR}{T_i T_2 s^3 + 20 T_i T_2 s^2} \cdot \frac{2}{100}}$$

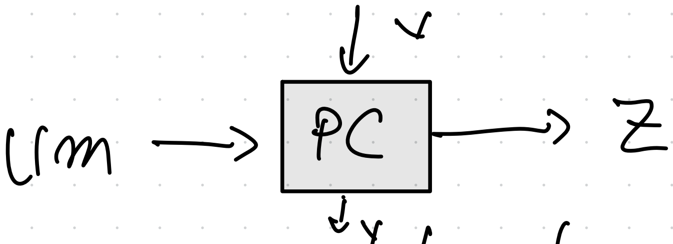
MM-isi

RG pi: $H_{pi}(s) = k_c(1+sT_i)/(sT_i)$ $\quad k_R = 5,\ T_i = 1$

Elemente de executie EE: paralel

$k_{E1} = 10$ ; $k_{E2} = 15$ $\rightsquigarrow$ $k_E = 25$

Procesul Condus PC:




$k_1 = 0{,}08$ $\quad 1/T_i = 1/0{,}1$

$T_1 = 0{,}05$ $\quad k_{em} = 0{,}8$

Elementul de măsură EM: $k_{EM} = 0{,}02$

$$\begin{cases} x' = Ax + Bu \\ y = C^T x \end{cases}$$

$u \begin{bmatrix} u \\ v \end{bmatrix}$ $\quad x = \begin{bmatrix} Um \\ z \end{bmatrix}$ $\quad y = z$

$$\begin{bmatrix} \dot{Um} \\ \dot{z} \end{bmatrix} = A \cdot \begin{bmatrix} Um \\ z \end{bmatrix} + B \begin{bmatrix} u \\ v \end{bmatrix}$$

$$y(t) = C^T \begin{bmatrix} Um \\ z \end{bmatrix}$$

$$\underline{\mathrm{I}} \quad \tilde{w}(s) = \frac{k_w}{T_w s + 1} \, w(s) \quad / \mathcal{L}^{-1}\{\}$$

$$T_w s \, \tilde{w}(s) + \tilde{w}(s) = k_w \, w(s)$$

$$\rightarrow \boxed{T_w \frac{d\tilde{w}(t)}{dt} + \tilde{w}(t) = k_w \, w(t)}$$

$$\underline{\mathrm{II}} \quad RG: \quad u_M(s) = \frac{k_C (1 + sT_2)}{sT_2} \cdot e(s)$$

$$T_2 \cdot s \cdot u_M(s) = k_C T_2 s \, e(s) + k_C \, e(s) \quad / \mathcal{L}^{-1}\{\}$$

$$\boxed{T_2 \frac{d\,u_M(t)}{dt} = k_C T_2 \frac{de(t)}{dt} + k_C \, e(t)}$$

$$\underline{\mathrm{III}} \quad m(s) = (10 + 15) \, u_M(t) \quad / \mathcal{L}^{-1}$$

$$\boxed{m(t) = 25 \, u_M(t)}$$

$$\underline{\mathrm{IV}} \quad n(s) = \frac{k_1}{T_1 \cdot s + 1} \, e_2(t) \quad / \mathcal{L}^{-1}$$

$$\boxed{T_1 \frac{de_2(t)}{dt} + e_2(t) = k_1 \, n(t)}$$

$\underline{V}$ $\quad Z(s) = 1/T_i \cdot e_1(s) \quad / \mathcal{L}^{-1}$

$$\boxed{z(t) = \frac{1}{T_i\, e_1(s)}}$$

$\underline{VI}$ $\quad Y_1(s) = k_{em} \cdot Z(s)$

$$\boxed{Y_1(t) = k_{em}\, Z(t)}$$

$\underline{VII}$ $\quad Y(s) = k_{EM} \cdot Z(s)$

$$\boxed{Y(t) = k_{EM} \cdot Z(t)}$$

Sumatoarele:

$\underline{I}$ $\quad \tilde{w}(s) - Y(s) = e(s)$

$\underline{II}$ $\quad m(s) - Y_1(s) = e_2(s)$

$\underline{III}$ $\quad n(s) - V(s) = e_1(s)$

$$\begin{bmatrix} \dot{U_m} \\ \dot{z} \end{bmatrix} = A \cdot \begin{bmatrix} U_m \\ z \end{bmatrix} + B \begin{bmatrix} u_i \\ v \end{bmatrix}$$

$$y(t) = C^T \begin{bmatrix} U_m \\ z \end{bmatrix}$$

---

$$U_m(s) = \frac{k_w}{sT_w + 1} \cdot w(s) - k_{EM} \, z(s) \quad / \, sT_w + 1$$

$$sT_w \, U_m(s) + U_m(s) = k_w \, w(s) - sT_w \, k_{EM} \, z(s) - k_{EM} \, z(s) \quad / \, \mathcal{L}^{-1}$$

$$T_w \, \dot{U}_m(t) + U_m(t) = k_w \, w(t) - T_w \, k_{EM} \, \dot{z}(t) - k_{EM} \, z(t)$$

$$m(s) = (k_{E_1} + k_{E_2}) \, U_m(s) \quad / \, \mathcal{L}^{-1}$$

$$m(t) = (k_{E_1} + k_{E_2}) \, U_m(t)$$

$$\begin{bmatrix} \dot{U_m} \\ \dot{z} \end{bmatrix} = A \cdot \begin{bmatrix} U_m \\ z \end{bmatrix} + B \begin{bmatrix} u_i \\ v \end{bmatrix}$$

$$y(t) = C^T \begin{bmatrix} U_m \\ z \end{bmatrix}$$

$$A \left[ \begin{matrix} \\ \\ (k_{E_1} + k_{E_2}) \cdot \\ \end{matrix} \right.$$