

Name: ALEGBELEYE FEMI OLANSIPIPO.

Matric No: 17/ENG04/011

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Department: ELECT/ELECT & ~~ME~~

EEE 441

## ASSIGNMENT

1. Briefly explain the Root Locus Technique.

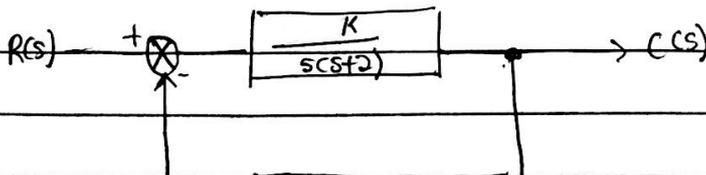
Root locus is a graphical method in which roots of the characteristic equation are plotted in s-plane for the different value of parameter. The locus of the roots of the characteristic equation when gain is varied from zero to infinity is called Root Locus.

The Root Locus technique is a graphical method for examining the changes of the roots of system with variation of a certain system parameter commonly a gain within a feedback system. It is used as a criterion of stability.

### Rules of the Root Locus.

1. The root locus starts from the open-loop poles 'K' and stops on either finite open loop zero or infinity.
2. The root locus is symmetrical about the real axis.

Let us consider a unity feedback system as shown in fig 1.0



The characteristic equation is  $1 + G(s)H(s) = 0$

$$G(s) = \frac{K}{s(s+2)}, \quad H(s) = 1$$

$$1 + \frac{K}{s(s+2)} = 0$$

$$s^2 + 2s + K = 0$$

Roots are,

$$s_1 = -1 + \sqrt{1-K} \quad s_2 = -1 - \sqrt{1-K}$$

As 'K' is varied, the two roots give the locii in s-plane. For various value of K, the location of the roots are:

1. when  $0 < K < 1$ , the roots are real and distinct
2. when  $K = 0$ , the roots are  $s_1 = 0$  and  $s_2 = -2$ . These are also the open loop poles
3. when  $K > 1$ , the roots are complex conjugate with the real part = -1

When K is varying the root locus starts from  $s = 0$  &  $s = -2$

(a) when  $K = 0$ , both roots meet at  $s = 1$

(b) when  $K = 1$

when K is varying the root locus is shown in fig 2.0

(a) when  $K = 0$ , two branches of root locus start from  $s = 0$  &  $s = -2$

(b) when  $K = 1$ , both roots meet at  $s = -1$

(c) when  $K > 1$ , the roots breakaway from the real axis and become complex conjugate having negative real part equal to -1.

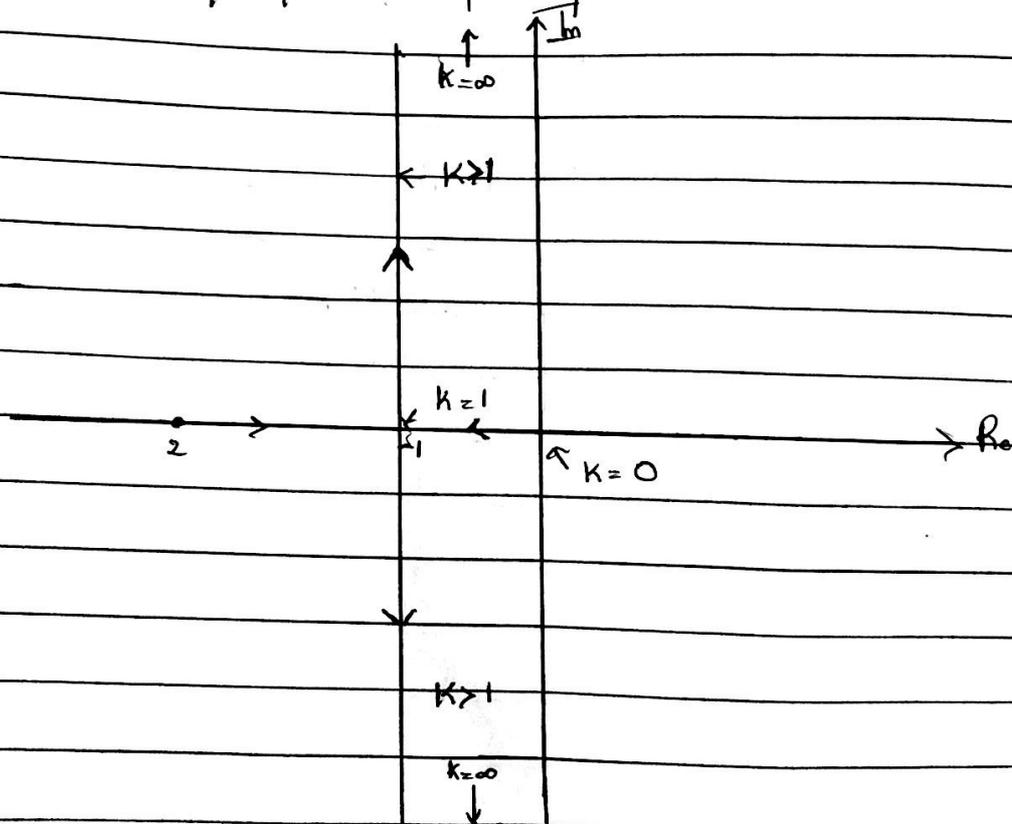


fig 2.0

(2) Describe the use of Routh Hurwitz to find stability of a closed loop system when.

- (a) entire row is zero (0) on the Routh table
- (b) to determine the poles on the  $j\omega$  axis.

(a) Entire row is zero (0) on the Routh table

This indicates that there is a possibility of  $j\omega$  roots i.e. the presence of pairs of poles, that are mirrored about the imaginary axis.

It can be resolved using the Routh Hurwitz Criterion by:

- \* Creating an auxiliary polynomial from the row above, the row of zero, skipping every other power of  $s$
- \* Differentiate the auxiliary polynomial with respect to  $s$ .
- \* Replace the zero row with the coefficients of the resulting polynomial
- \* Complete the Routh table.
- \* Evaluate the sign of the first column entries.

(b) To determine the poles on the  $j\omega$  axis

Forcing a row of zeros in the Routh table will yield the gain, going back one row to the even polynomial equation and solving for the roots, yields the frequency at the imaginary axis.

$$0 \pm j\omega \quad \text{--- Poles.}$$

Determines the system's poles for the underdamped system