4 Root Locus Technique

Multiple Choice Questions

Q.1 Consider the points $s_1 = -3 + j4$ and $s_2 = -3 - j2$ in the s-plane. Then, for a system with the open-loop transfer function

$$G(s)H(s) = \frac{K}{(s+1)^4}$$

(a) s_1 is on the root locus, but not s_2
(b) s_2 is on the root locus, but not s_1
(c) both s_1 and s_2 are on the root locus
(d) neither s_1 nor s_2 is on the root locus

[GATE-1999]

Q.2 The characteristic equation of a control system is given by
$s(s + 4)(s^2 + 2s + s) + k(s + 1) = 0$
What are the angles of the asymptotes for the root loci for $k \geq 0$?

(a) 60°, 180°, 300° (b) 0°, 180°, 300°
(c) 120°, 180°, 240° (d) 0°, 120°, 240°

[ESE-2005]

Q.3 The characteristic equation of a feedback control system is given by $s^3 + 5s^2 + (K + 6)s + K = 0$. In the root loci diagram, the asymptotes of the root loci for large 'K' meet at a point in the s-plane whose coordinates are

(a) (2, 0) (b) (–1, 0)
(c) (–2, 0) (d) (–3, 0) **[ESE-1999]**

Q.4 The root locus plot of the system having the loop transfer function

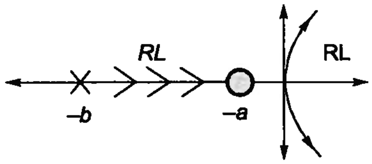
$$G(s)\,H(s) = \frac{K}{s(s+4)\,(s^2+4s+5)} \text{ has}$$

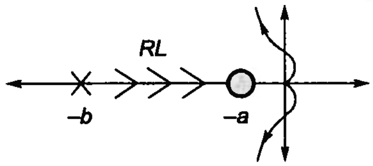
(a) no breakaway point
(b) three real breakaway points
(c) only one breakaway point
(d) one real and two complex breakaway points

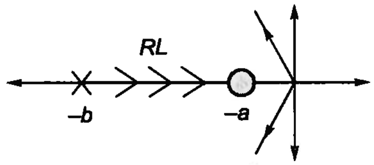
[ESE-2001]

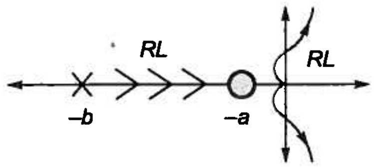
Q.5 Which of the following is the following is the valid root loci

$$G(s) = \frac{K(s+a)}{s^2(s+b)} |b| > |a|$$

(a)


(b)


(c)


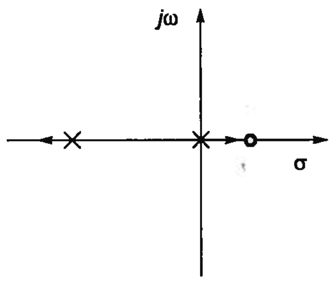
(d)


Q.6 An unity feedback system is given as,

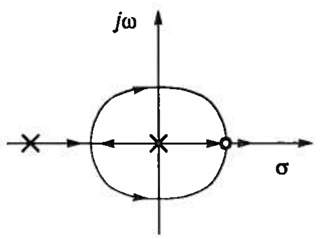
$$G(s) = \frac{K(1-s)}{s(s+3)}$$

Indicate the correct root locus diagram

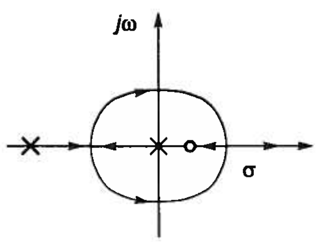
(a)



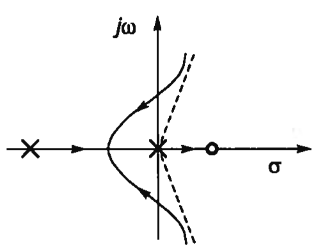
(b)



(c)



(d)

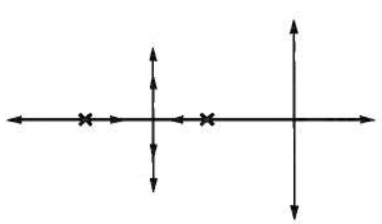


[GATE-2005, IES-2001]

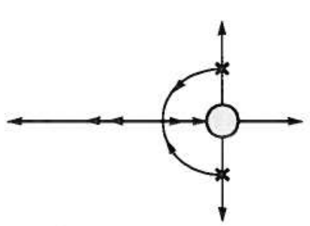
Q.7 The *O.L.T.F* of a system is $G(s) = \dfrac{K}{s(s+\alpha)}$

The valid root locus for $0 < \alpha < \infty$ when $K = 10$ is

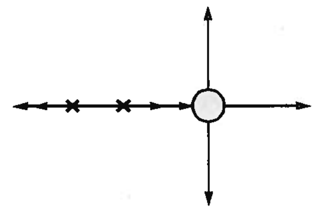
(a)



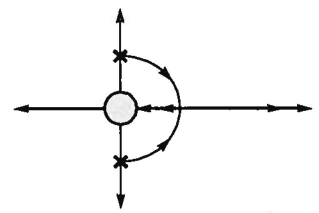
(b)



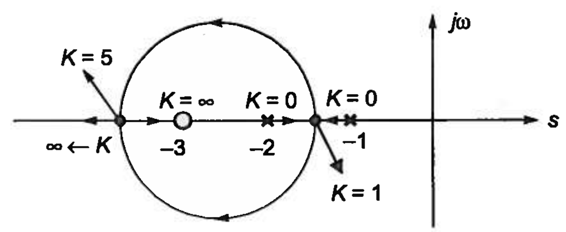
(c)



(d)



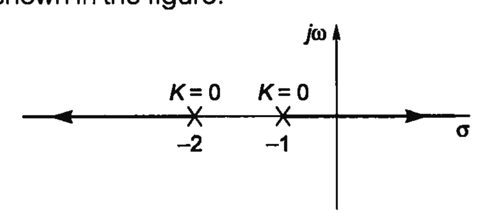
Q.8 The root-locus diagram for a closed-loop feedback system is shown in the figure. The system is overdamped.



(a) only if $0 \le K \le 1$
(b) only if $1 < K < 5$
(c) only if $K > 5$
(d) if $0 < K < 1$ or $K > 5$

[GATE-2001]

Q.9 The root locus of a unity feedback system is shown in the figure.



The closed-loop transfer function of the system is

(a) $\dfrac{C(s)}{R(s)} = \dfrac{K}{(s+1)(s+2)}$

(b) $\dfrac{C(s)}{R(s)} = \dfrac{-K}{(s+1)(s+2)+K}$

(c) $\dfrac{C(s)}{R(s)} = \dfrac{K}{(s+1)(s+2)-K}$

(d) $\dfrac{C(s)}{R(s)} = \dfrac{K}{(s+1)(s+2)+K}$

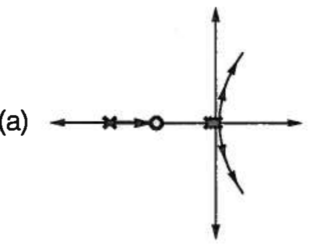
[GATE-2014]

Q.10 The OLTF of a control system is

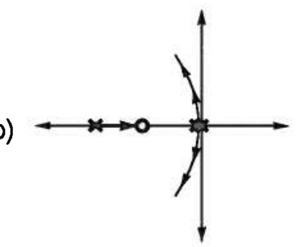
$$G(s) = \frac{K(s+4/3)}{s^2(s+12)}$$

The valid *RL* will be

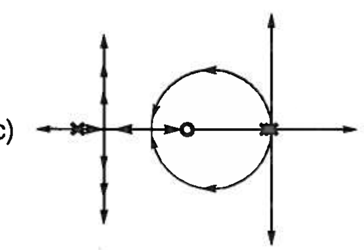
(a)



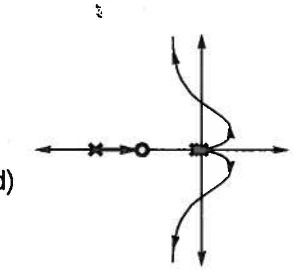
(b)



(c)



(d)



Numerical Data Type Questions

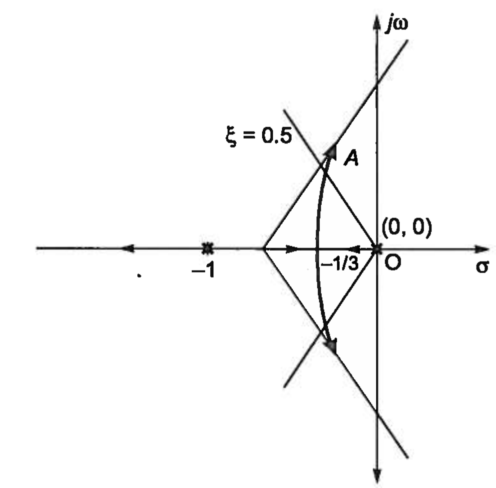
Q.11 A unity feedback control system has an open-loop transfer function

$$G(s) = \frac{K}{s(s^2+7s+12)}$$

_____ is gain *K* for which $s = -1 + j1$ will lie on the root locus of this system.

[GATE-2007]

Q.12 The characteristic equation of a unity negative feedback system is $1 + KG(s) = 0$. The open loop transfer function $G(s)$ has one pole at 0 and two poles at –1. The root locus of the system for varying *K* is shown in the figure.



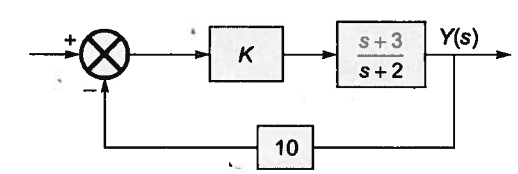
The constant damping ratio line, for $\xi = 0.5$, intersects the root locus at point *A*. The distance from the origin to point *A* is given as 0.5. The value of *K* at point *A* is _______.

[GATE-2014]

Q.13 The open-loop transfer function of a unity feedback configuration is given as $G(s) = \dfrac{K(s+4)}{(s+8)(s^2-9)}$. The value of a gain $K(>0)$ for which $-1 + j2$ lies on the root locus is _________.

[GATE-2015]

Q.14 For the system shown in figure, $s = -2.75$ lies on the root locus if *K* is_____.



[GATE-2015]

Try Yourself

T1. Consider a feedback system with characteristic equation

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

Compute the angles of the asymptotes of the root-locus branches with the real axis of the s-plane. Also find the centroid and the breakaway points of the root-locus of the system. Assume that K varies from 0 to ∞.

[Ans. Centroid → (–1, 0)
Breakaway point s = –0.422]

T2. Draw the root loci of the system showing all the relevant point for open-loop transfer function of the system given by

$$G(s) = \frac{K}{s(s^2+4s+8)}$$

T3. Given $G(s)\,H(s) = \dfrac{K}{s(s+1)(s+4)}$ sketch the root locus of the system

(*i*) Determine the value of K for which the system is at the verge of instability.

[Ans: K = 20]

(*ii*) For the damping ratio (δ) 0.34, determine the value of K and the gain margin (GM).

T4. The forward-path transfer function of a *ufb* system is

$$G(s) = \frac{K(s+2)}{(s+3)(s^2+2s+2)}$$

The angle of departure from the complex poles is $\pm\phi_D$; where ϕ_D = _____ degree.

[Ans: 108.4]

T5. The forward path transfer function of a unity negative feedback system is given by

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

The value of K which will place both the poles of the closed-loop system at the same location, is _____.

[Ans: K = 2.25]

■■■■