YAKUBU NATHAN BALA
17/ENG04/076
ELECT./ELECT
EEE441 ASSIGNMENT

Questions:

1.) Briefly Explain Root Locus Technique

2.) Describe the use of Routh Hurwitz to find the stability of a Closed loop System when:
- Entire row is Zero on the Routh Table
- To determine the Poles on the jw axis.

Answers:

1.) The Root Locus Technique:

Firstly, the 'Root Locus is the Path of the Closed loop Poles by Varying the gain, K from zero to infinity. It is a graphical method in which roots of the characteristics equation are Plotted in the Complex S-Plane as a function of the gain Parameter. It is used for examining how the roots of a System Change with variation of a Certain System Parameter, Commonly gain.

2.) The Routh Hurwitz Criterion States that any system Can be Stable if and Only if ~~all the roots of the first Column~~ the Sequence of determinants of it's Principal submatrices are all Positive.

Hence, the Routh Hurwitz method is a mathematical test that is a necessary condition for the Stability of a Control System.

To use the Routh Hurwitz method a 'Routh Table' must be generated and interpreted to know how many Closed loop System Poles are in the left half Plane, the right half Plane and on the jw axis.

For example:

$$a_1 s^n + a_2 s^{n-1} + a_3 s^{n-2} \ldots = 0$$

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$$b_1 = -\frac{\begin{vmatrix} a_1 & a_3 \\ a_2 & a_4 \end{vmatrix}}{a_2} \qquad C_1 = \frac{\begin{vmatrix} a_2 & a_4 \\ b_1 & b_2 \end{vmatrix}}{b_1}$$

$$b_2 = -\frac{\begin{vmatrix} a_1 & a_5 \\ a_2 & a_6 \end{vmatrix}}{a_2} \qquad C_2 = \frac{\begin{vmatrix} a_2 & a_6 \\ b_1 & b_3 \end{vmatrix}}{b_1}$$

$$b_3 = \frac{\begin{vmatrix} a_1 & a_7 \\ a_2 & a_8 \end{vmatrix}}{a_2} \qquad C_3 = \begin{vmatrix} a_2 & a_8 \\ b_1 & b_4 \end{vmatrix}$$

- In the case where an entire row is zero, it means there is an even polynomial that is a factor of the original, it indicates that the equation has at least one pair of roots which lie radially opposite each other and are equidistant from the origin. The array can be completed by forming the auxillary polynomial, this is a polynomial whose co-efficients are elements of the row just above the zeros.

For example:

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

s^5	1	6	8
s^4	1	6	8
s^3	0	0	0

Now, we are faces with the problem of zeros in the third row.

Hence, we form a new polynomial from the row above the zeros. The polynomial starts with the power of S in that row.

$$P(s) = s^4 + 6s^2 + 8 \quad \text{--- (ii)} \quad [\text{Auxillary Polynomial}]$$

Differentiate w.r.t s.

$$\frac{dP(s)}{ds} = 4s^3 + 12s + 0 \quad \text{--- (iii)}$$

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We can now replace all the zeros with the co-efficients in equation (iii) and continue the table.

s^5	1	6	8
s^4	1	6	8
s^3	1	3	0
s^2	3	8	0
s^1	1/3	0	0
s^0	8	0	0

- To determine the poles on the jw axis: Poles on the jw axis means that there is a row of zeros in a closed loop system with only imaginary axis poles of multiplicity 1 and poles in the left half plane it is marginally stable. We can therefore obtain the poles by equating the auxillary axis to zero.