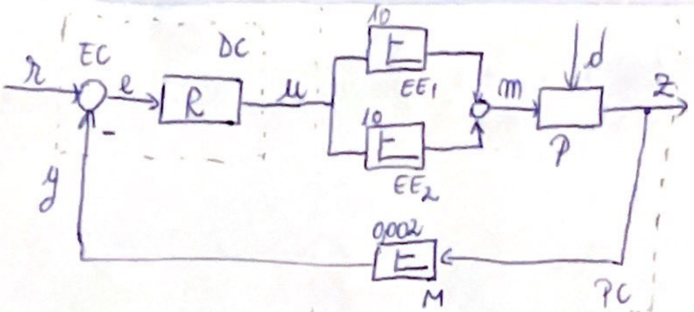


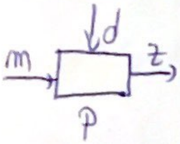
Se consideră SRA cu schema bloc alăturată, în care r(t) este referin, e(t) este eroarea de reglare și MM-ISI-ul blocului P este:

$$\begin{cases}\dot{X}_1=-2X_1+2X_2+40d\\ \dot{X}_2=-0,5X_2+12,5m\\ z=X_1\end{cases}$$

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

R_2: $H_R(s)=\frac{k_R(1+T_d s)}{1+T_f s}$ (ET-PDT$_1$)

<u>Rezolvare</u>: Căutăm ~~P-ul~~ $H_P(s)$?



, sunt 2 intrări și o ieșire ⇒ căutăm 2 f.d.t. $H_{zm}(s)=\frac{Z(s)}{m(s)}\Big|_{d=0}$ și $H_{zd}(s)=\frac{Z(s)}{d(s)}\Big|_{m}$

Căutăm matricile A, B, C, pt. a găsi matricea de transfer $H(s)=C\cdot(sI-A)^{-1}\cdot B$

$$\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\end{bmatrix}=\underbrace{\begin{bmatrix}-2 & 2\\ 0 & -0,5\end{bmatrix}}_{A}\cdot\begin{bmatrix}X_1\\ X_2\end{bmatrix}+\underbrace{\begin{bmatrix}0 & 40\\ 12,5 & 0\end{bmatrix}}_{B}\cdot\begin{bmatrix}m\\ d\end{bmatrix}\begin{matrix}\alpha 1\\ \alpha 2.\end{matrix}\qquad z=\underbrace{[1\ \ 0]}_{C}\cdot\begin{bmatrix}X_1\\ X_2\end{bmatrix}$$

Not. $M=sI-A=\begin{bmatrix}s & 0\\ 0 & s\end{bmatrix}-\begin{bmatrix}-2 & 2\\ 0 & -0,5\end{bmatrix}=\begin{bmatrix}s+2 & -2\\ 0 & s+0,5\end{bmatrix}$, $M^{-1}=?$ $M^{-1}=\frac{1}{\det M}\cdot M^*$

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

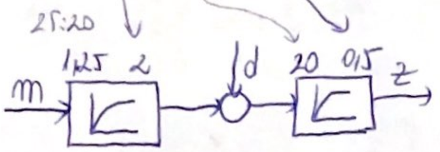
$=(1+0,5s)(1+2s)$ (mai util $(1+\ldots s)$)

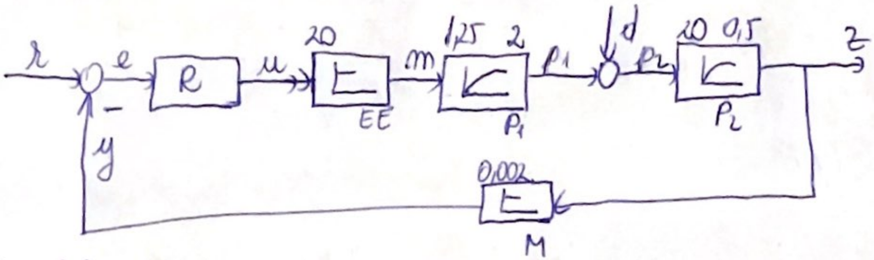
$M^*=\begin{bmatrix}(-1)^{1+1}(s+0,5) & (-1)^{1+2}(-2)\\ (-1)^{2+1}\underset{0}{\cancel{(s+2)}} & (-1)^{2+2}(s+2)\end{bmatrix}=\begin{bmatrix}s+0,5 & 2\\ 0 & s+2\end{bmatrix}\Rightarrow M^{-1}=\begin{bmatrix}\frac{\overset{s+0,5}{\cancel{1+0,5s}}}{(1+0,5s)(1+2s)} & \frac{2}{(1+0,5s)(1+2s)}\\ 0 & \frac{s+2}{(1+0,5s)(1+2s)}\end{bmatrix}$ mai bine nu:)

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

$=\frac{1}{(1+0,5s)(1+2s)}\cdot[25\ \ 40s+20]=\left[\frac{25}{(1+0,5s)(1+2s)}\ \ \frac{40(\overbrace{s+0,5}^{0,5(2s+1)})}{(1+0,5s)(1+2s)}\right]=\left[\frac{25}{(1+0,5s)(1+2s)}\ \ \frac{40\cdot0,5\cancel{(1+2s)}}{(1+0,5s)\cancel{(1+2s)}}\right]=$

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





$H_{EE}(s) = H_{EE_1}(s) + H_{EE_2}(s) = 10 + 10 = 20$ (ET-P)

$H_{P_1}(s) = \frac{1,25}{1+2s}$ (ET-PT$_1$)

$H_{P_2}(s) = \frac{20}{1+0,5s}$ (ET-PT$_1$)

$H_M(s) = 0,002$ (ET-P)

① Calc. c.d.t. adică $H_{y,r}(s)$, $H_{y,d}$, $H_d(s)$

Ⓡ1 $$H_{y,r}(s) = \left.\frac{y(s)}{r(s)}\right|_{d=0} = \frac{H_{EE}(s)\cdot H_{P_1}(s)\cdot H_{P_2}(s)\cdot H_M(s)\cdot H_R(s)}{1+H_{EE}(s)\cdot H_{P_1}(s)\cdot H_{P_2}(s)\cdot H_M(s)\cdot H_R(s)\cdot 1} =$$

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

$$= \frac{k_R(1+sT_i)}{\cancel{(1+2s)(1+0,5s)sT_i}}\cdot\frac{\cancel{(1+2s)(1+0,5s)sT_i}}{(1+2s)(1+0,5s)sT_i + k_R(1+sT_1)} =$$

$$= \frac{k_R + sT_ik_R}{(s^2+2,5s+1)sT_i + k_R + k_RsT_i} =$$

Pt $T_i = 2,5$ sec $$= \frac{k_R + sT_ik_R}{s^3T_i + s^2(2,5T_i + s(T_i + k_RT_i) + k_R}$$

$$= \frac{k_R + 2,5sk_R}{2,5s^3 + 6,25s^2 + 2,5s + 2,5k_Rs + k_R}$$

$$H_{y,d}(s) = \left.\frac{y(s)}{d(s)}\right|_{r=0} = \frac{H_{P_2}(s)\cdot H_M(s)}{1 \underset{-}{+} H_{P_2}(s)\cdot H_M(s)\cdot H_R(s)\, H_{EE}(s)\cdot H_{P_1}(s)(-)} =$$

$$= \frac{\frac{20}{1+0{,}5s}\cdot 0{,}002}{1+\frac{20}{1+0{,}5s}\cdot 0{,}002\cdot\frac{k_R(1+2{,}5s)}{2{,}5s}\cdot 20\cdot\frac{1{,}25}{1+2s}} = \cancel{\frac{\frac{0{,}04}{1+0{,}5s}}{1+}}$$

$$= \frac{0{,}04}{\cancel{1+0{,}5s}}\cdot\frac{2{,}5s(1+2s)\cancel{(1+0{,}5s)}}{2{,}5s(1+2s)(1+0{,}5s)+k_R(1+2{,}5s)} = \frac{0{,}1s(1+2s)}{2{,}5s(s^2+2{,}5s+1)+k_R+2{,}5sk_R} =$$

$$= \frac{0{,}1s(1+2s)}{2{,}5s^3+6{,}25s^2+\cancel{s(2{,}5}\,2{,}5s(1+k_R)+k_R}$$ (dacă ~~a~~ $H_{y,r}$ și $H_{y,d}$ au același numitor, e semn bun)

$$H_0(s) = H_R(s)\cdot H_{PC}(s)$$

$$H_{PC}(s) = H_{EE}(s)\cdot H_{P_1}(s)\cdot H_{P_2}(s)\cdot H_M(s) = 20\cdot\frac{1{,}25}{1+2s}\cdot\frac{20}{1+0{,}5s}\cdot 0{,}002 = \frac{1}{(1+2s)(1+0{,}5s)}$$

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

Ⓡ₂ $H_{y,d}$, $H_{y,r}$ și H_0 se calculează la fel, diferă doar funcția regulatorului

$T_d = 2{,}5$ sec

$T_f = 0{,}1$ sec

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

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

$$= \frac{k_R(1+2{,}5s)}{s^2+2{,}5s+1+0{,}1s^3+0{,}25s^2+0{,}1s+k_R+2{,}5sk_R} = \frac{k_R(1+2{,}5s)}{0{,}1s^3+1{,}25s^2+\cancel{s(2{,}6)}\,2{,}6s+2{,}5sk_R+k_R}$$

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

$$=\frac{0,04(s^2+2,5s+1)}{s^2+2,5s+1+0,1s^3+0,25s^2+0,1s+k_R+2,5sk_R}=\frac{0,04(s^2+2,5s+1)}{0,1s^3+1,25s^2+2,6s+2,5sk_R+k_R}$$

$$H_0(s)=H_R(s)\cdot H_{PC}(s)=\frac{k_R(1+2,5s)}{1+0,1s}\cdot\frac{1}{(1+0,5s)(1+2s)}=\frac{k_R(1+2,5s)}{(1+0,1s)(1+0,5s)(1+2s)}$$

② Găsiți $k_R>0$ pt. care SRA stabil

(R_1) Folosim criteriul de stabilitate a lui Hurwitz

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

Luăm $\Delta(s)$ ca fiind numărătorul

$$\Delta(s)=2,5s(s^2+2,5s+1)+k_R+2,5sk_R=2,5s^3+\cancel{s^2(6,25}\;6,25s^2+s(2,5+2,5k_R)+k_R$$

$$=2,5s^3+6,25s^2+2,5s(1+k_R)+k_R$$

Impunem condițiile necesare

$$\left.\begin{aligned}&a_3=2,5>0\\&a_2=6,25>0\\&a_1=1+k_R>0\Rightarrow k_R>-1\Rightarrow k_R\in(-1;+\infty)\\&a_0=k_R\Rightarrow k_R\in(0,\infty)\end{aligned}\right\}\Rightarrow k_R\in(-1;+\infty)\cap(0;+\infty)\Rightarrow k_R\in(0;+\infty)\ ①$$

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

Impunem condițiile suficiente

$$\left.\begin{aligned}&\det(H_1)=a_2=2,5>0\\&\det(H_2)=a_2a_1-a_3a_0=6,25+6,25k_R-2,5k_R>0\Leftrightarrow 6,25+3,75k_R>0\Rightarrow\\&\qquad\Rightarrow 3,75k_R>-6,25\Rightarrow \cancel{k_R\in(0,\infty)}\Rightarrow k_R>-1,66\Rightarrow k_R\in(-1,66;+\infty)\\&\det(H_3)=\overset{k_R}{\overset{\shortparallel}{a_0}}\cdot\underbrace{\det(H_2)}_{>0}\Rightarrow k_R\in(0;\infty)\end{aligned}\right\}\overset{*}{\Rightarrow}$$

$\overset{*}{\Rightarrow} k_R \in (-1{,}66;+\infty) \cap (0;\infty) \Rightarrow k_R \in (0;+\infty)$ ②

Din ①, ② şi cerinţă $\Rightarrow k_R \in (0,+\infty) \cap (0;+\infty) \cap (0;+\infty) \Rightarrow k_R \in (0,+\infty)$

(R₂) Folosim crit. lui Hurwitz

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

Luăm $\Delta(s)$ ca fiind numărătorul

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

$$= 0{,}1s^3 + 1{,}25s^2 + s(2{,}6 + 2{,}5k_R) + k_R$$

Impunem condiţiile necesare

$$\left.\begin{array}{l} a_3 = 0{,}1 > 0 \\ a_2 = \cancel{2}\,1{,}25 > 0 \\ a_1 = 2{,}6 + 2{,}5k_R > 0 \Leftrightarrow 2{,}5k_R > -2{,}6 \Leftrightarrow k_R > -1{,}04 \Rightarrow k_R \in (-1{,}04;+\infty) \\ a_0 = k_R > 0 \Rightarrow k_R \in (0;+\infty) \end{array}\right\} \Rightarrow k_R \in (-1{,}04;+\infty) \cap (0,\infty) \Rightarrow k_R \in (0;+\infty) \text{ ①}$$

f. $n=3 \Rightarrow$ mat. lui Hurwitz $H = \begin{bmatrix} a_2 & a_0 & 0 \\ a_3 & a_1 & 0 \\ 0 & a_2 & a_0 \end{bmatrix} = \begin{bmatrix} 1{,}25 & k_R & 0 \\ 0{,}1 & 2{,}6+2{,}5k_R & 0 \\ 0 & 1{,}25 & k_R \end{bmatrix}$

~~det~~ Impunem condiţiile suficiente

$$\left.\begin{array}{l} \det(H_1) = a_2 = 1{,}25 > 0 \\ \det(H_2) = a_2a_1 - a_3a_0 = 1{,}25(2{,}6+2{,}5k_R) - 0{,}1k_R = 3{,}25 + 3{,}125k_R - 0{,}1k_R = \\ \quad = 3{,}25 + 3{,}025k_R > 0 \Rightarrow 3{,}025k_R > -3{,}25 \Rightarrow k_R > -1{,}07 \Rightarrow k_R \in (-1{,}07;+\infty) \\ \det(H_3) = \underset{k_R}{\overset{\shortparallel}{a_0}} \cdot \underbrace{\det(H_2)}_{>0} \Rightarrow k_R > 0 \Rightarrow k_R \in (0;+\infty) \end{array}\right\} \overset{*}{\Rightarrow}$$

$\overset{*}{\Rightarrow} k_R \in (-1{,}07;+\infty) \cap (0;+\infty) \Rightarrow k_R \in (0;+\infty)$ ②

Din ①, ② şi cerinţă $\Rightarrow k_R \in (0,+\infty) \cap (0;+\infty) \cap (0;+\infty) \Rightarrow k_R \in (0;+\infty)$

⑤ Considerând ieșirea $y(t)$, sist. stabil, alegeți o val. pt. $k_R > 0$, găsiți val. statismului natural $\gamma_m^r(y)$. Acceptând val. nominale $d_n = 50$ și $y_m = 100$, găsiți valoarea statismului nat. în unități raportate în procente $\gamma_n^r(y)\%$

Ⓡ₁ Avem regulator ~~$ET - PI \Rightarrow \gamma_m^r(y) = 0$~~ de tip PI, are componentă integratoare

$\Rightarrow$ statismul natural este nul $\gamma_n^r(y) = 0$

$$\gamma_n^r(y)\% = \gamma_m^r(y) \cdot \frac{d_n}{y_m} \cdot 100\% = 0$$

Ⓡ₂ $\gamma_m^r(y) = \frac{y_\infty}{d_\infty}$ (cam lung) sau $\gamma_m^r(y) = \frac{k_N}{1 + k_0}$, $k_0 = k_R \cdot k_{PC}$

$$\left.\begin{array}{l} k_N = 20 \cdot 0{,}002 = 0{,}04 \\ \left.\begin{array}{l} k_R = 3 \text{ (ales)} > 0 \\ k_{PC} = 20 \cdot 1{,}25 \cdot 20 \cdot 0{,}002 \boxed{= 1} \end{array}\right\} k_0 = 3 + 1 = 4 \end{array}\right] \Rightarrow \gamma_m^r(y) = \frac{0{,}04}{4} = 0{,}01$$

$$\gamma_m^r(y)\% = \gamma_m(y) \cdot \frac{d_m}{y_m} \cdot 100\% = 0{,}01 \cdot \frac{50}{100} \cdot 100\% = \frac{0{,}5}{\cancel{100}} \cdot \cancel{100\%} = 0{,}5$$

④ Acceptând sist. stabil, alegeți o val. pt $k_R > 0$, pt. $d_\infty = 50$ și $Z_\infty = 5000$, calc. VRSC $\{r_\infty, e_\infty, u_\infty, m_\infty, y_\infty\}$

Ⓡ₁ Regulator tip PI

$$\left.\begin{array}{l} e_\infty = 0 \\ e_\infty = r_\infty - y_\infty \end{array}\right\} \Rightarrow r_\infty = y_\infty$$

$m_\infty = 20 u_\infty = 160$

$\rho_{1\infty} = 1{,}25 m_\infty = 1{,}25 \cdot 20 \cdot u_\infty = 25 u_\infty = 200$

$\rho_{2\infty} = \rho_{1\infty} + d_\infty = 25 u_\infty + 50 = 250$

$$\left.\begin{array}{l} Z_\infty = 20 \rho_{2\infty} = 500 u_\infty + 1000 \\ Z_\infty = 5000 \end{array}\right\} \Rightarrow \begin{array}{l} 500 u_\infty + 1000 = 5000 \\ 500 u_\infty = 4000 \Rightarrow u_\infty = 8 \end{array}$$

$y_\infty = 0{,}002 \cdot Z_\infty = 10 \Rightarrow r_\infty = 10$

- (R_2) Regulator $PDT_1 \Rightarrow e_\infty \neq 0$

  $e_\infty = r_\infty - y_\infty$

1 $m_\infty = 20 u_\infty = 160$

$p_{1\infty} = 1,25 m_\infty = 1,25 \cdot 20 u_\infty = 25 u_\infty = 200$

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

1 $\left.\begin{array}{l} z_\infty = 20 \cdot p_{2\infty} = 500 u_\infty + 1000 \\ z_\infty = 5000 \end{array}\right\} \Rightarrow 500 u_\infty + 1000 = 5000$

$u_\infty = 8$

1 $y_\infty = 0,002 \cdot 5000 = 10 \Rightarrow e_\infty = r_\infty - 10$

Alegem $k_R = 2 \Rightarrow \left.\begin{array}{l} u_\infty = \cancel{2k_R}\, k_R \cdot e_\infty = 2 e_\infty \\ u_\infty = 8 \end{array}\right\} \Rightarrow e_\infty = 4 \Rightarrow 4 = r_\infty - 10$

$r_\infty = 14$

⑤ Det. val. lui c care garantează stabilitatea sist. liniar în timp discret

(R_1) $H(z) = \dfrac{3z^2 - 4z + 1}{z^3 - 2z^2 + (c+1,3)z - 0,1}$

Luăm $\Delta(z)$ ca fiind numitorul

$\Delta(z) = z^3 - 2z^2 + (c+1,3)z - 0,1$ cu $n = 3$ și $a_3 = 1 > 0$

$\Downarrow$

Sunt testate 4 condiții de stabilitate

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

  $\Rightarrow c \in (-0,2; +\infty)$ ①

- $\Delta(-1) = (-1)^3 - 2 \cdot (-1)^2 + (c+1,3) \cdot (-1) - 0,1 = -1 - 2 - c - 1,3 - 0,1 = -4,4 - c < 0$ n impar

  ~~$\Rightarrow -c > 4,4 \,|\cdot(-1) \Rightarrow c < -4,4$~~ $-c < 4,4 \,|\cdot(-1) \Rightarrow c > -4,4 \Rightarrow c \in (-4,4; +\infty)$ ②

- $|a_0| < a_n \Leftrightarrow |a_0| < a_3 \Leftrightarrow |-0,1| < 1 \Leftrightarrow 0,1 < 1$ Ⓐ

- $|b_0| > |b_{n-1}| \Leftrightarrow |b_0| > |b_2|$

$b_0 = \begin{vmatrix} a_0 & a_3 \\ a_3 & a_0 \end{vmatrix} = a_0^2 - a_3^2 = (-0{,}1)^2 - 1^2 =$ ~~0,1−1=0,~~ $0{,}01 - 1 =$ ~~0,99~~ $-0{,}99$

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

$b_2 = \begin{vmatrix} a_0 & a_1 \\ a_3 & a_2 \end{vmatrix} = a_0 a_2 - a_1 a_3 = (-0{,}1)\cdot(-2) - (c+1{,}3)\cdot(1) =$ ~~0,2+1c+2,6~~
$0{,}2 - c - 1{,}3 = -c - 1{,}1$

$|b_0| > |b_2| \Leftrightarrow |-0{,}99| > |-c-1{,}1| \Leftrightarrow 0{,}99 > c + 1{,}1 \Leftrightarrow c < -0{,}11 \Rightarrow c \in (-\infty; -0{,}11)$ ③

Din ①, ② și ③ $\Rightarrow c \in (-0{,}2; +\infty) \cap (-4{,}4; +\infty) \cap (-\infty; -0{,}11) \Rightarrow c \in (-0{,}2; -0{,}11)$

Ⓡ₂ $H(z) = \dfrac{6z^2 - 3z + 0{,}5}{z^3 + 2z^2 + (c-1{,}3)z + 0{,}1}$

Luăm $\Delta(z)$ ca fiind numitorul

$\Delta(z^3) = z^3 + 2z^2 + (c-1{,}3)z + 0{,}1$

$a_3 = 1$
$a_2 = 2$
$a_1 = c - 1{,}3$
$a_0 = 0{,}1$

, $n = 3$ și $a_3 = 1 > 0$
$\Downarrow$
sunt testate 4 condiții de stabilitate

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

- $\Delta(-1) = (-1)^3 + 2\cdot(-1)^2 + (c-1{,}3)\cdot(-1) + 0{,}1 = -1 + 2 - c + 1{,}3 + 0{,}1 = -c + 2{,}4 < 0$ (n impar)
  $\Rightarrow$ ~~a_1~~ $-c < -2{,}4 \;|\cdot(-1) \Rightarrow c > 2{,}4 \Rightarrow c \in (2{,}4; +\infty)$ ②

- $|a_0| <$ [illegible] $\Leftrightarrow |a_0| < a_3 \Leftrightarrow 0{,}1 < 1$ ④
  a_n

- $|b_0| > |b_{n-1}| \Leftrightarrow |b_0| > |b_2|$

$$b_0 = \begin{vmatrix} a_0 & a_3 \\ a_3 & a_0 \end{vmatrix} = a_0^2 - a_3^2 = 0{,}1^2 - 1^2 = 0{,}01 - 1 = -0{,}99$$

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

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

$|b_0| > |b_2| \Leftrightarrow \cancel{(b_0 - b_2)(b_0 + b_2) > 0}$ $0{,}99 > c - 1{,}5 \Leftrightarrow c < 2{,}49 \Rightarrow c \in (-\infty; 2{,}49)$ ③

Din ①, ② și ③ $\Rightarrow c \in (-1{,}8; +\infty) \cap (2{,}4; \infty) \cap (-\infty; 2{,}49)$

$\Rightarrow c \in (2{,}4; 2{,}49)$