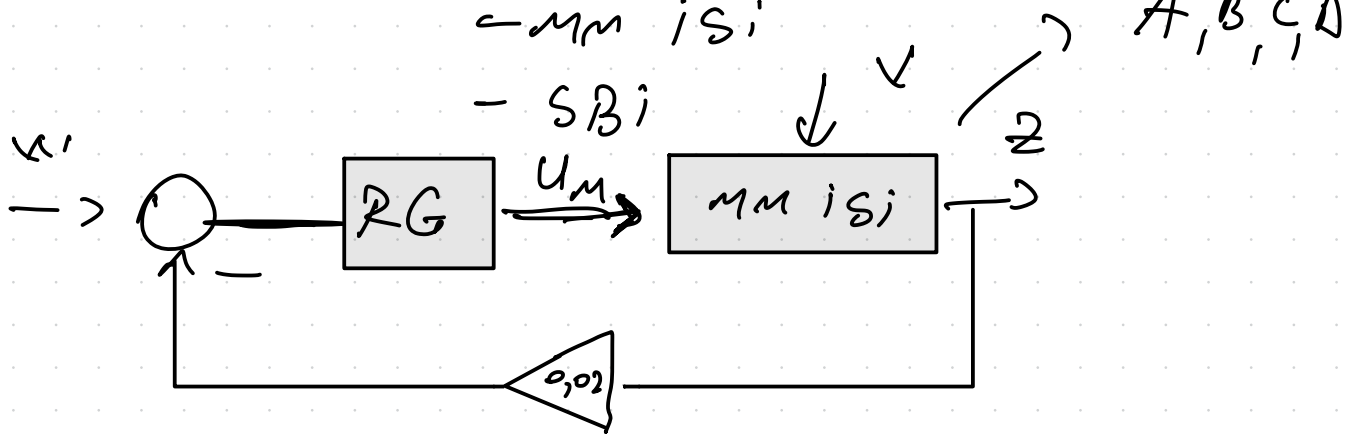


(1)  $H_{zy}(s)$   $H_{zy}(s) = ?$

(2) -3 structuri

- mm ii
- mm isi
- SBi



$w(t) = 5G(t)$  Step 5  
Final 5

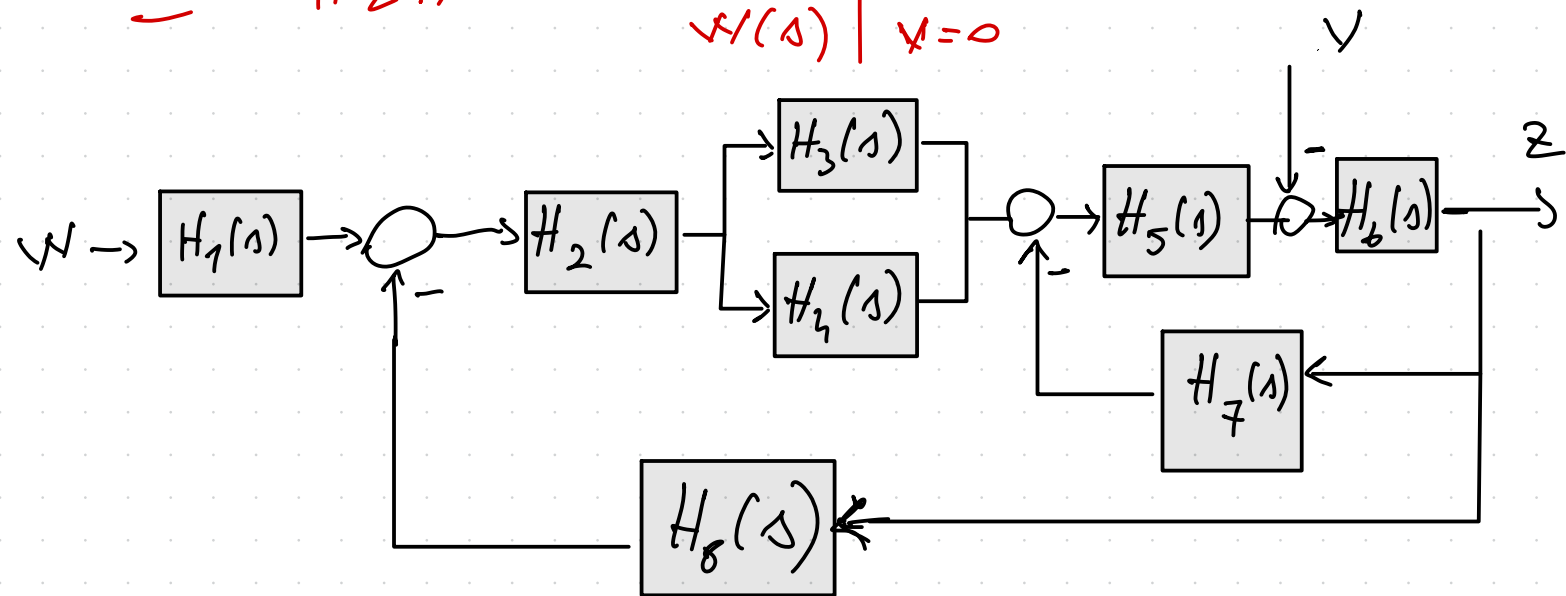
$v(t) = 1G(t-25)$  Step 25  
Final 1

Total 50

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

$\downarrow$   $\uparrow$   
 iesire intrare

$$I \quad H_{zw}(s) = \frac{Z(s)}{W(s)} \Big|_{v=0}$$



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

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

$$H_3(s) = 10$$

$$H_4(s) = 15$$

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

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

$$H_7(s) = 2,8$$

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

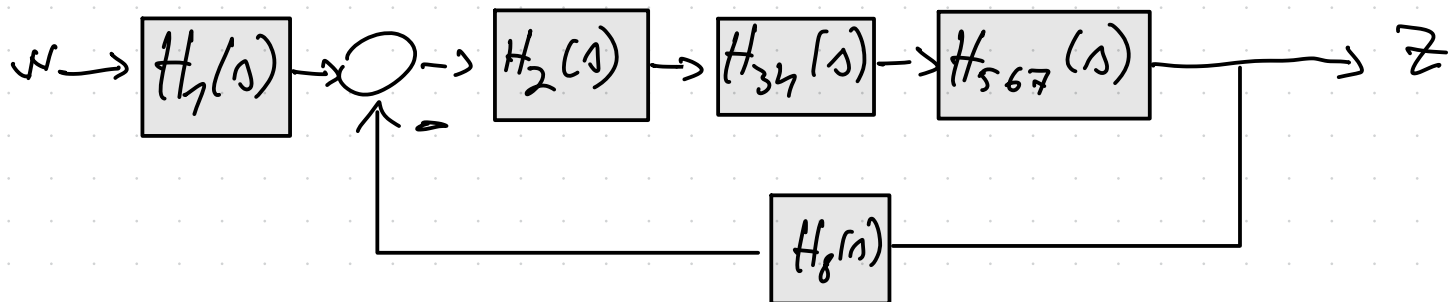
$$H_{34}(s) = H_3(s) + H_4(s) = 25$$

$$H_{s67}(s) = \frac{H_5(s) \cdot H_6(s)}{1 + H_5(s) H_6(s) H_7(s)}$$

$$= \frac{\frac{8}{5s+100} \cdot \frac{10}{s}}{1 + \frac{8}{5s+100} \cdot \frac{10}{s} \cdot \frac{2,8}{10}}$$

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

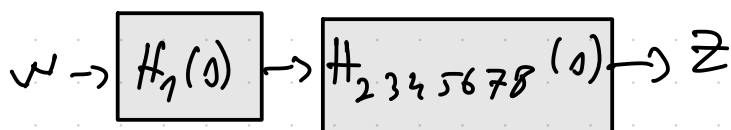
$$= \frac{80}{s(5s+100) + 64}$$



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

$$\frac{1(5s+100) + 64}{s^2(5s+100) + 64s}$$

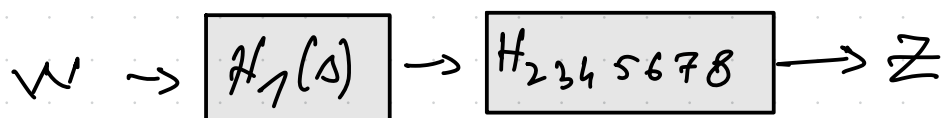
$$= \frac{s^5(s+1) \cdot 2000}{s^2(5s+100) + 64s}$$



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

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

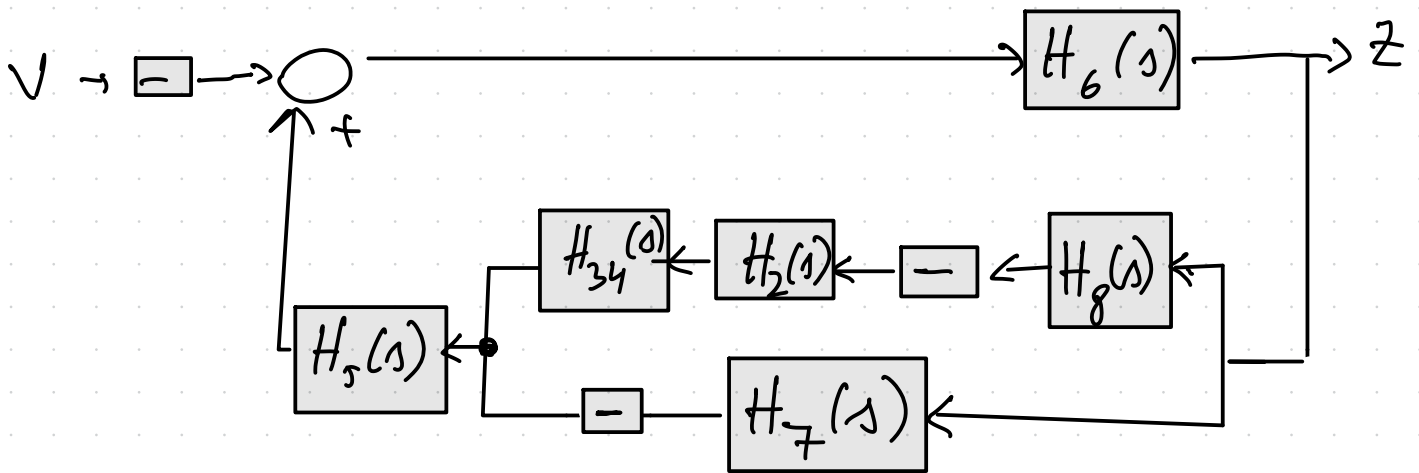
$$= \frac{2000 \cdot s^5(s+1)}{s^2(5s+100) + 64s + 40 \cdot s^5(s+1)} = \frac{10000(s+1)}{5(s+1)(s+40) + 64}$$



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

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

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



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

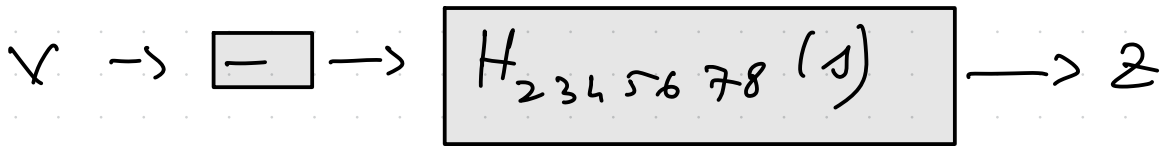
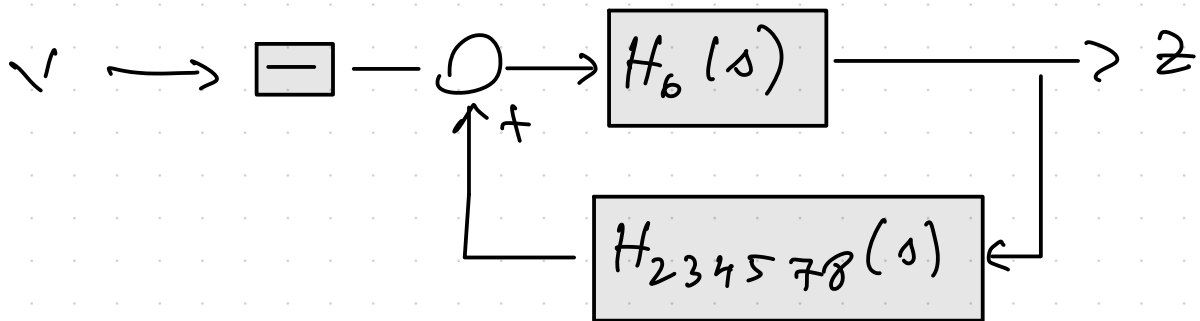
$$= - \left[ H_2(s) \cdot H_{34}(s) \cdot H_8(s) + H_7(s) \right]$$

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

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

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

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



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

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

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

$$= \frac{500\cancel{s^2} + 1000\cancel{s}}{\cancel{s}(50\cancel{s^3} + 1000\cancel{s^2} + 2640s + 2000)} = \frac{50s^2 + 1000s}{5s^3 + 100s^2 + 264s + 200}$$

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

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

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

$$() = 10000s + 10000$$

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

$$= 5s^2 + 205s + 264$$

$$\left(\frac{s}{2} + 1\right) \cdot (5s^2 + 205s + 264) =$$

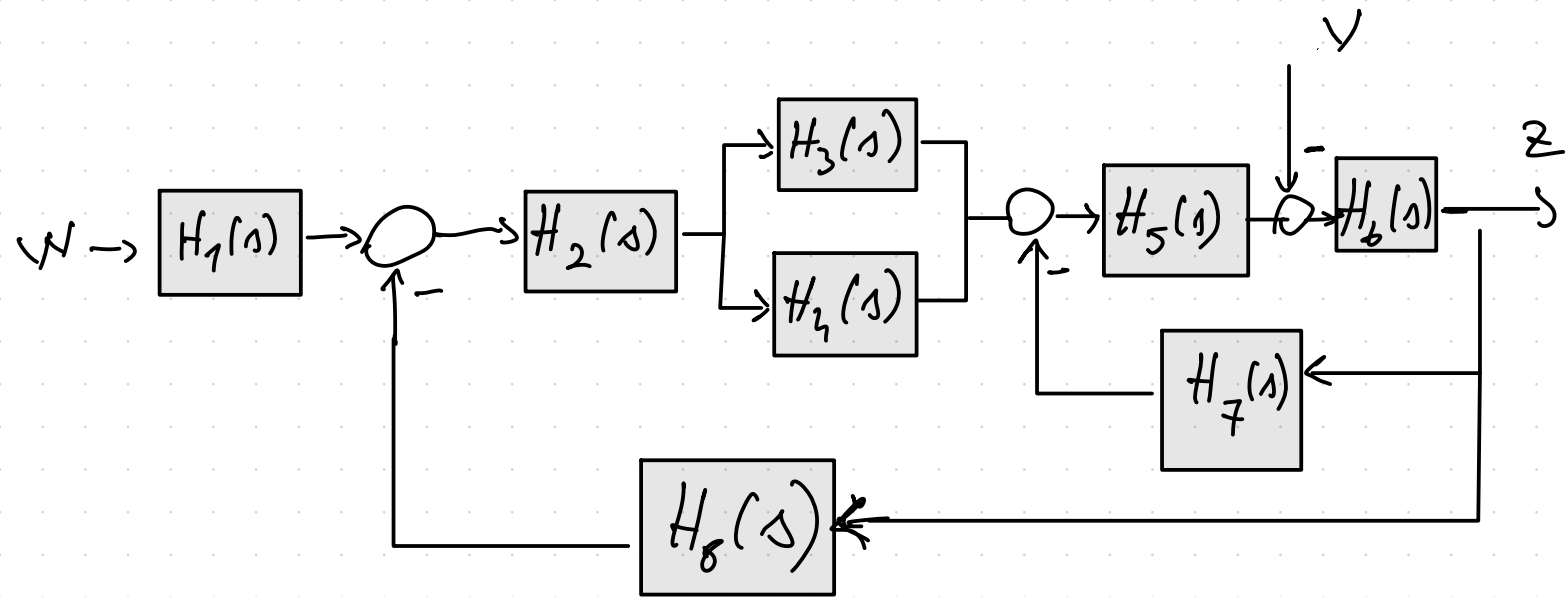
$$= 5s^3/2 + 205s^2/2 + 132s + 5s^2 + 205s + 264$$

$$= 5/2 \cdot s^3 + \left(205/2 + 5\right)s^2 + 337s + 264$$

$$= 2.5 \cdot s^3 + 107.5s^2 + 337s + 264$$

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

$$H_{Z\sqrt{}}(s) = \frac{50s^2 + 1000s}{5s^3 + 107.5s^2 + 264s + 200}$$



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

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

$$H_3(s) = kE_1 = 10$$

$$H_4(s) = kE_2 = 15$$

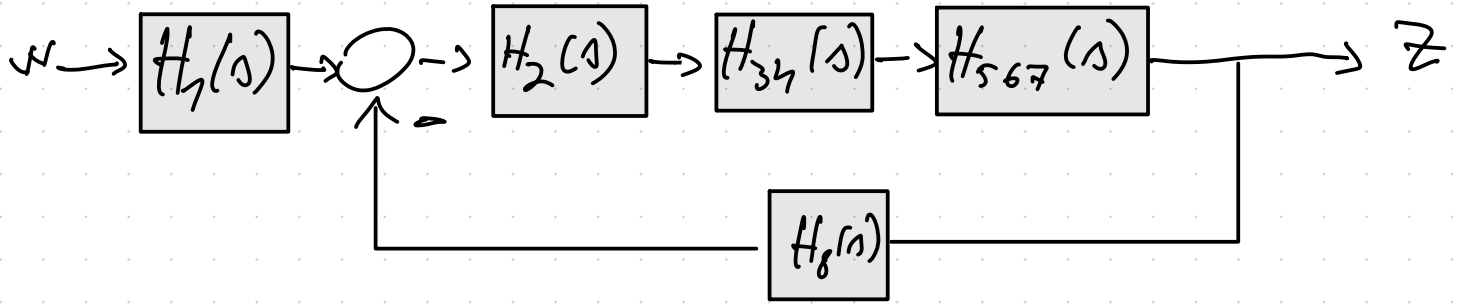
$$H_5(s) = \frac{k_1}{T_1 \cdot s + 1} = \frac{0,08}{0,05s + 1}$$

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

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

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

$$\underline{I} \quad H_{Z_{w_1}}(s) = \frac{Z(s)}{w(s)} \Big|_{w=0}$$



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

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

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

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

$$H_{Z_{w_1}}(s) = H_1(s) \cdot H_{2345678}(s) =$$

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

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



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

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

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

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

$$H_{Z/N}(s) = \frac{H_1(s) H_2(s) [H_3(s) + H_4(s)] H_5(s) H_6(s)}{1 + H_5(s) H_6(s) H_7(s) + H_2(s) [H_3(s) + H_4(s)] H_5(s) H_6(s) H_8(s)}$$

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

$$H_5(s) \cdot H_6(s) = \frac{\frac{8}{200}}{\frac{5s+100}{200}} \cdot \frac{1}{Ti \cdot s} = \frac{8}{5Ti \cdot s^2 + 100Ti \cdot s}$$

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

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

$$H_{56}(s) \cdot H_7(s) = \frac{8}{5T_1 s^2 + 100T_1 s} \cdot \frac{8}{10} = \frac{64}{50T_1 s^2 + 1000T_1 s}$$

$$H_{2ur}(s) = \frac{H_1(s) H_{256}(s) H_{34}(s)}{1 + H_{567}(s) + H_{256}(s) H_{34}(s) H_8(s)}$$

$$H_{256}(s) \cdot H_{34}(s) = \frac{5 \cdot 40k^2 T_2 s + 5 \cdot 40k^2}{5T_1 T_2 s^3 + 100T_1 T_2 s^2} =$$

$$= \frac{40k^2 T_2 s + 40k^2}{T_1 T_2 s^3 + 20T_1 T_2 s^2}$$

$$H_{2ur}(s) = \frac{\frac{2}{s+2} \cdot \frac{40k^2 T_2 s + 40k^2}{T_1 T_2 s^3 + 20T_1 T_2 s^2}}{1 + \frac{64}{50T_1 s^2 + 1000T_1 s} + \frac{40k^2 T_2 s + 40k^2}{T_1 T_2 s^3 + 20T_1 T_2 s^2} \cdot \frac{2}{100}}$$

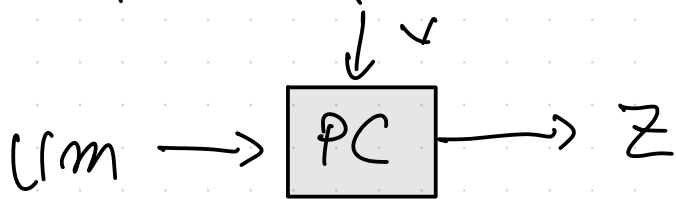
MM-isi

$$P_{GHP; i}(\Delta) = k_c (1 + s T_2) / (s T_2) \quad k_2 = 5, T_2 = 1$$

Elemente de execuție EE : paralel

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

Procesul Condus PC :



$$k_1 = 0,08 \quad 1/T_1 = 1/0,1$$

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

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

$$\begin{cases} \dot{x} = Ax + Bu \\ y = C^T x \end{cases}$$

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

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

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

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

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

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

$$\text{II} \quad \text{RG} : U_m(s) = \frac{k_c(1+sT_2)}{sT_2} \cdot e(s)$$

$$T_2 \cdot s \cdot U_m(s) = k_c T_2 s e(s) + k_c e(s) \quad / \mathcal{L}^{-1}$$

$$T_2 \frac{dU_m(t)}{dt} = k_c T_2 \frac{de(t)}{dt} + k_c e(t)$$

$$\text{III} \quad m(s) = (10+15) U_m(s) \quad / \mathcal{L}^{-1}$$

$$m(t) = 25 U_m(t)$$

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

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

$$\underline{\text{v}} \quad z(s) = 1/T_i \cdot e_1(s) \quad \mathcal{L}^{-1}$$

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

$$\underline{\text{vi}} \quad y_1(s) = k_{em} \cdot z(s)$$

$$y_1(t) = k_{em} z(t)$$

$$\underline{\text{vii}} \quad y(s) = k_{EM} \cdot z(s)$$

$$y(t) = k_{EM} \cdot z(t)$$

Summations:

$$\text{I} \quad \tilde{w}(s) - y(s) = e(s)$$

$$\text{II} \quad m(s) - y_1(s) = e_2(s)$$

$$\text{III} \quad n(s) - v(s) = e_4(s)$$

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

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


---

$$U_m(s) = \frac{k_u}{sT_u + 1} \cdot u(s) - k_{EM} z(s) / sT_u + 1$$

$$sT_u U_m(s) + U_m(s) = k_u u(s) - sT_u k_{EM} z(s) - k_{EM} z(s) / \mathcal{L}^{-1}$$

$$T_u \dot{U}_m(t) + U_m(t) = k_u u(t) - T_u k_{EM} \dot{z}(t) - k_{EM} z(t)$$

$$M(s) = (k_{E1} + k_{E2}) U_m(s) / \mathcal{L}^{-1}$$

$$m(t) = (k_{E1} + k_{E2}) U_m(t)$$

$$\begin{bmatrix} \dot{u}_m \\ \dot{z} \end{bmatrix} = A \cdot \begin{bmatrix} u_m \\ z \end{bmatrix} + B \begin{bmatrix} u_1 \\ v \end{bmatrix}$$

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

$$A = \begin{pmatrix} k_{E_1} + k_{E_2} \end{pmatrix}.$$