TEORIA SISTEMELOR an II CA

Student : Dragan Dan-Stefan
Grupa: 325 CA

Tema de Casa 1

I. Se considera sistemul liniar neted (SLN) avand realizarea de stare

A = $\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -a^2bc & -[a^2(b+c)+2\text{abc}] & -[a^2+2\text{a}(b+c)+bc] & -(2\text{a}+b+c) \end{bmatrix}$; B = $\begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$;

$x_0=\begin{bmatrix} 0 \\ 0 \\ 0 \\ (-1)^d\cdot e \end{bmatrix}$; C = $\begin{bmatrix} bd & b+c & 1 & 0 \\ ec & e & 0 & 0 \end{bmatrix}$; $ss^T=[x_1 \quad x_2 \quad x_3 \quad x_4 \quad y_1 \quad y_2]$

Sa se determine(numai) ss(b), daca x_0 este cel mentionat, iar
u(t) = $[b\cdot sin3(t-c)+d\cdot cos3(t-c)]\cdot 1(t-c)$

II. Fie sistemul liniar discret (SLD), exprimat intrare-iesire, prin ecuatia cu diferente

$$y(t+4)+(b-2\text{a})\cdot y(t+3)+(a^2-2\text{ab})\cdot y(t+2)+a^2b\cdot y(t+1)=c\cdot u(t+1)+5\cdot u(t) \quad (1)$$

a) Sa se determine functia de transfer a sistemului (conditii initiale nule)

b) Sa se determine, utilizand transformata Z, raspunsul sistemului (reprezentat ca in (1)), daca $u(t)=1(t-1); y(0)=c, y(1)=-e, y(2)=-c, y(3)=d$ (2)

c) Sa se determine realizarile(standard) de stare(inclusiv x_0) pentru sistemul (1)

III. Sa se analizeze stabilitatea interna si externa a SLN(utilizand criteriul Hurwitz)

$$A = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & ce(a^2+b^2)^2 \\ 1 & 0 & 0 & 0 & 0 & (c-e)(a^2+b^2)^2 \\ 0 & 1 & 0 & 0 & 0 & 2\mathrm{ce}(b^2-a^2)-(a^2+b^2)^2 \\ 0 & 0 & 1 & 0 & 0 & 2(c-e)(b^2-a^2) \\ 0 & 0 & 0 & 1 & 0 & ce-2(b^2-a^2) \\ 0 & 0 & 0 & 0 & 1 & c-e \end{bmatrix};$$

$$B = \begin{bmatrix} -c(a^2+b^2) & c(a^2+b^2) \\ a^2+b^2+2\mathrm{ac}-c(a^2+b^2) & -a^2-b^2-2\mathrm{ac}-c(a^2+b^2) \\ a^2+b^2+2\mathrm{ac}-2\mathrm{a}-c & a^2+b^2+2\mathrm{ac}+2\mathrm{a}+c \\ 1-2\mathrm{a}-c & -1-2\mathrm{a}-c \\ 1 & 1 \\ 0 & 0 \end{bmatrix}; \quad C = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

n = numarul de ordine		n = 8
a = n mod 5 + 1		a = 4
b = n mod 6 + 1	$\Rightarrow$	b = 3
c = n mod 4 + 1		c = 1
d = ultima cifra a grupei		d = 5
e = n mod 5 + 1		e = 4

Enunt personalizat:

I. Se considera sistemul liniar neted (SLN) avand realizarea de stare

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -48 & -88 & -51 & -12 \end{bmatrix}; \quad B = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}; \quad x_0 = \begin{bmatrix} 0 \\ 0 \\ 0 \\ -4 \end{bmatrix};$$

$$C = \begin{bmatrix} 15 & 8 & 1 & 0 \\ 4 & 4 & 0 & 0 \end{bmatrix}; \quad ss^T = \begin{bmatrix} x_1 & x_2 & x_3 & x_4 & y_1 & y_2 \end{bmatrix}$$

Sa se determine(numai) ss(3), daca x_0 este cel mentionat, iar

u(t) = $[3\cdot sin3(t-1)+5\cdot cos3(t-1)]\cdot 1(t-1)$

II. Fie sistemul liniar discret (SLD), exprimat intrare-iesire, prin ecuatia cu diferente

$$y(t+4)+(3-2\cdot 4)\cdot y(t+3)+(4^2-2\cdot 4\cdot 3)\cdot y(t+2)+4^2\cdot 3\cdot y(t+1)=1\cdot u(t+1)+5\cdot u(t)$$

$$y(t+4)-5\cdot y(t+3)-8\cdot y(t+2)+48\cdot y(t+1)=u(t+1)+5\cdot u(t) \quad (1)$$

a) Sa se determine functia de transfer a sistemului (conditii initiale nule)

b) Sa se determine, utilizand transformata Z, raspunsul sistemului (reprezentat ca in (1)), daca $u(t)=1(t-1); y(0)=1, y(1)=-4, y(2)=-1, y(3)=5$ (2)

c) Sa se determine realizarile(standard) de stare(inclusiv x_0) pentru sistemul (1)

III. Sa se analizeze stabilitatea interna si externa a SLN(utilizand criteriul Hurwitz)

A = $\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 2500 \\ 1 & 0 & 0 & 0 & 0 & -1875 \\ 0 & 1 & 0 & 0 & 0 & -681 \\ 0 & 0 & 1 & 0 & 0 & 42 \\ 0 & 0 & 0 & 1 & 0 & 18 \\ 0 & 0 & 0 & 0 & 1 & -3 \end{bmatrix}$; B = $\begin{bmatrix} -25 & 25 \\ 8 & -58 \\ 24 & 42 \\ -8 & -10 \\ 1 & 1 \\ 0 & 0 \end{bmatrix}$; C = $\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$

Rezolvare :

I.

A = $\begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ -48 & -88 & -51 & -12 \end{bmatrix}$; B = $\begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$; x_0 = $\begin{bmatrix} 0 \\ 0 \\ 0 \\ -4 \end{bmatrix}$

C = $\begin{bmatrix} 15 & 8 & 1 & 0 \\ 4 & 4 & 0 & 0 \end{bmatrix}$;

u(t) = $[3\cdot sin3(t-1)+5\cdot cos3(t-1)]\cdot 1(t-1)$

u(t) = $[3\cdot sin3(t-1)]\cdot 1(t-1)+[5\cdot cos3(t-1)]\cdot 1(t-1)$

u(s) = $e^{-s}\cdot 3\frac{3}{s^2+9}+e^{-s}\cdot 5\frac{s}{s^2+9}$

u(s) = $\frac{9+5s}{e^s(s^2+9)}$

$x_0+B\cdot u(s)$ = $\begin{bmatrix} 0 \\ 0 \\ 0 \\ \frac{9+5s}{e^s(s^2+9)}-4 \end{bmatrix}$

(sI-A) = $\begin{bmatrix} s & -1 & 0 & 0 \\ 0 & s & -1 & 0 \\ 0 & 0 & s & -1 \\ 48 & 88 & 51 & s+12 \end{bmatrix}$

$\chi(s)$ = det(sI-A)

$\chi(s)$ = $(-1)^{1+1}\cdot s\cdot\begin{vmatrix} s & -1 & 0 \\ 0 & s & -1 \\ 88 & 51 & s+12 \end{vmatrix}+(-1)^{1+2}\cdot(-1)\cdot\begin{vmatrix} 0 & -1 & 0 \\ 0 & s & -1 \\ 48 & 51 & s+12 \end{vmatrix}$

$\chi(s)$ = $s^3(s+12)+88s+51s^2+48$

$\chi(s)$ = $s^4+12s^3+51s^2+88s+48$

$\chi(s)$ = $(s+1)(s+3)(s+4)^2$

$$(sI-A)^T = \begin{bmatrix} s & 0 & 0 & 48 \\ -1 & s & 0 & 88 \\ 0 & -1 & s & 51 \\ 0 & 0 & -1 & s+12 \end{bmatrix}$$

$$x(s) = \frac{1}{\chi(s)}(sI-A)^* \begin{bmatrix} 0 \\ 0 \\ 0 \\ \frac{9+5s}{e^s(s^2+9)}-4 \end{bmatrix}$$

$$x(s) = \frac{1}{(s+1)(s+3)(s+4)^2} \begin{bmatrix} ? & ? & ? & e_{14}^* \\ ? & ? & ? & e_{24}^* \\ ? & ? & ? & e_{34}^* \\ ? & ? & ? & e_{44}^* \end{bmatrix} . \begin{bmatrix} 0 \\ 0 \\ 0 \\ \frac{9+5s}{e^s(s^2+9)}-4 \end{bmatrix}$$

$$e_{14}^* = (-1)^{1+4} \begin{vmatrix} -1 & s & 0 \\ 0 & -1 & s \\ 0 & 0 & -1 \end{vmatrix} = 1$$

$$e_{24}^* = (-1)^{2+4} \begin{vmatrix} s & 0 & 0 \\ 0 & -1 & s \\ 0 & 0 & -1 \end{vmatrix} = s$$

$$e_{34}^* = (-1)^{3+4} \begin{vmatrix} s & 0 & 0 \\ -1 & s & 0 \\ 0 & 0 & -1 \end{vmatrix} = s^2$$

$$e_{44}^* = (-1)^{4+4} \begin{vmatrix} s & 0 & 0 \\ -1 & s & 0 \\ 0 & -1 & s \end{vmatrix} = s^3$$

$$x(s) = \begin{bmatrix} \frac{9+5s}{e^s(s^2+9)(s+1)(s+3)(s+4)^2} - \frac{4}{(s+1)(s+3)(s+4)^2} \\ \frac{s(9+5s)}{e^s(s^2+9)(s+1)(s+3)(s+4)^2} - \frac{4s}{(s+1)(s+3)(s+4)^2} \\ \frac{s^2(9+5s)}{e^s(s^2+9)(s+1)(s+3)(s+4)^2} - \frac{4s^2}{(s+1)(s+3)(s+4)^2} \\ \frac{s^3(9+5s)}{e^s(s^2+9)(s+1)(s+3)(s+4)^2} - \frac{4s^3}{(s+1)(s+3)(s+4)^2} \end{bmatrix}$$

$$x_3(s)=\frac{e^{-s}s^2(9+5s)}{(s^2+9)(s+1)(s+3)(s+4)^2}-\frac{4s^2}{(s+1)(s+3)(s+4)^2}$$

$$\frac{9s^2+5s^3}{(s^2+9)(s+1)(s+3)(s+4)^2}=\frac{A}{s+1}+\frac{Bs+C}{s^2+9}+\frac{D}{s+3}+\frac{E}{s+4}+\frac{F}{(s+4)^2}$$

$$9s^2+5s^3=A(s^2+9)(s+3)(s+4)^2+(Bs+c)(s+1)(s+3)(s+4)^2+D(s+1)(s^2+9)(s+4)^2$$
$$+E(s+1)(s^2+9)(s+3)(s+4)+F(s+1)(s^2+9)(s+3)$$

$$9s^2+5s^3=A(s^5+11s^4+49s^3+147s^2+360s+432)+B(s^5+12s^4+51s^3+88s^2+48s)+C(s^4+12s^3+51s^2+88s+48)$$
$$+D(s^5+9s^4+33s^3+97s^2+216s+144)+E(s^5+8s^4+28s^3+84s^2+171s+108)+F(s^4+4s^3+12s^2+36s+27)$$

$$s^5: A+B+D+E=0$$
$$s^4: 11A+12B+C+9D+8E+F=0$$
$$s^3: 49A+51B+12C+33D+28E+4F=5$$
$$s^2: 147A+88B+51C+97D+84E+12F=9$$
$$s^1: 360A+48B+88C+216D+171E+36F=0$$
$$s^0: 432A+48C+144D+108E+27F=0$$

$$A=\frac{1}{45};B=\frac{147}{1250};C=\frac{387}{1250};D=\frac{3}{2};E=\frac{-9224}{5625};F=\frac{-176}{75}$$

$$\frac{4s^2}{(s+1)(s+3)(s+4)^2}=\frac{A}{s+3}+\frac{B}{s+4}+\frac{C}{(s+4)^2}+\frac{D}{s+1}$$
$$4s^2=A(s+4)^2(s+1)+B(s+3)(s+4)(s+1)+C(s+3)(s+1)+D(s+3)(s+4)^2$$
$$s^3: A+B+D=0$$
$$s^2: 9A+8B+C+11D=4$$
$$s^1: 24A+19B+4C+40D=0$$
$$s^0: 16A+12B+3C+48D=0$$
$$A=-18;B=\frac{160}{9};C=\frac{64}{3};D=\frac{2}{9}$$

$$x_3(s)=e^{-s}\left(\frac{1}{45(s+1)}+\frac{147s}{1250(s^2+9)}+\frac{387}{1250(s^2+9)}+\frac{3}{2(s+3)}-\frac{9224}{5625(s+2)}-\frac{176}{75(s+4)^2}\right)$$
$$-\left(\frac{-18}{s+3}+\frac{160}{9(s+4)}+\frac{64}{3(s+4)^2}+\frac{2}{9(s+1)}\right)$$

$$x_3(t)=\left(\frac{1}{45}\cdot e^{-1(t-1)}+\frac{147}{1250}\cdot cos3(t-1)+\frac{129}{1250}\cdot sin3(t-1)+\frac{3}{2}\cdot e^{-3(t-1)}-\frac{9224}{5625}\cdot e^{-2(t-1)}-\frac{176}{75}\cdot(t-1)e^{-4(t-1)}\right)$$
$$1(t-1)-\left(-18e^{-3t}+\frac{160}{9}\cdot e^{-4t}+\frac{64}{3}\cdot t\cdot e^{-4}+\frac{2}{9}\cdot e^{-t}\right)\cdot 1(t)$$

II.

a)

$y(t+4)-5\cdot y(t+3)-8\cdot y(t+2)+48\cdot y(t+1)=u(t+1)+5\cdot u(t)$

$$z^4 y(z)-[z^4 y(0)+z^3 y(1)+z^2 y(2)+z\cdot y(3)]-5\{z^3 y(z)-[z^3 y(0)+z^2 y(1)+z\cdot y(2)]\}$$
$$-8\{z^2 y(z)-[z^2 y(0)+z\cdot y(1)]\}+48\{z\cdot y(z)-[z\cdot y(0)]\}=z\cdot u(z)-z\cdot u(0)+5\cdot u(z)$$

$y(0)=y(1)=y(2)=y(3)=u(0)=0$ (conditii initiale nule)

$\Rightarrow (z^4-5\cdot z^3-8\cdot z^2+48\cdot z)\cdot y(z)=(z+5)\cdot u(z)$

$y(z)=H(z)\cdot u(z)$

$$\Rightarrow H(z)=\frac{z+5}{z^4-5\cdot z^3-8\cdot z^2+48\cdot z}$$

b)

$u(t)=1(t-1);\ y(0)=1;\ y(1)=-4;\ y(2)=-1;\ y(3)=5$

$$z^4 y(z)-(z^4-4\cdot z^3-z^2+5\cdot z)-5\cdot[z^3\cdot y(z)-(z^3-4\cdot z^2-z)]-8\cdot[z^2\cdot y(z)-(z^2-4\cdot z)]+48\cdot[z\cdot y(z)-z]$$
$$=Z\{1(t)\}+5\cdot Z\{1(t-1)\}=\frac{z+5}{z-1}$$

$$(z^4-5\cdot z^3-8\cdot z^2+48\cdot z)\cdot y(z)-(z^4-9\cdot z^3+11\cdot z^2+90\cdot z)=\frac{z+5}{z-1}$$

$$(z^4-5\cdot z^3-8\cdot z^2+48\cdot z)\cdot y(z)=\frac{z^5-10\cdot z^4+2o\cdot z^3+79\cdot z^2-89\cdot z+5}{z-1}$$

$$\Rightarrow y(z)=\frac{z^5-10\cdot z^4+20\cdot z^3+79\cdot z^2-89\cdot z+5}{z^5-6\cdot z^4-3\cdot z^3+56\cdot z^2-48\cdot z}$$

$$\frac{y(z)}{z}=\frac{z^5-10\cdot z^4+20\cdot z^3+79\cdot z^2-89\cdot z+5}{z\cdot(z^5-6\cdot z^4-3\cdot z^3+56\cdot z^2-48\cdot z)}$$

$$\frac{y(z)}{z}=\frac{A}{z^2}+\frac{B}{z-1}+\frac{C}{z}+\frac{D}{z+3}+\frac{E}{z-4}+\frac{F}{(z-4)^2}$$

$$A(z^4-6z^3-3z^2+56z-48)+B(z^5-5z^4-8z^3+48z^2)+C(z^5-64z^4-3z^3+56z^2-48z)$$
$$+D(z^5-9z^4+24z^3-16z^2)+E(z^5-2z^4-11z^3+12z^2)+F(z^4+2z^3-3z^2)=z^5-10\cdot z^4+20\cdot z^3$$
$$+79\cdot z^2-89\cdot z+5$$

$z^5: B+C+D+E=1$

$z^4: A-5B-6C-9D-2E+2F=-10$

$z^3: -6A-8B-3C+24D-11E+2F=20$

$z^2: 48B+56C-16D+12E\text{-}3F=79$

$z^1: 56A-48C=-89$

$z^0: -48A=5$

$$\Rightarrow A=\frac{-5}{48};B=\frac{1}{6};C=\frac{499}{288};D=\frac{305}{882};E=\frac{-5857}{4704};F=\frac{219}{112}$$

$$y(z)=\frac{-5}{48}\cdot z^{-1}+\frac{1}{6}\frac{z}{z-1}+\frac{499}{288}+\frac{305}{882}\frac{z}{z+3}-\frac{5857}{4704}\frac{z}{z-4}+\frac{219}{112}\frac{z}{(z-4)^2}$$

$$y(t)=[\frac{-5}{48}u_0(t-1)+\frac{1}{6}+\frac{499}{288}u_0(t)+\frac{305}{882}(-3)^t-\frac{5857}{4704}4^t+\frac{219}{112}4^{t-1}\cdot t]\cdot 1(t)$$

c)

III.

$$A = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 2500 \\ 1 & 0 & 0 & 0 & 0 & -1875 \\ 0 & 1 & 0 & 0 & 0 & -681 \\ 0 & 0 & 1 & 0 & 0 & 42 \\ 0 & 0 & 0 & 1 & 0 & 18 \\ 0 & 0 & 0 & 0 & 1 & -3 \end{bmatrix} ; \; B = \begin{bmatrix} -25 & 25 \\ 8 & -58 \\ 24 & 42 \\ -8 & -10 \\ 1 & 1 \\ 0 & 0 \end{bmatrix} ; \; C = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

a) stabilitatea interna

$\chi(s) = -2500 + 1875 \cdot s + 681 \cdot s^2 - 42 \cdot s^3 - 18 \cdot s^4 + 3 \cdot s^5 + s^6$ (Realizare standard observabila)

$$\chi(s) = s^6 + 3 \cdot s^5 - 18 \cdot s^4 - 42 \cdot s^3 + 681 \cdot s^2 + 1875 \cdot s - 2500$$

$$H = \begin{bmatrix} 3 & -42 & 1875 & 0 & 0 & 0 \\ 1 & -18 & 681 & -2500 & 0 & 0 \\ 0 & 3 & -42 & 1875 & 0 & 0 \\ 0 & 1 & -18 & 681 & -2500 & 0 \\ 0 & 0 & 3 & -42 & 1875 & 0 \\ 0 & 0 & 1 & -18 & 681 & -2500 \end{bmatrix}$$

$H_1 = 3 > 0$

$H_2 = 3 \cdot (-18) - 1 \cdot (-42) = -12 > 0$ $\Rightarrow$ SLN nu e stabil intern

b) stabilitatea externa

$$T(s) = C \cdot (sI - A)^{-1} \cdot B = \frac{\bar{R}(s)}{\chi(s)} = \frac{R(s)}{p(s)}$$

$$T(s) = \begin{bmatrix} 1 & s & s^2 & s^3 & s^4 & s^5 \end{bmatrix} \cdot B \frac{1}{\chi(s)}$$

$$T(s) = \begin{bmatrix} 1 & s & s^2 & s^3 & s^4 & s^5 \end{bmatrix} \cdot \begin{bmatrix} -25 & 25 \\ 8 & -58 \\ 24 & 42 \\ -8 & -10 \\ 1 & 1 \\ 0 & 0 \end{bmatrix} \frac{1}{s^6 + 3 \cdot s^5 - 18 \cdot s^4 - 42 \cdot s^3 + 681 \cdot s^2 + 1875 \cdot s - 2500}$$

$$T(s)=\frac{[-25\vdots 25]\cdot 1+[8\vdots -58]\cdot s+[24\vdots 42]\cdot s^2+[-8\vdots -10]\cdot s^3+[1\vdots 1]\cdot s^4+[0\vdots 0]\cdot s^5}{s^6+3\cdot s^5-18\cdot s^4-42\cdot s^3+681\cdot s^2+1875\cdot s-2500}$$

$$T(s)=\frac{[s^4-8s^3+24s^2+8s-25\vdots s^4-10s^3+42s^2-58s+25]}{s^6+3\cdot s^5-18\cdot s^4-42\cdot s^3+681\cdot s^2+1875\cdot s-2500}=\frac{[\bar{r}_{11}\vdots \bar{r}_{12}]}{\chi(s)}$$

$$\chi(s)=(s-1)(s+4)(s^2-8s+25)(s^2+8s+25)$$

$$\bar{r}_{11}=(s-1)(s+1)(s^2-8s+25)$$
$$\bar{r}_{12}=(s-1)^2(s^2-8s+25)$$

$$\begin{array}{c} s^4-8s^3+24s^2+8s-25 \\ s^4-10s^3+42s^2-58s+25 \\ s^6+3s^5-18s^4-42s^3+681s^2+1875s-2500 \end{array} \rightarrow \begin{array}{c} s^4-8s^3+24s^2+8s-25 \\ -2s^3+18s^2-64s+50 \\ 0 \end{array}$$

$$\rightarrow \begin{array}{c} s^3-9s^2+32s-25 \\ s^4-8s^3+24s^2+8s-25 \\ 0 \end{array} \rightarrow \begin{array}{c} s^3-9s^2+32s-25 \\ 0 \\ 0 \end{array}$$

$$\begin{array}{c} s^6+3s^5-18s^4-42s^3+681s^2+1875s-2500 \\ \underline{-s^6+8s^5-24s^4-8s^3+25s^2} \\ 11s^5-42s^4-50s^3+706s^2+1875s-2500 \\ \underline{-11s^5+88s^4-264s^3-88s^2+275s} \\ 46s^4-314s^3+618s^2+2150s-2500 \\ \underline{-46s^4+368s^3-1104s^2-368s-1150} \\ 54s^3-486s^2+1782s-1350 \\ 54(s^3-9s^2+33s-25) \end{array} \qquad :\frac{s^4-8s^3+24s^2+8s-25}{s^2+11s+64}$$

$$\begin{array}{c} s^4-8s^3+24s^2+8s-25 \\ \underline{-s^4+9s^3-33s^2+25s} \\ s^3-9s^2+33s-25 \\ \underline{-s^3+9s^2-33s+25} \\ 0 \end{array} \qquad :\frac{s\,3-9s^2+33s-25}{s+1}$$

$$
\begin{array}{c}
s^6+3s^5-18s^4-42s^3+681s^2+1875s-2500 \\
-s^6+9s^5-33s^4+25s^3 \\
\hline
12s^5-51s^4-17s^3+681s^2+1875s-2500 \\
-12s+108s^4-396s^3+3000s^2 \\
\hline
57s^4-413s^3+981s^2+1875s-2500 \\
-57s^4-513s^3-1881s^2+1425s \\
\hline
100s^3-900s^2+3300s-2500 \\
-100s^3+800s^2-3300s+2500 \\
\hline
0
\end{array}
\quad : \quad
\begin{array}{c}
s^3-9s^2+33s-25 \\
\hline
s^3+12s^2+57s+100
\end{array}
$$

$$p(s)=\frac{\chi(s)}{cmmdc\{\chi(s),\bar{r}_{11},\bar{r}_{12}\}}=s^3+12s^2+57s+100$$

$$H = \begin{bmatrix} 12 & 100 & 0 \\ 1 & 57 & 0 \\ 0 & 12 & 100 \end{bmatrix}$$

$$H_1=12>0$$

$$H_2=12\cdot57-100=674>0$$

$$H_3=12\cdot57\cdot100-100\cdot100=100\cdot H_2>0$$

$\Rightarrow$ SLN e strict stabil extern