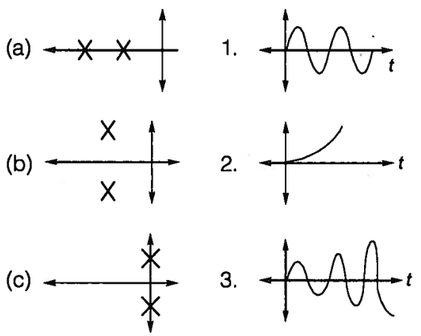
3 Stability

Multiple Choice Questions

Q.1 Match the following



	A	B	C	D	E
(a)	5	4	1	2	3
(b)	4	5	1	2	3
(c)	1	2	4	5	3
(d)	3	4	2	1	5

Q.2 The number of roots in left hand side of *s*-plane for the system whose characteristic equation is

$$s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$$

(a) 0 (b) 1
(c) 2 (d) 4 **[ESE-2006]**

Q.3 The characteristic equation of a control system is given by

$$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$$

The number of the roots of the equation which lie on the imaginary axis of *s*-plane is

(a) zero (b) 2
(c) 4 (d) 6 **[ESE-2003]**

Q.4 The characteristic polynomial of a system is

$$q(s) = 2s^5 + s^4 + 4s^3 + 2s^2 + 2s + 1$$

The system is

(a) stable (b) marginally stable
(c) unstable (d) oscillatory **[GATE-2004]**

Q.5 The characteristic equation of a control system is $s^5 + 15s^4 + 85s^3 + 225s^2 + 274s + 120 = 0$
What are the number of roots of the equation which lie to the left of the line $s + 1 = 0$?

(a) 2 (b) 3
(c) 4 (d) 5 **[ESE-2006]**

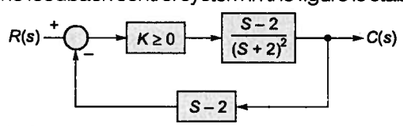
Q.6 The system having characteristic equation:

$$s^4 + 2s^3 + 3s^2 + 2s + k = 0$$

is to be used as an oscillator. What are the values of *k* and the frequency of oscillation ω?

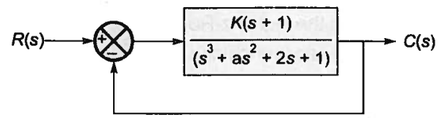
(a) $k = 1$ and $\omega = 1$ *r/s*
(b) $k = 1$ and $\omega = 2$ *r/s*
(c) $k = 2$ and $\omega = 1$ *r/s*
(d) $k = 2$ and $\omega = 2$ *r/s* **[ESE-2006]**

Q.7 The feedback control system in the figure is stable.



(a) for all $K \geq 0$ (b) only is $K \geq 0$
(c) only if $0 \leq K < 1$ (d) only if $0 \leq K \leq 1$
[GATE-2001]

Q.8 The positive values of "*K*" and "*a*" so that the system shown in the figure below oscillates at a frequency of 2 rad/sec respectively are



(a) 1, 0.75 (b) 2, 0.75
(c) 1, 1 (d) 2, 2 **[GATE-2006]**

Q.9 Consider the following statements about Routh-Hurwitz criterion:

If all the elements in one row of Routh array are zero, then there are

1. Pairs of conjugate roots on imaginary axis.
2. Pairs of equal roots with opposite sign.
3. Conjugate roots forming a quadrate in the s-plane.

Which of these statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3 **[ESE-2013]**

Q.10 A plant transfer function is given as

$$G(s) = \left(K_P + \frac{K_I}{s}\right)\frac{1}{s(s+2)}$$

When the plant operates in a unity feedback configuration, the condition for the stability of the closed loop system is

(a) $K_P > \frac{K_I}{2} > 0$ (b) $2K_I > K_P > 0$
(c) $2K_I < K_P$ (d) $2K_I > K_P$ **[GATE-2015]**

Q.11 The open loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{K(s+1)}{s(1+Ts)(1+2s)}, K > 0, T > 0.$$

The closed loop system will be stable if,

(a) $0 < T < \frac{4(K+1)}{K-1}$

(b) $0 < K < \frac{4(T+2)}{T-2}$

(c) $0 < K < \frac{T+2}{T-2}$

(d) $0 < T < \frac{8(K+1)}{K-1}$ **[EE : GATE-2016]**

Numerical Data Type Questions

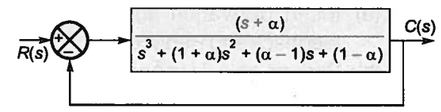
Q.12 Consider the unity feedback system with

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

The system is marginally stable. _____ is the rad/sec frequency of oscillation? **[ESE-2008]**

Q.13 For the polynomial $P(s) = s^5 + s^4 + 2s^3 + 2s^2 + 3s + 15$, ____ are number of roots which lie in the right half of the s-plane. **[GATE-2004]**

Q.14 For the given system, it is desired that the system be stable. The minimum value of α for this condition is _____.



[GATE-2014]

Q.15 Consider a transfer function

$$G_p(s) = \frac{ps^2 + 3ps - 2}{s^2 + (3+p)s + (2-p)}$$ with *p* a positive real parameter. The maximum value of *p* until which G_p remains stable is _____. **[GATE-2014]**

Q.16 The characteristic equation of an LTI system is given by

$$F(s) = s^5 + 2s^4 + 3s^3 + 6s^2 - 4s - 8 = 0$$

The number of roots that lie strictly in the left half s-plane is _____. **[GATE-2015]**

Try Yourself

T1. A single-input single-output feedback system has forward transfer function $G(s)$ and feedback transfer function $H(s)$. It is given that $|G(s)\,H(s)| < 1$. Which of the following is true about the stability of the system?

(a) The system is always stable.

(b) The system is stable if all zeros of $G(s)\,H(s)$ are in left half of the s-plane.

(c) The system is stable if all poles of $G(s)\,H(s)$ are in left half of the s-plane.

(d) It is not possible to say whether or not the system is stable from the information given.

[Ans: (d)]

T2. With negative feedback, the system stability and system gain respectively

(a) Increases and increases

(b) Increases and decreases

(c) Decreases and increases

(d) Decreases and decreases **[Ans: (b)]**

T3. The correct sequence of steps needed to improve system stability is

(a) Insert derivation action, Use negative feedback and Reduce gain.

(b) Reduce gain, Use negative feedback and Insert derivation action.

(c) Reduce gain, Insert derivation action and Use negative feedback.

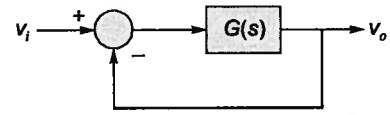
(d) Use negative feedback, Reduce gain and Insert derivation action.

[Ans: (d)]

T4. In the feedback system shown in figure

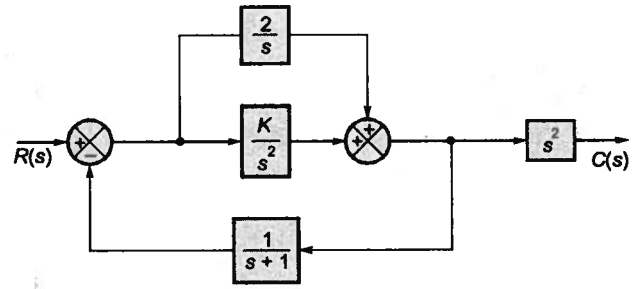
$$G(s) = \frac{K}{s\tau_1(1+s\tau_1)(1+s\tau_2)}$$

Using the Hurwitz-Routh method, determine the necessary conditions for the system to be stable.

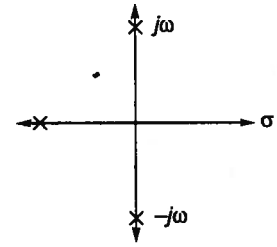


[Ans: $0 < K < \left(1+\frac{\tau_1}{\tau_2}\right)$ $\tau_1 > 0$ and $\tau_2 > 0$ **and this is the only possible case.]**

T5. Consider the feedback system shown below:



If the poles location for this system is as shown in figure below, then the value of K is _____



[Ans: $K = 2$]

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