CLASS-TEST-III

EE-305 Fundamentals of control system MM=15 TIME- 1Hr.

: Solution:

Q.① Solution:-

$s^4+8s^3+18s^2+16s+5=0$ Check stability By Routh array method.

Routh's Array से

s^4	1	18	5
s^3	8	16	0
s^2	16	5	0
s^1	13.5	0	0
s^0	5	0	0

Result - The system is stable. All the elements of 1st row are positive. There is no change sign.

Q.② Draw polar plot of following system

$$G(s) = \frac{1}{1+s}$$

Solution:-

$$G(s)H(s) = \frac{1}{1+s}$$

$$\Rightarrow G(j\omega)H(j\omega) = \frac{1}{1+j\omega}$$

$$= \frac{1}{\sqrt{1+\omega^2}} \angle -\tan^{-1}\omega$$

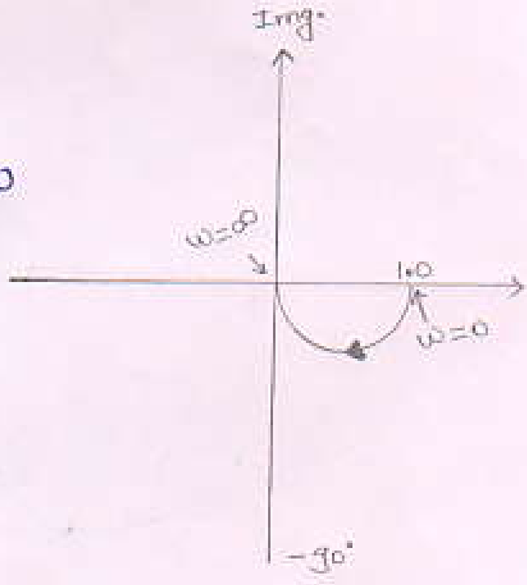

Fig. 1

$$|G(j\omega)H(j\omega)| = \frac{1}{\sqrt{1+\omega^2}}$$

$$\angle G(j\omega)H(j\omega) = -\tan^{-1}\omega$$

$$\lim_{\omega\to 0} |G(j\omega)H(j\omega)| = 1$$

$$\lim_{\omega\to 0} \angle G(j\omega)H(j\omega) = 0$$

$$\lim_{\omega\to\infty} |G(j\omega)H(j\omega)| = \lim_{\omega\to\infty} \frac{1}{\sqrt{1+\omega^2}} = 0$$

$$\lim_{\omega\to\infty} \angle G(j\omega)H(j\omega) = \lim_{\omega\to\infty} (-\tan^{-1}\omega) = -90^\circ$$

Polar plot is shown in Fig. 1

Q. ③ Open loop transfer - function of a control system is

$$G(s)H(s) = \frac{K}{S(S+6)}$$. Draw the root locus.

Solution:- There is no open loop zero. The open loop ploes are at $S=0$ and $S=-6$

1. The root locus starts at $S=0$ and $S=-6$ for $K=0$
2. As there is no open loop zero, so root loci terminates at ∞.
3. Number of root locus branches $= N = P = 2_2$ ($\because P>Z$)
4. Root locus on real axis line between $S=0$ to $S=-6$.
5. Breakaway point :- It is obtained by solving

$$\frac{dk}{ds} = 0$$

characteristic equation is,

$$1+G(s)H(s) = 0$$

$$\Rightarrow 1+\frac{K}{S(S+6)} = 0$$

$$\Rightarrow S(S+6)+K = 0$$

$$\Rightarrow S^2+6S+K = 0$$

$$\Rightarrow K = -S^2-6S$$

$$\Rightarrow \frac{dk}{ds} = -2S-6 = 0$$

$$\Rightarrow S=-3 \text{ is a breakaway point.}$$

6. angle of asymtotes are given by,

$$\phi = \frac{(2n+1)180^\circ}{P-Z} \qquad n=0,1$$

$$= \frac{180}{2}, \frac{3\times180}{2}$$

$$= 90^\circ, 270^\circ (\text{or} -90^\circ)$$

7. Centroid

$$\sigma_A = \frac{\Sigma \text{real part of poles} - \Sigma \text{real part of zeros}}{P-Z}$$

$$= \frac{(0-6)-0}{2}$$

$$\sigma_A = -3$$

With the data calculated from step 1 to 7, the required root locus is plotted in Fig. 2 ③

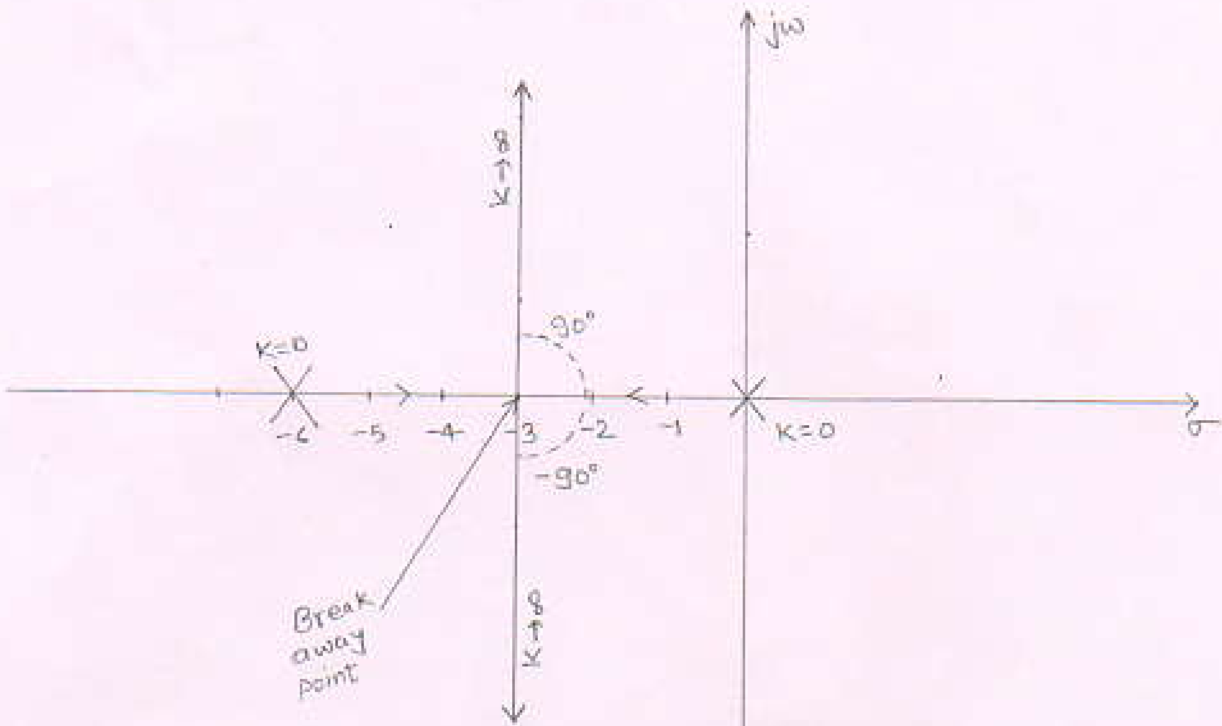

Fig-2