CHAPTER – I

BASICS OF CONTROL SYSTEMS

Class Room Objectives

1. The IR of a control system is $10e^{-3t}u(t)$ the transfer function is equal to

(a) $\frac{10}{S+3}$ (b) $\frac{10}{S-3}$

(c) $\frac{3}{S+10}$ (d) $\frac{3}{S-10}$

2. If the TF of a certain system is $\frac{1}{S^2+3S+2}$ The IR is

(a) $(e^{-t}+e^{-2t})u(t)$

(b) $(e^{-t}-e^{-2t})u(t)$

(c) $2(e^{-t}+e^{-2t})u(t)$

(d) $2(e^{-t}+e^{-2t})u(t)$

3. Input is $\delta(t)$ and output is $10e^{-2t}u(t)$, The TF of the system is

(a) $\frac{10}{S+2}$ (b) $\frac{2}{S+10}$

(c) $\frac{1}{S+2}$ (d) $\frac{10}{S-2}$

4. The impulse response of an initially relaxed linear system is $e^{-2t}u(t)$. To produce a response of $te^{-2t}u(t)$, the input must be equal to

(GATE-EE-1995)

(a) $2e^{-t}u(t)$ (b) $\frac{1}{2}e^{-2t}u(t)$

(c) $e^{-2t}u(t)$ (d) $e^{-t}u(t)$

5. A linear time invariant system has an impulse response e^{2t}, $t>0$. If the initial conditions are zero and the input is e^{3t}, then output for $t > 0$ is

(GATE-EC-2000)

(a) $e^{3t}-e^{2t}$ (b) e^{5t}

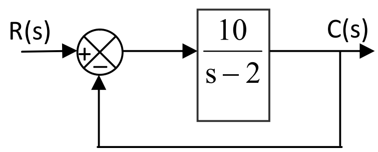
(c) $e^{3t}+e^{2t}$ (d) None

6. The relationship between input x(t) and output y(t) of a system is given as $\frac{d^2y}{dt^2}=x(t-2)+\frac{d^2x}{dt^2}$ the TF of this system is **(GATE-IN-1999)**

(a) $1+\frac{e^{-2s}}{s^2}$ (b) $1+\frac{e^{2s}}{s^2}$

(c) $1+s^2e^{-2s}$ (d) $1+s^2e^{2s}$

7. Find the TF



8. If the CLTF of a unity feedback system is $\frac{4}{S^2 + 7S + 13}$, find the corresponding OLTF

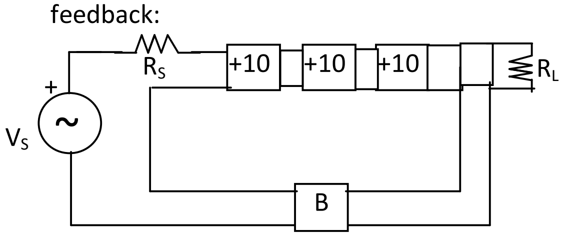
9. The unit – impulse response of a unit – feedback control system is given by c(t) = -te^{-t} + 2 e^{-t}, (t $\geq$ 0) the open loop transfer function is equal to

(GATE-1996-EE)

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

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

10. Consider the following amplifier with –ve feedback:



If the closed-loop gain of the above amplifier is + 100, the value B will be **(IES-EC-2002)**

(a) – 9 × 10^{-3} (b) + 9 × 10^{-3}

(c) – 11 × 10^{-3} (d) + 11 × 10^{-3}

11. Which one of the following is the transfer function of a linear system whose output is t^2e^{-t} for a unit step input?

(IES-EC-2003)

(a) $\frac{s}{(s+1)^3}$ (b) $\frac{2s}{(s+1)^3}$

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

12. A control system whose step response is 0.5(1-e^{-2t}) is cascaded to another control block whose impulse response is e^{-t}. What is the transfer function of the cascaded combination?

(IES-EC-2007)

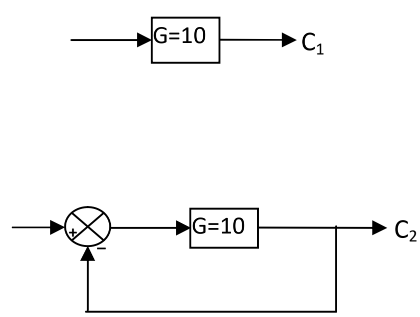
(a) $\frac{1}{(s+1)(s+2)}$

(b) $\frac{1}{s(s+1)}$

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

(d) $\frac{0.5}{(s+1)(s+2)}$

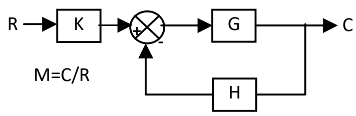
13. For the systems shown in figure below, if the G changes by 10%, the % changes in C_1 & C_2 respectively are



(a) 10%, 1% (b) 10%, 2%

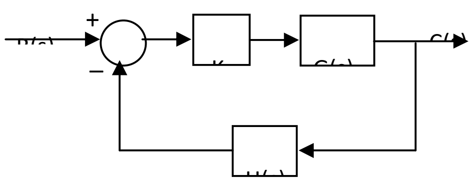
(c) 5%, 3% (d) 5%, 10%

14. Consider the following system



Find the sensitivity of 'M' with respect to changes in i) K ii) H

15. A feedback control system with high gain K, is shown in the figure below:



Then the closed loop transfer function is **(GATE-IN-2007)**

(a) sensitive to perturbations in G(s) and H(s)
(b) sensitive to perturbations in G(s) but not to perturbations in H(s)
(c) sensitive to perturbations in H(s) but not to perturbations in G(s)
(d) insensitive to perturbations in G(s) and H(s)

16. Consider the following statements in connection with the feedback of control system :

1) Feedback can improve stability or be harmful to stability if it is not properly applied.
2) Feedback can always improve stability.
3) In many situations the feedback can reduce the effect of noise and disturbance on system performance.
4) In general the sensitivity of the system gain of a feedback system to a parameter variation depends on where the parameter is located.

Which of the above statements are correct ? **(IES-EE-2010)**

(a) 1, 2 and 3 only
(b) 1, 3 and 4 only
(c) 1, 2 and 4 only
(d) 1, 2, 3 and 4

17. **Assertion (A)** : Feedback control systems offer more accurate control over open loop systems.
Reason (R) : The feedback path establishes a link for input and output comparison and subsequent error correction. **(IES-EC-2000)**

(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is NOT the correct explanation of A
(c) a is true but R is false
(d) a is false but R is true

18. Consider the following statements, feedback in control system can be used

1) to reduce the sensitivity of the system to parameter variations and disturbances
2) to change time constant of the system
3) to increase loop gain of the system

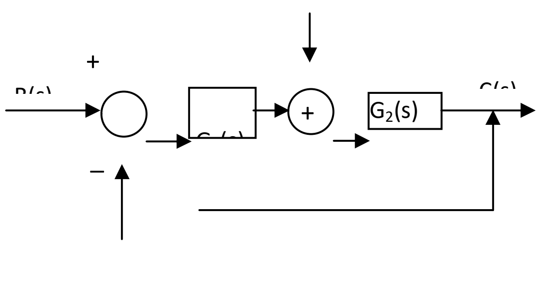
Which of the statements given above are correct? **(IES-EC-2004)**

(a) 1, 2 and 3 (b) 1 and 2

(c) 2 and 3 (d) 1 and 3

19. For the given system, how can the steady state error produced by step disturbance be reduced?

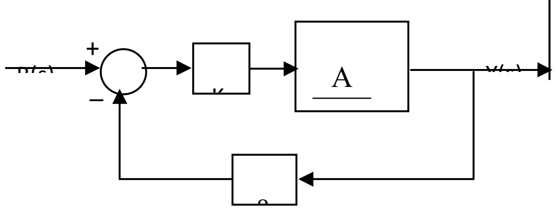
(IES-EC-2005)



(a) by increasing dc gain of $G_1(s)\ G_2(s)$
(b) by increasing dc gain of $G_2(s)$
(c) by increasing dc gain of $G_1(s)$
(d) by removing the feedback

20. For the system given below, the feedback does not reduce the closed-loop sensitivity due to variation of which one of the following ?

(IES-EC-2007)



(a) K (b) A

(c) $K\alpha$ (d) β

BASICS OF CONTROL SYSTEMS

Practice Questions

1. A closed loop control system is usually more accurate than the open loop control system. (T/F)

2. Feedback is some times used to improve the sensitivity of a control system. (T/F)

3. If an open loop system is unstable, applying feedback will always improve its stability. (T/F)

4. Feedback can increase the gain of a system in one frequency range but decrease it in another. (T/F)

5. Non linear elements are sometimes intentionally introduced to a control system to improve its performance. (T/F)

6. Discrete data control systems are more susceptible to noise, due to the nature of their signals. (T/F)

7. IR of a system is $2t^2e^{-3t}$, Find TF of a system.

8. AC control system has the advantage (s) of

   (a) availability of rugged high power amplifiers
   (b) smaller frame size of a.c components
   (c) both A and B
   (d) none

9. The transfer function of a system is the Laplace transform if its ---- response

   (a) ramp (b) impulse

   (c) squarewave (d) step

10. Any physical system which do not automatically correct for variation on its output is called as a/an system

    (a) unstable (b) open loop

    (c) closed loop (d) none

11. In a control system the comparator compares the output response and reference input and actuates the

    (a) primary sensing element
    (b) transducer
    (c) signal conditioner
    (d) control elements

12. Transfer function of a control system depends on

    (a) nature of output
    (b) nature of input
    (c) initial conditions of input and output
    (d) system parameters only

13. The open loop control system is one in which

(a) output is independent of control input
(b) only system parameters have effect on the control output
(c) output is dependent on control input
(d) all of the above

14. The order of the system is determined by number of

(a) poles of the system
(b) poles at the origin
(c) stable roots of the system
(d) zeros

15. The transfer function of a system is defined as the

(a) step response
(b) response due to an exponentially varying input
(c) laplace transform of the impulse response
(d) all of the above

16. In a control system an error detector

(a) produces an error signal as actual difference of value and desired value of output
(b) detects the system errors
(c) detects the error and signals out an alarm
(d) none

17. Potentiometers are used in control system

(a) to improve stability
(b) to improve frequency response
(c) as error sensing transducer
(d) to improve time response

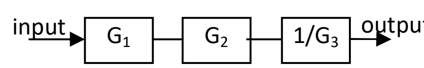
18. A control system with excessive noise, likely to suffer from

(a) loss of gain
(b) vibrations
(c) oscillations
(d) saturation is amplifying stages

19. In a control system, the use of negative feedback

(a) increases the influence of variations of component parameters on the system performance
(b) reduces the effects of disturbance and noise signals in the forward path
(c) increases the reliability
(d) eliminates the chances of instability

20. The measurement system shown the figure below uses three sub – systems in cascade whose gains are specified as G_1, G_2 and $1/G_3$. The relative small errors associated with each respective subsystem G_1, G_2 and G_3 are ε_1, ε_2 and ε_3. The error associated with the output is



(a) $\varepsilon_1+\varepsilon_2+\varepsilon_3$ (b) $\varepsilon_1 + \varepsilon_2 - \varepsilon_3$

(c) $\dfrac{\varepsilon_1\varepsilon_2}{\varepsilon_3}$ (d) $\varepsilon_1 + \varepsilon_2 - \varepsilon_3$

21. Feedback control systems are

(a) insensitive to both forward - and feedback path parameter changes.
(b) less sensitive to feedback path parameter changes than to forward path parameter changes.
(c) less sensitive to forward path parameter changes than to feedback path parameter changes.

(d) equally sensitive to forward and feedback path parameter changes.

22. A linear time invariant system initially at rest, when subjected to a unit step input, gives a response $y(t) = t\,e^{-t}$, $t > 0$. The transfer function of the system is

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

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

23. The transfer function of the system described by $\frac{d^2y}{dt^2}+\frac{dy}{dt}=\frac{du}{dt}+2u$ With u as input and y as output is

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

(c) $\frac{2}{(s^2+s)}$ (d) $\frac{2s}{(s^2+s)}$

24. For a tachometer, if $\theta(t)$ is the rotor displacement in radians, e(t) is the output voltage and K_t is the tachometer constant in V/rad/sec, then the transfer function $\frac{E(s)}{\theta(s)}$, will be

(a) $K_t s^2$ (b) $\frac{K_t}{s}$

(c) $K_t\, s$ (d) K_t

25. Tachometer feedback in a d.c. position control system enhances stability(T/F)

26. A linear time invariant system has an impulse response e^{2t}, t>0. If the initial conditions are zero and the input is e^{3t}, then output for t > 0 is

(a) $e^{3t}-e^{2t}$ (b) e^{5t}

(c) $e^{3t}+e^{2t}$ (d) None

27. Let x(t) be the input to a linear, time-invariant system. The required output is 4x(t-2). The transfer function of the system should be

(a) $4\,e^{j4\pi f}$ (b) $2\,e^{-j8\pi f}$

(c) $4\,e^{-j4\pi f}$ (d) $2\,e^{j8\pi f}$

28. The Laplace transform of a 4 second transportation lag element is

(a) $\frac{1}{(s+4)}$ (b) e^{4s}

(c) e^{-4s} (d) $e^{-s/4}$

29. The TF is the laplace transform of its

(a)square wave response

(b)step response

(c)ramp response

(d)impulse response

30. A TF has two zeros at infinity, then the relation between the numerator

degree(N) and the denominator degree(M) of TF is

(a)N=M+2 (b) N=M-2

(c)N=M+1 (d)N=M-1

31. Which one of the following effects in the system is NOT caused by negative feedback?

(a) Reduction in gain
(b) Increase in bandwidth
(c) Increase in distortion
(d) Reduction in output impedance

32. The input relationship of a linear time invariant continuous time system is given by r(t) = $\frac{d^2c(t)}{dt^2}+3\frac{dc(t)}{dt}+2c(t)$, where r(t) and c(t) are input and output respectively. What is the transfer function of the system equal to ?

(a) $\frac{1}{(s^2+s+2)}$ (b) $\frac{1}{(s^2+3s+2)}$

(c) $\frac{2}{(s^2+3s+2)}$ (d) $\frac{2}{(s^2+s+2)}$

33. With negative feedback in a closed loop control system, the system sensitivity to parameter variations:

(a) increases
(b) decreases
(c) becomes zero
(d) becomes infinite

34. Consider the following statements with respect to feedback control systems:

1) Accuracy cannot be obtained by adjusting loop gain.
2) Feedback decreases overall gain.
3) Introduction of noise due to sensor reduces overall accuracy.
4) Introduction of feedback may3 lead to the possibility of instability of closed loop system.

Which of the statements given above are correct?

(a) 1, 2, 3 and 4
(b) only 1, 2 and 4
(c) only 1 and 3
(d) only 2, 3 and 4

35. The impulse response of a linear time invariant system is given as g(t) =e^{-t}, t > 0. The transfer function of the system is equal to

(a) 1/s (b) 1/[s(s+1)]

(c) 1/(s+1) (d) s/(s+1)

36. What is the characteristic of a good control system ?

(a) sensitive to parameter variation
(b) insensitive to input command
(c) neither sensitive to parameter variation nor sensitive to input commands
(d) insensitive to parameter variation but sensitive to input commands

37. Which of the following may result in instability problem ?

(a) large error
(b) high selectivity
(c) high gain
(d) noise

38. A negative-feedback closed-loop system is supplied to an input of 5 V. The system has a forward gain of 1 and a feedback gain of 1. What is the output voltage ?

(a) 1.0 V (b) 1.5 V

(c) 2.0 V (d) 2.5 V

39. In closed loop control system, what is the sensitivity of the gain of the overall system, M to the variation in G ?

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

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

40. For the LTI system described by $2\frac{d^2y(t)}{dt^2}+3\frac{dy(t)}{dt}+4y(t)=r(t)+2r(t-1)$ and having zero initial conditions, the transfer function $\frac{Y(s)}{R(s)}$ is

(a) $\frac{1+2e^{s}}{2s^2+3s+4}$ (b) $\frac{2s^2+3s+4}{1+2e^{s}}$

(c) $\frac{1+2e^{-s}}{2s^2+3s+4}$ (d) $\frac{2s^2+3s+4}{1+2e^{-s}}$

41. Find the laplace transform of $\cos(w_o t+\phi)$

42. Find the Fourier transform of unity

43. The unit impulse response of a unity feedback control system is given by $C(t)=-te^{-t}+2e^{-t},(t\geq 0)$, open loop transfer function is equal to

(a) $\frac{S+1}{(S+2)^2}$ (b) $\frac{S}{(S+2)^2}$

(c) $\frac{S}{(S+1)^2}$ (d) $\frac{2S+1}{S^2}$

44. Characteristic of a linear system is that the magnitude of the scaling factor is preserved. This is referred to as

(a) principle of reciprocity
(b) principle of homogeneity
(c) principle of superposition
(d) principle of conservation of energy

45. Which of the following statement is not true for the TF.

(a) defined for only linear system

(b) obtained by taking the laplace transform of IR of the system

(c) depends on the input to the system

(d) zero initial conditions are assumed

46. Inverse laplace transformation of $\frac{se^{-\pi s}}{s^2+1}$ is

(a) cos(t-π)u(t--π) (b) cos(t-π)

(c) $e^{-\pi t}$ cost (d) sin(t-π)u(t- π)

47. Laplace transform of the function 10u(t-2) is

(a) $\frac{10}{s}$ (b) $\frac{10}{s+2}$

(c) $\frac{10}{s}e^{-2s}$ (d) $\frac{10}{s-2}$

48. A system is linear if only

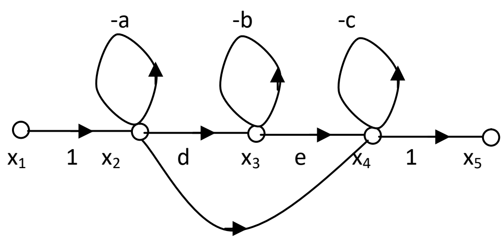
(a) principle of superposition is satisfied
(b) principle of homogeneity is satisfied
(c) both principle of homogenity and superposition is satisfied
(d) neither principle of superposition nor homogeneity is satisfied

CHAPTER – II

SIGNAL FLOW GRAPH AND BLOCK DIAGRAM

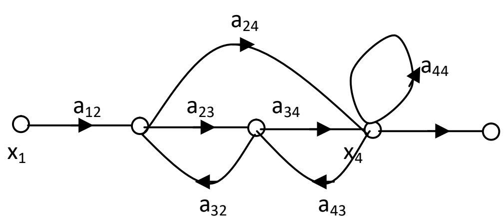
Class Room Objectives

1.

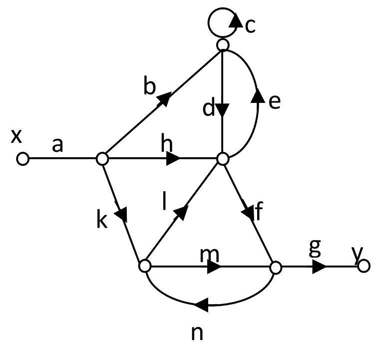


Find 1) $\frac{x_5}{x_1}$ 2) $\frac{x_5}{x_3}$

2. Find $\frac{x_4}{x_1}$



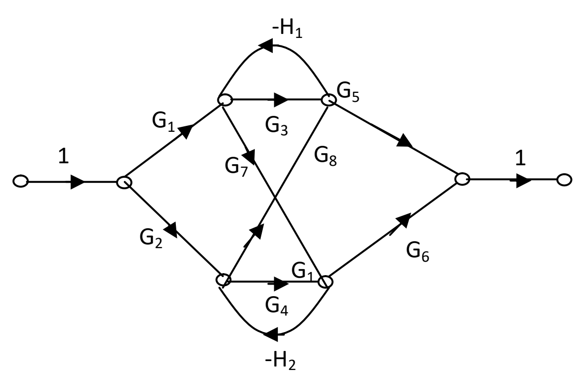
3. In the figure below The no. of forward paths and loops are



(a) 3, 3 (b) 3, 4

(c) 4, 3 (d) 4, 4

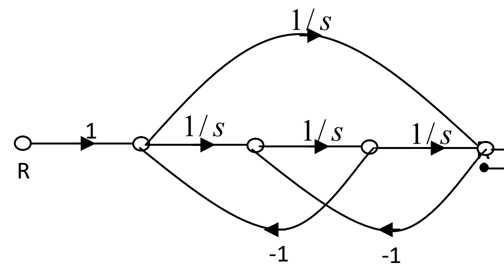
4. The no. of forward paths and loops in the below fig. respectively are



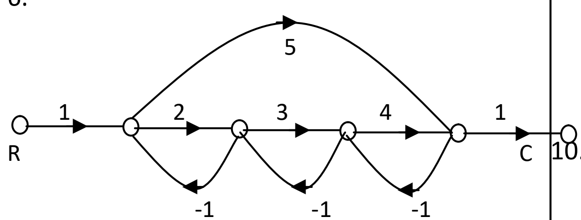
(a) 4, 2 (b) 4, 3

(c) 6, 2 (d) 6, 3

5.



6.

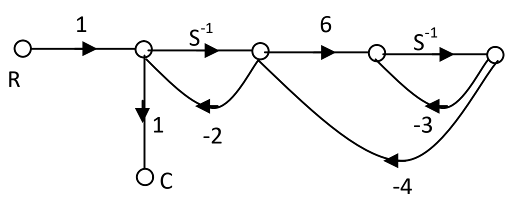


C/R of the fig. is

(a) 44/23 (b) 29/23

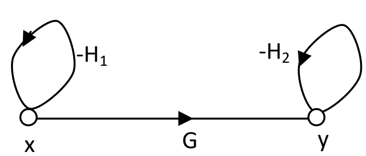
(c) 23/29 (d) None

7.



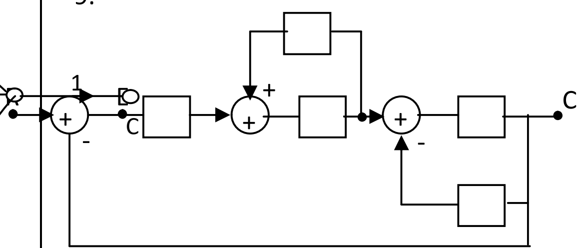
Find C/R

8.



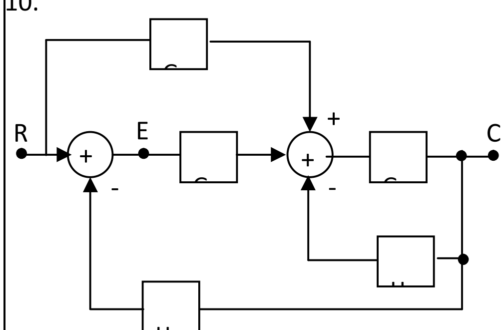
Find y/x

9.



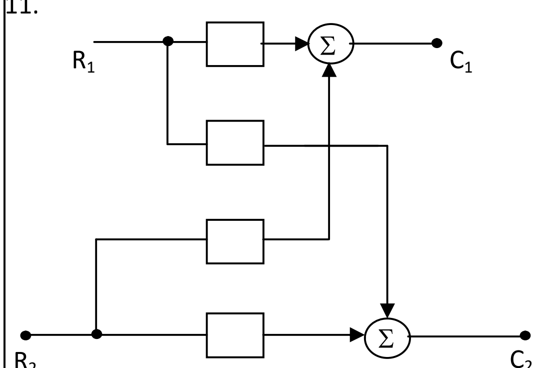
Find 1) C/R 2) E/R

10.



Find 1) C/R 2) E/R

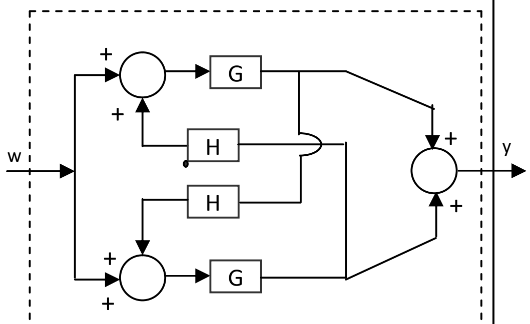
11.



Find C_1 & C_2

12. The overall transfer function of the system in Figure, is

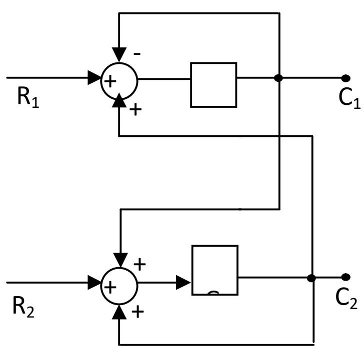
(GATE-EE- 1992)



(a) $\frac{G}{1-GH}$ (b) $\frac{2G}{1-GH}$

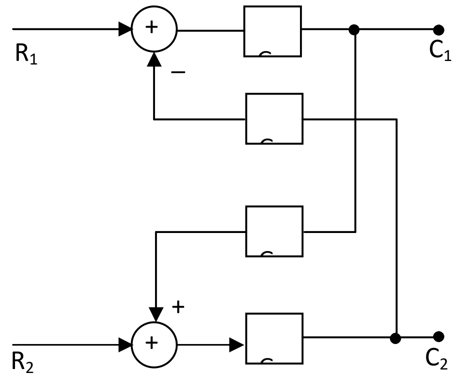
(c) $\frac{GH}{1-GH}$ (d) $\frac{GH}{1-H}$

13.



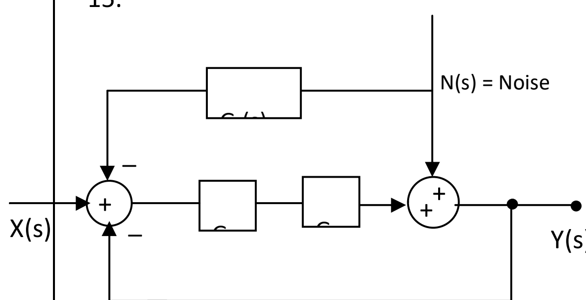
Find C_1 and C_2

14.



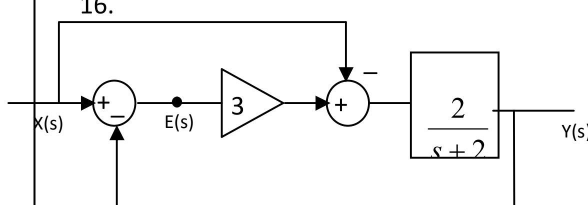
Find C_1 & C_2

15.



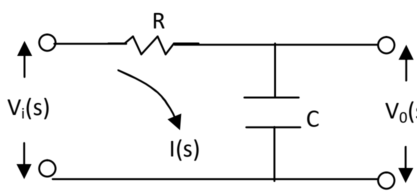
Find the condition on $G_c(s)$ in order to nullify the noise at the O/P.

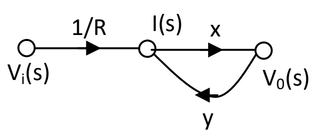
16.



Find i) $\frac{Y(S)}{X(S)}$ ii) $\frac{E(S)}{X(S)}$

17. The electrical n/w and its equivalent SFG is given below. The values of x and y are respectively

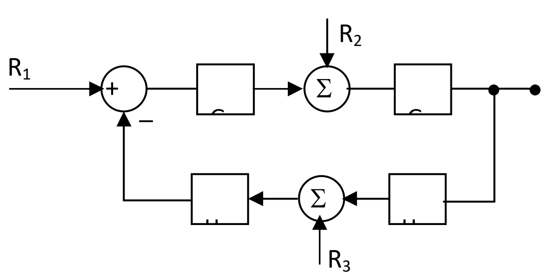




(a) 1/CS, 1/R (b) –1/CS, -1/R

(c) 1/CS, -1/R (d) -1/CS, 1/R

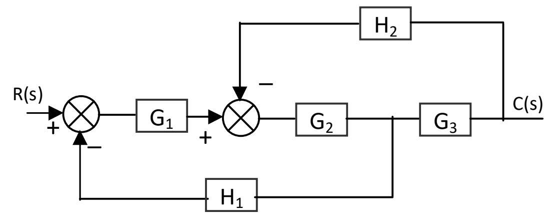
18. Find the value of 'C' in the following figure.



Find C/R

19. For block diagram shown in Figure C(s)/R(s) is given by

(GATE-EE-1998)



(a) $\frac{G_1G_2G_3}{1+H_2G_2G_3+H_1G_1G_2}$

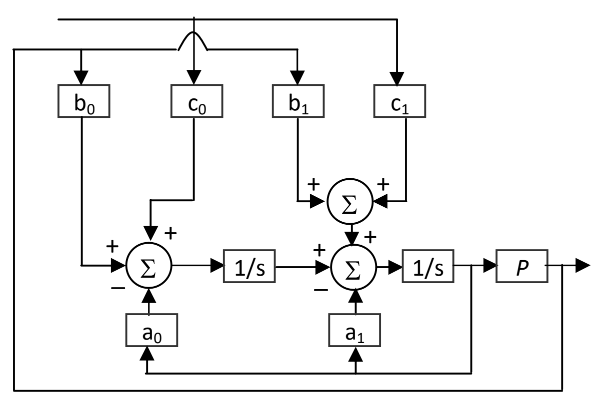
(b) $\frac{G_1G_2G_3}{1+G_1G_2G_3H_1H_2}$

(c) $\frac{G_1G_2G_3}{1+G_1G_2G_3H_1+G_1G_2G_3H_2}$

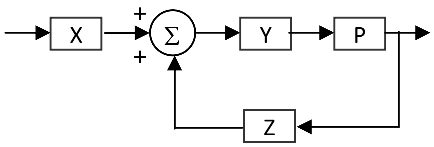
(d) $\frac{G_1G_2G_3}{1+G_1G_2G_3H_1}$

20. The system shown in figure below

(GATE- EE-2007)



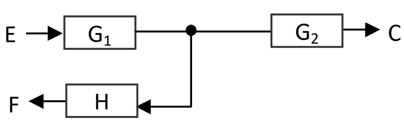
can be reduced to the form

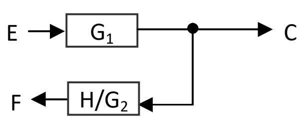


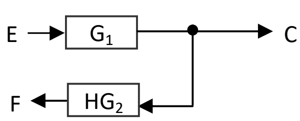
With

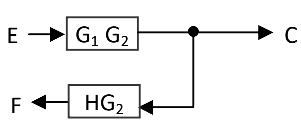
(a) $X = C_0s + C_1$, $Y = 1/(s^2 + a_0s + a_1)$, $Z = b_0s + b_1$
(b) $X = 1$, $Y = (c_0s + c_1) / (s^2 + a_0s + a_1)$, $Z = b_0s + b_1$
(c) $X = C_1s + C_0$, $Y = (b_1s + b_0)/(s^2+a_1s+a_0)$, $Z = 1$
(d) $X = C_1s + c_0$, $Y = 1/(s^2 + a_1s + a)$, $Z = b_1s + b_0$

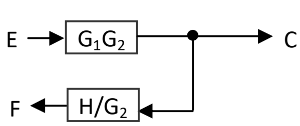
21. The equivalent of the block diagram in Fig. 1 is given in **(GATE-EC-2001)**



(a)


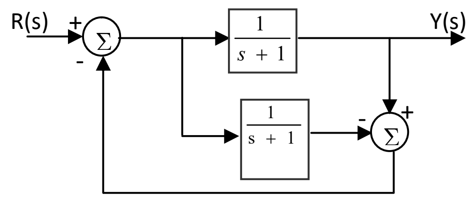
(b)


(c)


(d)


(a) Fig - A (b) Fig- B
(c) Fig - C (d) Fig -D

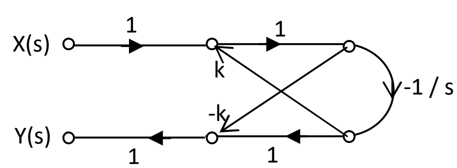
22. The transfer function Y(s)/R(s) of the system shown is **(GATE-EC-2010)**



(a) 0 (b) $\frac{1}{s+1}$

(c) $\frac{2}{s+1}$ (d) $\frac{2}{s+3}$

23. 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 **(GATE-IN-2009)**

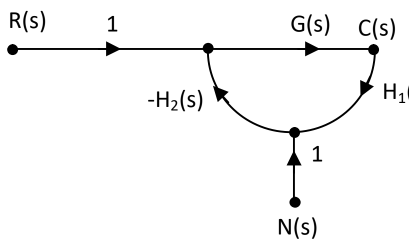


a) $\frac{-(1+ks)}{s+k}$ b) $\frac{(1+ks)}{s+k}$

c) $\frac{-(1-ks)}{s+k}$ d) $\frac{(1-ks)}{s+k}$

24. A closed-loop system is shown in the given figure. The noise transfer function C(s)/N(s) [$C_n(s)$ = output corresponding

to noise input N(s) is approximately **(IES-EE-2000)**



(a) $\dfrac{1}{G(s)H_1(s)}$ for $|G_1(s)H_1(s)H_2(s)| << 1$

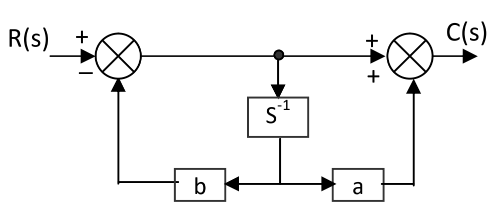
(b) $\dfrac{1}{H_1(s)}$ for $G_1(s)H_1(s)H_2(s) >> 1$

(c) $\dfrac{1}{H_1(s)H_1(s)}$ for $|G_1(s)H_1(s)H_2(s)| >> 1$

(d)

$$\frac{1}{G(s)H_1(s)H_2(s)} \text{ for } |G_1(s)H_1(s)H_2(s)| << 1$$

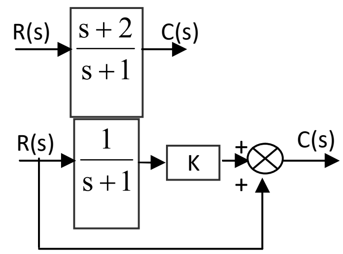
25. The block diagram for a particular control system is shown in the figure. What is the transfer function C(s)/ R(s) for this system? **(IES-EE-2007)**



(a) $\dfrac{s+a}{s-b}$ (b) $\dfrac{s+a}{s+b}$

(c) $\dfrac{s-b}{s+a}$ (d) $\dfrac{s+b}{s+a}$

26.

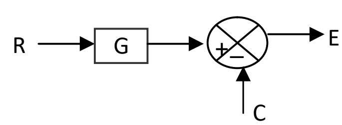


For what value of K are the two block diagrams as shown above equivalent ? **(IES-EE-2009)**

(a) 1 (b) 2

(c) (s + 1) (d) (s + 2)

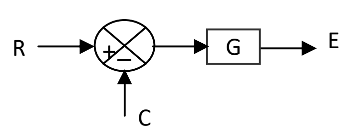
27.



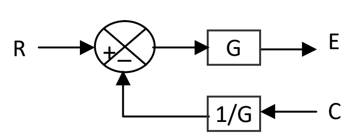
Which one of the following block diagrams is equivalent to the above shown block diagram?

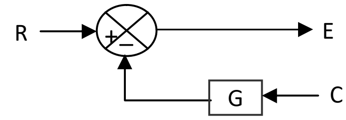
(IES-EE-2009)

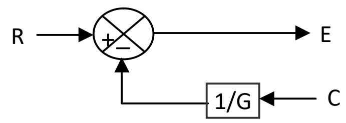
(a)



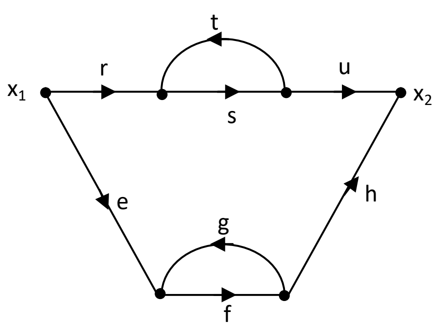
(b)



(c) 

(d) 

28. For the signal flow diagram shown in the given figure, the transmittance between x_2 and x_1 is **(IES-EC-2001)**



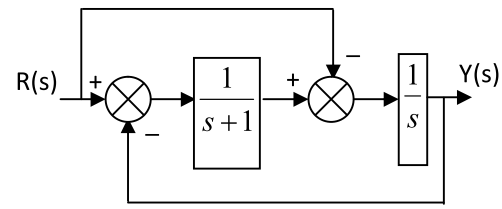
(a) $\frac{rsu}{1-st}+\frac{efh}{1-fg}$

(b) $\frac{rsu}{1-fg}+\frac{efh}{1-st}$

(c) $\frac{efh}{1-ru}+\frac{rsu}{1-eh}$

(d) $\frac{rst}{1-eh}+\frac{rsu}{1-st}$

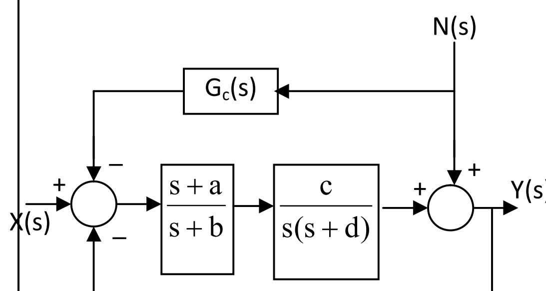
29. The transfer function $\frac{Y(s)}{R(s)}$ of the system shown in Fig. is **(DRDO-EE-2009)**



(a) $\frac{1}{s^2+s+1}$ (b) $\frac{-s}{s^2+s+1}$

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

30. For a linear time invariant system shown in Fig. X(s) is the input and Y(s) is the output.



In order to nullify the effect of noise N(s), the gain of the feed-forward path $G_c(s)$ is

(DRDO-EC-2009)

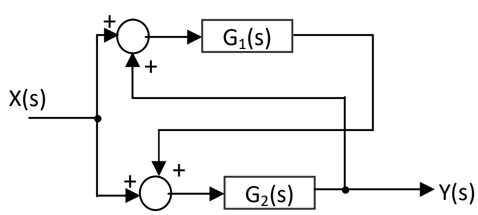
(a) $\frac{s(s+a)(s+d)}{c(s+b)}$

(b) $\frac{c(s+b)}{s(s+a)(s+d)}$

(c) $\dfrac{s(s+b)(s+d)}{c(s+a)}$

(d) $\dfrac{c(s+a)}{s(s+b)(s+d)}$

31. The transfer function $\dfrac{Y(s)}{X(s)}$ of the linear time invariant system shown in Fig. **(DRDO-EC-2009)**



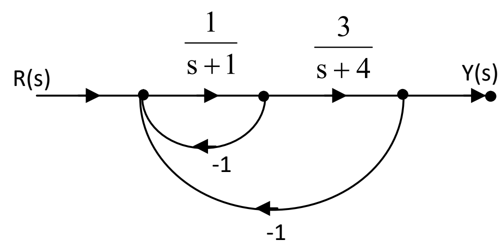
(a) $\dfrac{G_1(s)(G_2(s)+1)}{1-G_1(s)G_2(s)}$

(b) $\dfrac{G_2(s)(G_1(s)+1)}{1-G_1(s)G_2(s)}$

(c) $\dfrac{G_1(s)(G_2(s)+1)}{1-G_1(s)+G_2(s)}$

(d) $\dfrac{G_2(s)(G_1(s)+1)}{1+G_1(s)G_2(s)}$

32. For the flow diagram shown in Fig. Q41-II, the transfer function $\dfrac{Y(s)}{R(s)}$ is **(JTO-EC-2009)**



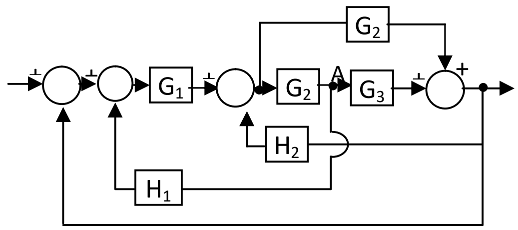
(a) $\dfrac{3}{s^2+6s+11}$ (b) $\dfrac{3}{s^2+5s+8}$

(c) $\dfrac{3}{s^2+6s+8}$ (d)

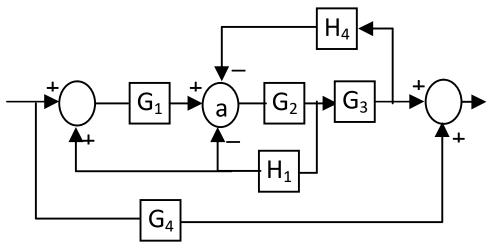
$\dfrac{-3}{s^2+6s+11}$

Practice Questions

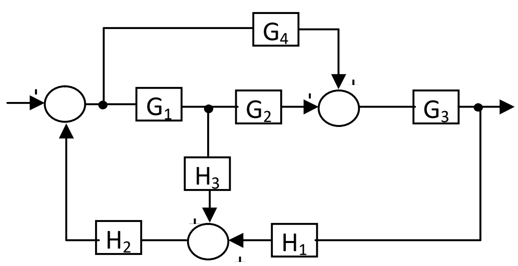
1.



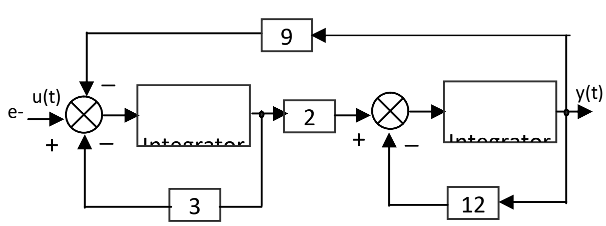
2.



3.



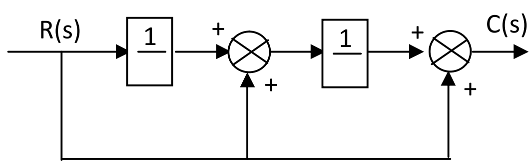
4. The block diagram of a control system is shown in Fig. 38. The transfer function G(s) = Y(s)/U(s) of the system is



(a) $\dfrac{1}{18\left(1+\dfrac{s}{12}\right)\left(1+\dfrac{s}{3}\right)}$ (b) $\dfrac{1}{27\left(1+\dfrac{s}{6}\right)\left(1+\dfrac{s}{9}\right)}$

(c) $\dfrac{1}{27\left(1+\dfrac{s}{12}\right)\left(1+\dfrac{s}{9}\right)}$ (d) $\dfrac{1}{27\left(1+\dfrac{s}{9}\right)\left(1+\dfrac{s}{3}\right)}$

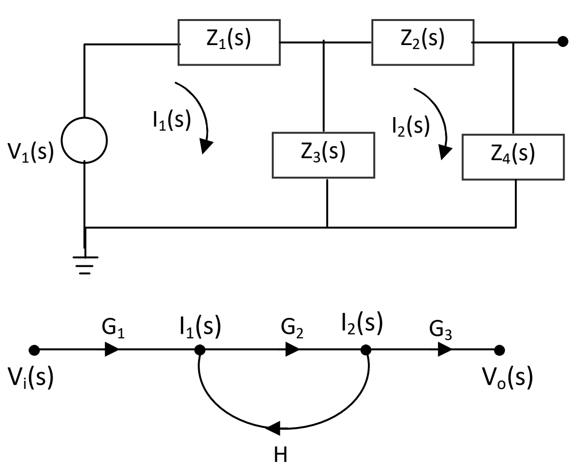
5. For the block diagram shown in figure, the transfer function is equal to



(a) $\dfrac{s^2+1}{s^2}$ (b) $\dfrac{s^2+s+1}{s^2}$

(c) $\dfrac{s^2+s+1}{s}$ (d) $\dfrac{1}{s^2+s+1}$

6. An electrical system and its signal-flow graph representation are shown in figure(a) and (b) respectively. The values of G_2 and H, respectively, are



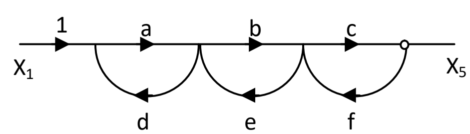
(a) $\dfrac{Z_3(s)}{Z_2(s)+Z_3(s)+Z_4(s)}, \dfrac{-Z_3(s)}{Z_1(s)+Z_3(s)}$

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

7. Consider the signal flow graph shown in figure. The gain $\dfrac{x_5}{x_1}$ is



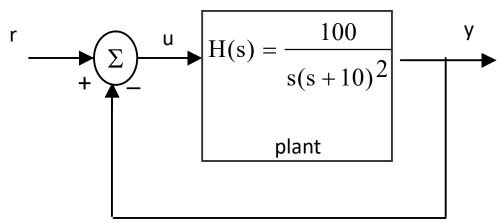
(a) $\dfrac{1-(be+cf+dg)}{abcd}$

(b) $\dfrac{bedg}{1-(be+cf+dg)}$

(c) $\dfrac{abc}{1-(be+cf+ad)+adcf}$

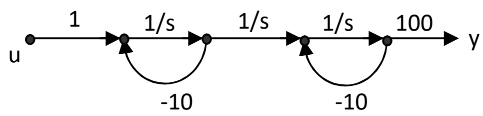
(d) $\dfrac{1-(be+cf+dg)+bedg}{abcd}$

8. The input-output transfer function of a plant $H(s)=\dfrac{100}{s(s+10)}$. The plant is placed in a unity negative feedback configuration as shown in the figure below.

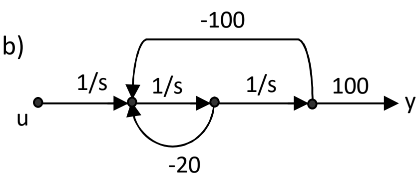


The signal flow graph that **DOES NOT** model the plant transfer function H(s) is

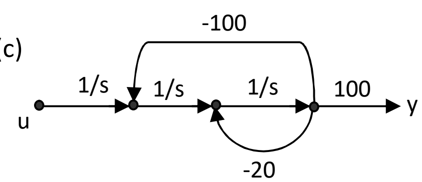
(a)



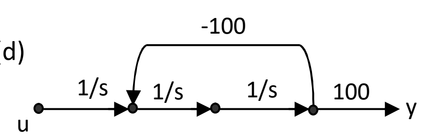
(b)



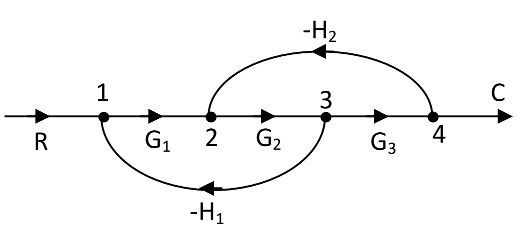
(c)



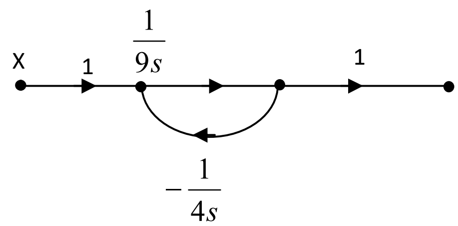
(d)



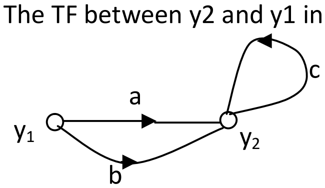
9. For the signal flow graph shown in Fig. the transfer function is $\dfrac{C(s)}{R(s)}$



10. Find the transfer function and impulse response of the linear time invariant system represented by the signal flow graph in the Fig.



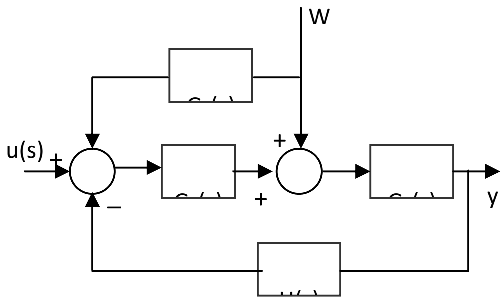
11. The TF between y2 and y1 in fig.below is



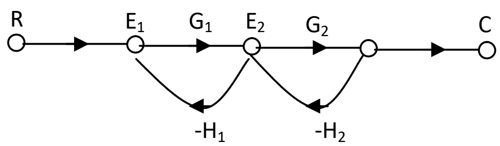
(a) a+b (b)(a+b)c

(c) $\frac{a+b}{1-c}$ (d) $\frac{a+b}{1+c}$

12. Fig. shows the block diagram for a system with feed forward control.
    (a) Find the transfer function between the output y and the disturbance input w.
    (b) What would be the transfer function of the feed forward controller $G_f(s)$ to eliminate completely the effect of the disturbance input w ?



13. The transfer function of the open loop system G(s) which is represented by the signal flow graph shown the figure below is



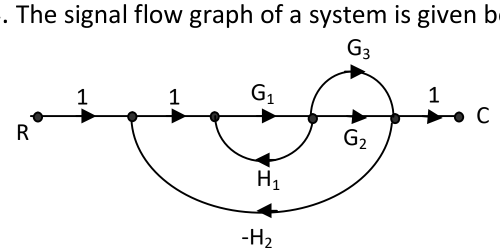
(a) $\dfrac{G_1G_2}{1+G_1H_1+G_2H_1}$

(b) $\dfrac{G_1G_2}{1+G_1H_1G_2H_2}$

(c) $\dfrac{G_1G_2}{(1+G_1H_1)(1+G_2H_2)}$

(d) $\dfrac{G_1G_2}{1+G_1H_1+G_2H_2}$

14. The signal flow graph of a system is given below.



The transfer function (C/R) of the system is

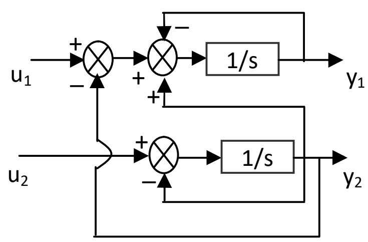
(a) $\dfrac{(G_1G_2 + G_1G_3)}{1 + G_1G_2H_2}$

(b) $\dfrac{(G_1G_2 + G_1G_3)}{(1 - G_1H_1 + G_1G_2H_2)}$

(c) $\dfrac{(G_1G_2 + G_1G_3)}{(1 - G_1H_1 + G_1G_2H_2 + G_1G_3H_2)}$

(d) $\dfrac{(G_1G_2 + G_1G_3)}{(1 - G_1H_1 + G_1G_2H_2 + G_1G_3H_2 + G_1G_2G_3H_1)}$

15. The control system shown in the given figure is represented by the equation $\begin{bmatrix} y_1 \\ y_2 \end{bmatrix}$ = [matrix 'G'] $\begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$



The matrix 'G' of the system is

(a) $\begin{bmatrix} 1/s & -1/s^2 \\ 0 & 1/s \end{bmatrix}$

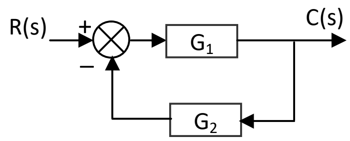
(b) $\begin{bmatrix} 1/s & 1/s^2 \\ 0 & -1/s \end{bmatrix}$

(c) $\begin{bmatrix} \dfrac{1}{(s+1)} & 0 \\ 0 & \dfrac{1}{(s+1)} \end{bmatrix}$

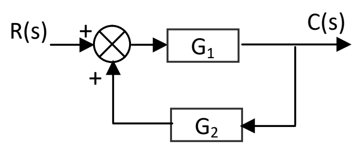
(d) $\begin{bmatrix} \dfrac{1}{(s+1)} & \dfrac{1}{(s+1)^2} \\ 0 & -\dfrac{1}{(s+1)} \end{bmatrix}$

16. Consider the following block diagrams:

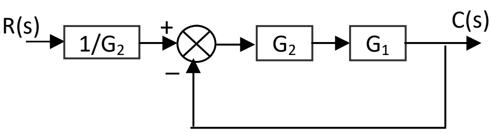
1



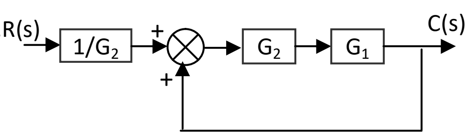
2.



3.



4.

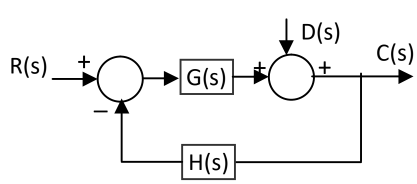


Which of these block diagrams can be reduced to transfer function $\frac{C(s)}{R(s)} = \frac{G_1}{1 - G_1 G_2}$

(a) 1 and 3 (b) 2 and 4

(c) 1 and 4 (d) 2 and 3

17. In the feedback system C(s), R(s) and D(s) are the system output, input and disturbance, respectively



Assertion (A): For the system

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

Reason (R): Transfer function of a system is defined as the ratio of output Laplace transform and input Laplace transform setting other inputs and the initial conditions to zero.

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

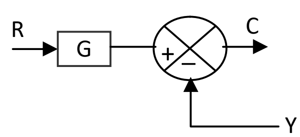
18. Match List I (Block Diagram) with List II (Transformed Block Diagram) and select the correct answer :

(IES-EE-2003)

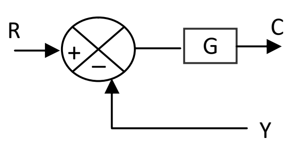
List – I

(Block Diagram)

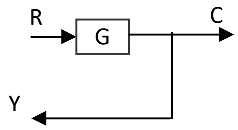
A.



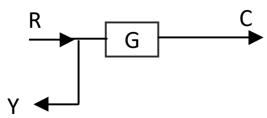
B.



C.



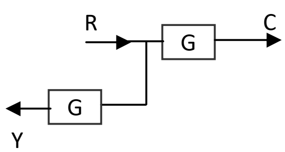
D.



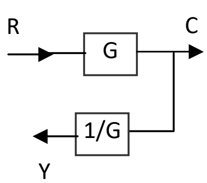
List – II

(Transformed Block Diagram)

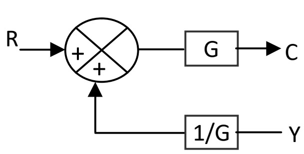
1.



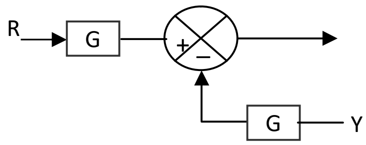
2.



3.



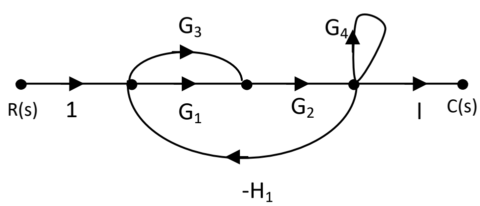
4.



Code:

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

19. The gain C(s)/R(s) of the signal flow graph shown above is



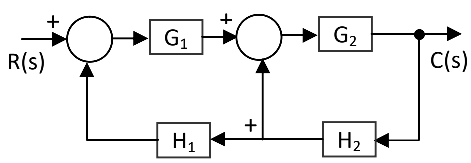
(a) $\dfrac{G_1G_2+G_2G_3}{1+G_1G_2H_1+G_2G_3H_1+G_4}$

(b) $\dfrac{G_1G_2+G_2G_3}{1+G_1G_2H_1+G_2G_3H_1-G_4}$

(c) $\dfrac{G_1G_2+G_2G_3}{1+G_1G_3H_1+G_2G_3H_1+G_4}$

(d) $\dfrac{G_1G_3+G_2G_3}{1+G_1G_3H_1+G_2G_3H_1-G_4}$

20. The overall gain $\frac{C(s)}{R(s)}$ of the block diagram shown above is



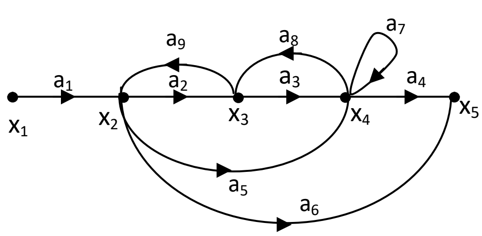
(a) $\frac{G_1G_2}{1 - G_2H_2H_1H_2}$

(b) $\frac{G_1G_2}{1 - G_2H_2 - G_1G_2H_1}$

(c) $\frac{G_1G_2}{1 - G_2H_2 - G_1G_2H_1H_2}$

(d) $\frac{G_1G_2}{1 - G_1G_2H_1 - G_1G_2H_2}$

21. The signal flow graph for a certain feedback control system is given below:



Now consider the following set of equations for the nodes:

1. $x_2 = a_1x_1 + a_9x_3$

2. $x_3 = a_2x_2 + a_8x_4$

3. $x_4 = a_3x_3 + a_5x_2$

4. $x_5 = a_4x_4 + a_6x_2$

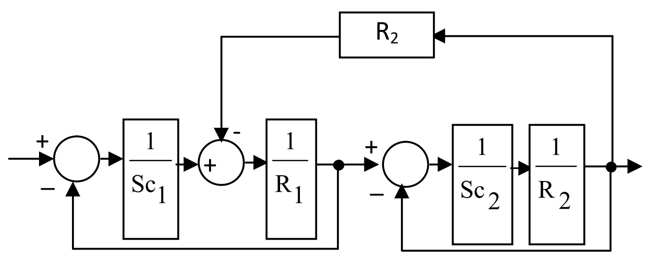
Which of the above equations are correct

(a) 1, 2 and 3 (b) 1, 3 and 4

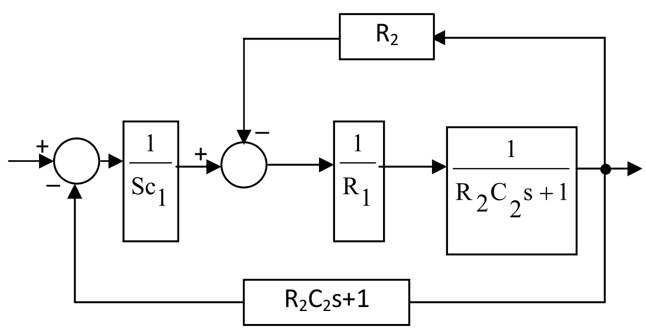
(c) 2, 3 and 4 (d) 1, 2 and 4

22. Consider the following three block diagram A, B and C shown below:

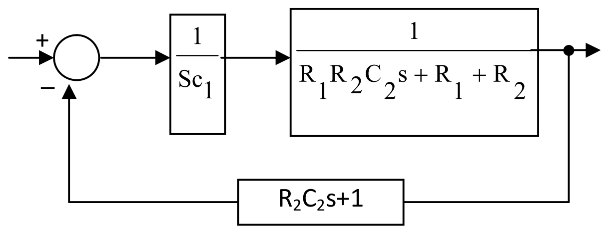
Block Diagram - A



Block Diagram – B



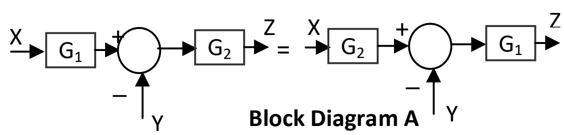
Block Diagram - C



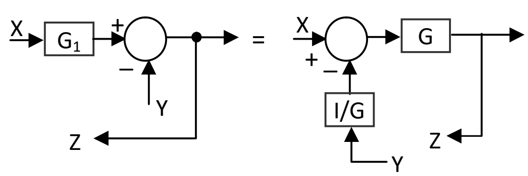
Which one of the following statement is correct in respect of the above block diagrams?

(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

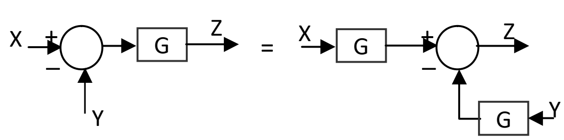
23. Consider the following three cases of block diagram algebra A, B and C



Block Diagram A



Block Diagram B



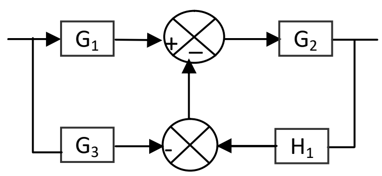
Block Diagram C

Which of the above relations are correct?

(a) A and B (b) B and C

(c) A and C (d) A, B and C

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



(a) $\dfrac{G_1G_2 + G_2G_3}{1 + G_2H_1}$

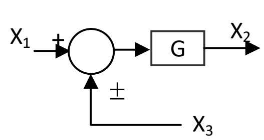
(b) $G_1G_2 + G_2G_3$

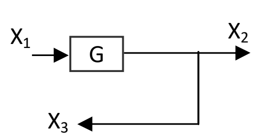
(c) $\dfrac{G_1G_3 + G_2G_3}{1 + G_3H_1}$

(d) $\dfrac{G_1G_2 + G_2G_3}{1 + G_2G_3H_1}$

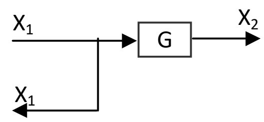
25. Match List I (Original Diagram) with List II (Equivalent Diagram) and select the correct answer using the code given below the Lists

List I

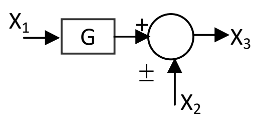
(a) 

(b) 

(c)

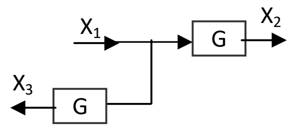


(d)

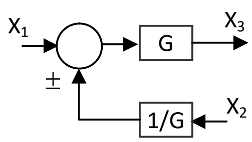


List - II

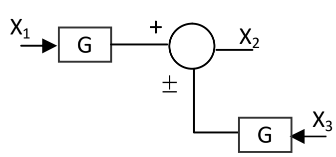
(1)



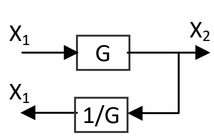
(2)



(3)



(4)



Code:

	A	B	C	D
a)	3	1	4	2
b)	2	4	1	3

c) 3 4 1 2

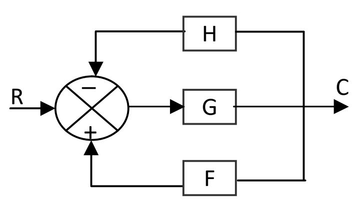
d) 2 1 4 3

26. Assertion **(A):** Signal flow graphs can be used for block diagram reduction of linear control system.

Reason (R): Signal flow graph is a graphical representation for the variables representing the outputs of the various blocks of the control system

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

27. For the feedback system shown in the figure above, which one of the following expresses the input-output relation C/R of the overall system



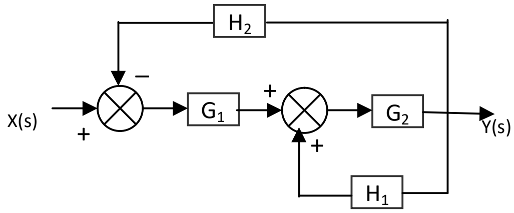
(a) $\dfrac{G}{1-FG+GH}$

(b) $\dfrac{G}{1+FG-GH}$

(c) $\dfrac{FG}{1+FGH}$

(d) $\dfrac{GH}{1-FGH}$

28. Which one of the following is the transfer function $\dfrac{Y(s)}{X(s)}$ for the block diagram given?



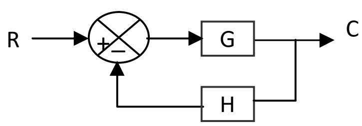
(a) $\dfrac{G_1G_2}{1+H_2G_1G_2-H_1G_2}$

(b) $\dfrac{G_1G_2}{1-H_2G_1G_2-H_1G_2}$

(c) $\dfrac{H_1G_1G_2}{1-H_2G_1G_2+H_1G_2}$

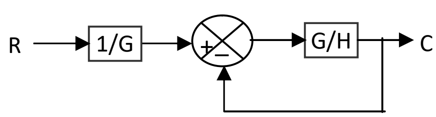
(d) $\dfrac{H_1G_1G_2}{1+H_2G_1G_2-H_1G_2}$

29.

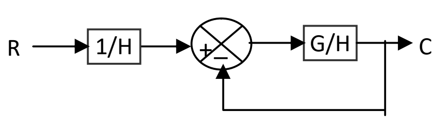


The above shown feedback control system has to be reduced to equivalent unity feedback system. Which one of the following is equivalent ?

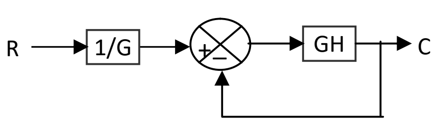
(a)

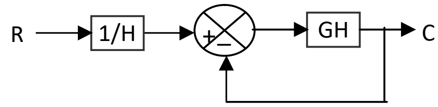


(b)

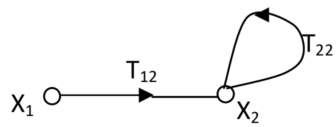


(c)



(d) 

30. In the SFG shown



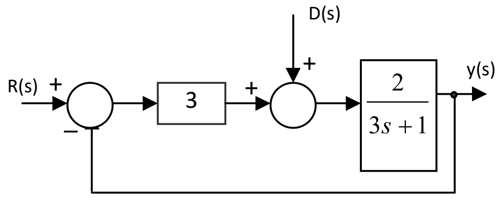
(a) $X_2=(T_{12}+T_{22})X_1$

(b) $X_2=(T_{12}-T_{22})X_1$

(c) $X_2 = \frac{T_{12}}{T_{22}} X_1$

(d) $X_2 = \frac{T_{12}}{1-T_{22}} X_1$

31. The transfer function from d(s) to y(s) is :



(a) $\frac{2}{3s+7}$ (b) $\frac{2}{3s+1}$

CHAPTER – III

STABILITY

Class Room Objectives

test whether the system is stable (or) not.

2. $\text{TF} = \dfrac{5(S+4)}{2S^4 + S^3 + 3S^2 + 5S + 10}$
find the no. of left hand, right hand and $j\omega$ axis poles of the above system.

3. $G(S)H(S) = \dfrac{4}{S^2}$ test the stability of a system.

4. Ch eq is $S^3-4S^2-5S+6=0$. find the no. of roots present in the right side of s-plane.

5. Characteristic equation $S^3-3S+2 = 0$ find the no. of right side roots.

6. The no. of open right half plane poles of $G(S) = \dfrac{10}{S^5+2S^4+3S^3+6S^2+5S+3}$

7. $\text{TF} = \dfrac{40}{S^5 + 4S^4 + 8S^3 + 8S^2 + 7S + 4}$
   i) Test the stability of system
   ii) If the system oscillates find the oscillating frequency with fixed/ constant oscillations.

8. Test the stability of a system with the following
Ch.eq. $S^5+S^4+2S^3+2S^2+S+1 = 0$

Ans: unstable

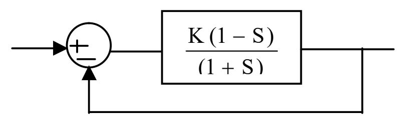
characteristic equations system.

i) $S^5+S^4+S^3+S^2+S+1 = 0$

ii) $S^5 +S^3+S^2+1 = 0$

iii) $S^6+ 2S^5+2S^4 -S^2-2S-2 = 0$

10. The range of K for the system to be stable is



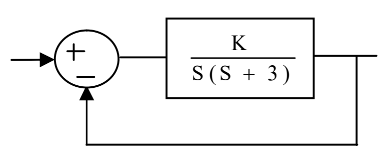
(a) K < 1 (b) k > -1

(c) |K|<1 (d) |K|>1

11. Ch. equation is $S^3+20S^2+16S+16K = 0$ Find the i) range of K for the system to be stable ii) The value of 'K' for the system to oscillate and the corresponding natural frequency (ω_n)

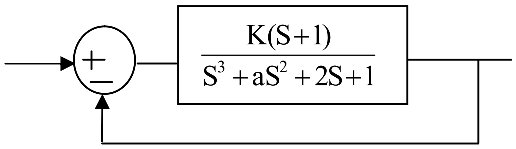
12. Ch. equation $S^3+6KS^2+(K+2)S+8 = 0$ Find the condition for the system to be stable.

13. Find the condition on 'K' for the system to oscillate, Where $0 < K < \infty$.

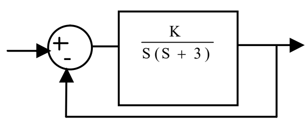


14. Find the values of 'K' and 'a' for the following system to oscillate at a frequency of 2 rad/ sec.

(GATE-EC-2006)



15. The value of 'K' for the closed loop poles to lie left side of S = -1 is

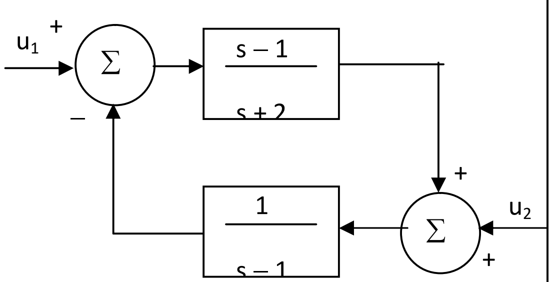


(a) $K > 2$ (b) $K < 2$

(c) $K > -2$ (d) $K \geq 1$

16. The system shown in the figure is

(GATE- EE- 2007)



(a) stable

(b) Unstable

(c) conditionally stable

(d) stable for input u_1, but unstable for input u_2

17. Consider a characteristic equation given by $s^4 + 3s^3 + 5s^2 + 6s + K + 10 = 0$
The condition for stability is

(GATE-EC-1988)

(a) $K > 5$ (b) $-10 < K$

(c) $K > -4$ (d) $-10 < K < -4$

18. An electromechanical closed-loop control system has the following characteristic equation: $s^3 + 6Ks^2 + (K+2)s + 8 = 0$ Where K is the forward gain of the system. The condition for closed loop stability is **(GATE-EC-1990)**

(a) $K = 0.528$ (b) $K = 2$

(c) $K = 0$ (d) $K = -2.258$

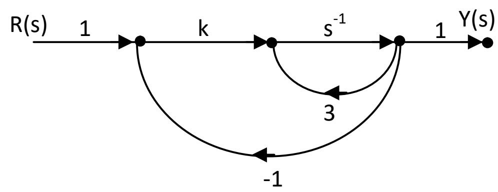
19. An amplifier with resistive negative feedback has two left half plane poles in its open-loop transfer function. The amplifier

(GATE-EC-2000)

(a) will always be unstable at high frequency
(b) will be stable for all frequency
(c) may be unstable, depending on the feedback factor
(d) will oscillate at low frequency

20. The system shown in the figure remains stable when

(GATE-EC-2002)



(a) k < -1 (b) –1 < k < 1

(c) 1 < k < 3 (d) k > 3

21. The number of open right half plane poles of $G(s) = \dfrac{10}{s^5 + 2s^4 + 3s^3 + 6s^2 + 5s + 3}$ is **(GATE-EC-2008)**

(a) 0 (b) 1

(c) 2 (d) 3

22. The condition for stability of a closed-loop system with a characteristic equation $s^3+bs^2+cs+1 = 0$, with positive co-efficient is

(GATE-IN-1995)

(a) b + c > 1 (b) bc > 1

(c) b = c (d) c > c

23. The characteristic roots of the system described as $\dfrac{dx}{dt} = y, \dfrac{dy}{dt} = -x$ are at

(GATE-IN-2000)

(a) +1, +1 (b) –1, +1

(c) –j, +j

24. The partial Routh array of the characteristic equation of a system is given by:

$$\begin{array}{llll} S^4 & 1 & a & 8 \\ S^3 & 3 & 12 & \end{array}$$

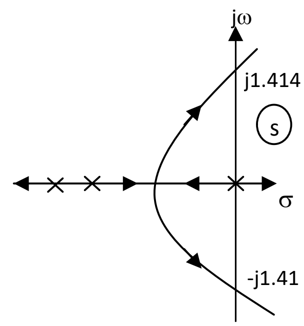
The system oscillates with a frequency of a 2 rad/s. The value of the parameter 'a' of the system is

(GATE-IN- 2002)

(a) 6 (b) 2

(c) 8 (d) 12

25. The Routh-Hurwitz array is given for a third order characteristic equation.



$$\begin{array}{l|llll} s^3 & 1 & b & 0 & 0 \\ s^2 & a & c & 0 & 0 \\ s^1 & \dfrac{(6-k)}{3} & 0 & & \\ s^0 & k & & & \end{array}$$

The coefficients a, b, c and k are such that a = 3, b > 0, k > 0, c > 0 and c is a function of k. The root locus for the corresponding characteristic equation is as shown in the given figure. The values of k and c for critical stability respectively are

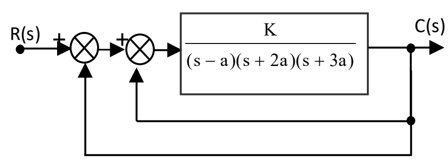
(GATE-IN-2005)

(a) 6 and 6 (b) 6 and 2

(c) 3 and 2 (d) 3 and 3

26. For the block diagram shown in the given figure, the limiting values of K for stability of inner loop is found to be X < K < Y. The overall system will be stable if and only if

(IES-EE-2000)

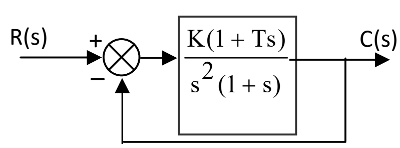


(a) 4X < K < 4Y (b) 2X < K < 2Y

(c) X < K < Y (d) X/2< K < Y/2

27. A feedback control system is shown in the given figure. The system is stable for all positive values, of K, if

(IES-EE-2000)



(a) T = 0 (b) T < 0

(c) T > 1 (d) 0 < T < 1

28. The characteristic equation for a third order system is $q(s) = a_0s^3+a_1s^2+a_2s+a_3 = 0$, for the third-order system to be stable, besides that all the coefficients have to be positive, which one of the following has to be satisfied as a necessary and sufficient condition? **(IES-EE-2004)**

(a) $a_0a_1 \geq a_2a_3$ (b) $a_1a_2 \geq a_0a_3$

(c) $a_2a_3 \geq a_1a_0$ (d) $a_0a_3 \geq a_1a_2$

29. **Assertion(A) :** For a stable feedback control system, the zeros of the characteristic equation must all be located in the left-half of the s-plane.

Reason (R) : The poles of the closed-loop transfer function are the zeros of the characteristic equation.

(IES–EE-2006)

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are individually true but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

30. Using Routh's criterion, the number of roots in the right half S-plane for the characteristic equation: $s^4+2s^3+2s^2+3s+6=0$ is

(IES-EE-2010)

(a) one (b) two

(c) three (d) four

31. Consider the following statements Routh – Hurwitz criterion gives
1) absolute stability
2) the number of roots lying on the right half of the s - plane
3) the gain margin and phase margin

Which of these statements are correct?

(IES-EC-2000)

(a) 1, 2 and 3 (b) 1 and 2

(c) 2 and 3 (d) 1 and 3

32. 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 **(IES-EC-2003)**

(a) Zero (b) 2

(c) 4 (d) 6

33. The unit step response of a system is $1 - e^{-t}(1 + t)$. Which is this system? **(IES-EC-2006)**

(a) Unstable

(b) Stable

(c) Critically stable

(d) Oscillatory

34. Which of the following conditions ensures that exactly two roots of $s^3 + as^2 + s + c = 0$ lie in the right half of the s-plane? **(JTO-EE-2009)**

(a) $a > 0$, $c > 0$ and $a > c$
(b) $a > 0$, $c > 0$ and $a < c$
(c) $a > 0$ and $c < 0$
(d) $a < 0$ and $c = a$

35. The characteristic polynomial of a feedback control system is $s^3+Ks^2+9s+18$. When the system is marginally stable, the frequency of the sustained oscillation (in rad/s) is **(DRDO-EC-2009)**

(a) 1 (b) $\sqrt{2}$

(c) $\sqrt{3}$ (d) 3

36. The first four rows of a Routh's table of a characteristic equation is given below. Which of the following statement is true

$$\begin{array}{c|ccc} s^5 & 1 & 15 & 44 \\ s^4 & 6 & 30 & 24 \\ s^3 & 10 & 40 & \\ s^2 & 6 & 24 & \end{array}$$

(a) three roots lie in the left half of s-plane
(b) a pair of roots lie on the imaginary axis
(c) there are no roots in the right half of s-plane
(d) all the above

37. The first column elements of Routh's tabulation of a characteristic equation are 2, 1, -7, 6.43, 10, which of the following statement is not true

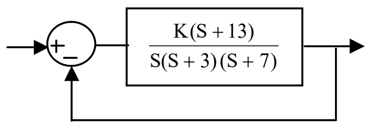
(a) the system is stable
(b) the system has two roots in the right half of s-plane
(c) the system has three roots in the left half of s-plane
(d) the system is of fourth order

Practice Questions

1. Test whether the system having characteristic equation
$S^6+2S^5+5S^4+8S^3+8S^2+8S+4 = 0$ is stable

2. Characteristic equation of a system is $S^3+3KS^2+(K+2)S+4=0$, find the value of 'K' for the stability of the closed loop system.

3.



For the system shown find the range of value of 'K' for which the closed loop poles are more negative than –1.

4. For the following polynomial the value of 'K' to have one pair of roots on the imaginary axis is $S(S^2+2S+5) + K(S+4) = 0$

(a) 5 (b) –5

(c) 4 (d) 4.5

5. The ch. Equation of a system is $S(S^2+6S+13) + K = 0$, the value of 'K' such that the characteristic equation has a pair of complex conjugate roots whose real part is –1, is

(a) 10 (b) 20

(c) 25 (d) 22

6. Ch. Equation of a system is $S(S^2+8S+20) + K = 0$The value of gain 'K' such that the characteristic equation has a pair of roots on the vertical axis which panes through –1 is
(a) 48 (b) 40

(c) 42 (d) 28

7. The no. of right hand, left hand and $j\omega$ axis poles are respectively

$$T(s)=\frac{s^2+7s+10}{s^6+2s^4-s^2-2}$$

(a) 1,1,4 (b) 2,1,2

(c) 4,0,2 (d) 3,1,2

8. OLTF of a unit of feed back control system is $\frac{K}{(S+1)^3\ (S+4)}$. The range of 'K' for stability is

(a) $0 < K < 20$ (b) $20 < K < \infty$

(c) $-4 < K < 20.41$ (d) none

9. OLTF $G(S)\ H(S) = \frac{K}{(S+1)^3\ (S+4)}$. The frequency of oscillation, when the system is marginally stable is

(a) 1.36 rad/sec (b) 1.56 rad/sec

(c) 2 rad/sec (d) 4 rad/sec

10. OLTF $G(S)\ H(S) = \frac{K}{S(S+1)(S+2)(S+5)}$ value of 'K' for the marginal stability is

(a) 9.69 (b) 19.69

(c) 1.969 (d) 0.969

11. $G(S)\ H(S) = \frac{K}{S(S+1)(S+2)(S+5)}$ when the system is marginally stable no. of LH, RH & $j\omega$ axis poles are respectively

(a) 2,2,0 (b) 1,1,2

(c) 2,0,2 (d) None

12. If the numbers in the 1^{st} column of RH's tabulation turn out to be all negative, the equation for which the tabulation is made has at least one root not in the left half of the s-plane (T/F)

13. Roots of AE = 0, of the Routh's tabulation of a characteristic equation must also be the roots of the latter- (T/F)

14. Following characteristic equation of a continuous data system represents an unstable system since it contains a negative coefficient (T/F)

$s^3-s^2+5s+10=0$

15. Following characteristic equation of a continuous data system represents an unstable system since these in a zero coefficient (T/F)

$s^3+5s^2+4=0$

16. When a row of Routh's tabulation contains all zeros before the tabulation ends, this means that the equation has roots on the imaginary axis of the s-plane- (T/F)

17. For the following polynomial the value of 'K' in term of a, b, c to have all the roots in the left side of s-plane is $as^3+bs^2+cs+K= 0$

(a) $< \frac{ac}{b}$ (b) $< \frac{bc}{a}$

(c) $> \frac{bc}{a}$ (d) $> \frac{ac}{b}$

18. For the following polynomial the value of 'K' in term of a, b, c to have all the roots in the left side of s-plane is $as^3+bs^2+ks+c= 0$

(a) $< \frac{ac}{b}$ (b) $< \frac{ab}{c}$

(c) $> \frac{bc}{b}$ (d) $> \frac{ac}{b}$

19. RH criteria cannot be applied when the characteristic equation of the system containing coefficients which are

(a) negative real and exponential function of 'S'
(b) negative real, both exponential and sinusoidal function of S
(c) both exponential and sinusoidal function of S
(d) complex, both exponential and sinusoidal function of S

20. Consider the following statements, RH criteria gives
1) Absolute stability
2) The number of roots lying in the right hand plane
3) Gain & phase margins

Which of these statements are correct

(a) 1, 2 & 3 (b) 1, 2

(c) 2, 3 (d) 1, 3

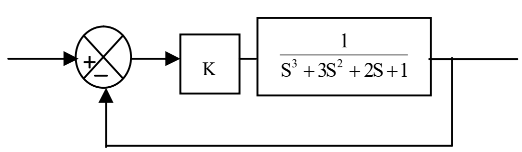
21. While forming Routh's array, the situation of a row of zero of zeros indicates that the system

(a) has symmetrically located roots

(b) is not sensitive to variations in gain

(c) is stable (d) unstable

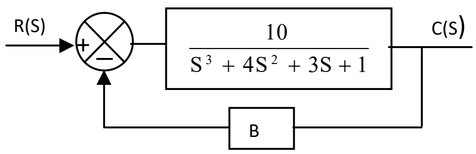
22. Control system is shown in figure below. The maximum value of gain 'K' for which the system is stable is



(a) $\sqrt{3}$ (b) 3

(c) 4 (d) 5

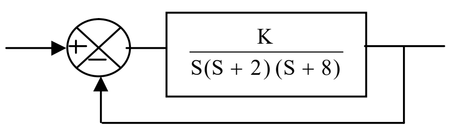
23. Closed loop system is shown in figure below. The largest possible value of 'B' for which the system would be stable is



(a) 1 (b) 1.1

(c) 1.2 (d) 2.3

24. A suitable choice of the scalar parameter 'K', the system shown in figure below, can be made to oscillate continuously at a frequency in rad/sec is



(a) 1 (b) 2

(c) 4 (d) 8

25. OLTF of a different unity feedback systems are shown below

1) $G(S) = \dfrac{2}{S+2}$

2) $G(S) = \dfrac{2}{S(S+2)}$

3) $G(S) = \dfrac{2}{S^2(S+2)}$

4) $G(S) = \dfrac{2(S+1)}{S(S+2)}$

among the above the unstable system is

(a) 1 (b) 2

(c) 3 (d) 4

26. OLTF of a feedback control system is given by $\frac{K(S+10)}{S(S+2)(S+a)}$. The smallest possible value of 'a' for which the system is stable in the closed loop for all positive values of 'K' is

(a) 0 (b) 8

(c) 10 (d) 12

27. OLTF of a unity feedback system is given by $\frac{K(S+2)}{(S+1)(S-7)}$ for K > 6, the stability characteristics of the open loop and closed loop configuration of the systems are respectively

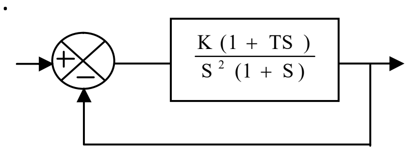
(a) stable & stable

(b) unstable & stable

(c) stable & unstable

(d) unstable & unstable

28.



Above system is stable for every positive values of 'K' if

(a) T = 0 (b) T < 0

(c) T > 1 (d) 0< T < 1

29. If the loop gain K of a negative feedback system having a loop transfer function $K(s+3)/(s+8)^2$ is to be adjusted to induce a sustained oscillation then

(a) The frequency of this ascillation must be $4/\sqrt{3}$ rad/s

(b) The frequency of this oscillation must be 4 rad/s

(c) The frequency fo this oscillation must be 4 or $4/\sqrt{3}$ rad/s

(d) such k does not exist

30. If G(s) is a stable transfer function, then $F(s) = \frac{1}{G(s)}$ is always a stable transfer function.

31. The characteristic polynomial of a system $q(s) = 2s^5+s^4+4s^3+2s^2+2s+1$. The system is

(a) stable

(b) marginally stable

(c) unstable

(d) ocillatory

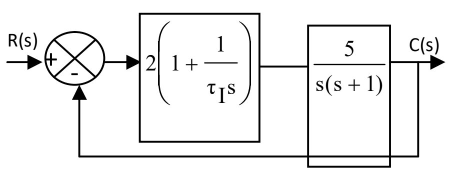
32. The open-loop transfer function of a unity feedback system is $G(s) = \dfrac{K}{s(s^2+s+2)(s+3)}$.
The range of K for which the system is stable is

(a) $\frac{21}{4} > K > 0$ (b) $13 > K > 0$

(c) $\frac{21}{4} > K > \infty$ (d) $-6 < K < \infty$

33. The characteristic equation of a closed loop system is $s^2+Ks+4K-1 = 0$. The system is stable for K greater than …..

34. The closed loop control system shown in Fig. has $\tau_1 > 0$. The system will remain stable for all τ_1 in the range



(a) $\tau_1 > 0.5$ (b) $0.5 < \tau_1 < 1.0$

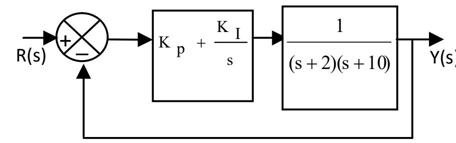
(c) $\tau_1 < 1.0$ (d) $\tau_1 > 1.0$

35. A certain closed loop system with unity feedback has the forward path transfer function given by $G(s) = \dfrac{K}{s(s+1)(s+5)}$. With the gain set at the ultimate value, the system will oscillate at an angular frequency of

(a) $\sqrt{6}$ rad/s (b) $\sqrt{5}$ rad/s

(c) $\sqrt{2}$ rad/s (d) $\sqrt{3}$ rad/s

36. The range of the controller gains (K_P, K_I) that makes the closed loop control system (shown in the following figure) stable is given as



(a) $K_I < 0$ and $K_p < \frac{K_I}{12} - 20$

(b) $K_I > 0$ and $K_p > 0$

(c) $K_I < 0$ and $K_p > \frac{K_I}{12} - 20$

(d) $K_I > 0$ and $K_p > \frac{K_I}{12} - 20$

37. The open loop transfer function of a unity gain feedback system is given by:

$G(s) = \frac{k(s+3)}{(s+1)(s+2)}$. The range of positive values of k for which the closed loop system will remain stable is

(a) $1<k<3$ (b) $0<k<10$

(c) $5<k<\infty$ (d) $0<k<\infty$

38. The first two rows of Routh's table of a third-order characteristic equation are

s^3	3	3
s^2	4	4

It can be inferred that the system has

(a) one real pole in the right half of a s-plane
(b) a pair of complex conjugate poles in the right-half of s-plane
(c) a pair of real poles symmetrically placed around s = 0
(d) a pair of complex conjugate poles on the imaginary axis of the s-plane

39. Consider the following equation: $2s^4+s^3+3s^2+5s+10=0$, How many roots does this equation have in the right half of s-plane?

(a) One (b) Two

(c) Three (d) Four

40. The characteristic equation of a system is given as $s^3 + 25s^2 + 10s + 50 = 0$. What is the number of roots in the right half s-place and on the $j\omega$ axis, respectively ?

a) 1, 1 b) 0, 0

c) 2, 1 d) 1, 2

41. Consider the following statements regarding Routh-Hurwitz criterion for stability.
1) Routh-Hurwitz criterion is a necssary and sufficient condition for stability.
2) The relative stability is indictated by the location of the roots of the characteristic equation.
3) A stable system is a dynamic system with a bounded response to a bounded input.

Which of the statements given above are correct ?

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

42. What is the range of K for Which the open loop transfer function $G(s) = \frac{K}{s^2(s+a)}$ represents an unstable closed loop system?

(a) $K > 0$ only (b) $K = 0$ only

(c) $K < 0$ only (d) $-\infty < K < \infty$

43. The characteristic equation of a feedback control system is given by : $S^3 + 6s^2 + 9s + 4 = 0$
What is the number of roots in the left-half of the s-plane ?

(a) Three (b) Two

(c) One (d) Zero

44. Which one of the following statements is correct for the open-loop transfer function? $G(s) = \dfrac{K(s+3)}{s(s-1)}$ for K > 1

(a) open-loop system is stable but the closed-loop system is unstable.
(b) open-loop system is unstable but the closed-loop system is stable.
(c) both open-loop and closed-loop systems are unstable.
(d) both open-loop and closed-loop systems are stable.

45. Which one of the following describes correctly the effect of adding a zero to the system ?

(a) system becomes oscillatory
(b) root locus shifts toward imaginary axis
(c) relative stability of the system increases
(d) operating range of K for stable operation decreases

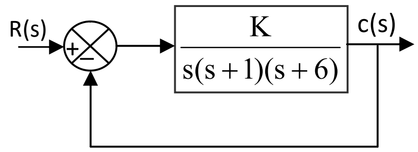
46. Consider the following statements:
1) A system is said to be stable if its output is bounded for any input.
2) A system is stable if all the roots of the characteristic equation lie in the left half of the s-plane.
3) A system is stable if all the roots of the characteristic equation have negative real parts.
4) A second order system is always stable for finite positive values of open loop gain.

Which of the above statements is/are correct ?

(a) 2, 3 and 4 (b) 1 only

(c) 2 and 3 only (d) 3 and 4 only

47. The feedback system shown above is stable for all values of K given by



(a) K > 0 (b) K < 0

(c) 0 < K < 42 (d) 0 < K < 60

48. The open -loop transfer function of unity feedback control system is $G(s) = \frac{K}{s(s+a)(s+b)}, 0 < a \le b$ The system is stable if

(a) $0 < K < \frac{(a+b)}{ab}$

(b) $0 < K < \frac{(a+b)}{ab}$

(c) 0 < K < ab(a+b)

(d) 0 < K < a / b(a+b)

49. The Routh – Hurwitz criterion cannot be applied when the characteristic equation of the system contains any coefficients which is

(a) negative real and exponential functions of s
(b) negative real, both exponential and sinusoidal functions of s
(c) both exponential and sinusoidal functions of s
(d) complex, both exponential and sinusoidal functions of s

50. The given characteristic polynomial $s^4+s^3+2s^2+2s+3 = 0$ has

(a) zero root in RHS of s-plane
(b) one root in RHS of s-plane
(c) two roots in RHS of s-plane
(d) three roots in RHS of s-plane

51. 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 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

52. The open loop transfer function of a unity negative feedback control system is given by

$$G(s) = \frac{k}{(s+2)(s+4)(s^2+6s+25)}$$

What is the value of k which causessustained oscillations in the closedloop system?

(a) 590 (b) 790

(c) 990 (d) 1190

53. The characteristic polynomial of a system is $q(s) = 2s^5+s^4+4s^3+2s^2+2s+1$ Which one of the following is correct ? The system is

(a) stable

(b) marginally stable

(c) unstable (d) oscillatory

54. The open loop transfer function of a unity feedback control system is $G(s) = \dfrac{K}{s(s+1)(s+5)}$. What is the value of K for its stable operation ?

(a) $0 < K < 5$ only (b) $0 < K < 6$ only

(c) $0 < K < 30$ (d) $1 < K < 5$ only

55. Consider the unity feedback system with $G(s) = \dfrac{K}{(s^2+2s+2)(s+2)}$. The system is marginally stable. What is the radian frequency of oscillation ?

(a) $\sqrt{2}$ (b) $\sqrt{3}$

(c) $\sqrt{5}$ (d) $\sqrt{6}$

56. The characteristic equation of a control system is given by $s^5+s^4+2s^3+2s^2+4s+6=0$. What is the number of roots of the equation which lie in the right half of s-plane?

(a) Zero (b) 1

(c) 2 (d) 3

57. The closed loop transfer function of a control system is $\dfrac{K}{s(s+1)(s+5)+K}$. What is the frequency of the sustained oscillations for marginally stable condition ?

(a) $\sqrt{5}$ rad/s (b) $\sqrt{6}$ rad/s

(c) 5 rad/s (d) 6 rad/s

58. **Assertion(A) :** All the coefficients of the characteristic equation should be positive and no term should be missing in the characteristic equation for a system to be stable.
Reason (R) : If some of the coefficients are zero or negative then the system is not stable..

(a) Both A and R are individually true and R is the correct explanation of A.
(b) Both A and R are individually true but R is not the correct explanation of A.
(c) A is true but R is false
(d) A is false but R is true.

59. For what positive value of K does the polynomial $s^4+8s^3+24s^2+32s+K$ have roots with zero real parts ?

(a) 10 (b) 20

(c) 40 (d) 80

60. How many roots with positive real parts do the equation s3+s2-s+1=0 have?

(a) Zero (b) One

(c) Two (d) Three

61. The characteristic equation of a control system is given as $s^4+8s^3+24s^2+32s+K = 0$. What is the range of values of K for this system to be stable ?

(a) $0 \le K < 80$ (b) $0 \le K < 100$

(c) $0 \le K < 300$ (d) $0 \le K < 600$

62. The characteristic equation of a control system is given as $s^4+4s^3+4s^2+3s+K=0$. What is the value of K for which this system is marginally stable ?

(a) 9/16 (b) 19/16

(c) 29/16 (d) 39/16

CHAPTER – VI
FREQUENCY RESPONSE ANALYSIS

Class Room Objectives

1. $TF = \frac{10}{S+2}$, The input is 2cos(2t+15°) find the steady state output.

2. A system with transfer function $\frac{Y(s)}{X(s)} = \frac{s}{s+p}$ has an output y(t) = $\cos\left(2t - \frac{\pi}{3}\right)$ for the input signal $x(t) = p\cos\left(2t - \frac{\pi}{2}\right)$. Then, the system parameter 'p' is

(GATE-EC-2010)

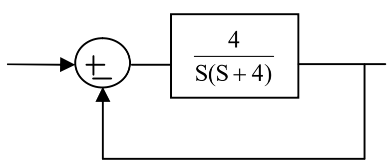
(a) $\sqrt{3}$ (b) $\frac{2}{\sqrt{3}}$

(c) 1 (d) $\frac{\sqrt{3}}{2}$

3. $TF = \frac{10}{S^2(S+1)}$ input is sin(t) find the steady state output.

Ans: No steady state output

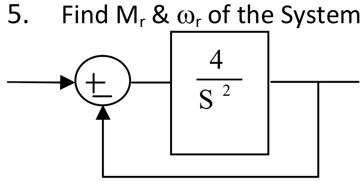
4. Find M_r & ω_r of the System



$M_r = \infty$

$\omega_r = \omega_n = 2$

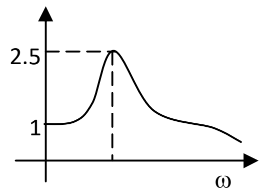
5. Find M_r & ω_r of the System



6. CLTF of a certain unity feedback system is $\frac{4}{S^2 + 7S + 13}$. Find the DC gain of the corresponding open loop system.

7. TF of a system and its frequency response is given below. Find the value of 'K' and damping ratio

$$TF = \frac{K\omega_n^2}{S^2 + \zeta\omega_n S + \omega_n^2}$$



8. $TF = \frac{S^2 + 4}{(S+1)(S+4)}$ The frequency at which the magnitude becomes zero is

(a) 1 rad/sec (b) 2 rad/sec

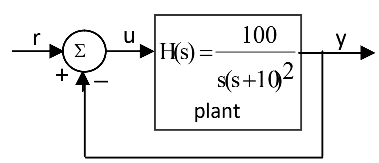
(c) 3 rad/sec (d) 4 rad/sec

9. $G(S)H(S) = \frac{10}{S(S^2 + S + 1)}$ the GM is

(a) 0.1 dB (b) –10 dB

(c) –20 dB (d) 10

10. The input-output transfer function of a plant $H(s) = \frac{100}{s(s+10)^2}$. The plant is placed in a unity negative feedback configuration as shown in the figure below.



The gain margin of the system under

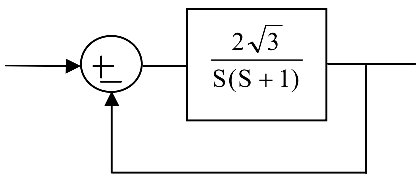
closed loop unity negative feedback

is **(GATE-EC-2011)**

(a) 0 dB (b) 20 dB

(c) 26 dB (d) 46 dB

11. The gain crossover frequency and PM of the system is



(a) $\sqrt{3}$, -150° (b) $1/\sqrt{3}$, -30°

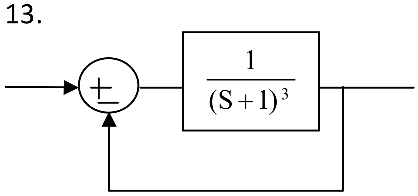
(c) $\sqrt{3}$, 30° (d) $1/\sqrt{3}$, -150°

12. $G(S)H(S) = \frac{10}{(S+20)}$ the GM & PM respectively are

(a) 0.9, 90° (b) ∞, 90°

(c) ∞, ∞ (d) 0.5 ∞

13.



GM of the system is

(a) 8 dB (b) 1/8 dB

(c) 1/8 (d) 18 dB

14. The GM of the system is 20 dB, the gain of the system is doubled, GM becomes

(a)10dB (b)14dB

(c)30dB (d)26dB

15. $G(S)H(S) = \frac{\pi\, e^{-0.25S}}{S}$ the GM of the system is

(a) 2 (b) 2dB

(c) –6 dB (d) ½

16. $G(S)H(S) = \frac{10}{S(S+10)}$ the phase crossover frequency of the system is

(a) 10 (b) 0

(c) ∞ (d) 1

17. $G(S)H(S) = \frac{\pi\, e^{-0.25s}}{S}$ The GM of the system is

(a) 2 (b) 1.5

(c) 1.0 (d) 0.5

18. $G(S)H(S) = \frac{10}{S}$ The PM of the system is

(a) 90° (b) -90°

(c) 0 (d) ∞

19. $G(S)H(S) = \frac{10}{(S+1)(S+20)}$ The GM & PMs of the system are respectively

(a) ½, ∞ (b) 0. 180°

(c) ∞, ∞ (d) ∞, 180°

20. $G(S)H(S) = \frac{10\ e^{-5S}}{S}$ The gain crossover frequency of the system is

(a) 5 rad/sec (b) 10 rad/sec

(c) 1 rad/sec (d) ∞

21. The G(s)H(s) at ω=2rad/sec is $1\angle\text{-}145^0$ find ω_{gc} and PM

22. The G(s)H(s) at ω=1rad/sec is $0.5\angle\text{-}180^0$ find ω_{pc} and GM

23. The G(s)H(s) at ω=10rad/sec is $1\angle\text{-}180^0$ find ω_{gc}, ω_{pc}, PM and GM

24. If the system is stable for gain 0<K<100, then find the GM of the system for i)K=10 ii)K=100 iii)K=1000

25. PM of the system is -20°, the phase of G(S)H(S) at gain crossover frequency is

(a) 20° (b) 160°

(c) -200° (d) -160°

26. At the phase crossover frequency G(S)H(S) = $1\angle\text{-}180°$ the system is

(a) stable (b) just stable

(c) unstable (d) GM = 20dB

27. The open loop transfer function of a unit feedback control system is given as $G(s) = \frac{as+1}{s^2}$. The value of 'a' to give a phase margin of 45^0 is equal to **(GATE-EE-2004)**

(a) 0.141 (b) 0.441

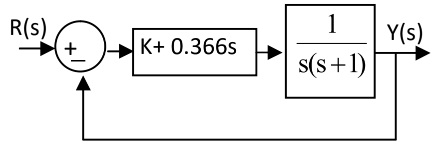
(b) 0.841 (d) 1.141

28. The gain margin of a unity feedback control system with the open loop transfer function $G(s) = \frac{(s+1)}{s^2}$ is **(GATE-EE-2005)**

(a) 0 (b) $\frac{1}{\sqrt{2}}$

(c) $\sqrt{2}$ (d) ∞

29. If the compensated system shown in the figure has a phase margin of 60^0 at the crossover frequency of 1rad/sec, then value of the gain K is **(GATE-EE-2005)**



(a) 0.366 (b) 0.732

(c) 1.366 (d) 2.738

30. The frequency response of a linear system G(jω) is provided in the tabular form below.

|G(jω)|	∠G(jω)
1.3	-130°
1.2	-140°
1.0	-150°
0.8	-160°
0.5	-180°
0.3	-200°

The gain margin and phase margin of the system are

(GATE-EE-2011-1M)

(a) 6 dB and 30°
(b) 6 dB and -30°
(c) -6 dB and 30°
(d) -6 dB and -30°

31. The phase margin of a system with the open-loop transfer fuction

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

(GATE-EC-2002)

(a) 0° (b) 63.4°

(c) 90° (d) ∞

32. The gain margin and the phase margin of a feedback system with $G(s)H(s) = \frac{s}{(s+100)^3}$ are

(GATE-EC-2003)

(a) 0 dB, 0° (b) ∞, ∞

(c) ∞, 0° (d) 88.5 dB, ∞

Common Data for Question 33 & 34

33. The open loop transfer function of a unity feedback system is given by

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

The gain and phase crossover frequencies in rad/sec are, respectively **(GATE-EC-2005)**

(a) 0.632 and 1.26
(b) 0.632 and 0.485
(c) 0.485 and 0.632
(d) 1.26 and 0.632

34. Based on the above results, the gain and phase margins of the system will be **(GATE-EC-2005)**

(a) –7.09 and 87.5°
(b) 7.09 and 87.5°
(c) 7.09 dB and -87.5°
(d) –7.09 dB and -87.5°

Statement linked answer questions

34 and 36

The impulse response h(t) of a linear time invariant system is given by $h(t)=e^{-2t}u(t)$, where u(t) denotes the unit step function. **(GATE-EC-2008)**

35. The frequency response $H(\omega)$ of the system in terms of angular frequency 'ω' is given by $H(\omega)$ **(GATE-EC-2008)**

(a) $\dfrac{1}{1+j2\omega}$ (b) $\dfrac{\sin\omega}{\omega}$

(c) $\dfrac{1}{2+j\omega}$ (d) $\dfrac{j\omega}{2+j\omega}$

36. The output of this system to the sinusoidal input x(t)=2cos(2t) for all time 't' is **(GATE-EC-2008)**

(a) 0

(b) $2^{-0.25}\cos(2t-0.125\pi)$

(c) $2^{-0.5}\cos(2t-0.125\pi)$

(d) $2^{-0.5}\cos(2t-0.25\pi)$

37. Gain margin of the unity feedback system with the loop transfer function $G(s)=\dfrac{100}{(s+1)^3}$ **(JTO-EE-2009)**

(a) 35.35 (b) 12.5

(c) 0.08 (d) 0.03

38. The gain margin of a system with the loop transfer function $\dfrac{64}{(s+1)^4}$ is **(DRDO-EE-2009)**

(a) 64 (b) 1

(c) 1/16 (d) 1/64

39. Consider a unity feedback system whose open loop transfer function is $\dfrac{\beta s+1}{s^2}$. The value of β that results in a phase margin of 45° is **(DRDO-EE-2009)**

(a) 2^{-1} (b) $2^{-\frac{1}{2}}$

(b) $2^{-\frac{1}{4}}$ (d) $2^{-\frac{1}{8}}$

Sketch the Bode plot of the system with OLTF as given in Q40 to Q49.

40. $G(S)H(S)=\dfrac{10(S+1)}{S^2(S+0.1)(S^2+S+10)}$

41. $G(S)H(S) = \dfrac{10S}{(S+10)(S+2)^2}$

42. $G(S)H(S) = \dfrac{10(S+1)}{(S+2)(S+4)}$

43. $G(S)H(S) = \dfrac{10(S+4)^2}{S(1+10S)(S+2)^2}$

44. $G(S)H(S) = \dfrac{10}{(1+2S)^3(S^2+2S+2)^2}$

45. $G(S)H(S) = \dfrac{400S^2(S+4)^2}{(1+0.1S)(S+8)^2(S+16S+20)}$

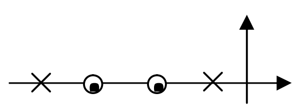
46. $G(S)H(S) = \dfrac{10(S^2+S+2)}{(1+2S)(S+2)}$

47. $G(S)H(S) = \dfrac{4\ e^{-.2S}}{S(S+1)}$

48. $G(S)H(S) = \dfrac{4\ e^{-.2S}}{S(S-1)}$

49. $G(S)H(S) = \dfrac{4}{S(1-S)}$

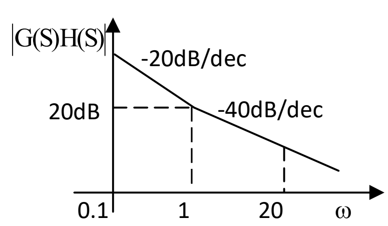
50. Pole zero plot of a system is given below the system is



(a) LPF (b) BPF

(c) BEF/BRF (d) HPF

51. From the following magnitude plot find the magnitude at ω=0.1rad/sec, and ω=20rad/sec



Sketch the phase plot of the following OLTF G(S)H(S) Q52 to Q54.

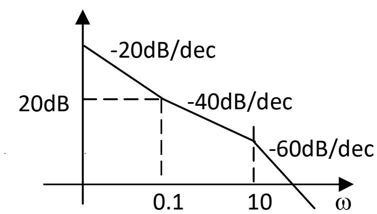
52. $G(S)H(S) = \dfrac{K}{S(S+1)(S+2)}$

53. $G(S)H(S) = \dfrac{K}{S(S-1)}$

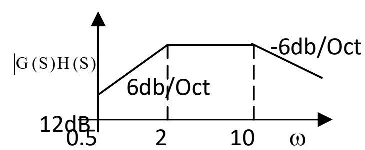
54. $G(S)H(S) = \dfrac{10(1-S)}{(S+1)}$

The Bode magnitude plot of a certain minimum phase system is given below. Find the TF G(S)H(S) Q55 to Q61.

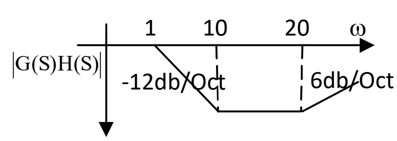
55.



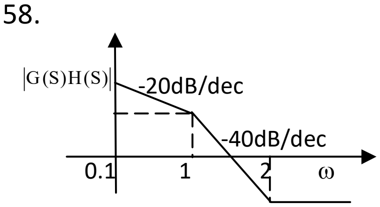
56.



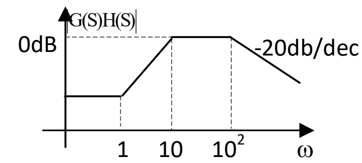
57.



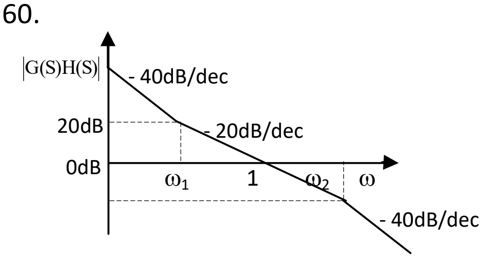
58.



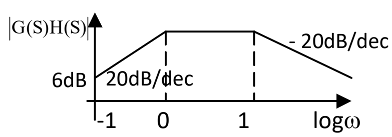
59.



60.

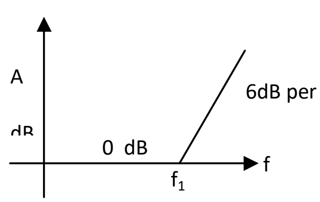


61.



62. The function corresponding to the Bode plot of Figure, is

(GATE-EE-1999)



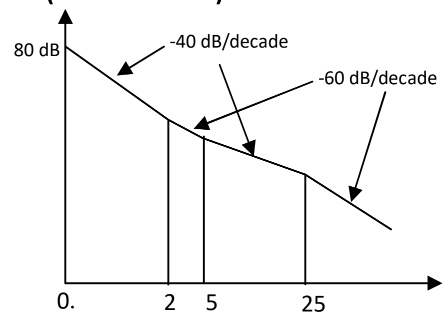
(a) $A = jf/f_1$

(b) $A = 1(1-jf_1/f)$

(c) $A = 1(1+jf_1/f)$

(d) $A = 1+jf/f_1$

63. The asymptotic approximation of the log – magnitude vs frequency plot of a system containing only real poles and zeros is shown. Its transfer function is **(GATE-EE-2009)**

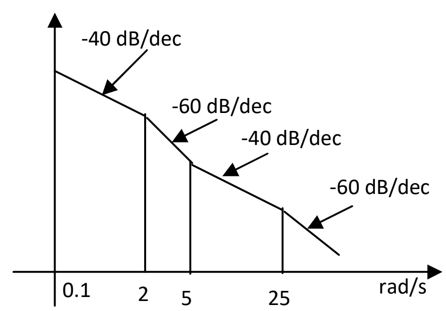


(a) $\frac{10((s+5)}{s(s+2)(s+25)}$ (b) $\frac{1000((s+5)}{s^2(s+2)(s+25)}$

(c) $\frac{100((s+5)}{s(s+2)(s+25)}$ (d) $\frac{80((s+5)}{s^2(s+2)(s+25)}$

64. The asymptotic approximation of the log-magnitude versus frequency plot of a minimum phase system with real poles and one zero is shown in Fig. Its transfer functions is

(GATE-EE-2001)



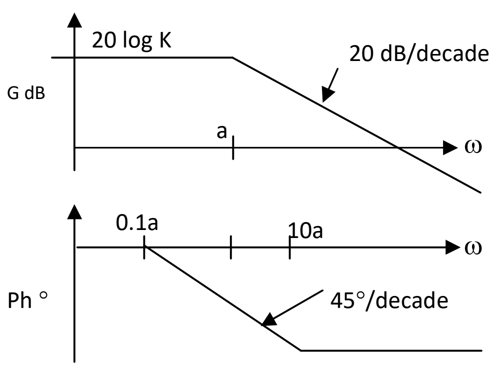
(a) $\frac{20(s+5)}{s(s+2)(s+25)}$

(b) $\frac{10(s+5)}{(s+2)^2(s+25)}$

(c) $\frac{20(s+5)}{s^2(s+2)(s+25)}$

(d) $\dfrac{50(s+5)}{s^2(s+2)(s+25)}$

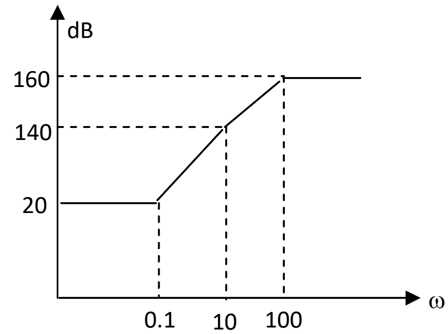
65. The asymptotic Bode plot of the transfer function $\dfrac{K}{1+\frac{s}{a}}$ is given below.The error in phase angle and dB gain at a frequency of a frequency of ω=0.5a are respectively **(GATE-EE-2003)**



(a) 4.9^0, 0.97 dB (b) 5.7^0, 3 dBs

(c) 4.9^0, 3 dB (d) 5.7^0, 0.97dB

66. The approximate Bode magnitude plot of a minimum phase system is shown in figure. The transfer function of the system is **(GATE-EC-2003)**



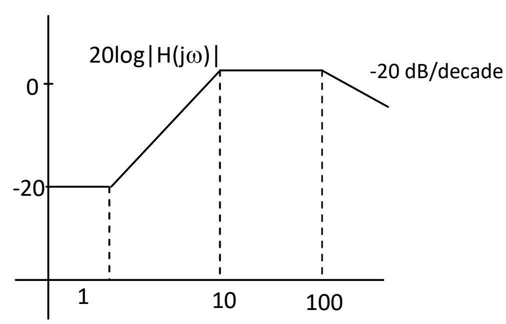
(a) $10^8 \dfrac{(s+0.1)^3}{(s+10)^2(s+100)}$

(b) $10^7 \dfrac{(s+0.1)^3}{(s+10)(s+100)}$

(c) $10^8 \dfrac{(s+0.1)^2}{(s+10)^2(s+100)}$

(d) $10^9 \dfrac{(s+0.1)^3}{(s+10)(s+100)^2}$

67. Consider the Bode magnitude plot shown in figure. The transfer function H(s) is **(GATE-EC-2004)**



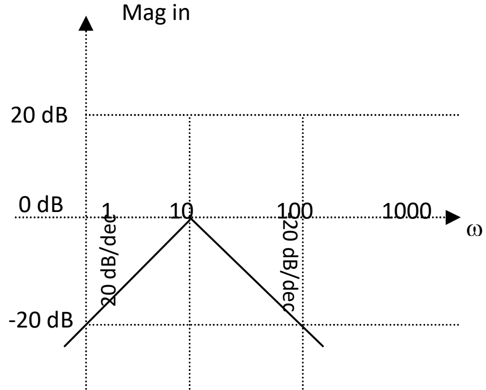
(a) $\dfrac{(s+10)}{(s+1)(s+100)}$

(b) $\dfrac{10(s+10)}{(s+1)(s+100)}$

(c) $\frac{10^2(s+1)}{(s+10)(s+100)}$

(d) $\frac{10^3(s+100)}{(s+1)(s+10)}$

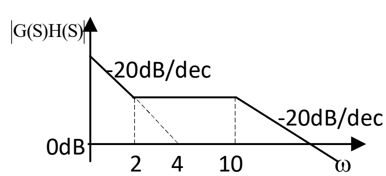
68. The Bode asymptotic magnitude plot of a critically damped system is shown in Fig. The system transfer function can approximately be expressed as **(DRDO-EE-2009)**



(a) $\frac{1}{(s+10)^2}$ (b) $\frac{s}{(s+10)^2}$

(c) $\frac{10s}{(s+10)^2}$ (d) $\frac{(s+1)(s+100)}{(s+10)^2}$

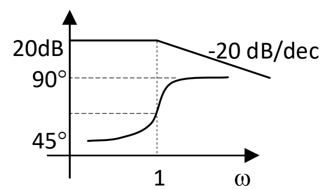
69. The Bode magnitude plot of a certain minimum phase system is given below. The velocity error constant of the system is



(a) 4 (b) 8

(c) 2 (d) 1

70. The Bode plot is shown in fig. below. The TF G(S)H(S) is



(a) $\frac{10}{S+1}$ (b) $\frac{10}{S-1}$

(c) 10(S+1) (d) $\frac{10}{(1-S)}$

71. The open loop frequency response of a system at two particular frequencies are given by : 1.2 $\angle 180^0$ and 1.0 $\angle -190^0$. The closed loop unity feedback control is then_____ **(GATE-EC-1994)**

72. In the Bode-plot of a unity feedback control system, the value of the phase of G(jω) at the gain cross over frequency is -125°. The phase margin of the system is **(GATE-EC-1998)**

(a) -125° (b) -55°

(c) 55° (d) 125°

Sketch the polar plots of the following G(S)H(S) Q73 to Q85.

73. $G(S)H(S) = \frac{K}{(1+ST)}$ K & T > 0

74. $G(S)H(S) = \frac{K}{(1+ST_1)(1+ST_2)}$

75. $G(S)H(S) = \frac{K}{(S-1)}$

76. $G(S)H(S) = \frac{K}{(1-S)}$

77. $G(S)H(S) = \frac{K\, e^{-ST_D}}{(S+1)}$

78. $G(S)H(S) = \frac{K}{S(1+ST)}$

79. $G(S)H(S) = \frac{K}{S(1+ST_1)(1+ST_2)}$

80. $G(S)H(S) = \frac{K_1(1+K_2S)}{S(S-1)}$

81. $G(S)H(S) = \frac{K(S+1)^2}{S^3}$

82. $G(S)H(S) = \frac{4}{S^2+4}$

83. $G(S)H(S) = \frac{K}{S^2(1+ST)}$

84. $G(S)H(S) = \frac{s}{(s+1)(s+2)}$

85. $G(S)H(S) = \frac{8s}{(s-1)(s-2)}$

86. The polar plot of e^{-ST_D} is a

(a) clock wise unit circle centered at the origin
(b) CCW unit circle centered at the origin
(c) clock wise semi circle of unit radius
(d) CCW semi circle of unit radius

87. Polar plot of the following system is in --- quadrant

$G(S)H(S) = \frac{-K}{(1+ST)}$

(a) 1^{st} (b) 2^{nd}
(c) 3^{rd} (d) 4^{th}

88. Polar plot of $G(S)H(S) = \frac{K\, e^{-ST_D}}{S}$ is asymptotic at $\omega \to 0$ to

(a) $x = -K$ (b) $x = -KT_D$
(c) $x = -\omega T_D$ (d) $x = -\frac{1}{KT_D}$

89. The polar plot of $G(S)H(S) = \frac{K}{S}$ is

(a) an imaginary axis
(b) a negative real axis
(c) a positive real axis
(d) none of the above

90. Polar plot of

$$G(S)H(S) = \frac{K}{S(1+ST_1)(1+ST_2)}$$

when $\omega \to 0$, is asymptotic to the straight line

(a) x = -K(T1+T2)
(b) x = -K+(T1+T2)y
(c) y = -K(T1+T2)
(d) $x = -K(T_1+T_2)+y$

91. Polar plot of $G(S)H(S) = \frac{1}{S(1+S)^2}$ intersects the negative real axis at

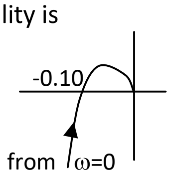
(a) 0.5
(b) 1.0
(c) 1.5
(d) 2.0

92. Polar plot of $\frac{K}{S(1+ST)}$ when $\omega \to 0$ is asymptotic to the straight line

(a) x = -K (b) x = -K+y

(c) x = -KT (d) x = -K+Ty

93. The polar plot of G(S)H(S) for K = 10 is given below. The range of 'K' for stability is



(a) 0 < k < 10 (b) $0 < k < 10^3$

(c) $0 < k < 10^2$ (d) 0 < k < 1

94. For the Q56 polar plot, the gain 'k' for a 40dB GM is

(a) k = 1 (b) k = 10

(c) $k = 10^2$ (d) k = 0.1

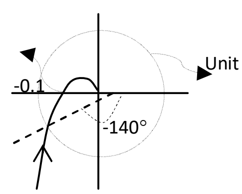
95. The GM = -40 dB the point of intersection of the polar plot w.r.to negative real axis is

(a) 0.01 (b) 0.1

(c) 10 (d) 10^2

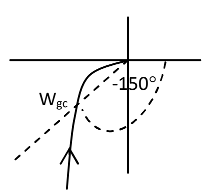
96. Find the gain and phase margins of the system whose polar plots are given below.

i)



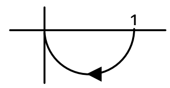
GM=20dB PM=40°

ii)



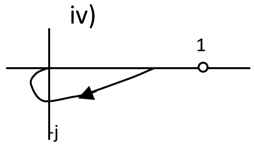
GM=∞ PM=30°

iii)



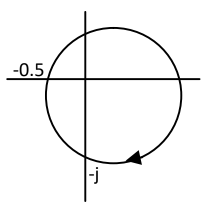
GM=∞ PM=180°

iv)



GM=∞ PM=∞

v)



GM=6dB PM=90°

97. $G(S)H(S) = \dfrac{K\,e^{-0.1S}}{S}$ the range of 'K' for stability is

(a) $0 < K < \pi$ (b) $0 < K < 5\pi$

(c) $0 < K < 2\pi$ (d) $0 < K < \pi/2$

98. $G(S)H(S) = \dfrac{e^{-ST_D}}{S}$ the value of T_D for the system to be just stable is

(a) π (b) $\pi/4$

(c) $\pi/2$ (d) $\pi/3$

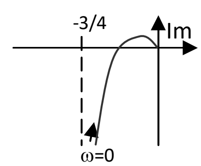
99. $G(S)H(S) = \dfrac{e^{-ST_D}}{s(s+1)}$ the value of T_D for the system to be just stable is

(a) 1.2 sec (b) 1.8 sec

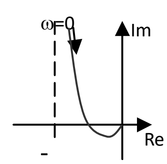
(c) 2.4 sec (d) 3.6 sec

100. The frequency response of $G(s)=1/[s(s+1)(s+2)]$ plotted in the complex $G(j\omega)$ plane (for $0<\omega<\infty$) is **(GATE-EE-2010)**

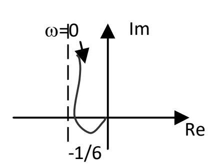
(a)



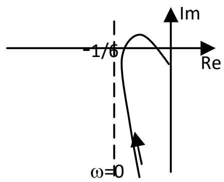
(b)



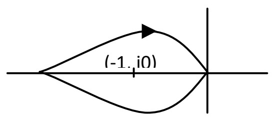
(c)



(d)

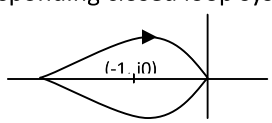


101.The Nyquist plot of G(S)H(S), which has one right hand pole is given below. The corresponding closed loop system is



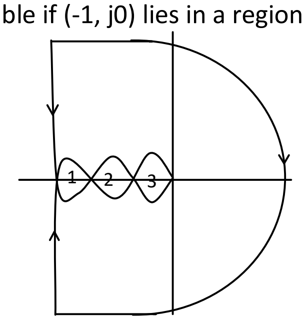
(a) stable
(b) unstable with one right hand pole
(c) unstable with two right hand poles
(d) unstable with three right hand poles

102.The Nyquist plot of G(S)H(S) which has no right hand pole is given below. The corresponding closed loop system is



(a) stable
(b) unstable with one right hand pole
(c) unstable with two right hand poles
(d) unstable with three right hand poles

103.The Nyquist plot of G(S)H(S) which has no right hand pole is given below. The corresponding closed loop system is stable if (-1, j0) lies in a region



(a) 2 (b) 3

(c) 1 (d) None

104.A unity feedback system has the open loop transfer function

(GATE-EE-1992)

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

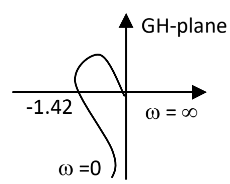
The Nyquist plot of G encircle the origin

(a) Never (b) Once

(c) Twice (d) Thrice

105.The polar plot of a type-1, 3-pole, open-loop system is shown in Fig. below. The closed-loop system is

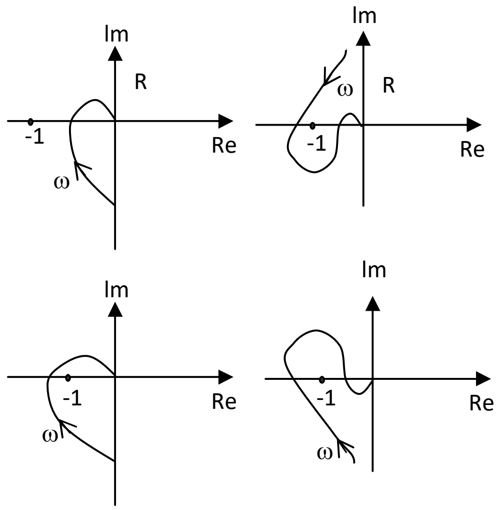
(GATE-EE-2001)



(e) always stable
(f) marginally stable
(g) unstable with one pole on the right half s-plane

(h) unstable with two poles on the right half s-plane.

106.Consider the following Nyquist plots of loop transfer functions over ω = 0 to ω = ∞. Which of these plots represents a stable closed loop system? **(GATE-EE-2006)**



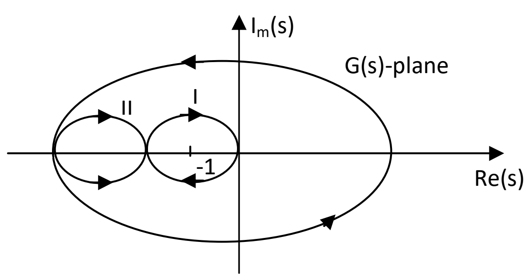
(a) (1) only

(b) all, except (1)

(c) all, except (3)

(d) (1) and (2) only

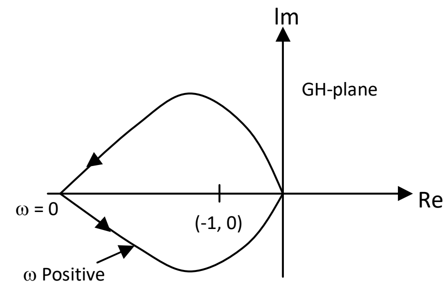
107. The Nyquist plot for the open-loop transfer function G(s) of a unity negative feedback system is shown in figure. If G(s) has no pole in the right half of s-plane, the number of roots of the system characteristics equation in the right-half of a s-plane is **(GATE-EC-2001)**



(a) 0 (b) 1

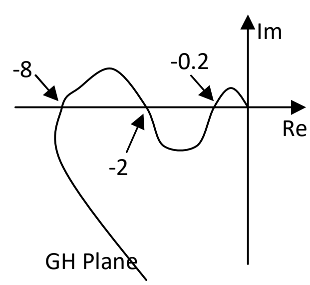
(c) 2 (d) 3

108. Figure shows the Nyquist plot of the open-loop transfer function G(s) H(s) of a system. If G(s) H(s) has one right-hand pole, the closed-loop system is **(GATE-EC-2003)**



(a) always stable
(b) unstable with one closed-loop right hand pole
(c) unstable with two closed-loop right hand pole
(d) unstable with three closed-loop right hand pole

109. The polar diagram of a conditionally stable system for open loop gain K = 1 is shown in figure. The open loop transfer function of the system is known to be stable. The closed loop system loop system is stable for **(GATE-EC-2005)**



(a) $K < 5$ and $\frac{1}{2} < K < \frac{1}{8}$

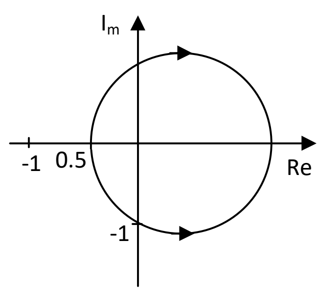
(b) $K < \frac{1}{8} <$ and $\frac{1}{2} < K < 5$

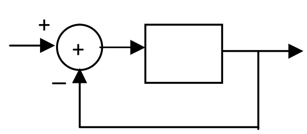
(c) $K < \frac{1}{8}$ and $5 < K$

(d) $K < \frac{1}{8}$ and $K < 5$

Common data for the following two questions 110 and 111

The Nyquist plot of a stable transfer function G(s) is shown in the figure. We are interested in the stability of the closed loop system in the feedback configuration shown.





110.Which of the following statements is true? **(GATE-EC-2009)**

(a) G(s) is an all-pass filter

(b) G(s) has a zero in the right-half plane

(c) G(s) is the impedance of a passive network

(d) G(s) is marginally stable

111.The gain and phase margins of G(s) for closed loop stability are **(GATE-EC-2009)**

(a) 6dB and 180º (b) 3dB and 180º

(c) 6dB and 90º (d) 3dB and 90º

112.A plant is controlled by a proportional controller. If a time delay element is introduced in the loop then **(GATE-IN-1993)**

(a) gain margin remains the same
(b) phase margin remains the same
(c) gain margin decreases
(d) phase margin decreases

113.A unity feedback closed loop system has the loop transfer function $G(s) = \frac{Ke^{-2s}}{s}$. The system becomes stable for the range **(DRDO-EE-2009)**

(a) $0 < K < \frac{\pi}{4}$ (b) $\frac{\pi}{4} < K < \frac{\pi}{2}$

(c) $\frac{\pi}{4} < K < \pi$ (d) $\pi < K < 2\pi$

Practice Questions

1. By applying a sinusoidal signal of frequency w_0 to a linear system, the steady state output of the system will be of the same frequency (T/F)

2. For the proto type 2nd order system, the value of M_r depends solely on the damping ratio ζ. (T/F)

3. Adding a zero to OLTF will always increase the BW of the closed loop system (T/F)

4. The general effect of adding a pole to the loop TF is to make the closed loop system less stable, while decreasing the BW (T/F)

5. For a minimum phase loop TF, if the PM is negative the closed loop system is always unstable (T/F)

6. Phase cross over frequency is the frequency at which phase of G(S)H(S) is $0°$ (T/F)

7. Gain cross over frequency is the frequency at which the gain of G(S)H(S) is 0dB (T/F)

8. GM is measured at the phase cross over frequency (T/F)

9. PM is measured at the gain cross over frequency (T/F)

10. A closed loop system with a pure time delay in the loop is usually less stable than one without a time delay (T/F)

11. The slope of magnitude curve of the Bode plot of loop TF at the gain cross over frequency usually gives an indication of relative stability of the closed loop system (T/F)

12. A Nichols chart can be used to find BW & M_r information for a closed loop system (T/F)

13. A Bode plot can be used for stability analysis for minimum as well as non minimum phase TF (T/F)

14. $\text{TF} = \dfrac{10}{(S+2)}$ .... (1)

    $\text{TF} = \dfrac{10}{(S+5)}$ .... (2)

    (a) system (1) band width is more than (2)
    (b) system (2) band width is more than (1)
    (c) band widths are equal
    (d) can't be calculated

15. The resonant peak of a proto type 2nd order system is 1.042 the damping ratio of the system is

    (a) 0.4 (b) 0.6
    (c) 0.8 (d) none

16. $\mathrm{TF} = \frac{1}{(S+1)}$ the steady state O/P of a system to the I/P of 10 cos(t +45°)

(a) $\frac{10}{\sqrt{2}} \cos t$

(b) $\frac{10}{\sqrt{2}} \sin t$

(c) $\frac{1}{\sqrt{2}} \cos(t-45°)$

(d) $\frac{1}{\sqrt{2}} \cos(t+45°)$

17. $\mathrm{TF} = \frac{1}{S(S+1)}$ the steady state O/P of a system to the I/P, of sin(t+45°) is

(a) $\sqrt{2} \sin(t+180°)$

(b) $\frac{1}{\sqrt{2}} \cos(t+135°)$

(c) $\frac{1}{\sqrt{2}} \cos(t+180°)$

(d) None

18. For the standard/prototype 2^{nd} order system, if the damping ratio is 0.8 the resonant peak is

(a) 1 (b) 0.8

(c) 0.9 (d) None

19. For the standard 2^{nd} order system damping ratio is 0.9 the resonant frequency is

(a) 1.9 (b) 1

(c) 0.9 (d) 0

20. GM of the standard 2^{nd} order under damped system is

(a) ∞ (b) 0

(c) 1 (d) None

21. PM of the standard 2^{nd} order under damped system is

(a) 0 < PM < 90°

(b) 90°

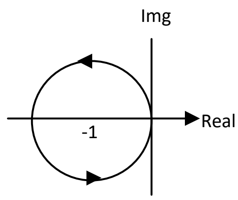
(c) does not exist

(d)can't be calculated

22. The presence of transportation lag in the forward path of a closed loop control system

(a) decreases margin of stability
(b) increases margin of stability
(c) does not affect margin of stability
(d) none of the above

23. Figure below shows the Nyquist plot of a unity feedback system having open loop TF G(S) with one pole in right half of S-plane. The corresponding feedback system is

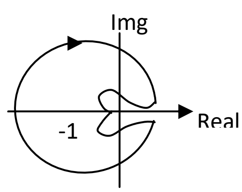


(a) Stable (b) unstable

(c) marginally stable

(d) can't say

24. Fig. below shows the Nyquist plot of a unity feedback system having open loop TF G(S) with one pole in right half of S-plane. The feedback system is



(a) Stable (b) unstable

(c) marginally stable (d) can't say

25. The TF of a system is $G(S) = \dfrac{10(1+0.2S)}{(1+0.5S)}$. The phase shifts at w = 0 and w = ∞, will be respectively

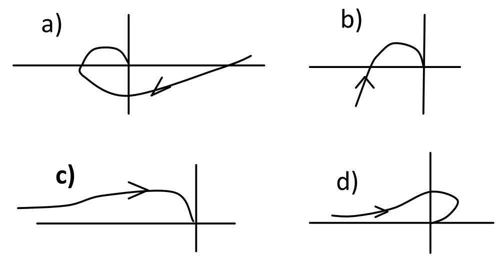
(a) 90° & 0° (b) -180° & 180°

(c) -90° & 90° (d) None

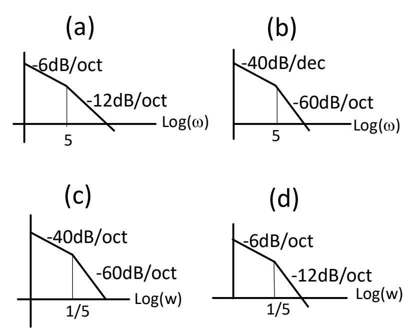
26. Polar plot of $G(j\omega) = \dfrac{1}{j\omega(1+j\omega T)}$

(a) Crosses the negative real axis
(b) Crosses the negative imaginary axis
(c) Crosses the positive imaginary axis
(d) None

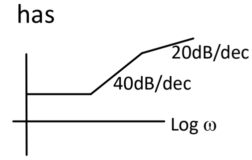
27. Which of the polar plots shown in fig. below is the correct plot for $G(j\omega) = \dfrac{1}{(j\omega)^2(1+j\omega T)}$



28. Which of the Bode asymptotic plots shown in fig. below is the correct plot for $G(S) = \dfrac{K}{S^2(S+5)}$



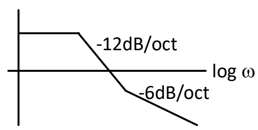
29. The Bode asymptotic plot of a transfer function is given in fig. below. The TF has



(a) one pole and one zero
(b) two poles & one zero

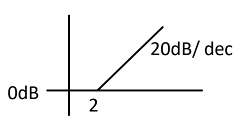
(c) one pole & two zeros
(d) none of these

30. The Bode asymptotic plot of a TF is given in fig. below there



(a) are no poles at the origin
(b) is one pole at the origin
(c) are two poles at the origin
(d) none of these

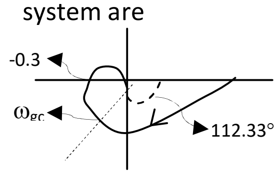
31. The minimum phase TF that corresponds to the Bode asymptotic plot shown in fig. below is



(a) $\frac{1}{1+2S}$ (b) 2S+1

(c) $\frac{1}{1+\frac{S}{2}}$ (d) $1+\frac{S}{2}$

32. A unity feedback system has open loop TF G(S). Polar plot of G(jω) is shown in fig. below. The gain margin (GM) and phase margin (PM) of the feedback system are



(a) GM = -0.3, PM = 112.33°
(b) GM = 0.3, PM = 112.33°
(c) GM = 3.33, PM = 67.67°
(d) None of the above

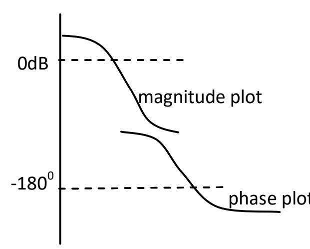
33. A unity feedback system has open loop TF $G(S)=\frac{K}{S(1+ST)}$. The GM of the feedback system is

(a)∞ (b)0

(c)1

(d) None of the above

34. A unity feedback system has open loop TF G(S). Bode plot of G(jω) is shown in fig. below. The feedback system has



(a) positive phase margin & negative gain margin
(b) positive phase margin & positive gain margin
(c) negative phase margin & negative gain margin
(d) negative phase margin & positive gain margin

35. Consider the following statements for an under damped 2nd order system

i) Peak over shoot in step input response reduces as damping ratio is increased from 0.2 to 0.6

ii) Resonant peak in frequency response reduces as damping ratio is increased from 0.2 to 0.6

(a) None of the above statements are true
(b) Statement (i) is true but (ii) is false
(c) Statement (i) is false but (ii) is true
(d) Both (i & (ii) are true

36. For a unity feedback system with OLTF

$$G(S)=\frac{\omega_n^2}{S(S+2\zeta\omega_n)},\ \zeta<0.7$$

i) Phase margin is explicitly indicative of damping ratio.

ii) Resonant peak is explicitly indicative of damping ratio

Which one of the following answer is correct

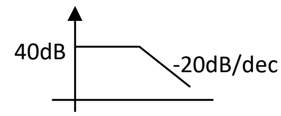
(a) None of the above statements are true
(b) Statement (i) is true but (ii) is false
(c) Statement (i) is false but (ii) is true
(d) Both (i) & (ii) are true

37. A system has 12 finite poles and 2 finite zeros. It's high frequency Bode magnitude plot slope is

(a) –200dB/dec (b) –240dB/dec

(c) –40dB/dec (d) –320dB/dec

38. The Bode magnitude plot of OLTF G(S)H(S) is shown in fig. below. What is the steady state error corresponding to a unit step input.



(a) 1/41 (b) 140

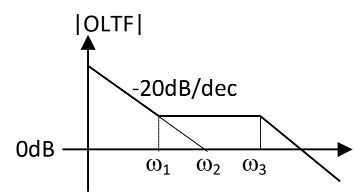
(c) 1/101 (d) 1/100

39. Consider the frequency response of OLTF as shown below.
1) The type of the system is one

2) ω_2 is the static error co-efficient (numerically)

$$3)\ \omega_2=\frac{\omega_1+\omega_3}{2}$$

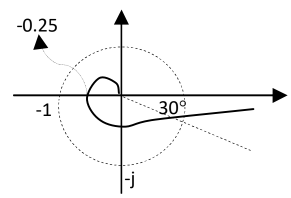
Select the correct answer using the codes given below



(a) 1, 2, 3 (b) 1, 2

(c) 2, 3 (d) 1, 3

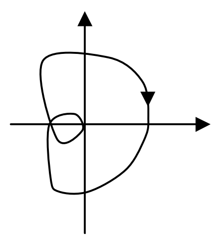
40. The Nyquist plot (for positive frequencies) of an OLTF of a unity feedback system is given in the fig. below. The PM & GM are respectively



(a) 150°, 4 (b) 150°, ¾

(c) 30°, 4 (d) 30°, ¾

41. Nyquist plot shown in the given figure is for a type ………… System



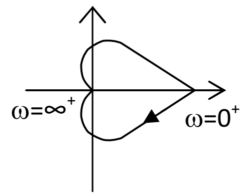
(a) 0 (b) 2

(c) 1 (d) 3

42. The Nyquist plot of $G(S)H(S) = \dfrac{10}{S^2(1+0.5S)(1+S)}$ for positive frequencies will start

(a) at ω = ∞ in the first quadrant and will terminate at ω = 0 in the 2nd quadrant
(b) at ω = ∞ in the fourth quadrant and will terminate at ω = 0 in the 2nd quadrant
(c) at ω = ∞ in the 2nd quadrant and will terminate at ω = 0 in the 3rd quadrant
(d) at ω = ∞ in the first quadrant and will terminate at ω = 0 in the 4^{th} quadrant

43. The Nyquist plot shown in fig below matches with the TF



(a) $\dfrac{1}{(S+1)^3}$ (b) $\dfrac{1}{(S+1)^2}$

(c) $\dfrac{S-1}{S^2+2S+2}$ (d) $\dfrac{1}{S+1}$

44. A unity feedback control system has the OLTF $G(S) = \dfrac{1}{(S-1)(S+2)(S+3)}$. The Nyquist plot of G(S) encircles the origin

(a) never (b)once

(c)twice (d) thrice

45. 1) Nyquist criterion analysis is in the frequency domain

2) Bode analysis is in the frequency domain

3) Root locus analysis is in the time domain

4) RH criterion analysis is in the time domain

(a) 1, 2, 3 are true

(b) 2, 3 & 4 are true

(c) 1 & 2 are true

(d) all four are true

46. Match list I with List II and select the correct answer using the codes given below the lists.

List – I

A. $\frac{1 - S}{1 + S}$

B. $\frac{4S}{(1+S)(1+2S)(1+3S)}$

C. $\frac{1-3S}{(1+4S)(1+2S)(1+S)}$

List–II (Description)

1.Non minimum phase system

2.Minimum phase system

3. All pass system

	A	B	C
(a)	1	3	2
(b)	3	2	1
(c)	3	1	2
(d)	2	1	3

47. Match the list I (Scientist) with List – II (Contribution in the area of) and select the correct answer using the codes given below the lists.

List – I (TF)

A. Bode

B. Evans

C. Nyquist

List–II (Description)

1. Asymptotic plots

2. Polar plots

3.Root locus technique

4. Constant M & N plot

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

48. The BW for the particular value of ω_n and damping ratio is

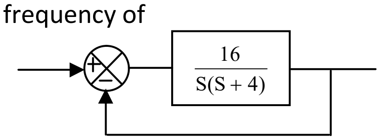
(a) $\sqrt{\omega_n(1-\zeta+2\zeta^2)}$

(b) $\sqrt{\omega_n(1-2\zeta^2)}$

(c) $\omega_n\sqrt{1-2\zeta^2+\sqrt{2-4\zeta^2+4\zeta^4}}$

(d) $\omega_n\sqrt{1-\zeta^2}$

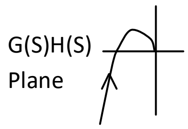
49. In the system shown in figure input is sin(ωt), the steady state response will exhibit a resonance peak at a frequency of



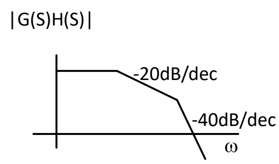
(a) 4 rad/Sec (b) $2\sqrt{3}$ rad/Sec

(c) 2 rad/Sec (d) $\sqrt{2}$ rad/Sec

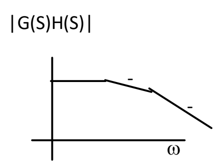
50. The Nyquist plot for a control system is shown in fig. below. The Bode plot of the same will be



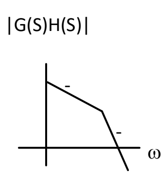
a)



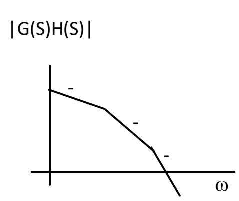
b)



c)

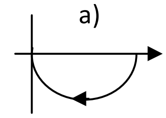


d)

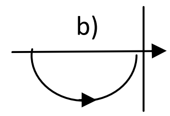


51. The polar plot of $G(S) = \dfrac{1+S}{1+4S}$ for $0 \le \omega \le \infty$ is

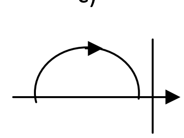
a)



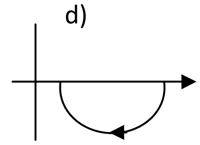
b)



c)



d)

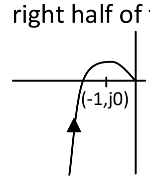


52. OLTF of a unity feedback control system is $\dfrac{10}{(S+5)^3}$. The GM of the system will be

(a) 20dB (b) 40dB

(c) 60dB (d) 80dB

53. The Nyquist plot of the OLTF of a feedback control system for ω = 0 to ∞ is shown in fig. below. If no open loop poles & zeros are right side of S-plane, then the no. of closed loop poles in the right half of the s-plane will be



(a) 0 (b)1

(c) 2 (d) 3

54. If the GM of a certain feedback system is 20 dB, the point of intersection of the Nyquist plot w.r.to negative real axis is

(a) –0.05 (b) –0.2

(c) –10 (d)–0.1

55. A signal $e^{-\alpha t}\sin(\omega t)$ is the input to a Linear Time Invariant system. Given K and ϕ are constants, the output of the system will be of the form $Ke^{-\beta t}\sin(\upsilon+\phi)$ where

(a) β need not be equal to α but υ equal to ω

(b) υ need not be equal to ω but β equal to α

(c) β equal to α and υ equal to ω

(d) β need not be equal to α and υ need not be equal to ω

56. The polar plot of $G(s)=\dfrac{10}{s(s+1)^2}$ intercepts real axis at $\omega = \omega_o$ Then, the real part and ω_o are respectively given by:

(a) –2.5, 1 (b) –5, 0.5

(c) –5, 1 (d) –5, 2

57. The open loop frequency response of a system at two particular frequencies are given by : 1.2 $\angle 180^0$ and 1.0 $\angle -190^0$. The closed loop unity feedback control is then_____

58. Non – minimum phase transfer function is defined as the transfer function

(a) which has zeros in the right – half S- plane.

(b) which has zeros only in the left – half S-plane.

(c) which has poles in the right – half S-plane.

(d) which has poles in the left – half S- plane.

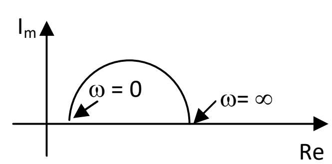
59. A system has poles at 0.01 Hz, 1 Hz and 80 Hz; zeros at 5 Hz, 100 Hz and 200 Hz. The approximate phase of the system response at 20 Hz is

(a) -90° (b) 0°

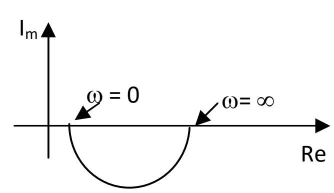
(c) 90° (d) -180°

60. Which one of the following polar diagrams corresponds to a lag network?

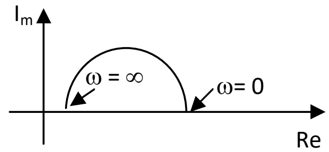
(a)



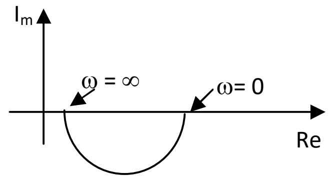
(b)



(c)



(d)



61. The Nyquist plot of $G(j\omega)\ H(j\omega)$ for a closed loop control system, passes through (-1, j0) point in the GH plane. The gain margin of the system in dB is equal to

(a) infinite
(b) greater than zero
(c) less than zero
(d) zero

Common Data for Question 62 & 63

62. Consider a unity-gain feedback control system whose open-loop transfer function is $G(s) = \frac{as+1}{s^2}$.
The value of "a" so that the system has a phase-margin equal to $\pi/4$ is approximately equal to

(a) 2.40 (b) 1.40

(c) 0.84 (d) 0.74

63. With the value of "a" set for phase-margin of $\pi/4$, the value of unit-impulse response of the open-loop system at t = 1 second is equal to

(a) 3.40 (b) 2.40

(c) 1.84 (d) 1.74

64. The frequency response of a linear, time-invariant system is given by $H(f) = \frac{5}{1+j10\pi f}$. The step response of the system is

(a) $5(1-e^{-5t})u(t)$ (b) $5\left(1-e^{-\frac{t}{5}}\right)u(t)$

(c) $1/5(1-e^{-5t})u(t)$ (d) $\frac{1}{5}\left(1-e^{-\frac{1}{5}}\right)u(t)$

65. If the closed-loop transfer function of a control system is given as $T(s) = \frac{s-5}{(s+2)(s+3)}$, then it is

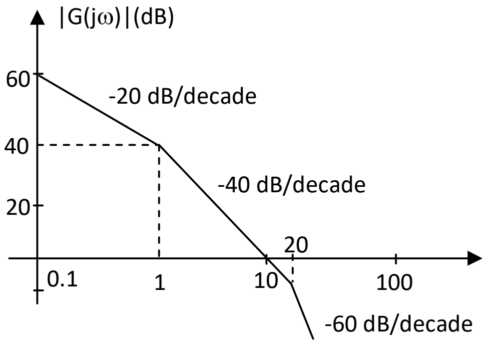
(a) an unstable system

(b) an uncontrollable system

(c) a minimum phase system

(d) a non-minimum phase system

66. The asymptotic Bode plot of a transfer function is as shown in the figure. The transfer function G(s) corresponding to this Bode plot is



(a) $\dfrac{1}{(s+1)(s+20)}$

(b) $\dfrac{1}{(s+1)(s+20)}$

(c) $\dfrac{100}{s(s+1)(s+20)}$

(d) $\dfrac{100}{s(s+1)(s+0.05s)}$

67. The magnitude of frequency response of an underdamped second order system is 5 at 0 rad/sec and peaks to $\dfrac{10}{\sqrt{3}}$ at $5\sqrt{2}$ rad/sec. The transfer function of the system is

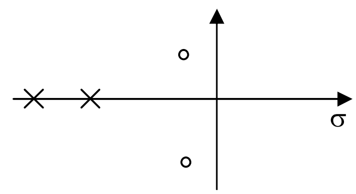
(a) $\dfrac{500}{s^2+10s+100}$

(b) $\dfrac{375}{s^2+5s+75}$

(c) $\dfrac{750}{s^2+12s+144}$

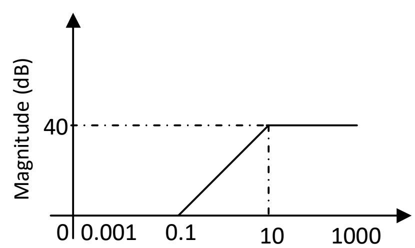
(d) $\dfrac{500}{s^2+10s+100}$

68. The pole-zero plot given below corresponds to a pole zero plot



(a) low pass filter
(b) high pass filter
(c) band pass filter
(d) notch filter

69. For the asymptotic Bode magnitude plot shown below, the system transfer function can be



(a) $\dfrac{10s+1}{0.1s+1}$ (b) $\dfrac{100s+1}{0.1s+1}$

(c) $\dfrac{100s}{10s+1}$ (d) $\dfrac{0.1s+1}{10s+1}$

70. A first order system with a transfer function $\dfrac{1}{1+s}$ is excited by a signal 10sint. Its steady state output will be

(a) $10\sin\left(2t-\dfrac{\pi}{4}\right)$ (b) $10\sin\left(t-\dfrac{\pi}{4}\right)$

(c) $\dfrac{10}{\sqrt{2}}\sin\left(t-\dfrac{\pi}{4}\right)$ d) $\dfrac{10}{\sqrt{2}}\sin\left(t-\dfrac{\pi}{4}\right)$

71. Of the following transfer functions, the function that has a minimum phase characteristic is

(a) $\frac{1+s}{1-s}$ (b) $\frac{1-s}{1+s}$

(c) $\frac{e^{-3}}{1-s}$ (d) $\frac{s}{(s+1)(s+2)}$

72. Match the characteristic with the system transfer function

(a) All pass (e) $e^{-0.5s}$

(b) Transport delay (f) $\frac{1-s}{1+s}$

(c) Lead compensator (g) $\frac{1}{s^2+2s-3}$

(d) Unstable (h) $\frac{s}{s^2+s+100}$

(i) $\frac{10(1+0.3s)}{(1+0.1s)}$

73. The open-loop transfer function of a feedback control system is $\frac{1}{(s+1)^3}$.
The gain margin of the system is

(a) 16 (b) 8

(c) 4 (d) 2

74. The phase margin of the system for which loop gain
GH(jω)= $\frac{1}{(j\omega+1)^3}$ is

(a) $-\pi$ (b) π

(c) 0 (d) $\pi/2$

75. Match the TFs with the systems

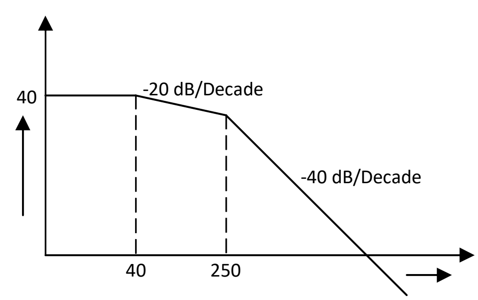
(a) All pass filter (e) e^{-as}

(b) Transport delay (f) $\frac{1-s}{1+s}$

(c) Lag network (g) $\frac{1+as}{1+bs}$, $a<b$

(d) Servomotor (h) $\frac{k}{s(1+as)}$

76. The asymptotic Bode plot for the gain magnitude of a minimum phase system G(s) is shown in Fig. The transfer function is G(s) =



(a) $\frac{100}{(1+s/40)(1+s/250)}$

(b) $\frac{40}{s(s+250)}$

(c) $\frac{100}{(s+10)(s+250)}$

(d) $\dfrac{100s}{(s+10)(s+250)}$

77. The transfer function of a second order all pass filter is

(a) $\dfrac{s^2}{s^2+as+b}$ (b) $\dfrac{cs}{s^2+as+b}$

(c) $\dfrac{s^2+d}{s^2+as+b}$ (d) $\dfrac{s^2-as+b}{s^2+as+b}$

78. An analog LTI system has a negative phase shift which varies linearly with frequency. Its magnitude response is frequency independent. The system transfer function is

(a) $\dfrac{1-s\tau}{1+s\tau}$ (b) $e^{-s\tau}$

(c) $\dfrac{1-s^2\tau^2}{1+s^2\tau^2}$ (d) $\dfrac{1-s\tau}{1+s\tau}e^{-s\tau}$

79. The loop transfer function of asystem is given by $G(s)H(s)=\dfrac{10e^{-Ls}}{s}$. The phase cross-over frequency is 5 rad/s. The value of the dead time L is

(a) $\pi/20$ (b) $\pi/10$

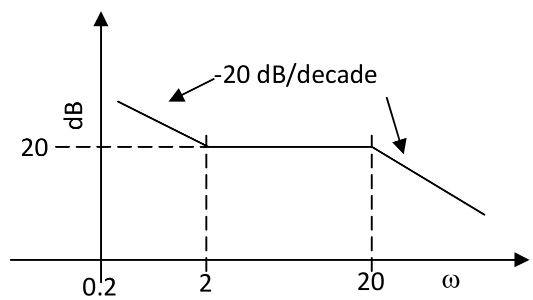
(c) $-\pi/20$ (d) zero

80. The transfer function of a system is given by $\dfrac{Y(s)}{X(s)}=\dfrac{e^{-0.1s}}{1+s}$. If x(t) is 0.5sint, then the phase angle between the output and the input will

(a) –39.27° (b) -45°

(c) –50.73° (d) -90°

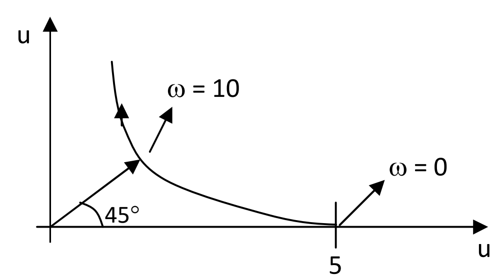
81. Fig. shows the Bode magnitude plot of a system. The minimum phase transfer function of the system is given by



(a) $\dfrac{80\left(\frac{s}{2}+1\right)}{s\left(\frac{s}{20}+1\right)}$ (b) $\dfrac{20\left(\frac{s}{2}+1\right)}{s\left(\frac{s}{20}+1\right)}$

(c) $\dfrac{8(s+2)}{s(s+20)}$ (d) $\dfrac{20(s+2)}{s(s+20)}$

82. Fig. shows the polar plot of a system. The transfer function of the system is



(a) 5(1 + 0.1s) (b) (1 + 0.5.s)

(c) 5(1 + 10s) (d) 5(1 + s)

83. The loop transfer function of a system is given by $G(s) = \frac{e^{-0.1s}}{s}$. The phase crossover frequency is given by

(a) $\pi/2$ (b) $\pi/10$

(c) $\pi/0.2$ (d) $\pi/4$

84. Consider the following systems:

System 1: $G(s) = \frac{1}{(s2+1)}$

System 2: $G(s) = \frac{1}{(5s+1)}$

The true statement regarding the

system is

(a) Bandwidth of system 1 is greater than the bandwidth of system 2

(b) Bandwidth of system 1 is lower than the bandwidth of system 2

(c) Bandwidth of both the systems are the same

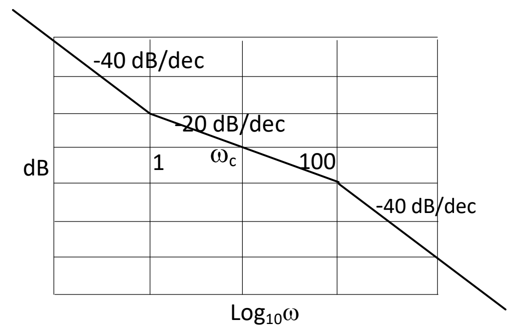
(d) Bandwidth of both the systems are the infinite

85. Identify the transfer function corresponding to an all-pass filter from the following

(a) $\frac{1-s\tau}{1+s\tau}$ (b) $\frac{1+s\tau_1}{1+s\tau_2}$

(c) $\frac{1-s\tau}{1+s\tau}$ (d) $\frac{1-s\tau}{1+s\tau}$

86. The asymptotic magnitude Bode plot of an open loop system G(s) with K > 0 and all poles and zeros on the s-plane is shown in the figure. It is completely symmetric about ω_c. The minimum absolute phase angle contribution by G(s) is given by



(a) 78.6° (b) 90°

(c) 101.4° (d) 180°

87. The open loop part of a unity feedback control system G(s) is unstable and has two poles on the right hand side of the s-plane. However; the closed loop system is stable. The number of encirclements made by the Nyquist plot of the
(-1,0) point in the G(s) plane is

(a) 2 (b) 0

(c) –3 (d) –1

88. A unity feedback system has the following open loop frequency response:

ω (rad/sec)	|G(jω)|	∠G(jω)
2	7.5	-118°

3	4.8	-130°
4	3.15	-140°
5	2.25	-150°
6	1.70	-157°
8	1.00	-170°
10	0.64	-180°

The gain and phase margin of the

System are

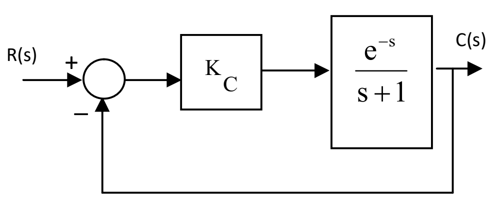
(a) 0 dB, -180° (b) 3.88 dB, -170°

(c) 0 dB, 10° (d) 3.88 dB, 10°

Common Data for Questions 89 and

90

89. The following figure represents a proportional control scheme of a first order system with transportation lag.



The angular frequency in radian/s at which the loop phase lag becomes 180°is

(a) 0.408 (b) 0.818

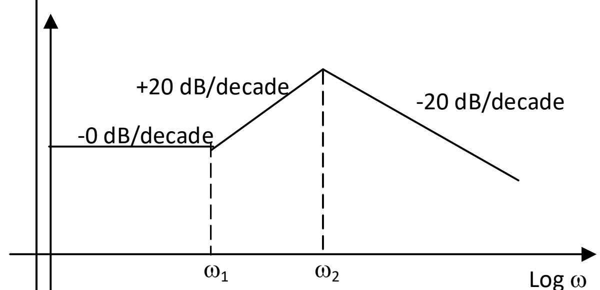
(c) 1.56 (d) 2.03

90. The steady state error for a unity step input when the gain $K_C = 1$ is

(a) 1/4 (b) 1/2

(c) 1 (d) 2

91. The bode asymptotic plot of a transfer function is given below. In the frequency range shown, the transfer function has



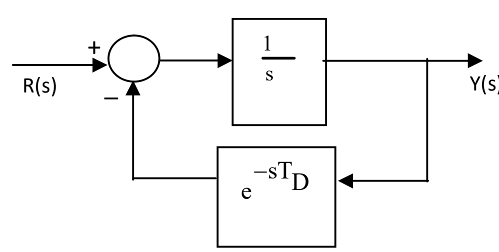
(a) 3 poles and 1 zero

(b) 1 poles and 2 zero

(c) 2 poles and 1 zero

(d) 2 poles and 2 zero

92. For the closed loop system shown below to be stable, the value of time delay T_D (in seconds) should be less than



(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$

(c) $\frac{\pi}{2}$ (d) π

Statement for Linked Answers for the following two Questions 93 and 94

Consider a unity feedback system with open loop transfer function.

$$G(s) = \frac{1+6s}{s^2(1+s)(1+2s)}$$

93. The phase crossover frequency of the system in radians per second is

(a) 0.125 (b) 0.25

(c) 0.5 (d) 1

94. The gain margin of the system is

(a) 0.125 (b) 0.25

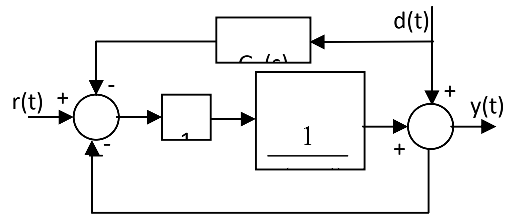
(c) 0.5 (d) 1

95. A linear time-invariant causal system has a frequency response given in polar form as $\frac{1}{\sqrt{1+\omega^2}}\angle\text{-}\tan^{-1}\omega$. For input x(t)=sint, the output is

(a) $\frac{1}{\sqrt{2}}\cos t$ (b) $\frac{1}{\sqrt{2}}\cos\left(t-\frac{\pi}{4}\right)$

(c) $\frac{1}{\sqrt{2}}\sin t$ (d) $\frac{1}{\sqrt{2}}\sin\left(t-\frac{\pi}{4}\right)$

96. A disturbance input d(t) is injected into the unity feedback control loop shown in the figure. Take the reference input r(t) to be a unit step.



If the disturbance is measurable, its effect on the output can be minimized significantly using a feedforward controller $G_{ff}(s)$. To eliminate the component of the output due to d(t) = sint, $G_{ff}(j\omega)|_{\omega=1}$ should be

(a) $\frac{1}{\sqrt{2}}\angle-\frac{3\pi}{4}$ (b) $\frac{1}{\sqrt{2}}\angle-\frac{\pi}{4}$

(c) $\sqrt{2}\angle\pi$ (d) $\sqrt{2}\angle-\frac{\pi}{4}$

Common data for questions 97 and 98

The open-loop transfer function of a unity negative feedback control system is given by $G(s) = \frac{K}{(s+5)^3}$

97. The value of K for the phase margin of the system to be 45° is

(a) $250\sqrt{5}$ (b) $250\sqrt{2}$

(c) $125\sqrt{5}$ (d) $125\sqrt{2}$

98. The value of K for the damping ratio ξ to be 0.5, corresponding to the dominant closed-loop complex conjugate pole pair is

(a) 250 (b) 125

(c) 75 (d) 50

99. A system with transfer function $G(s)=\dfrac{1}{(1+s)}$ is subjected to a sinusoidal input r(t)=sinωt. In steady–state, the phase angle of the output relative to the input at ω = 0 and ω = ∞ will be respectively

(a) 0° and –90° (b) 0° and 0°

(c) 90° and 0° (d) 90° and –90°

100. A system has fourteen poles and two zeros. The slope of its highest frequency asymptote in its magnitude plot is

(a) –40 dB/decade

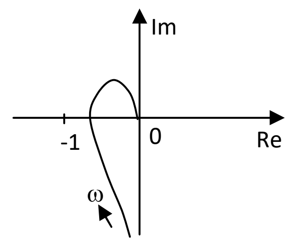
(b) –240 dB/decade

(c) –280 dB/decade

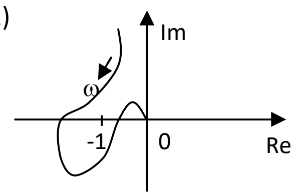
(d) –320 dB/decade

101. Consider the following Nyquist plots of different control systems :

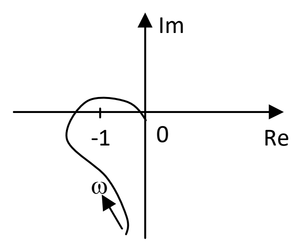
(1)



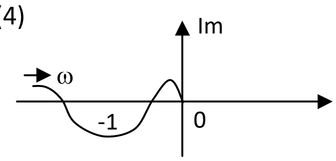
(2)



(3)



(4)



Which of these plot(s) represent(s) a stable system?

(a) 1 alone (b) 2, 3 and 4

(c) 1, 3 and 4 (d) 1, 2 and 4

102. **Assertion (A) :** The stability of a closedloop system can be obtained from the open-loop transfer function G(jω)H(jω) plot with respect to the critical point (–1,j0) in G(jω)H(jω) plane.

Reason (R): The origin of 1+G(jω)H(jω) corresponds to

(–1, j0) point in G(jω)H(jω) plane.

(a) Both A and R are true and R is the correct explanation of A
(b) **Both A and R** are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

103. In an amplifier, the increase in gain is 12dB if the frequency doubled. If the frequency is increased by 10 times, then the increase in gain will be

(a) 2.4 dB (b) 20 dB

(c) 40 dB (d) 60 dB

104. The phase angle of the system $G(s) = \dfrac{s+5}{s^2+4s+9}$ varies between

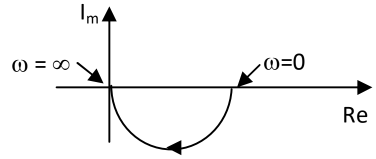
(a) 0° and 90° (b) 0° and –90°

(c) 0° and –180° (d) –90° and –180°

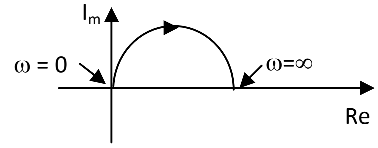
105. The transfer function of a certain system is given by $G(s) = \dfrac{s}{(1+s)}$

The Nyquist plot of the system is

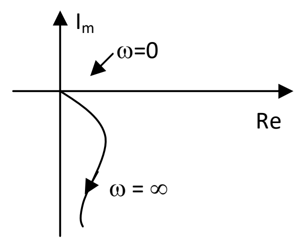
(a)



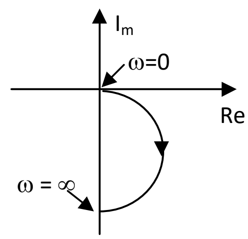
(b)



(c)



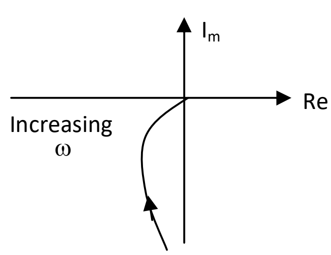
(d)



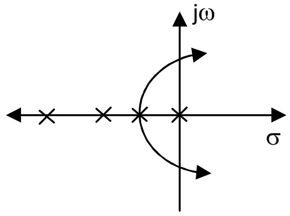
(IES -EE-2001)

106. The Nyquist plot of a servo system is shown in the Figure I. The root loci for the system would be

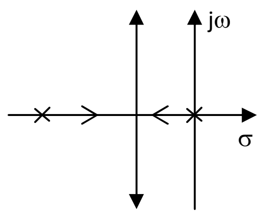
Figure – 1



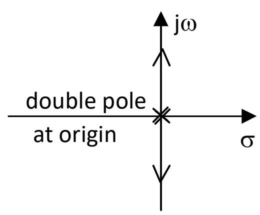
(a)



(b)



(c)



(d) None of the drawn plot of (a), (b),(c) of the question

107. If the Nyquist plot cuts the negative real axis at a distance of 0.4, then the gain margin of the system is

(a) 0.4 (b) – 0.4

(c) 4% (d) 2.5

108. The system function $H(s) = \dfrac{1}{s+1}$ for a signal cost, the steady state response is

(a) $\dfrac{1}{\sqrt{2}}\cos\left(t - \dfrac{\pi}{4}\right)$

(b) cos t

(c) $\cos\left(t - \dfrac{\pi}{4}\right)$

(d) $\dfrac{1}{\sqrt{2}}\cos t$

109. List I and List II show the transfer function and polar plots respectively. Match List I with list II and select the correct answer:

List I

A. $\dfrac{1}{s(1+sT)}$

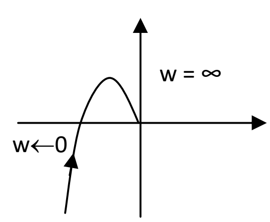
B. $\dfrac{1}{(1+sT_1)s(1+sT_2)}$

C. $\dfrac{1}{s(1+sT_1)s(1+sT_2)}$

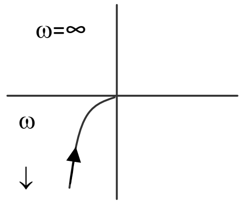
D. $\dfrac{1}{s^2(1+sT_1)s(1+sT_2)}$

List II

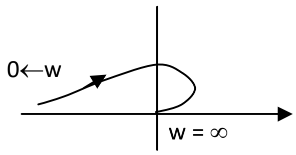
(1)



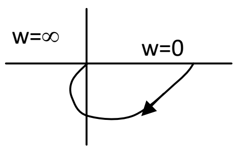
(2)



(3)



(4)



Codes:

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

110.Match List I with List II and select the correct answer:

List I (Property)

A. Relative stability

B. Speed of response

C. Accuracy

D. Sensitivity

List II (Specification)

1. Rise time

2. Velocity error constant

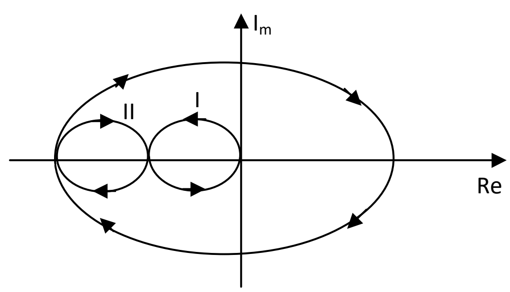
3. Return difference

4. M-peak

Codes:

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

111.Consider the Nyquist diagram for given KG(s)H(s). The transfer function KG(s)H(s) has no poles and zeros in the right half of s-plane. If the (-1,j0) point is located first in region I and then in region II, the change in stability of the system will be from



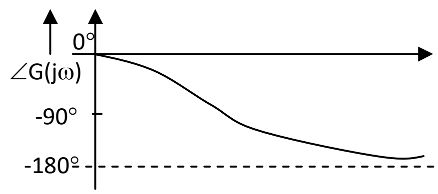
(a) unstable to stable
(b) stable to stable
(c) unstable to unstable
(d) stable to unstable

112.A second order control system has $M(j\omega) = \dfrac{100}{100 - \omega^2 + 10\sqrt{2}\, j\omega}$. Its M_P (Peak magnitude) is

(a) 0.5 (b) 1

(c) $\sqrt{2}$ (d) 2

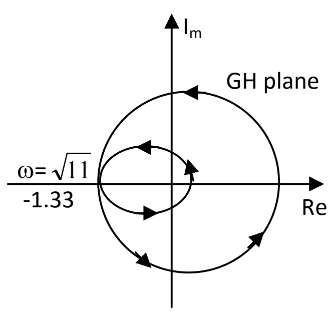
113. The Bode phase angle plot of a system is shown below.
The type of the system is



(a) 0 (b) 1

(c) 2 (d) 3

114.

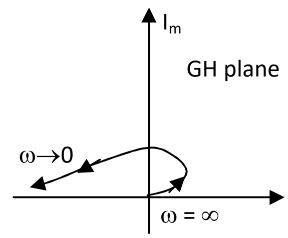


The Nyquist plot of a unity feedback system having open loop transfer function $G(s) = \dfrac{K(s+3)(s+5)}{(s-2)(s-4)}$ for K=1 is as shown above. For the system to be stable, the range of values of K is

(a) $0 < K < 1.33$ (b) $0 < K < 1/1.33$

(c) $K > 1.33$ (d) $K > 1/1.33$

115. The Nyquist plot of a control system is shown below. For this system, G(s)H(s) is equal to



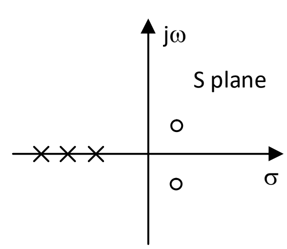
(a) $\dfrac{K}{s(1+sT_1)}$

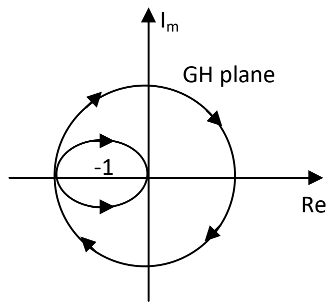
(b) $\dfrac{K}{s^2(1+sT_1)}$

(c) $\dfrac{K}{s^3(1+sT_1)}$

(d) $\dfrac{K}{s^2(1+sT_1)(1+sT_2)}$

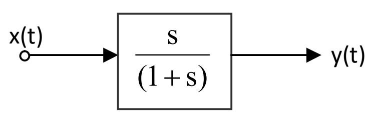
116. The pole-zero map and the Nyquist plot of the loop transfer function GH(s) of a feedback system are shown below. For this





a) Both open loop and closed loop systems are stable
b) Open loop system is stable but closed loop system is unstable
c) Open loop system is unstable but closed loop system is stable
d) Both open loop and closed loop systems are unstable

117. Consider the following system shown in the diagram:



In the system shown in the above diagram x(t) = sin t. What will be the response y(t) in the steady state?

(a) $\sin(t-45°)/\sqrt{2}$

(b) $\sin(t + 45°)/\sqrt{2}$

(c) $\sqrt{2}\, e^{-t} \sin t$

(d) sin t – cos t

118. Match List I (Type of plots) with List II (Functions) and select the correct answer using the codes given below:

List I (Types of plots)

A. Bode plots

B. Polar plots

C. Nyquist plots

D. Nichols chart

List – II (Functions)

1) Open loop response due to damped sinusoidal inputs as a function of complex frequency
2) Open loop response due to undamped sinusoidal as a function of real frequency
3) Closed loop response due to sinusoidal inputs as a function of real frequency
4) Open loop magnitude and phase angle responses for undamped sinusoidal inputs plotted separately as a function of real frequency

Code:

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

119. A unity feedback control system has a forward loop transfer function as $\frac{e^{-Ts}}{[s(s+1)]}$. Its phase value will be zero

at frequency ω_1. Which one of the following equations should be satisfied by ω_1?

(a) $\omega_1 = \cot(T\omega_1)$

(b) $\omega_1 = \tan(T\omega_1)$

(c) $T\omega_1 = \cot(\omega_1)$

(d) $T\omega_1 = \cot(\omega_1)$

120.The Nyquist plot for the closed-loop control system with the loop transfer function $G(S)H(S)=\frac{100}{S(S+10)}$ is plotted. Then, the critical point (-1, j0) is

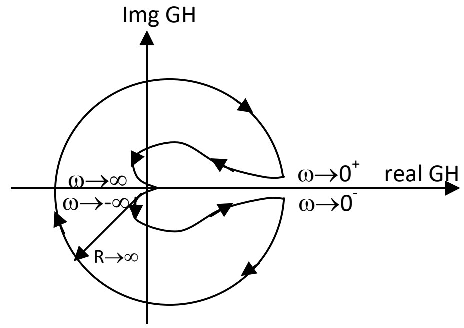
(a) never enclosed
(b) enclosed under certain conditions
(c) just touched
(d) enclosed

121.A minimum phase unity feedback system has a Bode plot with a constant slope of -20db/decade for all frequencies. What is the value of the maximum phase margin for the System?

(a) 0° (b) 90°

(c) - 90° (d) 180°

122.Consider the following Nyquist plot of a feedback system having open loop transfer function.
$GH(s)=(s+1)/[s^2(s-2)]$ as shown in the diagram given below:



What is the number of closed loop poles in the right half of the s-plane?

(a) 0 (b) 1

(c) 2 (d) 3

123.Match **ListI** (Plot/Model) with **ListII** (Related parameter) and select

The correct answer using the codes

given below:

List I
(Plot/ Model)

A. Root locus plot

B. Bode plot

C. Nyquist plot

D. Signal flow chart

List II
(Related parameter)

1. Corner frequency

2. Breakaway point

3. Critical point

4. Transmittance

Code:

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

124. Consider the following statements with regard to the bandwidth of a closed-loop system:

1) In systems where the low frequency magnitude is 0dB in the Bode diagram, the bandwidth is measured at the -3dB frequency.
2) The bandwidth of the closed loop control system is a measurement of the range of fidelity of response of the system.
3) The speed of response to a step input is proportional to the bandwidth.
4) The system with the larger bandwidth provides slower step response and lower fidelity ramp response.

Which of the statements given above are correct?

(a) 1, 2 and 3 (b) 1, 2 and 4

(c) 1, 3 and 4 (d) 2, 3 and 4

125. Match List I (Nyquist Plot of Loop Transfer Function of a Control System) with List II (Gain Margin in dB) and select the correct answer using the code given below the Lists

List I

A. Does not intersect the negative real axis

B. Intersects the negative real axis between 0 and (-1, j0)

C. Passes through (-1, j0)

D. Encloses (-1, j0)

List II

1. > 0
2. ∞
3. < 0
4. 0

Code:

	A	B	C	D
(a)	2	41	3	
(b)	3	14	2	
(c)	2	14	3	
(d)	3	41	2	

126. Encirclement of origin of 1 + G(s) plane corresponds to encirclement of a point in the -1 + G(s) plane, given by

(a) 1 + j0 (b) 0 + j0

(c) - 2 + j0 (d) - 1 + j0

127.**Assertion (A):** The variation in gain of the system does not alter the phase angle plot in the Bode diagram.
Reason (R): The phase margin of the system is not affected by the variation in gain of the system.

(a) Both A and R are individually true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

128.Consider the following statements The gain cross-over point is the point where

1. the magnitude $|G(j\omega)|=1$ in polar plot
2. the magnitude curve of $G(j\omega)$ crosses zero dB line in Bode plot
3. magnitude vs phase plot touches the zero dB loci in Nichol's chart

Which of the statements given above

are correct?

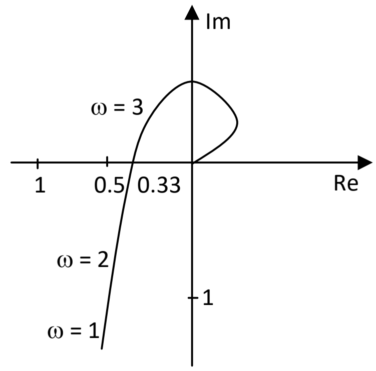
(a) Only 1 and 2

(b) Only l and 3

(c) Only 2 and 3

(d) 1, 2 and 3a

129.



What is the approximate value of the gain margin in the Nyquist diagram given above?

(a) 0.67 (b) 3.0

(c) 1.0 (d) 1/3

130.Consider the following statements in connection with the addition of a pole to the forward path transfer function :
1. Closed-loop system becomes less stable.

2. Rise time of the system increases.
3. Bandwidth of the system increases.

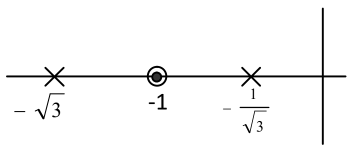
Which of the statements given above are correct?

(a) Only 1 and 2 (b) Only 2 and 3

(c) Only 1 and 3 (d) 1, 2 and 3

131.The pole zero diagram of an impedance Z(s) is shown in the below figure. K = 1,

$\times \Rightarrow$ poles ($\times$) are at $\frac{-1}{\sqrt{3}}$ and $-\sqrt{3}$ and zero (0) is at s = -1. For a signal I=cost, the steady state response across Z(s) is V = $V_m\cos(t+\theta)$. What is the value of θ ?



(a) -45° (b) 45°

(c) -90° (d) 90°

132. Consider the following statements in connection with frequency domain specifications of a control system :

1. Resonant peak and peak overshoot are both functions of the damping ratio ζ only.
2. The resonant frequency $\omega_r=\omega_n$ for $\zeta > 0.707$.
3. Higher the resonant peak, higher is the maximum overshoot of the step response. Which of the statements given above are correct ?

(a) 1 and 2 only (b) 2 and 3 only

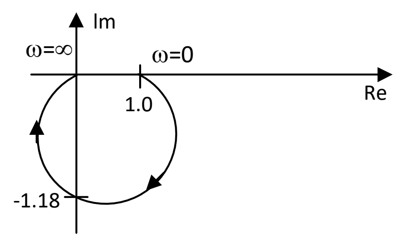
(c) 1 and 3 only (d) 1, 2 and 3

133. Which one of the following is the correct statement ?
For the minimum phase system to

be stable,

(a) phase margin should be negative and gain margin positive
(b) phase margin should be positive and gain margin negative
(c) both gain margin and phase margin should be positive
(d) both gain margin and phase margin should be negative

134. The polar plot of frequency response of a linear under damped second order system is shown in the figure given. What is the transfer function of this system ?



(a) $\frac{8}{s^2+10s+1}$

(b) $\frac{8}{s^2+8.48s+10}$

(c) $\frac{100}{s^2+8.48s+100}$

(d) $\frac{100}{s^2+10s+8.48}$

135. Which one of the following is correct ?
A unity feedback system with forward path transfer function $G(s)=\frac{K}{s(1+sT_1)(1+sT_2)}$ is stable provided the value of K is given by

(a) $K < \frac{T_1 + T_2}{T_1 T_2}$ (b) $K < \frac{T_1 T_2}{T_1 + T_2}$

(c) $K > \frac{T_1 + T_2}{T_1 T_2}$ (d) $K > \frac{T_1 T_2}{T_1 + T_2}$

136. Match List I with List II and select the correct answer using the code given below the Lists :

List – I

A. Relative stability
B. Eigen value
C. Difference equation
D. Corner frequency

List – II

1. State model
2. G.M.
3. Bode plot
4. Sampled-data system

Code:

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

137. At which frequency does the Bode magnitude plot for the function K/s^2 have gain crossover frequency ?

(a) ω = 0 r/s (b) $\omega = \sqrt{K}\ r/s$

(c) ω = K r/s (d) $\omega = K^2$ r/s

138. Which one of the following is the correct statement?
A minimum phase transfer function has

(a) Poles in the righ half of s-plane
(b) Zeros in the right half of s-plane
(c) Poles in the left half of s-plane and zeros in the right half of s-plane
(d) No poles or zeros in the right half of s-plane or on the $j\omega$-axis excluding the origin

139. The transfer function of a system is (1-s)/(1+s). The system is then which one of the following ?
(a) Non-minimum phase system
(b) Minimum phase system
(c) Low-pass system
(d) Second-order system

140. The Nyquist plot of a system passes through (-1, j0) point in the $G(j\omega)H(j\omega)$ plane, the phase-margin of the system is:

(a) infinite
(b) greater than zero but not infinite
(c) zero
(d) less than zero

141. Which of the following transfer functions is/are minimum phase transfer function(s)?

1) $\frac{1}{(s-1)}$

2) $\frac{(s-1)}{(s+3)(s+4)}$

3) $\frac{(s-2)}{(s+3)(s-4)}$

Select the correct answer using the code given below:

(a) 1 and 3 (b) 1 only

(c) 2 and 3 (d) None

142. Which one of the following is correct ?
The slope of the asymptotic Bode magnitude plot is integer multiple of

(a) ± 40 db/decade
(b) ± 12 db/decade
(c) ± 6 db/decade
(d) ± 3 db/decade

143. Which one of the following is correct?
If the open-loop transfer function has one pole in the right half of s-plane, the closed loop system will be stable if the Nyquist plot of GH

(a) does not encircle the (-1 + j0) point
(b) encircles the (-1 + j0) point once in the counter-clockwise direction
(c) encircles the (-1 + j0) point once in the clockwise direction
(d) encircles the origin once- in the counter clockwise direction

144. The low frequency and high frequency asymptotes of Bode magnitude plot are respectively ---60db/decade and –40db/dccade. What is the type of the system?

(a) Type 0 (b) Type I

(c) Type II (d) Type III

145. Consider the following

1. Phase margin
2. Gain margin
3. Maximum overshoot
4. Bandwidth

Which of the above are the frequency domain specifications required to design a control system ?

(a) 1 and 2 only (b) 1 and 3 only

(c) 1, 2 and 4 (d) 1, 2 and 4

146. What is the error in magnitude at the corner frequency for an asymptotic Bode magnitude plot for the term $(1+s\tau)^{\pm n}$?

(a) ± 20 n db (b) ± 6 n db

(c) ± 3n db (d) ± 1 n db

147. What is the slope of the line due to $\frac{1}{j\omega}$ factor in magnitude part of Bode plot ?

(a) -20 db per octave
(b) -10 db per octave
(c) -6 db per octave
(d) -2 db per octave

148. What is the initial slope of Bode magnitude plot of a type-2 system ?

(a) - 20 db/decade
(b) + 20 db/decade
(c) - 40 db/decade

(d) + 40 db/decade

149. The open-loop transfer function of a system has one pole in the right half of s-plane. If the system is to be closed loop stable, then (-1+j0) point should have how many encirclements in the GH-plane ?

(a) -2 (b) -1

(c) + 1 (d) + 2

150. A second order system has a natural frequency of oscillations of 3rad/sec and damping ratio of 0.5. What are the values of resonant frequency and resonant peak of the system ?

(a) 1.5 rad/sec and 1.16
(b) 1.16 rad/sec and 1.5
(c) 1.16 rad/sec and 2.1
(d) 2.1 rad/sec and 1.16

151. The poles and zeroes of an all-pass network are located in which part of the s-plane?

(a) Poles and zeroes are in the right half of s-plane.
(b) Poles and zeroes are in the left half of s-plane.
(c) Poles in the right half and zeroes in the left half of s-plane.
(d) Poles in the left half and zeroes in the right half of s-plane.

152. Match List I (Scientist) with List II (Contribution in the area of) and select the correct answer :

List I

A. Bode

B. Evans

C. Nyquist

List II

1. Asymptotic plots

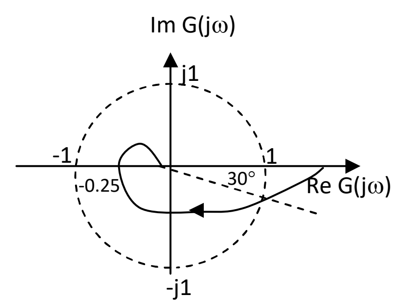
2. Polar plots.

3. Root -locus technique

4. Constant M and N plots

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

153. The polar plot (for positive frequencies) for the open-loop transfer function of a unity feedback control system is shown in the given figure



The phase margin and the gain margin of the system are respectively

(a) 150° and 4 (b) 150° and 3/4

(c) 30° and 4 (d) 30° and 3/4

154. The open loop transfer function of a system is

$$G(s)H(s) = \frac{K}{(1+s)(1+2s)(1+3s)}$$ The

phase crossover frequency ω_c is

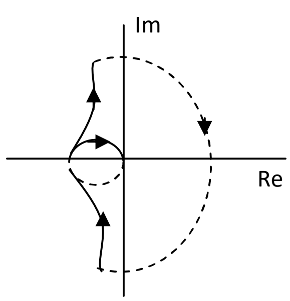
(a) $\sqrt{2}$ (b) 1

(c) Zero (d) $\sqrt{3}$

155. Open loop transfer function of a system having one zero with a positive real value is called

(a) zero phase function
(b) negative phase function
(c) positive phase function
(d) non-minimum phase function

156. Nyquist plot shown in the given figure is for a type



(a) zero system

(b) one system

(c) two system

(d) three system

157. The open-loop transfer function of a unity feedback control system is given as $G(s) = \frac{1}{s(1+sT_1)(1+sT_2)}$ The phase crossover frequency and the gain margin are, respectively

(a) $\frac{1}{\sqrt{T_1T_2}}$ and $\frac{T_1+T_2}{T_1T_2}$

(b) $\sqrt{T_1T_2}$ and $\frac{T_1+T_2}{T_1T_2}$

(c) $\frac{1}{\sqrt{T_1T_2}}$ and $\frac{T_1T_2}{T_1+T_2}$

(c) $\sqrt{T_1T_2}$ and $\frac{T_1T_2}{T_1+T_2}$

158. An open loop transfer function of a unity feedback control system has two finite zeros, two poles at origin and two pairs of complex conjugate poles) The slope of high frequency asymptote in Bode magnitude plot will be

(a) + 40 dB/decade
(b) 0 dB/decade
(c) - 40 dB/decade
(d) - 80 dB/decade

159. The Nyquist plot of

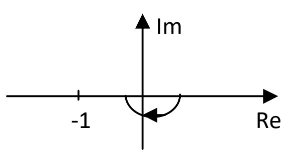
$$G(s)H(s) = \frac{10}{s^2(1+0.5s)(1+s)}$$

(a) will start ($\omega = \infty$) in the first quadrant arid will terminate (ω=0) in the second quadrant
(b) will start ($\omega = \infty$) in the fourth quadrant and will terminate (ω=0) in the second quadrant
(c) will start ($\omega = \infty$) in the second quadrant and will terminate (ω=0) in the third quadrant
(d) will start ($\omega = \infty$) in the first quadrant and will terminate (ω=0) in the fourth quadrant

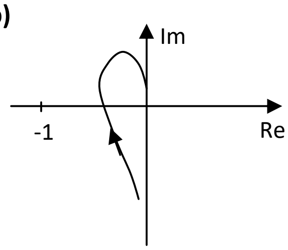
160. Which of following is the Nyquist diagram for the open loop function

$$G(s)H(s) = \frac{5}{s(1+0.1s)(1+0.01s)}?$$

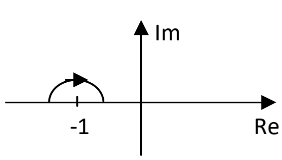
(a)



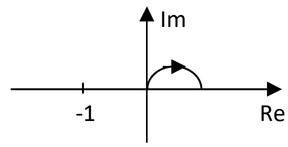
(b)



(c)



(d)



161. Consider the following statements associated with phase and gain margins :

1. They are a measure of closeness of the polar plot the – 1 + j0 point
2. For a non-minimum phase to be stable it must have positive phase and gain margins
3. For a minimum phase system to be stable, both the margins must be positive

Which of the above statements is/are

correct?

(a) 2 and 3 (b) 1 and 3

(c) 1 and 2 (d) 1 alone

162. **Assertion** **(A)**: $G(s) = \frac{10(s-25)}{s(s+1)(s+5)}$ represents a non-minimum phase transfer function)

Reason (R): A minimum phase transfer function has the property that its magnitude and phase are uniquely related

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

163. Consider the following techniques :
1. Bode plot

2. Nyquist plot

3. Nichol's chart

4. Routh-Hurwitz criterion

Which of these techniques are used to determine relative stability of a closed loop linear system?

(a) 1 and 2 (b) 1 and 4

(c) 1, 2 and 3 (d) 2, 3 and 4

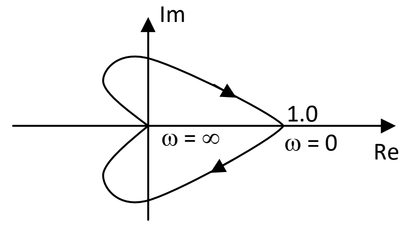
164. Consider the following open loop frequency response of a unity feedback system :

ω (rad/sec)	$\lvert G(j\omega)\rvert$	$\angle G(j\omega)$
2	7.5	-118°
3	4.8	-130°
4	3.15	-140°
5	2.25	-150°
6	1.70	-157°
8	1.00	-170°
10	0.64	-180°

The gain and phase margin of the system are respectively

(a) 0.00 dB, –180°
(b) 3.86 dB, –180°
(c) 0.00 dB, –10°
(d) 3.86 dB, 10°

165.



The Nyquist plot shown above, matches with the transfer function

(a) $\frac{1}{(s+1)^3}$ (b) $\frac{1}{(s+1)^2}$

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

166. The phase margin (PM) and the damping ratio (ζ) are related by

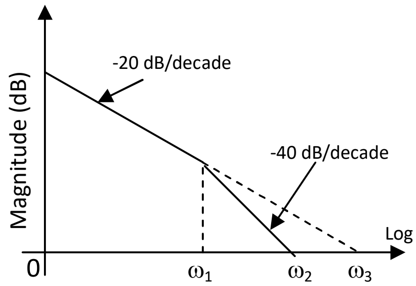
(a) $PM = 90^0 - \tan^{-1}\left\{\frac{\sqrt{-2\zeta^2+\sqrt{1+4\zeta^4}}}{2}\right\}$

(b) $PM = \tan^{-1}\left\{\frac{2\zeta}{\sqrt{-2\zeta^2+\sqrt{1+4\zeta^4}}}\right\}$

(c) $PM = 90^0 + \tan^{-1}\left\{\frac{\sqrt{2\zeta^2+\sqrt{1+4\zeta^4}}}{2\zeta}\right\}$

(d) $PM = 180^0 + \tan^{-1}\left\{\frac{\sqrt{2\zeta^2-\sqrt{1+4\zeta^4}}}{2}\right\}$

167.



Consider the following statements regarding the frequency response of a system as shown above :

1. The type of the system is one

2. ω_3 = static error coefficient (numerically)

3. $\omega_2 = \dfrac{\omega_1 + \omega_3}{2}$

Select the correct answer using the codes given below:

(a) 1, 2 and 3 (b) 1 and 2

(c) 2 and 3 (d) 1 and 3

168. The forward path transfer function of a unity feedback system is given by $G(s) = \dfrac{1}{(1+s)^2}$ What is the phase margin for this system?

(a) - π rad (b) 0 rad

(c) $\pi/2$ rad (d) π rad

169. Which one of the following statements is correct?
A plant is controlled by a proportional controller. If a time delay element is introduced in the loop, its

(a) phase margin remains the same
(b) phase margin increases
(c) phase margin decreases
(d) gain margin increases

170. Which one of the following statements is correct in respect of the theory of stability?

a) Phase margin is the phase angle lagging, in short of 180°, at the frequency corresponding to a gain of 10
b) Gain margin is the value by which the gain falls short of unity, at a frequency corresponding to 90° phase lag
c) Routh-Hurwitz criterion can determine the degree of stability
d) Gain margin and phase margin are the measure of the degree of stability

171. For a stable closed loop system, the gain at phase crossover frequency should always be :

(a) > 20 dB (b) > 6 dB

(c) < 6 dB (d) < 0 dB

172. If the gain of the open loop system is doubled, the gain margin of the system is :

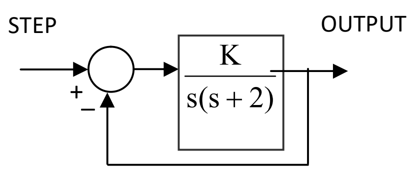
(a) not affected
(b) doubled
(c) halved
(d) one fourth of original value

173. For a unity feedback control system the damping ratio is 0.421. What is the resonance magnitude ?

(a) $M_r = 1$ (b) $M_r = 0.707$

(c) $M_r = 1.30$ (d) $M_r = 1.95$

174. A closed loop system is shown in the below figure. What is the ratio of output frequencies $\dfrac{\omega(\text{for} K = 32)}{\omega(\text{for} K = 16)}$?



(a) 1.40 (b) 1.42

(c) 1.44 (d) 1.46

175. Match List I with List II and select the correct answer using the code given below the lists:

List – I

(Shape of Nyquist Plot)

A) The plot does not intersect negative real axis
B) The plot intersects negative real axis between 0 and (-1, j0)
C) The plot passes through the point (-1, j0)
D) The plot encloses the point (-1,j0)

List – II

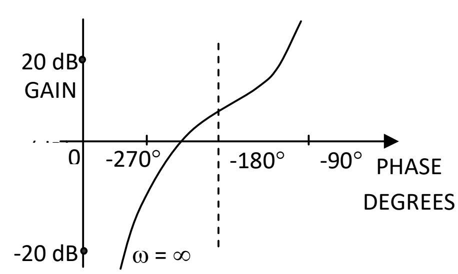
(Gain Margin)

1. <0 dB
2. 0 dB
3. > 0 dB
4. ∞ dB

Code:

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

176. The gain-phase plot of a linear control system is shown in the above figure.What are the gain-margin (GM) and the phase-margin (PM) of the system?



(a) GM > 0 dB and PM > 0 degree
(b) GM > 0 dB and PM < 0 degree
(c) GM < 0 dB and PM > 0 degree
(d) GM < 0 dB and PM < 0 degree

177. What is the gain margin of a system when the magnitude of the polar plot at phase cross over is 'a' ?

(a) 1/a (b) –a

(c) Zero (d) a

178. What is the value of the damping ratio of a second order system when the value of the resonant peak is unity ?

(a) $\sqrt{2}$ (b) Unity

(c) $1/\sqrt{2}$ (d) Zero

179. In the Bode plot of a unity feedback control system, the value of phase angle of G(jω) is -90° at the gain cross over frequency of the Bode plot, the phase margin of the system is :

(a) -180° (b) +180°

(c) -90° (d) +90°

180. The Nyquist plot of loop transfer function G(s)H(s) of a closed loop control system passes through the point (-1,j0) in the G(s)H(s) plane. The phase margin of the system is

(a) 0° (b) 45°

(c) 90° (d) 180°

181. The approximate transfer function of a system with the following frequency response is

ω (radian/s)	0.1	0.3	3	30
Gain in dB	-20	-20.5	-26	-60
Phase in Degree	0	0	-90	-180

(a) $\frac{0.9}{(s+3)^2}$ (b) $\frac{0.9}{s(s+3)}$

(c) $\frac{0.9}{(s+1)(s+3)}$ (d) $\frac{0.9}{(s+1)(s+30)}$

182. The open-loop transfer function of a system is given by $G(s)H(s)=\frac{100(s+100)}{s(s+10)}$. In the straight line approximation of the Bode plot, |G(jω)H(jω)| and ∠G(jω)H(jω) at ω = 100 rad/s are

(a) 0 dB and $\frac{-3\pi}{4}\text{rad}$

(b) 0 dB and $\frac{\pi}{4}\text{rad}$

(c) 20 dB and $\frac{-3\pi}{4}\text{rad}$

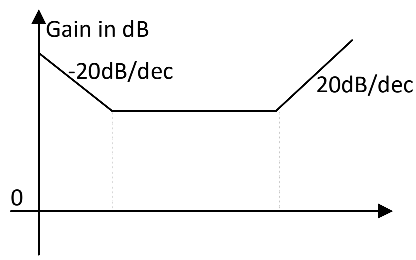
(d) 20 dB and $\frac{\pi}{4}\text{rad}$

183. For which of the following function the polar plot is a circle

(a) $\frac{S}{(S+1)(S+2)}$ (b) $\frac{S^2+1}{S^3}$

(c) $\frac{S^2 - 1}{S^2 + 1}$ (d) $\frac{1}{S^2 + 10}$

184.The Bode plot of aTF is given, the estimate of TF is



(a) $\frac{5(s+2)(s+10)}{s}$ (b) $\frac{5(s+10)}{(s+2)}$

(c) $\frac{5(s+2)}{(s+10)}$ (d) $\frac{5s}{(s+2)(s+10)}$

185.Stability of a system in frequency domain is determined by

(a) gain margin

(b) phase margin

(c) both gain and phase margins

(d) neither gain margin nor phase margin

186.Nyquist plot of a system is shown in figure below,The gain margin is

(a)0.5 (b)-6dB

(c)60^0 (d)+6dB