Nise 6.9

Closed-loop t.f.

$E = R - C \qquad C = GE = G(R-C)$ we want $\frac{C(s)}{R(s)}$

$\Rightarrow \quad C + GC = GR$

$\Rightarrow \quad C = \frac{G}{1+G} R \quad \rightarrow \quad \frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)}$

$$\frac{C(s)}{R(s)} = \frac{240}{(s+1)(s+2)(s+3)(s+4)+240} = \frac{240}{s^4+10s^3+35s^2+50s+264}$$ #

Routh table

s^4	1	35	264
s^3	10	50	0
s^2	$b_1=30$	b_2	b_3
s^1	$c_1=-38$	c_2	0
s^0	$d_1=264$		

$$b_1 = -\frac{\begin{vmatrix} 1 & 35 \\ 10 & 50 \end{vmatrix}}{10} = 30$$

$$b_2 = -\frac{\begin{vmatrix} 1 & 264 \\ 10 & 0 \end{vmatrix}}{10} = 264$$

$$b_3 = 0$$

$$c_1 = -\frac{\begin{vmatrix} 10 & 50 \\ b_1 & b_2 \end{vmatrix}}{b_1} = -38$$

$$c_2 = -\frac{\begin{vmatrix} 10 & 0 \\ b_1 & b_3 \end{vmatrix}}{b_1} = 0$$

$$d_1 = -\frac{\begin{vmatrix} b_1 & b_2 \\ c_1 & c_2 \end{vmatrix}}{c_1} = 264$$

Interpretation

This is a basic Routh table. There are two sign changes in the first column. Therefore, the c.l. system is unstable with two poles in the l.h.p. There are two poles in r.h.p.