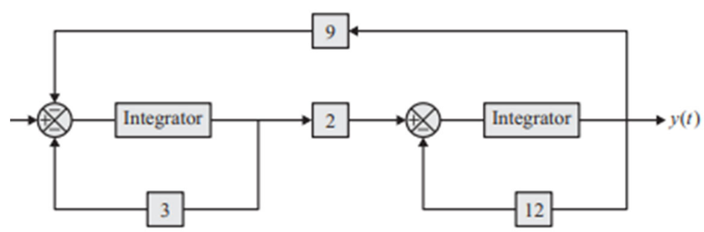
GATE QUESTIONS

A.Y.: 2021-2022 (Odd SEM) Scheme: CBCGS-HME 2020

Class: S.E. E&TC Subject: Control Engineering

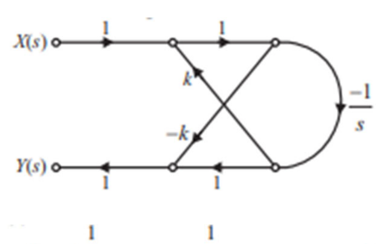
1 mark sample questions

1. The block diagram of a control system is as shown in figure. Find transfer function of the system



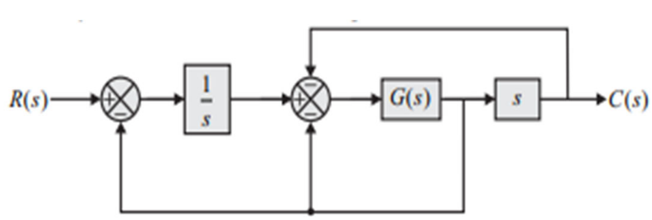
(A) $\dfrac{1}{18\left(1+\frac{s}{12}\right)\left(1+\frac{s}{3}\right)}$ (B) $\dfrac{1}{27\left(1+\frac{s}{6}\right)\left(1+\frac{s}{9}\right)}$ (C) $\dfrac{1}{27\left(1+\frac{s}{12}\right)\left(1+\frac{s}{9}\right)}$ (D) $\dfrac{1}{27\left(1+\frac{s}{9}\right)\left(1+\frac{s}{3}\right)}$

2. A filter is represented by the signal flow graph shown in the figure. Its input is x(t) and output is y(t). The transfer function of the filter is



(A) $\dfrac{-(1+ks)}{s+k}$ (B) $\dfrac{(1+ks)}{s+k}$ (C) $\dfrac{-(1-ks)}{s+k}$ (D) $\dfrac{(1-ks)}{s+k}$

3. The block diagram of a system is shown in the figure



If the desired transfer function of the system is

$\frac{C(s)}{R(s)} = \frac{s}{s^2+s+2}$ then G(s)is

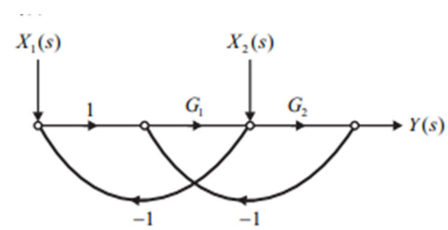
(A) 1 (B) s (C) $1/s$ (D) $\frac{-s}{s^3+s^2-s-2}$

4. By performing cascading and/or summing/differencing operations using transfer function blocks G1(s) and G2 (s), one CANNOT realize a transfer function of the form

(A) $G_1(s)G_2(s)$ (B) $\frac{G_1(s)}{G_2(s)}$

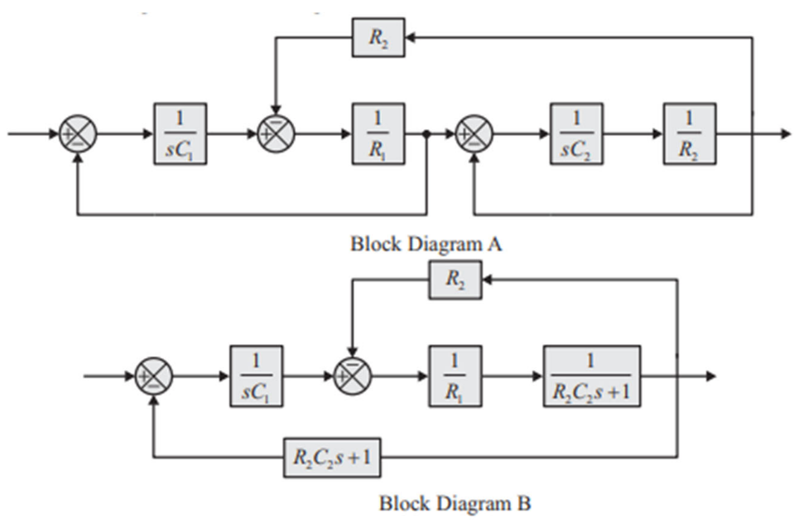
(C) $G_1(s)\left(\frac{1}{G_1(s)} + G_2(s)\right)$ (D) $G_1(s)\left(\frac{1}{G_1(s)} - G_2(s)\right)$

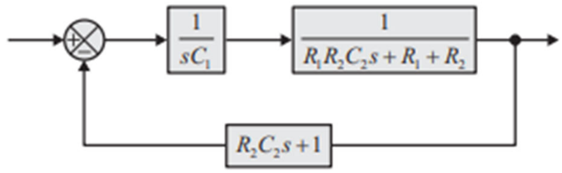
5. For the signal-flow graph shown in the figure, which one of the following expressions is equal to the transfer function



(A) $\frac{G_1}{1+G_2(1+G_1)}$ (B) $\frac{G_2}{1+G_1(1+G_2)}$ (C) $\frac{G_1}{1+G_1G_2}$ (D) $\frac{G_2}{1+G_1G_2}$

6. Consider the following three block diagrams A, B and C shown below.



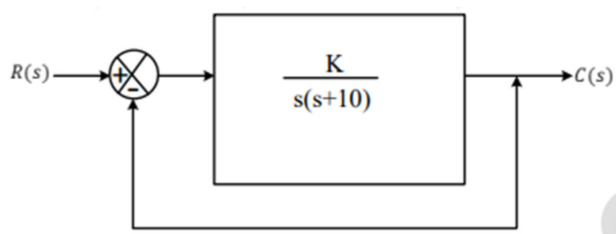


Block Diagram C

Which one of the following statements is correct in respect of the above block diagrams ?

(A) Only A and B are equivalent
(B) Only A and C are equivalent
(C) Only B and C are equivalent
(D) A, B and C are equivalent

7. The unity feedback system shown in figure has:



(a) Zero steady state position error

(b)Zero steady state velocity error

(c) Steady state position error K/10 units

(d)Steady state velocity error K/10 units

8. The steady state error of a stable ‘type 0’ unity feedback system for a unit step function is

(a) 0
(b) $\frac{1}{1+K_P}$
(c) ∞
(d) $\frac{1}{K_P}$

9. Which of the following statements is incorrect?

a. Lead compensator is used to reduce the settling time.

b. Lag compensator is used to reduce the steady state error.

c. Lead compensator improves transient response of system.

d. Lag compensator always stabilizes an unstable system.

10. A critically damped, continuous-time, second order system, when sampled, will have (in Z domain)

(a) A simple pole (b)Double pole on real axis

(c) Double pole on imaginary axis (d)A pair of complex conjugate poles

11. If $L[f(t)] = \frac{2(S+1)}{S^2+2S+5}$ *then* $f(0^+)$ *and* $f(\infty)$ are given by

(a) 0,2 respectively (b)2. 0 respectively (c) 0, 1 respectively (d)2/5, 0 respectively

12. The final value theorem is used to find the

(a)steady state value of the system output

(b)initial value of the system output

(c) transient behavior of the system output

(d)none of these

13. Consider a feedback control system with loop transfer function

$$G(s)H(s) = \frac{K(1+0.5s)}{s(1+s)(1+2s)}$$

The type of the closed loop system is

(a) zero (b)one (c) two (d)three

14. If the characteristic equation of a closed-loop system is s^2 + 2s + 2 = 0, then the system is

(a) Overdamped (b)Critically damped (c) Under damped (d)undamped

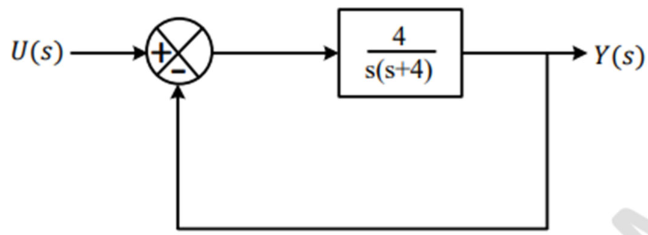
15. Consider a system with the transfer function (s)

$$(s) = \frac{s+6}{Ks^2+s+6}$$

Its damping ratio will be 0.5 when the value of K is

(a) 2/6 (b)3 (c) 1/6 (d)6

16. For the second order closed-loop system shown in the figure, the natural frequency (in rad/s) is



(a) 16 (b)4 (c) 2 (d)1

17. The Nyquist stability criterion and the Routh criterion both are powerful analysis tools for determining the stability of feedback controllers. Identify which of the following statements is FALSE:

(A) Both the criteria provide information relative to the stable gain range of the system.

(B) The general shape of the Nyquist plot is readily obtained from the Bode magnitude plot for all minimum-phase systems.

(C) The Routh criterion is not applicable in the condition of transport lag, which can be readily handled by the Nyquist criterion.

(D) The closed-loop frequency response for a unity feedback system cannot be obtained from the Nyquist plot.

18.

The loop transfer function of a negative feedback system is

$$G(s)H(s) = \frac{K(s+11)}{s(s+2)(s+8)}.$$

The value of K, for which the system is marginally stable, is _________.

19.

The characteristic equation of a system is

$$s^3 + 3s^2 + (K+2)s + 3K = 0.$$

In the root locus plot for the given system, as K varies from 0 to ∞, the break-away or break-in point(s) lie within

$(-1, 0)$.

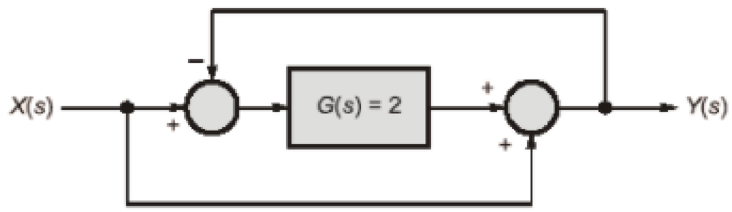
$(-2, -1)$.

$(-3, -2)$.

$(-\infty, -3)$.

20.

For the system shown in the figure, Y (s) / X (s) = ______



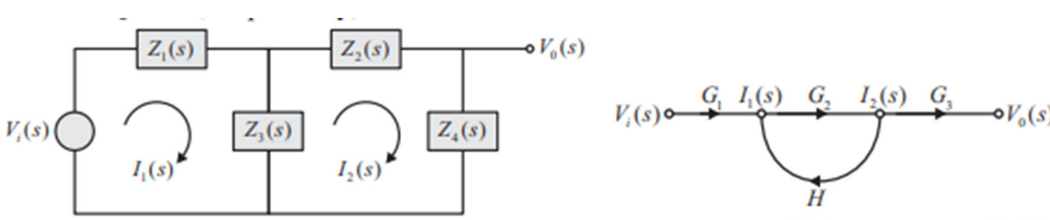
2 mark sample questions

1. Draw the signal flow graph for the following set of algebraic equations

$$y_2 = ay_1 - gy_3$$
$$y_3 = ey_2 + cy_4$$
$$y_4 = by_2 - dy_4$$

Hence, find the gain y2/y1

2. An electrical system and its signal-flow graph representations are shown in the figure respectively. The values of G2 and H, respectively, are



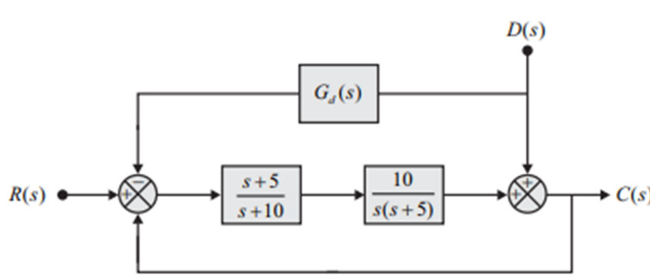
(A) $\dfrac{Z_3(s)}{Z_2(s)+Z_3(s)+Z_4(s)}, \dfrac{-Z_3(s)}{Z_1(s)+Z_3(s)}$

(B) $\dfrac{-Z_3(s)}{Z_2(s)-Z_3(s)+Z_4(s)}, \dfrac{-Z_3(s)}{Z_1(s)+Z_3(s)}$

(C) $\dfrac{Z_3(s)}{Z_2(s)+Z_3(s)+Z_4(s)}, \dfrac{Z_3(s)}{Z_1(s)+Z_3(s)}$

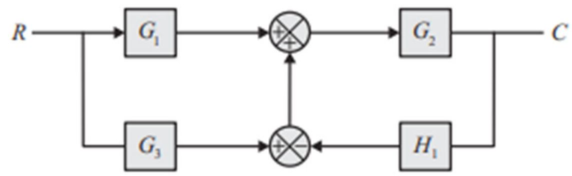
(D) $\dfrac{-Z_3(s)}{Z_2(s)-Z_3(s)+Z_4(s)}, \dfrac{Z_3(s)}{Z_1(s)+Z_3(s)}$

3. In the system shown in the given figure, to eliminate the effect of disturbance D(s) on C(s), the transfer function Gd (s) should be



(A) $\frac{(s+10)}{10}$ (B) $\frac{s(s+10)}{10}$ (C) $\frac{10}{s+10}$ (D) $\frac{10}{s(s+10)}$

4. What is the overall transfer function of the block diagram given above ?



(A) $\frac{G_1G_2+G_2G_3}{1+G_2H_1}$ (B) $\frac{G_1G_2+G_2G_3}{1+G_3H_1}$ (C) $G_1G_2+G_2G_3$ (D) $\frac{G_1G_3+G_2G_3}{1+G_2G_3H_1}$

5. A unity-feedback control system has the open-loop transfer function $G(s)$ =

$\frac{4(1+2s)}{S^2(S+2)}$ if the input to the system is a unity ramp, the steady-state error will be

(a) 0 (b)0.5 (c) 2 (d)Infinity

6. A second-order system has transfer function given by

$$G(s) = \frac{25}{S^2+8s+25}.$$

If the system, initially at rest, is subjected to a unit step input at t = 0, the second peak in the response will occur at

(a) π sec (b)$\pi/3$ sec (c) $2\pi/3$ sec (d)$\pi/2$ sec

7. The transfer function of a plant is

$$(s) = \frac{5}{(s+5)(s^2+s+1)}$$

The second order approximation of T(s) using dominant pole concept is

(a) $\frac{1}{(s+5)(s+1)}$ (c) $\frac{5}{(s^2+s+1)}$

(b) $\frac{5}{(s+5)(s+1)}$ (d) $\frac{1}{(s^2+s+1)}$

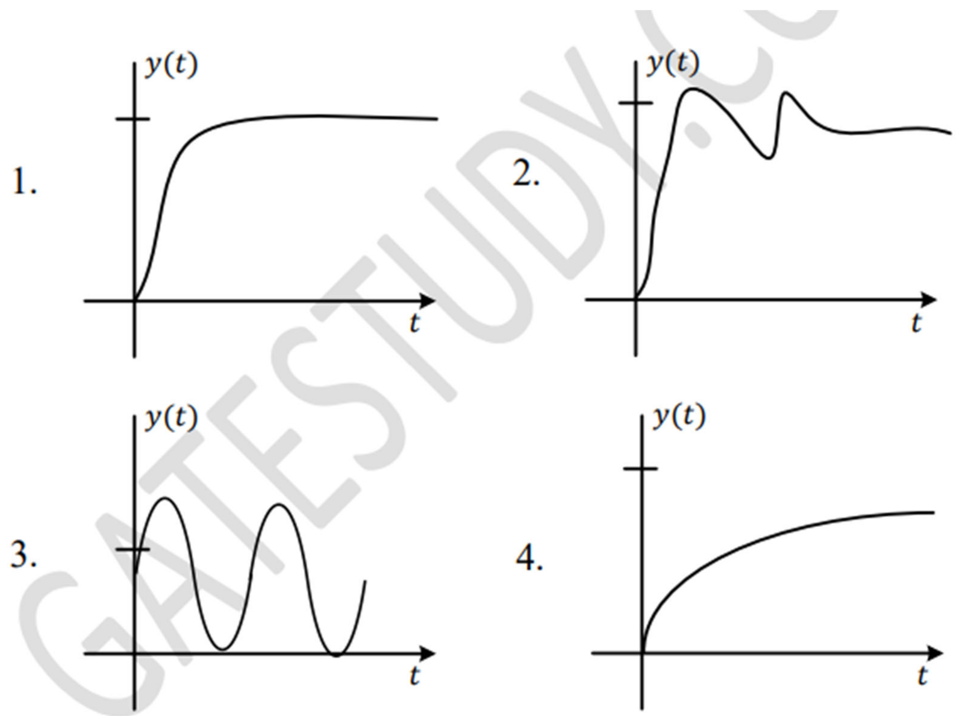
8. Group I lists a set of four transfer functions. Group II gives a list of possible step responses y(t). Match the step responses with the corresponding transfer functions.

Group I

$$P = \frac{25}{s^2 + 25} \qquad R = \frac{36}{s^2 + 12s + 36}$$

$$Q = \frac{36}{s^2 + 20s + 36} \qquad S = \frac{36}{s^2 + 7s + 49}$$

Group II



(a) P – 3, Q – 1, R – 4, S – 2 (b)P – 3, Q – 2, R – 4, S – 1

(c) P – 2, Q – 1, R – 4, S – 3 (d)P – 3, Q – 4, R – 1, S – 2

9.

Let the state-space representation of an LTI system be $\dot{x}(t) = Ax(t) + Bu(t)$, y(t) = C x(t) + d u(t) where A, B, C ar matrics, d is a scalar, u(t) is the input to the system, and y(t) is its output. Let B = $[0\ 0\ 1]^T$ and d = 0. Which one of the following options for A and C will ensure that the transfer function of this LTI system is

$$H(s) = \frac{1}{s^3 + 3s^2 + 2s + 1}?$$

$A = \begin{vmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{vmatrix}$ and C = [1 0 0]

$A = \begin{vmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{vmatrix}$ and C = [0 0 1]

$A = \begin{vmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -2 & -1 \end{vmatrix}$ and C = [0 0 1]

$A = \begin{vmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -2 & -1 \end{vmatrix}$ and C = [1 0 0]

10.

The state equation and the output equation of a control system are given below:

$$\dot{\mathbf{x}} = \begin{bmatrix} -4 & -1.5 \\ 4 & 0 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 2 \\ 0 \end{bmatrix} u,$$

$$y = \begin{bmatrix} 1.5 & 0.625 \end{bmatrix} \mathbf{x}.$$

The transfer function representation of the system is

(A) $\dfrac{3s+5}{s^2+4s+6}$ (B) $\dfrac{3s-1.875}{s^2+4s+6}$

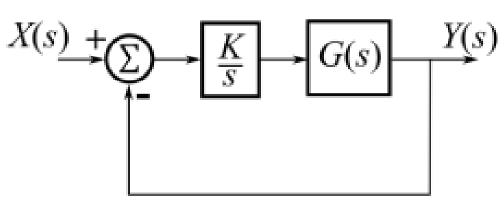
(C) $\dfrac{4s+1.5}{s^2+4s+6}$ (D) $\dfrac{6s+5}{s^2+4s+6}$

11.

Consider a unity feedback system, as in the figure shown, with an integral compensator $\frac{K}{s}$ and open-loop transfer function

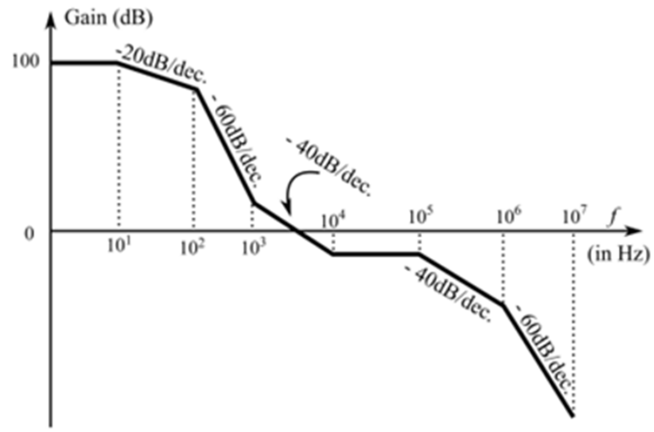
$$G(s) = \frac{1}{s^2 + 3s + 2}$$

where $K > 0$. The positive value of K for which there are exactly two poles of the unity feedback system on the $j\omega$ axis is equal to ______ (rounded off to two decimal places).



12.

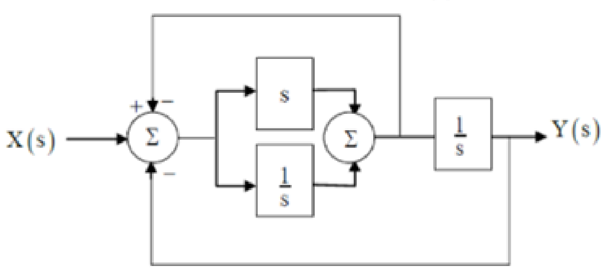
For an LTI system, the Bode plot for its gain is as illustrated in the figure shown. The number of system poles N_p and the number of system zeros N_z in the frequency range $1\text{ Hz} \leq f \leq 10^7\text{ Hz}$ is



(A) $N_p = 5, N_z = 2$ (B) $N_p = 6, N_z = 3$ (C) $N_p = 7, N_z = 4$ (D) $N_p = 4, N_z = 2$

13.

The block diagram of a system is illustrated in the figure shown, where X(s) is the input and Y(s) is the output. The transfer function $H(s) = \frac{Y(s)}{X(s)}$ is



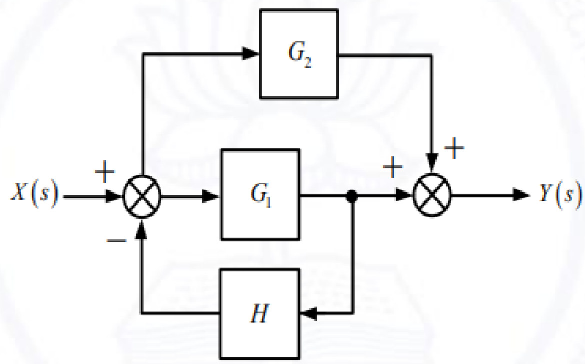
(A) $H(s) = \frac{s^2+1}{s^3+s^2+s+1}$

(B) $H(s) = \frac{s^2+1}{s^3+2s^2+s+1}$

(C) $H(s) = \frac{s+1}{s^2+s+1}$

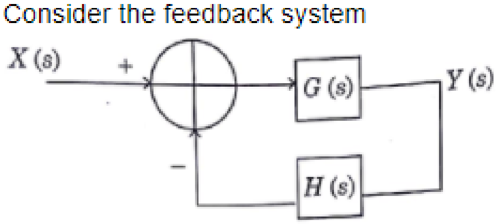
(D) $H(s) = \frac{s^2+1}{2s^2+1}$

14.

The block diagram of a feedback control system is shown in the figure.  **The transfer function $\frac{Y(s)}{X(s)}$ of the system is**
$\frac{G_1 + G_2 + G_1G_2H}{1+G_1H}$
$\frac{G_1 + G_2}{1+G_1H + G_2H}$
$\frac{G_1 + G_2}{1+G_1H}$
$\frac{G_1 + G_2 + G_1G_2H}{1+G_1H + G_2H}$

15.

Consider the feedback system



$$G(S) = \frac{K(s+4)}{s(s+1)} \quad H(S) = \frac{1}{s+2}$$

The value of gain for which system is marginally stable is

K = 4

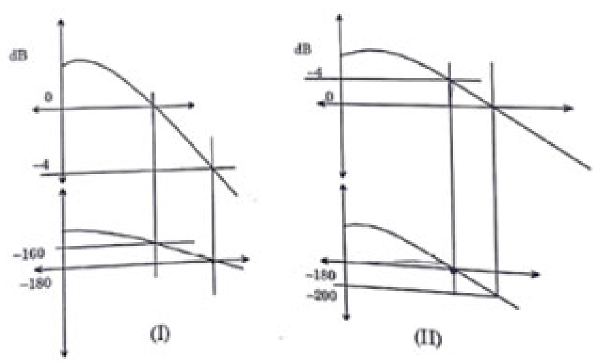
K = 6

K = 10

K = 2

16.

Consider the Bode plots (magnitude and phase) of two different open loop transfer functions of two unity feedback systems. The open loop transfer functions have poles in right half plane. The closed loop system formed from these open loop systems. Which of the following holds true?



Closed loop system with I is stable and with II is unstable

Closed loop systems using I and II both are unstable

Closed loop system with I is unable and II is stable

Closed loop system with I and II are stable

17. For a second-order system with the closed-loop transfer function

$$T(s) = \frac{9}{s^2+4s+9}$$

the settling time for 2-percernt band, in seconds, is

(a) 1.5 (b)2.0 (c) 3.0 (d)4.0

18.

Consider the following statements for continuous-time linear time invariant (LTI) systems.
I. There is no bounded input bounded output (BIBO) stable system with a pole in the right half of the complex plane.
II. There is non causal and BIBO stable system with a pole in the right half of the complex plane.
Which one among the following is correct?

Both I and II are true

Both I and II are false

Only I is true

Only II is true

19.

The Nyquist plot of the transfer function G(s) = $\frac{K}{(s^2+2s+2)(s+2)}$ does not encircle the point (1+j0) for K=10 but does encircle the point (-1+j0) for K=100. The the closed loop system (having unity gain feedback) is

stable for K = 10 and stable for K = 100

stable for K = 10 and unstable for K = 100

unstable for K = 10 and stable for K =100

unstable for K = 10 and unstable for K = 100

20.

For the system governed by the set of equations:

$$dx_1/\mathrm{dt} = 2x_1 + x_2 + u$$
$$dx_2/\mathrm{dt} = -2x_1 + u$$
$$y = 3x_1$$

the transfer function Y(s)/U(s) is given by

(A) $3(s+1)/(s^2-2s+2)$

(B) $3(2s+1)/(s^2-2s+1)$

(C) $(s+1)/(s^2-2s+1)$

(D) $3(2s+1)/(s^2-2s+2)$