REZOLVARE EXAMEN

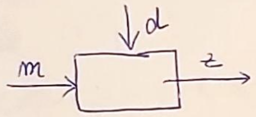
Se consideră sistemul de reglare automată cu schema bloc prezentată în figură, în care $r(t)$ este referința, $e(t)$ este eroarea de reglare și modelul de stare (MM-isi) al blocului P este:

$$\begin{cases} \dot{x}_1 = -2x_1 + 2x_2 + 40d \\ \dot{x}_2 = -0{,}5x_2 + \underline{12{,}5m} \\ z = x_1 \end{cases}$$

Sunt considerate 2 variante de regulatoare (R) cu f.d.t:

R_1: $H_R(s) = k_R\left(1 + \frac{1}{T_i \cdot s}\right) = \frac{k_R(1+sT_i)}{sT_i}$ (ET-PI)

R_2: $H_R(s) = \frac{k_R(1+T_d s)}{1+ s\cdot T_f}$ (ET-PDT1)



$\Rightarrow H_{zm}(s) = \left.\frac{z(s)}{m(s)}\right|_{d=0}$ și $H_{zd}(s) = \left.\frac{z(s)}{d(s)}\right|_{m=0}$

– trebuie găsite matricile A, B și C pt. a se găsi matricea de transfer $H(s) = C\cdot(sI-A)^{-1}\cdot B = C\cdot M^{-1}\cdot B$

$$\begin{cases} \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \underbrace{\begin{bmatrix} -2 & 2 \\ 0 & -0{,}5 \end{bmatrix}}_{A} \cdot \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \underbrace{\begin{bmatrix} 0 & 40 \\ 12{,}5 & 0 \end{bmatrix}}_{B} \cdot \begin{bmatrix} m \\ d \end{bmatrix} \\ z = \underbrace{\begin{bmatrix} 1 & 0 \end{bmatrix}}_{C} \cdot \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \end{cases}$$

deci $A = \begin{bmatrix} -2 & 2 \\ 0 & -0{,}5 \end{bmatrix}$ $\quad B = \begin{bmatrix} 0 & 40 \\ 12{,}5 & 0 \end{bmatrix}$ $\quad C = \begin{bmatrix} 1 & 0 \end{bmatrix}$

$$H(s) = C\cdot(sI-A)^{-1}\cdot B = C\cdot M^{-1}\cdot B = \begin{bmatrix} H_{x_1m}(s) & H_{x_1d}(s) \end{bmatrix} = \begin{bmatrix} H_{zm}(s) & H_{zd}(s) \end{bmatrix}$$

$$M = (sI - A) = \begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} -2 & 2 \\ 0 & -0{,}5 \end{bmatrix} = \begin{bmatrix} s+2 & -2 \\ 0 & s+0{,}5 \end{bmatrix} \Rightarrow$$

$M^T = M^t = \begin{bmatrix} s+2 & 0 \\ -2 & s+0{,}5 \end{bmatrix}$, $\quad \det(M) = (s+2)(s+0{,}5) = 2(1+0{,}5s)\cdot 0{,}5(1+2s) \Rightarrow$

$\det(M) = (1+0{,}5s)(1+2s)$

$$M^{-1} = \frac{1}{\det(M)} \cdot M^*$$

$$M^* = \begin{bmatrix} (-1)^{1+1}(s+0{,}5) & (-1)^{1+2}\cdot(-2) \\ (-1)^{2+1}\cdot 0 & (-1)^{2+2}(s+2) \end{bmatrix} = \begin{bmatrix} s+0{,}5 & 2 \\ 0 & s+2 \end{bmatrix}$$

$$M^{-1} = \frac{1}{(1+0{,}5s)(1+2s)} \begin{bmatrix} s+0{,}5 & 2 \\ 0 & s+2 \end{bmatrix}$$

$$H(s) = [1 \quad 0] \cdot \frac{1}{(1+0{,}5s)(1+2s)} \begin{bmatrix} s+0{,}5 & 2 \\ 0 & s+2 \end{bmatrix} \begin{bmatrix} 0 & 40 \\ 12{,}5 & 0 \end{bmatrix} =$$

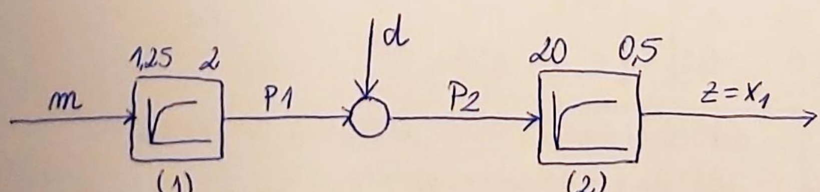
$$= \frac{1}{(1+0{,}5s)(1+2s)} [1 \quad 0] \begin{bmatrix} s+0{,}5 & 2 \\ 0 & s+2 \end{bmatrix} \begin{bmatrix} 0 & 40 \\ 12{,}5 & 0 \end{bmatrix} = \frac{1}{(1+0{,}5s)(1+2s)} [s+0{,}5 \quad 2] \cdot \begin{bmatrix} 0 & 40 \\ 12{,}5 & 0 \end{bmatrix}$$

$$= \frac{1}{(1+0{,}5s)(1+2s)} [1 \quad 0] \begin{bmatrix} s+0{,}5 & 2 \\ 0 & s+2 \end{bmatrix} \begin{bmatrix} 0 & 40 \\ 12{,}5 & 0 \end{bmatrix}$$

$$= \frac{1}{(1+0{,}5s)(1+2s)} [25 \quad 40(s+0{,}5)] = \left[\frac{25}{(1+0{,}5s)(1+2s)} \quad \frac{40 \cdot 0{,}5 \cdot \cancel{(1+2s)}}{(1+0{,}5s)\cancel{(1+2s)}} \right]$$

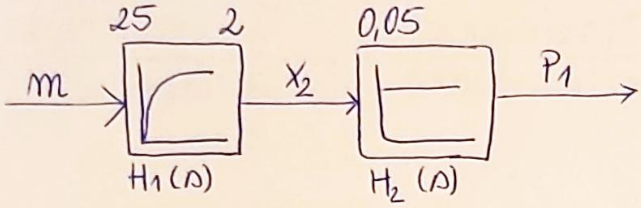
$$= \left[\frac{25}{(1+0{,}5s)(1+2s)} \quad \frac{20}{1+0{,}5s} \right] = [H_{zm}(s) \quad H_{zd}(s)]$$

$$H_{zm}(s) = \frac{25}{(1+0{,}5s)(1+2s)} \quad \text{și} \quad H_{zd}(s) = \frac{20}{1+0{,}5s}$$



=> verificăm să vedem dacă obținem MM-isi-ul

$P_1(s) = \dfrac{1{,}25}{1+2s}\, m(s) \Rightarrow P_1(s) + 2s\, p_1(s) = 1{,}25\, m(s) \Rightarrow$ trebuie să avem $12{,}5\, m(s) \Rightarrow$ despărțim primul bloc în 2 blocuri (un ET-PT1 și un ET-P)



$H_1(s) \cdot H_2(s) = \dfrac{25}{1+2s} \cdot 0{,}05 = \dfrac{1{,}25}{1+2s}$

$P_1(s) = 0{,}05\, x_2(s) \Rightarrow p_1 = 0{,}05 x_2$

$x_2(s) = \dfrac{25}{1+2s}\, m(s) \Rightarrow x_2(s) + 2s\, x_2(s) = 25\, m(s) \Rightarrow x_2 + 2\dot{x}_2 = 25m \Rightarrow$

$2\dot{x}_2 = -x_2 + 25m \Rightarrow \boxed{\dot{x}_2 = -0{,}5 x_2 + 12{,}5 m}$

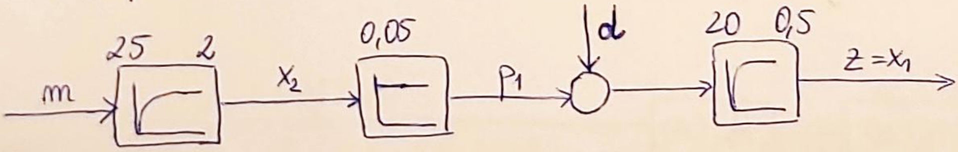
$p_2(s) = p_1(s) + d(s) \Rightarrow p_2 = p_1 + d$

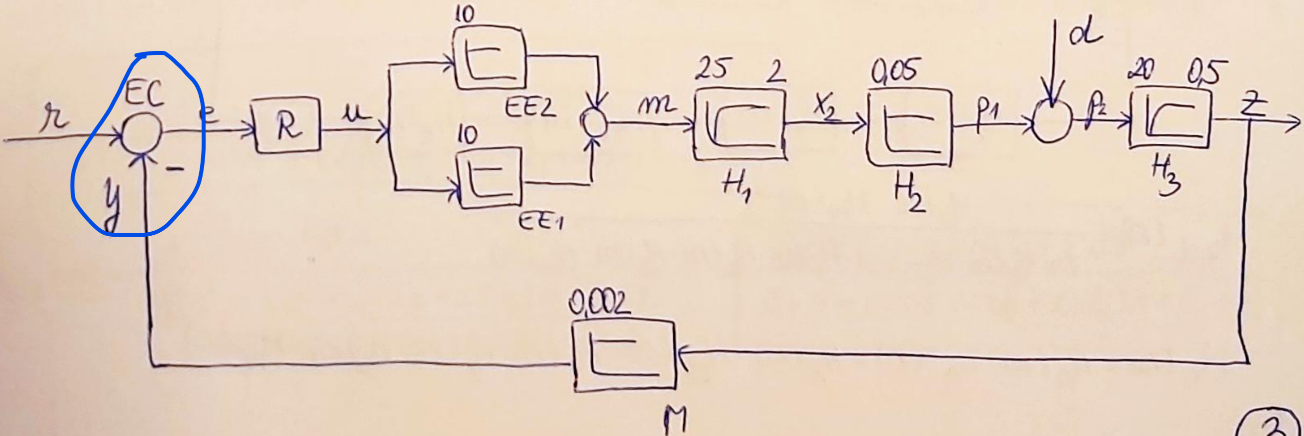
$z(s) = \dfrac{20}{1+0{,}5s}\, p_2(s) \xRightarrow{z = x_1} x_1(s) + 0{,}5\, x_1(s) \cdot s = 20\, p_2(s) \Rightarrow x_1 + 0{,}5\dot{x}_1 = 20 p_2$

$\Rightarrow \left.\begin{matrix} 0{,}5\dot{x}_1 = -x_1 + 20p_2 \\ p_2 = p_1 + d \end{matrix}\right\} \Rightarrow \left.\begin{matrix} 0{,}5\dot{x}_1 = -x_1 + 20p_1 + 20d \\ p_1 = 0{,}05 x_2 \end{matrix}\right\} \Rightarrow$

$0{,}5\dot{x}_1 = -x_1 + x_2 + 20d \mid :0{,}5 \Rightarrow \boxed{\dot{x}_1 = -2x_1 + 2x_2 + 40d}$

$\Rightarrow$ se respectă MM-isi-ul





$$\left.\begin{array}{l} H_{EE1}(s) = 10\ (ET-P) \\ H_{EE2}(s) = 10\ (ET-P) \end{array}\right\} \Rightarrow H_{EE}(s) = H_{EE1}(s) + H_{EE2}(s) \Rightarrow \boxed{H_{EE}(s) = 20\ (ET-P)}$$

(conexiune paralel)

$$\boxed{H_1(s) = \frac{25}{1+2s}\ (ET-PT1)}$$

$$\boxed{H_2(s) = 0{,}05\ (ET-P)}$$

$$\boxed{H_3(s) = \frac{20}{1+0{,}5s}\ (ET-PT1)}$$

$$\boxed{H_M(s) = 0{,}002\ (ET-P)}$$

1 Calculați c.d.t. adică $H_{y,r}(s)$, $H_{y,d}(s)$ și f.d.t $H_0(s)$

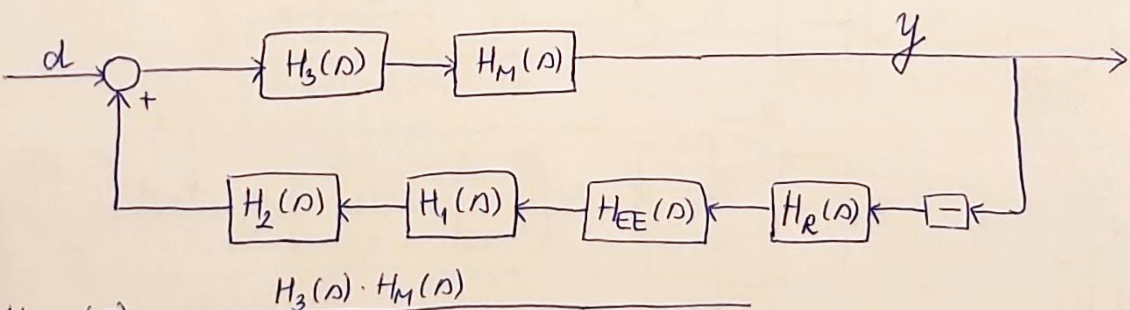
f.d.t a sistemului deschis

pentru: R1: $T_i = 2{,}5$ sec

R2: $T_d = 2{,}5$ sec, $T_f = 0{,}1$ sec

$$H_{y,r}(s) = \left.\frac{y(s)}{r(s)}\right|_{d=0} = \frac{H_R(s)\cdot H_{EE}(s)\cdot H_1(s)\cdot H_2(s)\cdot H_3(s)\cdot H_M(s)}{1 + H_R(s)\cdot H_{EE}(s)\cdot H_1(s)\cdot H_2(s)\cdot H_3(s)\cdot H_M(s)}$$

$$H_{y,d}(s) = \left.\frac{y(s)}{d(s)}\right|_{r=0} = \frac{H_3(s)\cdot H_M(s)}{1 - H_3(s)\cdot H_M(s)\cdot [(-)H_R(s)\cdot H_{EE}(s)\cdot H_1(s)\cdot H_2(s)]}$$



$$H_{y,d}(s) = \frac{H_3(s)\cdot H_M(s)}{1 + H_R(s)\cdot H_{EE}(s)\cdot H_1(s)\cdot H_2(s)\cdot H_3(s)\cdot H_M(s)}$$

$$H_0(s) = H_R(s)\cdot H_{PC}(s) = H_R(s)\cdot H_{EE}(s)\cdot H_1(s)\cdot H_2(s)\cdot H_3(s)\cdot H_M(s)$$

$\boxed{R1}$:

$$H_{y,r}(s) = \frac{\frac{k_R(1+2{,}5s)}{2{,}5s}\cdot 20\cdot\frac{25}{1+2s}\cdot 0{,}05\cdot\frac{20}{1+0{,}5s}\cdot 0{,}002}{1+\frac{k_R(1+2{,}5s)\cdot 1}{2{,}5s(1+2s)(1+0{,}5s)}} =$$

$$= \frac{k_R(1+2{,}5s)}{\cancel{2{,}5s(1+2s)(1+0{,}5s)}}\cdot\frac{\cancel{2{,}5s(1+2s)(1+0{,}5s)}}{2{,}5s(1+2s)(1+0{,}5s)+k_R(1+2{,}5s)} =$$

$$= \frac{k_R(1+2{,}5s)}{2{,}5s(s^2+2{,}5s+1)+2{,}5k_R s+k_R} = \frac{k_R(1+2{,}5s)}{2{,}5s^3+6{,}25s^2+2{,}5s+2{,}5k_R s+k_R}$$

$$\Rightarrow \boxed{H_{y,r}(s) = \frac{k_R(1+2{,}5s)}{2{,}5s^3+6{,}25s^2+2{,}5s+2{,}5k_R s+k_R}}$$

$$H_{y,d}(s) = \frac{\frac{20}{1+0{,}5s}\cdot 0{,}002}{\frac{2{,}5s^3+6{,}25s^2+2{,}5(1+k_R)s+k_R}{2{,}5s(1+2s)(1+0{,}5s)}} = \boxed{\frac{0{,}1s(1+2s)}{2{,}5s^3+6{,}25s^2+2{,}5(1+k_R)s+k_R}}$$

$$H_0(s) = \frac{k_R(1+2{,}5s)}{2{,}5s}\cdot\frac{1}{(1+0{,}5s)(1+2s)} \Rightarrow \boxed{H_0(s) = \frac{k_R(1+2{,}5s)}{2{,}5s(1+0{,}5s)(1+2s)}}$$

$\boxed{R2}$:

$$H_{y,r}(s) = \frac{\frac{k_R(1+2{,}5s)}{1+0{,}1s}\cdot\frac{1}{(1+0{,}5s)(1+2s)}}{1+\frac{k_R(1+2{,}5s)}{(1+0{,}1s)(1+0{,}5s)(1+2s)}} = \frac{k_R(1+2{,}5s)}{(1+0{,}1s)(1+0{,}5s)(1+2s)+k_R(1+2{,}5s)}$$

$$= \frac{k_R(1+2{,}5s)}{(1+0{,}1s)(s^2+2{,}5s+1)+2{,}5k_R s+k_R} \Rightarrow \frac{k_R(1+2{,}5s)}{s^2+2{,}5s+1+0{,}1s^3+0{,}25s^2+0{,}1s+2{,}5k_R s+k_R}$$

$$\Rightarrow \boxed{H_{y,r}(s) = \frac{k_R(1+2{,}5s)}{0{,}1s^3+1{,}25s^2+(2{,}6+2{,}5k_R)s+k_R+1}}$$

$$H_{y,d}(s) = \frac{\frac{20}{1+0{,}5s}\cdot 0{,}002}{\frac{0{,}1s^3+1{,}25s^2+(2{,}6+2{,}5k_R)s+k_R+1}{(1+0{,}1s)(1+0{,}5s)(1+2s)}} = \boxed{\frac{0{,}04(1+0{,}1s)(1+2s)}{0{,}1s^3+1{,}25s^2+(2{,}6+2{,}5k_R)s+k_R+1}}$$

$$H_0(s) = \frac{k_R(1+2,5s)}{1+0,1s} \cdot \frac{1}{(1+0,5s)(1+2s)} \Rightarrow \boxed{H_0(s) = \frac{k_R(1+2,5s)}{(1+0,1s)(1+0,5s)(1+2s)}}$$

② Găsiți valorile parametrului $k_R > 0$ pt. care SRA este stabil.

$\boxed{R1:}$ $\Delta(s) = 1 + H_0(s) = 2,5s^3 + 6,25s^2 + 2,5(1+k_R)s + k_R = a_3 s^3 + a_2 s^2 + a_1 s + a_0$

Sunt impuse condițiile necesare specificate în T_3:

$a_3 = 2,5 > 0$

$a_2 = 6,25 > 0$

$$\left.\begin{array}{l} a_1 = 1 + k_R > 0 \Rightarrow k_R > -1 \Rightarrow k_R \in (-1;\ \infty) \\ a_0 = k_R > 0 \Rightarrow k_R \in (0;\ \infty) \end{array}\right\} \Rightarrow \underline{k_R \in (0; +\infty)}\ (*)$$

$$m = 3 \Rightarrow H = \begin{bmatrix} a_2 & a_0 & 0 \\ a_3 & a_1 & 0 \\ 0 & a_2 & a_0 \end{bmatrix} = \begin{bmatrix} 6,25 & k_R & 0 \\ 2,5 & 1+k_R & 0 \\ 0 & 6,25 & k_R \end{bmatrix}$$

Sunt impuse condițiile de stabilitate:

$\det(H_1) = 6,25 > 0$

$\det(H_2) = 6,25(k_R+1) - 2,5k_R = 3,75k_R + 6,25 > 0 \Rightarrow k_R > -1,6667 \Rightarrow$

$k_R \in (-1,6667;\ \infty)$ (1)

$\det(H_3) = a_0 \det(H_2) = k_R(3,75k_R + 6,25) > 0 \Rightarrow k_R \in (0; +\infty) \cap (-1,6667; +\infty)$

$\Rightarrow k_R \in (0; +\infty)$ (2)

$\xRightarrow{(1)\ și\ (2)} \underline{k_R \in (0;\ +\infty)}\ (**)$

din $(*)$ și $(**)$ $\Rightarrow \boxed{k_R \in (0;\ +\infty)}$

$\boxed{R2:}$ $\Delta(s) = 1 + H_0(s) = 0,1s^3 + 1,25s^2 + (2,6 + 2,5k_R)s + k_R + 1 = a_3 s^3 + a_2 s^2 + a_1 s + a_0$

$a_3 = 0,1 > 0$

$a_2 = 1,25 > 0$

$$\left.\begin{array}{l} a_1 = 2,6 + 2,5k_R > 0 \Rightarrow k_R > -1,04 \Rightarrow k_R \in (-1,04;\ \infty) \\ a_0 = k_R + 1 > 0 \Rightarrow k_R > -1 \Rightarrow k_R \in (-1;\ \infty) \end{array}\right\} \Rightarrow k_R \in (0; \infty) \cap (-1; +\infty) \cap (-1,04; +\infty)$$

$\Rightarrow \underline{k_R \in (0; +\infty)}\ (*)$

$$m = 3 \Rightarrow H = \begin{bmatrix} 1,25 & k_R+1 & 0 \\ 0,1 & 2,5k_R + 2,6 & 0 \\ 0 & 1,25 & k_R+1 \end{bmatrix} \Rightarrow \det(H_1) = 1,25 > 0$$

$\det(H_2) = 1,25(2,5k_R + 2,6) - 0,1(k_R+1)$

$= 3,125k_R + 3,25 - 0,1k_R - 0,1$

$= 3,025k_R + 3,15 > 0 \Rightarrow k_R > -1,041$

$\Rightarrow k_R \in (-1,041; +\infty)$ (1)

$\det(H_3) = a_0 \det(H_2) = (k_R+1)(3{,}025k_R + 3{,}15) > 0 \Rightarrow k_R \in (-1; +\infty) \cap (-1{,}041; +\infty) \Rightarrow$
$\Rightarrow k_R \in (-1; +\infty)$ (2)

$\xrightarrow{\text{din (1) și (2)}} k_R \in (-1; \infty) \Rightarrow k_R \in (0; +\infty) \cap (-1; +\infty) \Rightarrow \underline{k_R \in (0; +\infty)}$ (**)

$\xrightarrow{\text{din }^{(*)}\text{ și }^{(**)}} \boxed{k_R \in (0; +\infty)}$

③ Considerând ieșirea $y(t)$, acceptând că sistemul este stabil și alegând o valoare a lui $k_R > 0$, găsiți valoarea statismului natural $\gamma_n(y)$. Acceptând valorile nominale $d_n = 50$ și $y_n = 100$, găsiți valoarea statismului natural în unități raportate în procente $\gamma_n(y)^{\%}$.

$\boxed{R1}$: Regulatorul este de tip PI, are componentă integratoare $\Rightarrow$ statismul natural este nul $\Rightarrow \boxed{\gamma_n(y) = 0}$

$\gamma_n(y)^{\%} = \gamma_n(y) \cdot \frac{d_n}{y_n} \cdot 100\% \Rightarrow \boxed{\gamma_n(y)^{\%} = 0}$ (pe baza relației din L4, pag. 3) → relația 28

$\boxed{R2}$: $\gamma_n(y) = \left.\frac{y_\infty}{d_\infty}\right|_{r_\infty = 0}$ sau $\gamma_n(y) = \frac{k_N(y)}{1+k_0}$, $k_0 = k_R \cdot k_{PC}$

luăm $k_R = 3$ și alegem a 2-a opțiune deoarece nu avem valoarea lui d_∞

$\gamma_n(y) = \frac{k_N(y)}{1+k_0} = \frac{0{,}04}{1+3} \Rightarrow \boxed{\gamma_n(y) = 0{,}01}$; $\gamma_n(y)^{\%} = 0{,}01 \cdot \frac{50}{100} \cdot 100\% = 0{,}5$

$\boxed{\gamma_n(y)^{\%} = 0{,}5}$ (rel. 28)

$$\left.\begin{aligned} k_N &= 20 \cdot 0{,}002 = 0{,}04 \\ k_0 &= k_R \cdot k_{PC} \\ k_R &= 3 \\ k_{PC} &= 20 \cdot 25 \cdot 0{,}05 \cdot 20 \cdot 0{,}002 = 1 \end{aligned}\right\} \Rightarrow k_0 = 3$$

④ Acceptând că sistemul este stabil și alegând o valoare a lui $k_R > 0$, pentru $d_\infty = 50$ și $z_\infty = 5000$ calculați VRSC $\{r_\infty, e_\infty, u_\infty, m_\infty, y_\infty\}$

$\boxed{R1}$: $\left.\begin{aligned} &\text{RG-PI} \Rightarrow \boxed{e_\infty = 0} \\ &e_\infty = r_\infty - y_\infty \end{aligned}\right\} \Rightarrow r_\infty = y_\infty$

$y_\infty = 0{,}002 \cdot z_\infty = 10 \Rightarrow \boxed{y_\infty = 10}$

$\Rightarrow \boxed{r_\infty = 10}$

$m_\infty = 20\, u_\infty \Rightarrow \boxed{m_\infty = 160}$

$x_{2\infty} = 25 m_\infty = 500\, u_\infty \Rightarrow \boxed{x_{2\infty} = 4000}$

$p_{1\infty} = 0{,}05 X_{2\infty} = 25 u_\infty \Rightarrow \boxed{p_{1\infty} = 200}$

$p_{2\infty} = p_{1\infty} + d_\infty = 25 u_\infty + 50 \Rightarrow \boxed{p_{2\infty} = 250}$

$z_\infty = X_{1\infty} = 20 p_{2\infty} = 500 u_\infty + 1000 = 5000 \Rightarrow 500 u_\infty = 4000 \Rightarrow \boxed{u_\infty = 8}$

$\boxed{R2}$: RG-PDT1 $\Rightarrow$ $\left.\begin{array}{l} e_\infty \neq 0 \\ e_\infty = r_\infty - y_\infty \end{array}\right\} \Rightarrow e_\infty = r_\infty - 10 \Rightarrow 4 = r_\infty - 10 \Rightarrow$

$\boxed{r_\infty = 14}$

$y_\infty = 0{,}002 z_\infty = 10 \Rightarrow \boxed{y_\infty = 10}$

$u_\infty = 2 e_\infty \ (k_R = 2) \Rightarrow \boxed{u_\infty = 8}$

$m_\infty = 20 u_\infty = 40 e_\infty \Rightarrow \boxed{m_\infty = 160}$

$X_{2\infty} = 25 m_\infty = 1000 e_\infty \Rightarrow \boxed{X_{2\infty} = 4000}$

$p_{1\infty} = 0{,}05 X_{2\infty} = 50 e_\infty \Rightarrow \boxed{p_{1\infty} = 200}$

$p_{2\infty} = p_{1\infty} + d_\infty = 50 e_\infty + 50 \Rightarrow \boxed{p_{2\infty} = 250}$

$z_\infty = 20 p_{2\infty} \Rightarrow 1000 e_\infty + 1000 = 5000 \Rightarrow 1000 e_\infty = 4000 \Rightarrow \boxed{e_\infty = 4}$

5 Det. valorile parametrului c care garantează stabilitatea sistemului liniar în timp discret.

$\boxed{R1}$: $H(z) = \dfrac{3z^2 - 4z + 1}{z^3 - 2z^2 + (c + 1{,}3)z - 0{,}1}$

$\Delta(z) = z^3 - 2z^2 + (c+1{,}3)z - 0{,}1 = a_3 z^3 + a_2 z^2 + a_1 z + a_0 \Rightarrow \begin{array}{l} a_3 = 1 \\ a_2 = -2 \\ a_1 = c + 1{,}3 \\ a_0 = -0{,}1 \end{array}$

cu $n = 3$ și $a_3 = 1 > 0$

Sunt testate primele 3 condiții de stabilitate:

$\Delta(1) = 1 - 2 + c + 1{,}3 - 0{,}1 = c + 0{,}2 > 0 \Rightarrow c > -0{,}2 \Rightarrow \underline{c \in (-0{,}2\,;+\infty)}$, (1)

$\Delta(-1) = -1 - 2 - (c + 1{,}3) - 0{,}1 = -3 - c - 1{,}3 - 0{,}1 = -c - 4{,}4 < 0$ (n este impar) $\Rightarrow$

$c + 4{,}4 > 0 \Rightarrow c > -4{,}4 \Rightarrow \underline{c \in (-4{,}4\,;+\infty)}$, (2)

$\left.\begin{array}{l} a_0 = -0{,}1 \Rightarrow |a_0| = 0{,}1 \\ a_3 = 1 \end{array}\right\} \Rightarrow 0{,}1 < 1 \Rightarrow |a_0| < a_3$

$b_0 = \begin{vmatrix} a_0 & a_3 \\ a_3 & a_0 \end{vmatrix} = \begin{vmatrix} -0{,}1 & 1 \\ 1 & -0{,}1 \end{vmatrix} = (-0{,}1)^2 - 1 = -0{,}99$

$b_1 = \begin{vmatrix} a_0 & a_2 \\ a_3 & a_1 \end{vmatrix} = \begin{vmatrix} -0{,}1 & -2 \\ 1 & c + 1{,}3 \end{vmatrix} = -0{,}1(c + 1{,}3) + 2 = -0{,}1c - 0{,}13 + 2 = 1{,}87 - 0{,}1c$

$$b_2 = \begin{vmatrix} a_0 & a_1 \\ a_3 & a_2 \end{vmatrix} = \begin{vmatrix} -0,1 & c+1,3 \\ 1 & -2 \end{vmatrix} = 0,2-(c+1,3) = 0,2-c-1,3 = -(c+1,1)$$

Linie	z^0	z^1	z^2	z^3
1	$-0,1$ (a_0)	$c+1,3$ (a_1)	-2 (a_2)	1 (a_3)
2	1 (a_3)	-2 (a_2)	$c+1,3$ (a_1)	$-0,1$ (a_0)
3	$-0,99$ (b_0)	$1,87-0,1c$ (b_1)	$-(c+1,1)$ (b_2)	$-$
4	$-(c+1,1)$ (b_2)	$1,87-0,1c$ (b_1)	$-0,99$ (b_0)	$-$

$$\left.\begin{array}{l} |b_0| = 0,99 \\ |b_2| = |-(c+1,1)| = c+1,1 \end{array}\right\} \Rightarrow |b_0| > |b_2| \Rightarrow 0,99 > c+1,1 \Rightarrow c < -0,11$$

$$\Rightarrow \underline{c \in (-\infty; -0,11)}, \ (3)$$

Din (1), (2) și (3) $\Rightarrow c \in (-0,2; -0,11)$

$\boxed{R2}$: $H_2(z) = \dfrac{6z^2-3z+0,5}{z^3+2z^2+(c-1,3)z+0,1}$

$$\Delta(z) = z^3+2z^2+(c-1,3)z+0,1 = a_3z^3+a_2z^2+a_1z+a_0 \Rightarrow \begin{array}{l} a_3 = 1 \\ a_2 = 2 \\ a_1 = c-1,3 \\ a_0 = 0,1 \end{array}$$

cu $n=3$ și $a_3 = 1 > 0$

Sunt testate primele 3 condiții de stabilitate:

$\Delta(1) = 1+2+c-1,3+0,1 = c+1,8 > 0 \Rightarrow c > -1,8 \Rightarrow \underline{c \in (-1,8; \infty)}, \ (1)$

$\Delta(-1) = -1+2+(c-1,3)(-1)+0,1 = 1-c+1,3+0,1 = 2,4-c < 0 \Rightarrow c > 2,4$

$\Rightarrow \underline{c \in (2,4; \infty)}, \ (2)$

$$\left.\begin{array}{l} a_0 = 0,1 \Rightarrow |a_0| = 0,1 \\ a_3 = 1 \end{array}\right\} \Rightarrow |a_0| < a_3 \Rightarrow 0,1 < 1$$

$$b_0 = \begin{vmatrix} a_0 & a_3 \\ a_3 & a_0 \end{vmatrix} = \begin{vmatrix} 0,1 & 1 \\ 1 & 0,1 \end{vmatrix} = 0,1^2 - 1 = -0,99$$

$$b_1 = \begin{vmatrix} a_0 & a_2 \\ a_3 & a_1 \end{vmatrix} = \begin{vmatrix} 0,1 & 2 \\ 1 & c-1,3 \end{vmatrix} = 0,1(c-1,3)-2 = 0,1c-0,13-2 = 0,1c-2,13$$

$$b_2 = \begin{vmatrix} a_0 & a_1 \\ a_3 & a_2 \end{vmatrix} = \begin{vmatrix} 0,1 & c-1,3 \\ 1 & 2 \end{vmatrix} = 0,2-(c-1,3) = 0,2-c+1,3 = -c+1,5 = -(c-1,5)$$

Linie	z^0	z^1	z^2	z^3
1	0,1 (a_0)	$c-1,3$ (a_1)	2 (a_2)	1 (a_3)
2	1 (a_3)	2 (a_2)	$c-1,3$ (a_1)	0,1 (a_0)
3	$-0,99$ (b_0)	$0,1c-2,13$ (b_1)	$-(c-1,5)$ (b_2)	–
4	$-(c-1,5)$ (b_2)	$0,1c-2,13$ (b_1)	$-0,99$ (b_0)	–

$$\left.\begin{array}{l}|b_0| = 0,99 \\ |b_2| = |-(c-1,5)| = c-1,5\end{array}\right\} \Rightarrow |b_0| > |b_2| \Rightarrow 0,99 > c-1,5 \Rightarrow c < 2,49$$

$$\Rightarrow \underline{c \in (-\infty ; 2,49)}, \ (3)$$

din (1), (2), (3) $\Rightarrow \boxed{c \in (2,4;\ 2,49)}$

SCHEMA DE LA ÎNCEPUTUL EXAMENULUI: