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EEE 441 Assignment:

1) Briefly explain the Root locus Technique.

→ The root locus is a graphical representation in s-domain and it is symmetrical about the real axis. Because the open loop poles & zeros exist in the s-domain having the values as either as real or as complex conjugate pairs. Any physical system is represented by a transfer function in the form of

$$G(s) = K \times \frac{\text{numerator of } s}{\text{denominator " } s}$$

This technique is use to determine the stability of the given system. In order to determine the stability of the system using the root locus technique we find the range of values for K for which the complete performance of the system will be satisfactory and the operation is stable.

Where K at any S on the root locus is given by

$$K = \frac{\text{product of all of the vector lengths drawn from the poles of } G(s)H(s) \text{ to } S}{\text{product of all of the vector lengths drawn from the zeros of } G(s)H(s) \text{ to } S}$$

- Phase Margin = $180 + \angle(G(j\omega)H(j\omega))$
- K can also be calculated by $|G(s)H(s)| = 1$
- Gain Margin = $\frac{\text{Value of K at the imaginary axes cross over}}{\text{Design value of K}}$
- Angle of asymptotes = $\frac{(2p+1) \times 180}{N-M}$

N → number of poles
M → " " holes.
$p = 0, 1, 2 \ldots (N-M-1)$

- $\sigma_A = \frac{(\text{Sum of real parts of poles}) - (\text{Sum of real parts of zeros})}{N-M}$

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- Characteristic Equation related to root locus technique $= 1 + G(s)H(s)$ $= 0$. Differentiating Xtristics Equation
- Break away points can be gotten by differentiating the xristics equation and equating $dk/ds = 0$.

Advantages:-
- It provides the better way to indicate the parameters.
- Prediction ~~to~~ of the performance of the whole system.

2 Describe the use of Routh Hurwitz to find the stability of a closed loop system when:

a) entire rows zero on the Routh table.

Solu

Using the characteristics equation

$$S^5 + 3s^4 + S^3 + 3s^2 + s + 3 = 0$$

- This system satisfied the necessary condition because the coefficient of the given characteristic polynomial are positive.

$$\begin{array}{llll}
S^5 & 1 & 1 & 1 \\
S^4 & 3 & 3 & 3 \\
S^3 & \frac{(1\times1)-(1\times1)}{1} = 0 & \frac{(1\times1)-(1\times1)}{1} = 0 & \\
S^2 & & & \\
S^1 & & & \\
S^0 & & &
\end{array}$$

The row s^4 elements have the common factor of 3.

For the case, all elements of row S^3 are zero. Auxiliary equation $A(s)$ of the row s^4

$$A(s) = s^4 + s^2 + 1$$

$$\frac{dA(s)}{ds} = 4s^3 + 2s$$

replacing the coefficients in row s^3

S^5	1	1	1
S^4	1	1	1
S^3	$\cancel{4}$ 2	$\cancel{0}$ 1	
S^2	$\dfrac{(2\times1)-(1\times1)}{2} = 0.5$	$\dfrac{(2\times1)-(0\times1)}{2} = 1$	
S^1	$\dfrac{(0.5\times1)-(1\times2)}{0.5} = \dfrac{-1.5}{0.5} = -3$		
S^0	1		

There are two sign changes in the first column of Routh table, hence, the control system is unstable. A whole row of zeros indicates the presence of pairs of poles that are mirrored about the imaginary

~~b) to determine the poles on the jω axis axis which shows~~ ~~Row of zeros indicates~~

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Row of zeros indicates that system is marginaly stable.

b) to determine the poles on the jω axis

- A whole row of zeros indicates the presences of pairs of poles that are mirrored about the imaginary axis. Marginally stable systems have closed-loop transfer functions with only imaginary axis poles of multiplicity 1 and poles in the left half-plane. If a row of zeros did not appear in the Routh table, the system can't have jω poles

Using the example below.

$$T.f = \frac{128}{s(s^7 + 3s^6 + 10s^5 + 24s^4 + 48s^3 + 96s^2 + 128s + 192)}$$

- The closed loop T.F is

$$T(s) = \frac{128}{s^8 + 3s^7 + 10s^6 + 24s^5 + 48s^4 + 96s^3 + 128s^2 + 192s + 128}$$

- Return to the s^6 row and form the even polynomial

$$P(s) = s^6 + 8s^4 + 32s^2 + 64 \rightarrow \text{equi}$$

- Differentiating $P(s)$ to form the coefficients that will replace the row of zeros.

$$\frac{dP(s)}{ds} = 6s^5 + 32s^3 + 64s + 0 \rightarrow \text{equii}$$

s^8	1	10	48	128	128
s^7	$\cancel{3}\ 1$	$\cancel{24}\ 8$	$\cancel{96}\ 32$	$\cancel{192}\ 64$	
s^6	$\cancel{2}\ 1$	$\cancel{16}\ 8$	$\cancel{64}\ 32$	$\cancel{128}\ 64$	
s^5	$\cancel{0}\ \cancel{6}\ 3$	$\cancel{0}\ \cancel{32}\ 16$	$0\ \cancel{64}\ 32$	$0\ \cancel{0}\ 0$	
s^4	$\cancel{8/3}\ 1$	$\cancel{64/3}\ 8$	$\cancel{64}\ 24$		
s^3	$\cancel{-8}\ -1$	$\cancel{-40}\ -5$			
s^2	$\cancel{3}\ 1$	$\cancel{24}\ 8$			
s^1	3				
s^0	8				

Replace the row of zeros at the s^5 row by the coefficients of equii and multiply through by $1/2$ for convinience.

Location	Even (sixth order)	other (second-order)	Total (eighth-order)
RHP	2	0	2
LHP	2	2	4
$j\omega$	2	0	2

The closed loop system is unstable because of the RHP poles.