KORANOLE JOSEPH O.
17/ENG04/038
Elect/Elect
EEE 441

1) In control theory & stability theory, root locus analysis is a graphical method for examining how the roots of a system change with variation of a certain system parameter, commonly a gain with a feedback system. This is a technique used as a stability criterion in the field of classical control theory. The root locus plots the poles ~~of~~ the closed loop transfer function in the complex s-plane as a function of a gain ~~parameter~~ parameter.

A graphical method that uses a special protractor called a "Spirule" was once used to determine angles and draw the root loci.

2) A

Initial layout for Routh's table

s^4	a_4	a_2	a_0
s^3	a_3	a_1	0
s^2	b_1	b_2	0
s^1	c_1	0	0
s^0	d_1	0	0

$$b_1 = -\frac{\begin{vmatrix} a_4 & a_2 \\ a_3 & a_1 \end{vmatrix}}{a_3} \qquad b_2 = -\frac{\begin{vmatrix} a_4 & a_0 \\ a_3 & 0 \end{vmatrix}}{a_3}$$

$$b_3 = -\frac{\begin{vmatrix} a_4 & 0 \\ a_3 & 0 \end{vmatrix}}{a_3} = 0$$

In that order; $C_1 = -\frac{\begin{vmatrix} a_3 & a_1 \\ b_1 & b_2 \end{vmatrix}}{b_1}$ $\qquad C_2 = -\frac{\begin{vmatrix} a_3 & 0 \\ b_1 & 0 \end{vmatrix}}{b_1} = 0$

$$d_1 = -\frac{\begin{vmatrix} b_1 & b_2 \\ c_1 & 0 \end{vmatrix}}{c_1} = d_1$$

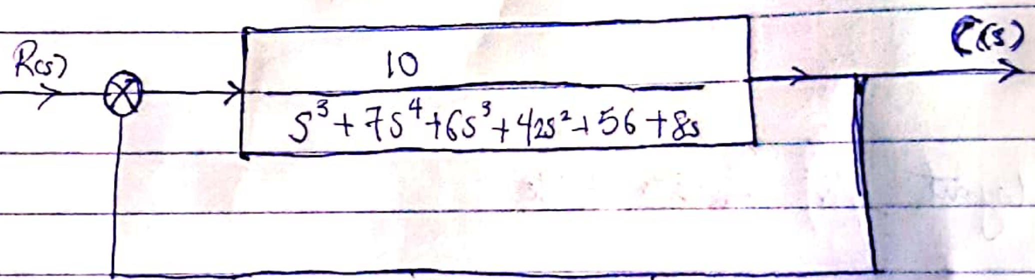
Therefore standard equation will be

$$b_k = -\det \frac{\begin{vmatrix} a_n & a_{n-2k} \\ a_{n-1} & a_{n-2k-1} \end{vmatrix}}{a_{n-1}}$$

where $d(s) = a_n s^n + a_{n-1} s^{n-1} + \dots a_1 s + a_0$

Example :

In a case where a whole row becomes zero



$$T(s) = \frac{10}{s^5 + 7s^4 + 6s^3 + 42s^2 + 56 + 8s}$$

s^5 : 1 | 6 | 8

s^4 : 7 | 42 | 56

s^3 : $-\frac{\begin{vmatrix} 1 & 6 \\ 7 & 42 \end{vmatrix}}{7} = 0$ | $-\frac{\begin{vmatrix} 1 & 8 \\ 7 & 56 \end{vmatrix}}{7} = 0$ | $-\frac{\begin{vmatrix} 1 & 0 \\ 7 & 0 \end{vmatrix}}{7} = 0$ } Entire row is Zero

When a row of zero's appears, we develop an auxilliary polynomial form s^4, s_0 we have :

$P(s) = 7s^4 + 42s^2 + 56$ — (1)

$\frac{d[P(s)]}{ds} = 28s^3 + 84s$ — (2)

∴ We continue with auxiliary equation.

S^3 28   84   0

S^2 $\dfrac{-\begin{vmatrix} 7 & 42 \\ 28 & 84 \end{vmatrix}}{28}$ $\dfrac{-\begin{vmatrix} 7 & 56 \\ 28 & 0 \end{vmatrix}}{28}$ $\dfrac{-\begin{vmatrix} 7 & 0 \\ 28 & 0 \end{vmatrix}}{28}$

$= 21$ $= 56$ $= 0$

S^1 $\dfrac{-\begin{vmatrix} 28 & 84 \\ 21 & 56 \end{vmatrix}}{21}$ $\dfrac{-\begin{vmatrix} 28 & 0 \\ 21 & 0 \end{vmatrix}}{21}$ 0

$= 28/3$ 0

S^0 $\dfrac{\begin{vmatrix} 24 & 56 \\ 28/3 & 0 \end{vmatrix}}{28/3}$ $= 56$ 0   0

There is no sign change therefore, the system is marginally stable.

3 To determine the poles on jw axis.

ANSWER: When the entries from the row before the row of the zero to the last row are looking at the even polynomials and there are no sign changes then all the poles there belong to the jw axis.