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Objective Solved Questions

Volume-4

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Signal and System
Electromagnetic Field Theory

MCQ

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UNIT-I

CONTROL SYSTEM

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CHAPTER 1

TRANSFER FUNCTION

OBJECTIVE QUESTIONS

1. Open loop control system is one in which the control action
   (a) Depends on the input signal
   (b) Is independent of the desired output
   (c) Depends on system variables
   (d) Depends on system size

2. Mass, in force-voltage analogy, is analogous to
   (a) Charge (b) Current
   (c) Inductance (d) Resistance
   [TNPSC AE - 2018]

3. Which of the following represents the transfer function of a closed loop control system with negative feedback?
   (a) G (b) $\frac{G}{H}$ (c) $\frac{G}{(1-GH)}$ (d) $\frac{G}{(1+GH)}$
   [TNPSC AE - 2018]

4. In an open loop control system, which of the following is not present?
   (a) Comparator (b) Controller
   (c) Actuator (d) Reference
   [TNPSC AE - 2018]

5. As compared to closed loop system, an open loop system is
   (a) More stable as well as more accurate
   (b) Less stable as well as less accurate
   (c) More stable but less accurate
   (d) Less stable but more accurate

6. Signal flow graph is used to find
   (a) Stability of the system
   (b) Controllability of the system
   (c) Transfer function of the system
   (d) Poles of the system

7. Consider the following statements regarding negative feedback in a closed-loop system
   1. It increases sensitivity.
   2. It minimizes the effect of disturbance.
   3. There is a possibility of instability.
   4. It improves the transient response.
   of these statements are correct-
   (a) 1, 3 and 4 (b) 1, 2 and 4
   (c) 1, 2 and 3 (d) 2, 3 and 4

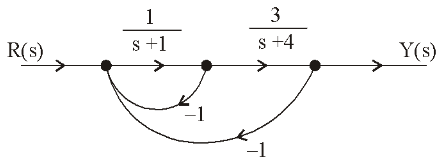
8. A function f(x) is linear under the condition(s)
   (a) $f(x_1 + x_2) = f(x_1) + f(x_2)$ only
   (b) $f(kx) = kf(x)$
   (c) $f(x_1 + x_2) = f(x_1) + f(x_2)$ and $f(kx) = kf(x)$
   (d) $f(x_1 + x_2) = f(x_1) + f(x_2)$ or $f(kx) = kf(x)$

9. Which of the following are correct?
   The feedback affects the control system in the following ways-
   1. Increases accuracy but reduces sensitivity of gain to variation in system parameters.
   2. Increases bandwidth and reduces the effect of non-linearity.
   3. Increases tendency towards oscillation or leads even to instability.
   Select the correct answer using the code given below-
   (a) 1 and 2 (b) 1 and 3
   (c) 2 and 3 (d) 1, 2 and 3

10. **Assertion (A) :** Negative feedback in amplifiers improves performance.
    Reason (R) : Gain of the amplifier is reduced by use of negative feedback.
    (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

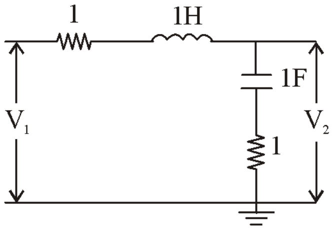
11. The output of the system is $y(t) = x(0) - x(t)$, where x(t) is the input to the system. The system is
    (a) Linear and time varying (b) Non-linear and time varying
    (c) Linear and time invariant (d) Non-linear & time-invariant

12. For the signal flow diagram shown in figure, the transfer function Y(s)/R(s) is



    (a) $\frac{3}{s^2+6s+11}$ (b) $\frac{3}{s^2+5s+11}$
    (c) $\frac{3}{s^2+6s+8}$ (d) $\frac{-3}{s^2+6s+11}$

13. What is the transfer function of the network given below?



(a) $(s + 1)/(2s + 1)$ (b) $1/(1 + s)$

(c) $1/(2s + 1)$ (d) $1/(s^2 + 2s + 1)$

14. The presence of negative feedback in a control system

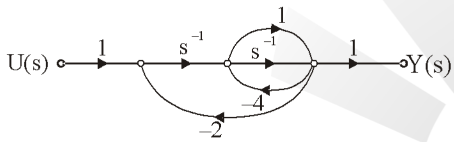
(a) Increases accuracy and reduces bandwidth

(b) Reduces bandwidth and increase distortion

(c) Increases the effect of non linearities and reduces distortion

(d) Reduces distortion and increases bandwidth

15. The signal flow graph for a system is given below. The transfer function $\frac{Y(s)}{U(s)}$ for this system is

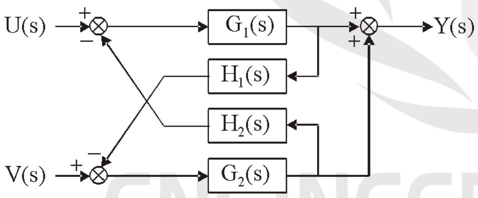


(a) $\frac{s+1}{5s^2+6s+2}$ (b) $\frac{s+1}{s^2+6s+2}$

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

[TNPSC AE - 2018]

16. For the block diagram shown, the ratio Y(s)/U(s)

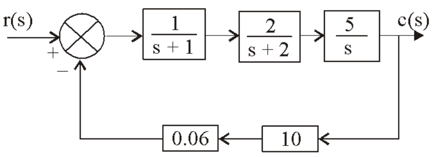


(a) $\frac{G_1(1+H_1G_2)}{1-G_1H_2G_2H_1}$ (b) $\frac{G_1(1-H_1G_2)}{1-G_1H_2G_2H_1}$

(c) $\frac{G_1(1-H_1G_2)}{1+G_1H_2G_2H_1}$ (d) $\frac{G_1(1+H_1G_2)}{1+G_1H_2G_2H_1}$

[TNPSC AE - 2018]

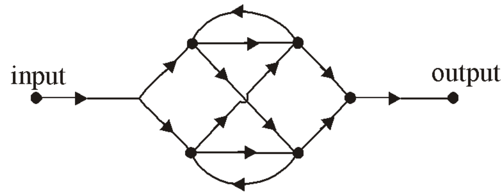
17. The loop transfer function of the control system shown in the given figure is



(a) $\frac{6}{s(s+1)(s+2)}$ (b) $\frac{0.6}{s(s+1)(s+2)}$

(c) $\frac{10}{s(s+1)(s+2)}$ (d) $\frac{10}{s^3+3s^2+2s+6}$

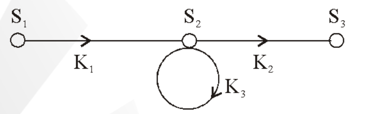
18. If the signal flow graph shown in the given figure has M number of forward paths and P number of individual loops, then

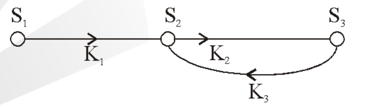


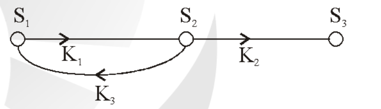
(a) M = 6, P = 6 (b) M = 6, P = 3

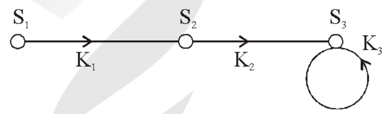
(c) M = 4, P = 6 (d) M = 4, P = 4

19. Consider the following signal flow graphs

1. 

2. 

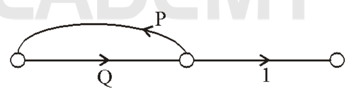
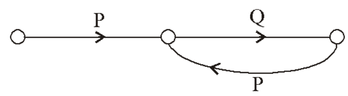
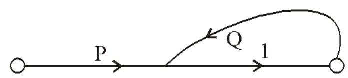
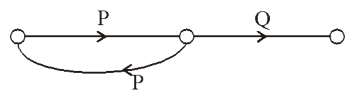
3. 

4. 

These signal flow graphs which have the same transfer function, would include-

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

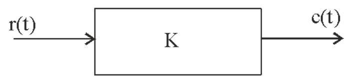
20. Match List-I (Signal flow graph) with List-II (Transfer function) and select the correct answer using the codes given below the lists-

List-I		List-II	
A.		1.	$\frac{P}{1-Q}$
B.		2.	$\frac{Q}{1-PQ}$
C.		3.	$\frac{PQ}{1-PQ}$
D.		4.	$\frac{PQ}{1-P^2}$

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

(c) A-3 B-2 C-1 D-4 (d) A-3 B-2 C-4 D-1

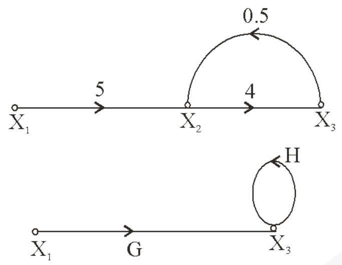
58. If r(t) has units ºC and c(t) has units mm, the units of K in the figure shown are



(a) ºC (b) mm/ºC (c) mm (d) ºC/mm

[APGenco-2012]

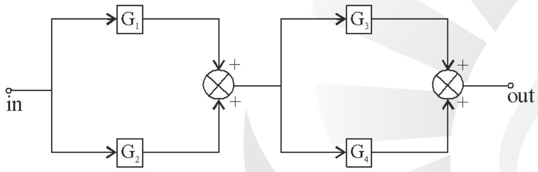
59. The two signal flow graphs shown in figure are equivalent. The value of G and H respectively are



(a) 9, 4.5 (b) 9, 3.5 (c) 20, 8 (d) 20, 2

[APGenco-2012]

60. The overall gain for the block diagram shown below is given by

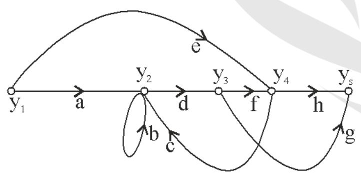


(a) $G_1G_2G_3G_4$ (b) $G_1+G_2+G_3+G_4$

(c) $G_1G_2+G_3G_4$ (d) $(G_1+G_2)\times(G_3+G_4)$

[APSPDCL-2012]

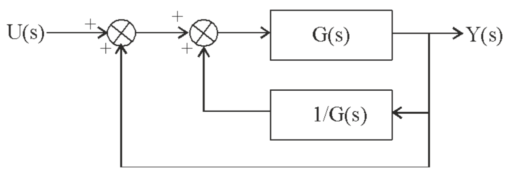
61. The number of forward paths in the following signal flow-graph is



(a) 2 (b) 3 (c) 5 (d) 4

[EPDCL-2014]

62. The overall transfer function of the following system is

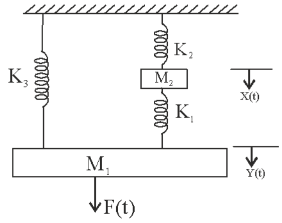


(a) –1 (b) Indeterminate

(c) 1 (d) Infinity

[EPDCL-2014]

63. The mathematical model of an analogous electrical system for the following mechanical system using force-current analogy is (I-Current, v-Voltage, L-Inductance, C-Capacitance)



(a) $\frac{1}{C_{K1}}\int(i_y-i_x)dt = L_{M2}\frac{di_x}{dt}+\frac{1}{C_{K2}}\int i_x\,dt$,

$v_F(t) = L_{M1}\frac{di_y}{dt}+\frac{1}{C_{K3}}\int i_y dt-\frac{1}{C_{K1}}\int(i_y-i_x)dt$

(b) $\frac{1}{L_{K1}}\int(i_y-i_x)dt = C_{M2}\frac{di_x}{dt}+\frac{1}{L_{K2}}\int i_x\,dt$

$v_F(t) = C_{M1}\frac{dv_y}{dt}+\frac{1}{L_{K1}}\int i dt-\frac{1}{L_{K1}}\int(i_y-i_x)dt$

(c) $\frac{1}{C_{K1}}\int(v_y-v_x)dt = L_{M2}\frac{dv_x}{dt}+\frac{1}{C_{K2}}\int v_x\,dt$

$i_F(t) = L_{M2}\frac{dv_y}{dt}-\frac{1}{C_{K3}}\int v_y dt-\frac{1}{C_{K1}}\int(v_y-v_x)dt$

(d) $\frac{1}{L_{K1}}\int(v_y-v_x)dt = C_{M2}\frac{dv_x}{dt}+\frac{1}{L_{K2}}\int v_x\,dt$

$i_F(t) = C_{M1}\frac{dv_y}{dt}+\frac{1}{L_{K3}}\int v_y dt+\frac{1}{L_{K1}}\int(v_y-v_x)dt$

[EPDCL-2014]

64. In force-current analogy capacitance is analogous to

(a) Compliance of spring

(b) Mass

(c) Damping coefficient

(d) Spring constant

[APSPDCL-2014]

65. A servomotor is connected through a gear ratio of 10 to a load having moment of inertia J and coefficient of friction f. The equivalent parameters referred to motor shaft side are

(a) J_{eq} = 0.01J, f_{eq} = 0.01f

(b) J_{eq} = 10J, f_{eq} = 10 f

(c) J_{eq} = 0.1J, f_{eq} = 0.1f

(d) J_{eq} = 100J, f_{eq} =100f

[HMWS-2012]

❑❑❑

ANSWERS AND EXPLANATIONS

1. *Ans. (b)*
2. *Ans. (c)*
3. *Ans. (d)*
4. *Ans. (c)*
5. *Ans. (c)*
6. *Ans. (c)*
7. *Ans. (d)*
8. *Ans. (c)*
9. *Ans. (d)*
10. *Ans. (a)*
11. *Ans. (d)*
12. *Ans. (a)*
13. *Ans. (b)*
14. *Ans. (d)*
15. *Ans. (a)*

$$\frac{Y(s)}{U(s)} = \frac{\frac{1}{s}[1-0]+\frac{1}{s^2}[1-0]}{1-\left[-\frac{4}{s}-\frac{2}{s}-\frac{2}{s^2}-4\right]}$$

$$= \frac{s+1}{5s^2+6s+2}$$

16. *Ans. (b)*

Mason gain formula

$$\frac{Y(s)}{U(s)} = \frac{P_1\Delta_1+P_2\Delta_2}{\Delta}$$

here $P_1 = G_1$, $\Delta_1 = 1 - 0 = 1$

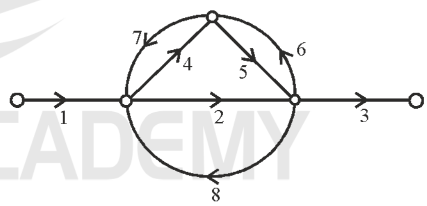
$P_2 = -G_1\ G_2\ H_1,$

$\Delta_2 = 1 - 0 = 1$

$\Delta = 1 - G_1H_2G_2H_1$

So, $$\frac{Y(s)}{U(s)} = \frac{G_1[1-H_1G_2]}{1-G_1H_2G_2H_1}$$

17. *Ans. (a)*
18. *Ans. (b)*
19. *Ans. (d)*
20. *Ans. (b)*
21. *Ans. (c)*
22. *Ans. (a)*
23. *Ans. (a)*
24. *Ans. (a)*
25. *Ans. (d)*
26. *Ans. (c)*
27. *Ans. (b)*
28. *Ans. (a)*
29. *Ans. (c)*
30. *Ans. (a)*
31. *Ans. (b)*
32. *Ans. (c)*
33. *Ans. (a)*
34. *Ans. (c)*
35. *Ans. (b)*
36. *Ans. (d)*
37. *Ans. (d)*
38. *Ans. (d)*
39. *Ans. (c)*
40. *Ans. (a)*
41. *Ans. (a)*
42. *Ans. (b)*
43. *Ans. (d)*
44. *Ans. (b)*
45. *Ans. (d)*
46. *Ans. (b)*
47. *Ans. (b)*
48. *Ans. (a)*
49. *Ans. (c)*
50. *Ans. (b)*
51. *Ans. (b)*
52. *Ans. (c)*
53. *Ans. (b)*
54. *Ans. (a)*
55. *Ans. (b)*
56. *Ans. (a)*



For simplicity numbers are shown in figure

Forward paths = 123, 1453 (total 2)

Loops = 47, 56, 28,458,267 (total 5)

Option (a) is the correct choice

57. *Ans. (b)*
58. *Ans. (b)*

$$K = \frac{\text{Output}}{\text{Input}} = \frac{c(t)}{r(t)}$$

$K = \text{mm/°C}$

CHAPTER 2

TIME RESPONSE ANALYSIS

OBJECTIVE QUESTIONS

1. After the first time constant, a transient current has changed by .... % leaving .... % remaining.
(a) 63.2, 36.8 (b) 36.8, 63.2
(c) 13.5, 86.5 (d) 86.5, 13.5

2. Which of the following factor (s) is/are associated with the determination of step response of a time invariant linear network?
1. Initial conditions of the network
2. Time of application of the input
3. Size of the step input
Select correct answer using the codes given below
(a) 1, 2 and 3 (b) 2 and 3
(c) 1 and 3 (d) 3 alone

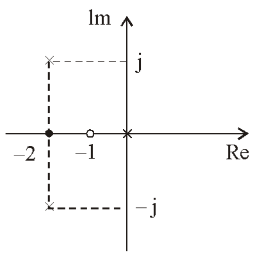
3. The derivative of a step function is
(a) Zero (b) An impulse function
(c) A ramp function (d) A constant

4. The double integration of a unit step function will result
(a) Unit step function (b) Ramp function
(c) Impulse (d) Parabola

5. The closed-loop transfer function of a unity feedback control system is $\frac{25}{s^2+10s+25}$, what is the loop transfer of the system?
(a) $\frac{25}{s^2+10s}$ (b) $\frac{25}{s^2+25}$ (c) $\frac{25}{s+25}$ (d) $\frac{25}{s+10}$

6. If the unit-step response of a system is a unit impulse function, then the transfer function of such a system will be
(a) 1 (b) 1/s (c) s (d) $1/s^2$

7. A transfer function G(s) has pole-zero plot as shown in the figure. Given that the steady state function gain is 2, the transfer function G(s) will be given by



(a) $\frac{5(s+1)}{s^2+4s+4}$ (b) $\frac{2(s+1)}{s(s^2+4s+5)}$
(c) $\frac{10(s+1)}{s(s^2+4s+5)}$ (d) $\frac{10(s+1)}{s(s+2)^2}$

8. Of the following transfer function of second order linear time-invariant systems, the underdamped system is represented by
(a) $H(s)=\frac{1}{s^2+4s+4}$ (b) $H(s)=\frac{1}{s^2+5s+4}$
(c) $H(s)=\frac{1}{s^2+4.5s+4}$ (d) $H(s)=\frac{1}{s^2+3s+4}$

9. For the control system with
$$G(s)H(s) = \frac{K(s+2)}{s(s^2+2s+3)}$$
the type number is
(a) 1 (b) 2 (c) 3 (d) 4

10. ***Assertion (A):*** If the transfer function of a system is known, then its impulse response can be calculated.
Reason (R): The impulse response is the inverse Laplace transform of the transfer function.
(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 a correct explanation A
(c) A is true but R is false
(d) A is false but R is true

11. Match List-I and List-II and select the correct answer using the code given below the lists-

	List-1 (Transfer function system)		**List-II (Type and Order of the of the system)**
A.	$\frac{2(s+2)}{s(s+5)}$	**1.**	Type 0, second order
B.	$\frac{(s+2)}{(s+3)(s+5)}$	**2.**	Type 1, second order
C.	$\frac{2(s+5)}{s^2(s+2)}$	**3.**	Type 0, third order
D.	$\frac{5(s+2)}{(s+1)(s+3)(s+5)}$	**4.**	Type 2, third order

Codes:	**A**	**B**	**C**	**D**
(a)	2	1	4	3
(b)	4	3	2	1
(c)	2	3	4	1
(d)	4	1	2	3

12. The characteristic equation of closed loop control system is given as $s^2 + 4s + 16 = 0$. The natural frequency in radian/sec of the system is

(a) 2 (b) $2\sqrt{3}$ (c) 4 (d) $2\sqrt{2}$

13. The transfer function of the system is $\frac{2s^2 + 6s + 5}{s(s+1)^2(s+2)}$, the characteristic equation of the system is

(a) $2s^2 + 6s + 5 = 0$

(b) $s(s+1)^2(s+2) = 0$

(c) $2s^2 + 6s + 5 + (s+1)^2(s+2) = 0$

(d) $2s^2 + 6s + 5\ (s+1)^2(s+2) = 0$

14. Consider a system having forward path and feedback path transfer functions as $16/[s(s+0.8)]$ and $(1 + 2s)$ respectively. Which is the characteristic polynomial of the system

(a) $s^2 + 0.8s + 16$ (b) $s^2 + 2.8s + 16$

(c) $s^2 + 32.8s + 16$ (d) $s^2 + 32s + 16$

15. Natural frequency of a unity feedback control system of open loop transfer function $G(s) = \frac{10}{s(s+1)}$ is

(a) 0.5 rad/sec (b) 3.16 rad/sec

(c) 4.6 rad/sec (d) None of these

16. A system is having a transfer function of $\frac{1}{s+a}$. What will be its impulse response?

(a) t (b) e^{-at} (c) t^2 (d) e^{at}

17. For the unity feedback control system whose open loop transfer function is $\frac{1}{s(s+1)}$, the natural frequency of oscillation is :

(a) 2 rad/sec (b) 0.5 rad/sec

(c) 5 rad/sec (d) 1 rad/sec

18. Due to over-damping, the instrument will become

(a) Both Lethargic and Slow

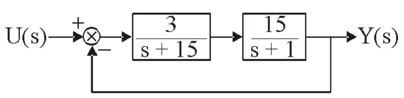
(b) Fast

(c) Slow

(d) Lethargic

[UPPCL JE - 2018]

19. The steady state error for the system shown below to unit step input is



(a) 25% (b) 0.75%

(c) 6% (d) 33%

[TNPSC AE - 2018]

20. In case of type-1 system, steady state acceleration error is

(a) Unity (b) Infinity

(c) Zero (d) 10

[TNPSC AE - 2018]

21. The transfer function of a system is given as $\frac{100}{s^2 + 20s + 100}$.

This system is

(a) An over damped system

(b) An under damped system

(c) A critically damped system

(d) An unstable system

[TNPSC AE - 2018]

22. 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

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

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

23. The Laplace transformation of f(t) is F(s). Given $F(s) = \frac{\omega}{s^2 + \omega^2}$ the final value of f(t) is

(a) Infinity (b) Zero

(c) One (d) Indeterminate

24. The close loop transfer function of control system is given $\frac{C(s)}{R(s)} = \frac{1}{1+s}$

For the input r(t) = sint, the steady state value of C(t) is equal to

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

(c) $\frac{1}{\sqrt{2}}\sin t$ (d) $\frac{1}{\sqrt{2}}\sin(t - \pi/4)$

25. A system is critically damped. Now if the gain of the system is increased. The system will behave as

(a) Over damped (b) Under damped

(c) Oscillatory (d) Critically damped

26. The transfer function of a control system is given as $T(s) = \frac{K}{s^2 + 4s + K}$, where K is gain of the system in radian/amp. For this system to be critically damped the value of K should be

(a) 1 (b) 2 (c) 3 (d) 4

27. The unit impulse response of a system is given by $c(t) = 0.5e^{-t/2}$ its transfer function is

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

28. When a unit step input is applied, a second order underdamped system has a peak overshoot of OP occurring at t_{max}. If another step input equal in magnitude to the peak overshoot OP is applied at $t = t_{max}$. Then the system will settle down at

(a) 1 + OP (b) 1 – OP
(c) OP (d) 1.0

29. The steady state error due to a ramp input for a type two system is equal to

(a) Zero (b) Infinite
(c) Constant (d) Data is insufficient

30. Given the transfer function $G(s) = \frac{121}{s^2 + 13.2s + 121}$ of a system. Which of the following characteristics does it have?

(a) Overdamped and settling time 1.1 s.
(b) Underdamped and settling time 0.6 s.
(c) Critically damped and settling time 0.8 s.
(d) Underdamped and settling time 0.707 s.

31. What is the steady state error for a unity feedback control system having $G(s) = \frac{1}{s(s+1)}$ due to unit ramp input ?

(a) 1 (b) 0.5
(c) 0.25 (d) $\sqrt{0.5}$

32. When the time period of observation is large, the type of the error is

(a) Transient error (b) Steady state error
(c) Half–power error (d) Position error constant

33. Consider a system with the transfer function

$G(s) = \frac{s+6}{Ks^2 + s + 6}$. Its damping ratio will be 0.5 when the value of K is

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

34. A system is represented by $\frac{dy}{dt} + 2y = 4t\,u(t)$. The ramp component in the forced response will be

(a) t u(t) (b) 2t u(t) (c) 3t u(t) (d) 4t u(t)

35. Which one of the following is the steady state error of a step input applied to a unity feedback system with the open loop transfer function $G(s) = \frac{10}{s^2 + 14s + 50}$?

(a) $e_{ss} = 0$ (b) $e_{ss} = 0.83$
(c) $e_{ss} = 1$ (d) $e_{ss} = \infty$

36. The unit step response of a particular control system is given by $c(t) = 1 - 10e^{-t}$, its transfer functions is

(a) $\frac{10}{s+1}$ (b) $\frac{s-9}{s+1}$ (c) $\frac{1-9s}{s+1}$ (d) $\frac{1-9s}{s(s+1)}$

37. Consider the following statements with a reference to a system with velocity error constant $k_v = 100$

1. The system is stable.
2. The system is of type 1.
3. The test signal used is a step input.

Which of these statements are correct?

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

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

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

39. A second order system has the damping ratio ξ and undamped natural frequency of oscillation ω_n, the settling time at 2% tolerance band of the system is

(a) $\frac{2}{\xi\omega_n}$ (b) $\xi\omega_n$ (c) $\frac{4}{\xi\omega_n}$ (d) $\frac{3}{\xi\omega_n}$

40. The response c(t) to a system is described by the differential equation $\frac{d^2c(t)}{dt^2} + \frac{4dc(t)}{dt} + 5c(t) = 0$; the system response is

(a) Undamped (b) Underdamped
(c) Critically damped (d) Oscillatory

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

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

42. The impulse response of a system is given by $c(t) = \frac{1}{2}e^{-t/2}$. Which one of the following is it's unit step response?

(a) $1 - e^{-1/2t}$ (b) $1 - e^{-1}$
(c) $2 - e^{-t}$ (d) $1 - e^{-2t}$

43. The final value of function $F(s) = \frac{5}{s(s^2 + s + 2)}$ is equal to

(a) Zero (b) $\frac{2}{5}$ (c) $\frac{5}{2}$ (d) 5

55. In feedback control system with G(s) = 16/[s (s+ 4)] and H(s) = 1 + Ks, the damping ratio of 0.6 will be achieved for K equal to

(a) 0.1 (b) 0.02 (c) 0.025 (d) 0.05

56. For a 2nd order servo system, the damping ratio ξ = 0.5456 and un-damped natural frequency is $\omega_n = 31.6 \text{rad/sec}$. The percentage overshoot is

(a) 7.07 (b) 10.2 (c) 12.9 (d) 21.21

57. For a system with derivative feedback, forward path transfer function is $G(s) = 1/(s^2 + s + 1)$ and feedback path transfer function is H(s) = Ks. What is the value of the K to obtain a critically-damped closed loop transient response.

(a) 0.5 (b) 0.707 (c) 1 (d) 1.414

58. The error response of a second order system to a step input is obtained as

$$E(t) = 1.66e^{-8t} \sin(6t + 37°)$$

The damping ratio is

(a) 0.4 (b) 0.5 (c) 0.8 (d) 1.0

59. A step input as shown in fig. II is given to the circuit shown in fig. I. The output is as shown in fig. III. The rise time of the circuit response is equal to

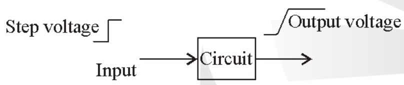


Fig. I

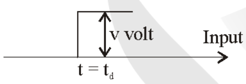


Fig. II

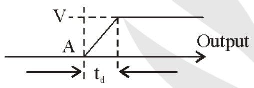


Fig. III

(a) t_d

(b) The time taken to reach 100% of V from the instant at which the output is 5% of V

(c) The time taken to reach 95% of V from A

(d) The time taken to reach 90% of V from the instant at which the output is 10% of V

60. **Assertion (R):** The steady-state error due to step input to a system represented by $G(s) = \dfrac{10(1+0.5s)}{s(s+1)(1+2s)}$ is zero

Reason (R): For a type 1 system, the steady-state error due to step input is zero.

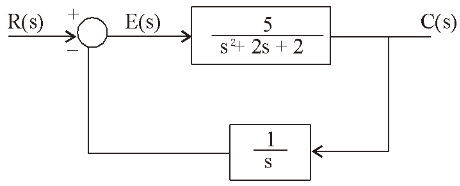
(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true but R is not a correct explanation A.

(c) A is true but R is false

(d) A is false but R is true

61. **Assertion (A):** The closed-loop system represented in the given figure is a type-1 system.



Reason (R): Number of poles at the origin possessed by the feedback path decides the type of the closed-loop system.

(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 a correct explanation of A

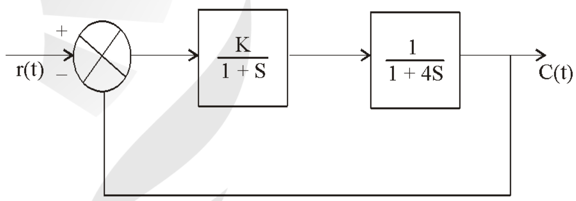
(c) A is true but R is false

(d) A is false but R is true

62. If a second order system has poles at –1 ± j, then step response of the system will exhibit a peak value at

(a) 4.5 s (b) 3.5 s (c) 3.14 s (d) 1s

63. A system is shown in the given figure. The value of K which gives a steady-state error of 20% to a unit step-input is given as



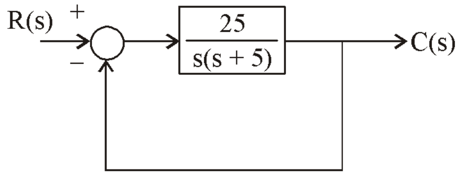
(a) 500 (b) 100 (c) 20 (d) 4

64. The impulse response of a second order under damped system starting from rest is given by $C(t) = 12.5e^{-6t} \sin 8t, t > 0$. What are the natural frequency and the damping ratio of the system?

(a) 10 and 0.6 (b) 10 and 0.8

(c) 8 and 0.6 (d) 8 and 0.8

65.



What are the values of undamped natural frequency and damping ratio respectively for the system shown in the figure above?

(a) 5 and 0.5 (b) 25 and 0.5

(c) 5 and 1 (d) 10 and 0.5

152. For a type 1, second order control system, when there is an increase of 25% in its natural frequency, the steady state error to unit ramp input is

(a) Increased by 20%

(b) Equal to $\frac{2\delta}{\omega_n}$, where δ = Damping factor

(c) Decreased by 21%

(d) Decreased by 20%

[HMWS-2012]

153. A system is required to have a peak overshoot of 4.32% and a natural frequency of 5 rad/sec. The required location of the dominant pole is

(a) 3.5325 + j5.535 (b) 2.535 + j2.525

(c) 2.535 + j3.535 (d) –3.535 + j3.535

[HMWS-2012]

154. The steady state error for an input 2 u(t) applied to a type-0 system is

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

(c) $\frac{1}{kp}$ (d) 0

[HMWS-2012]

155. For a feedback control system of type 2, the steady state error for a ramp input is

(a) Infinite (b) Constant

(c) Zero (d) Indeterminate

[TRANSCO-2012]

156. The output of a linear time invariant control system is c(t) for a certain input r(t). If r(t) is modified by passing it through a block whose transfer function is e^{-s} and then applied to the system, the modified output of the system would be

(a) $\frac{c(t)}{1+e^{t}}$ (b) $\frac{c(t)}{1+e^{-t}}$

(c) c(t – 1)u(t – 1) (d) c(t)u(t – 1)

[TRANSCO-2012]

157. When the closed-loop system is subjected to a step input of magnitude 2, the system response is given by $y(t) = 2 + 0.4e^{-60t} - 2.4e^{-10t}$. The closed loop-transfer function of this system is

(a) $\frac{1200}{(s+10)(s+60)}$ (b) $\frac{1200}{s(s+10)(s+60)}$

(c) $\frac{600}{(s+10)(s+60)}$ (d) $\frac{1200}{(s-10)(s+60)}$

[EPDCL-2014]

158. If the closed-loop transfer function T(s) of a unity negative feedback system is given by:

$T(s) = \frac{a_{n-1}S + a_n}{S^n + a_1 S^{n-1} + ... + a_{n-1}S + a_n}$, then the steady state error for a unit ramp input is

(a) $\frac{a_n}{a_{n-1}}$ (b) Infinity (c) Zero (d) $\frac{a_n}{a_{n-2}}$

[EPDCL-2014]

159. The unit parabolic function may be regarded as the

(a) The integral of the unit step

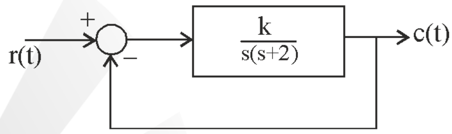
(b) The differential of the unit step

(c) The differential of the unit ramp

(d) The integral of the unit ramp

[APSPDCL-2014]

160. The step response of the system for K = 1 is



(a) Over-damped (b) Critically-damped

(c) Under-damped (d) Undamped

[APSPDCL-2014]

161. The steady state error to a unit ramp input for a unity feedback system with transfer function (G)s = $\frac{20}{s(s+2)(s^2+2s+2)}$

(a) 0 (b) 5 (c) 0.2 (d) ∞

[APSPDCL-2014]

162. Which one of the following is the most likely reason for large overshoot in a control system

(a) High gain in a system

(b) Presence of dead time delay in a system

(c) High positive correcting torque

(d) High retarding torque

[ISRO-2014]

163. The open loop transfer function of a unity feedback system is given by $G(s) = \frac{k}{s}(1 + sT)$. By what factor the gain 'k' should be multiplied so that the damping ratio is increased from 0.3 to 0.6

(a) 0.25 (b) 2.0 (c) 4.0 (d) 0.5

[HMWS-2015]

164. An unity feedback control system has open-loop transfer function $G(s) = \frac{9}{s(s+1)}$. The damping ratio ξ of the system is

(a) 1.0 (b) 0.3

(c) 0.6 (d) None of these

[TSTRANSCO-2015]

ANSWERS AND EXPLANATIONS

1. *Ans. (a)*
2. *Ans. (c)*
3. *Ans. (b)*
4. *Ans. (d)*
5. *Ans. (a)*
6. *Ans. (c)*
7. *Ans. (c)*
8. *Ans. (d)*
9. *Ans. (a)*
10. *Ans. (a)*
11. *Ans. (a)*
12. *Ans. (c)*

$$s^2 + 4s + 16 = 0$$

$$\Rightarrow \quad s^2 + 2\delta\omega_n s + \omega_n^2 = 0$$

Here, $\omega_n = 4$

13. *Ans. (b)*
14. *Ans. (c)*
15. *Ans. (b)*
16. *Ans. (b)*
17. *Ans. (d)*

$$\frac{Y(S)}{X(S)} = \frac{1}{S^2+S+1}$$

So, $\omega_n = 1$ rad/sec

18. *Ans. (a)*
19. *Ans. (a)*

$$G(s) = \frac{3}{s+15} \times \frac{15}{s+1}$$

$$G(s) = \frac{45}{(s+15)(s+1)}$$

Position error coefficient

$$K_p = \lim_{S\to 0} G(s)H(s)$$

$$= \lim_{s\to 0} \frac{45}{(s+15)(s+1)}$$

$$= \frac{45}{15} = 3$$

$$\Rightarrow \quad e_{ss} = \frac{1}{1+K_P} = \frac{1}{1+3}$$

$$= \frac{1}{4} = 25\%$$

20. *Ans. (b)*
21. *Ans. (c)*

$$\omega_n^2 = 100$$

$$\omega_n = 10$$

$$2\xi\omega_n = 20$$

$$\xi = \frac{20}{20} = 1$$

$\xi = 1$, critical damped system

22. *Ans. (c)*

For impulse input,

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

Now, $C(s) = R(s) \cdot G(s)$

i.e. $$\frac{1}{(s+2)^2} = R(s) \times \frac{1}{s+2}$$

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

Then, $r(t) = e^{-2t}u(t)$

23. *Ans. (d)*
24. *Ans. (d)*
25. *Ans. (b)*
26. *Ans. (d)*

For critically damped,

$$\xi = 1$$

Here, $\omega_n = \sqrt{k}$

$$\xi\omega_n = 2$$

$\therefore$ $k = 4$

27. *Ans. (b)*

$$C(s) = L\left[0.5e^{-t/2}\right] = \frac{1}{1+2s}$$

28. *Ans. (a)*
29. *Ans. (a)*
30. *Ans. (b)*

$$\omega_n = \sqrt{121} = 11 \text{ rad/s}, \; 2\xi\omega_n = 13.2$$

$\Rightarrow$ $\xi = 0.6$ (<1, underdamped)

$$\therefore \quad t_s = \frac{4}{\xi\omega_n} = 0.606\,s$$

161. ***Ans. (c)***

For ramp input

$$K_v = \lim_{s\to 0} s\cdot G(s)\cdot H(s)$$

$$= \lim_{s\to 0} s\cdot\frac{20}{s(s+2)(s^2+2s+2)}$$

$$= \frac{20}{4}$$

$$\therefore \quad \text{Error} = \frac{1}{K_v} = \frac{4}{20} = 0.2$$

162. ***Ans. (a)***

163. ***Ans. (a)***

Given, $G(s) = \frac{k}{s(1+sT)}$

$\therefore$ The relation between ξ, and 'k' is

$$\xi \propto \frac{1}{\sqrt{k}}$$

or $\xi^2 K = \text{Constant}$

$$\xi_2^2 k_2 = \xi_1^2 k_1$$

$$k_2 = \frac{\xi_1^2}{\xi_2^2} k_1 = \left[\frac{0.3}{0.6}\right]^2 k_1$$

$$k_2 = 0.25\ k_1$$

$\therefore$ k should be multiplied with 0.25, to change ξ value from 0.3 to 0.6

164. ***Ans. (d)***

Given, $G(s) = \frac{9}{s(s+1)}$

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

$$= 1 + \frac{9}{s(s+1)}$$

$$= s^2 + s + 9$$

$$\therefore \quad \omega_n = 3$$

$$2\zeta\omega_n = 1$$

$$\zeta = \frac{1}{6} = 0.167$$

165. ***Ans. (b)***

166. ***Ans. (a)***

Given, $\frac{C(s)}{R(s)} = \frac{1}{(1+s)}$

$$C(s) = \frac{1}{1+s}\times R(s)$$

$$= \frac{1}{1+s}\times\frac{1}{s}\left(R(s)=\frac{1}{s}\right)$$

$$C(\infty) = \lim_{s\to 0} s\frac{1}{s(1+s)} = 1$$

167. ***Ans. (b)***

168. ***Ans. (c)***

$$\frac{C(s)}{R(s)} = \frac{\frac{100}{(s+1)(s+5)}}{1+\frac{100\times 0.2}{(s+1)(s+5)}}$$

$$= \frac{100}{s^2+6s+5+20}$$

$$= \frac{100}{s^2+6s+25}$$

$$\omega_n^2 = 25$$

$$\omega_n = 5$$

$$2\xi\omega_n = 6$$

$$\xi = \frac{6}{10} = \frac{3}{5}$$

$$\omega_d = \omega_n\sqrt{1-\xi^2}$$

$$= 5\sqrt{1-\left(\frac{3}{5}\right)^2} = 5\times\frac{4}{5}$$

$$= 4 \text{ rad/sec}$$

169. ***Ans. (d)***

$$C(t) = 10e^{-5t}\sin 10t$$

$$\frac{C(s)}{R(s)} = \frac{10\times 10}{(s+5)^2+10^2}$$

$$Ae^{-at}\sin\omega t = \frac{A.\omega}{(s+a)^2+\omega^2} \qquad \left(R(s)=\frac{1}{s}\right)$$

$$\lim_{s\to 0} sC(s) = s\frac{100}{(s+5)^2+100}\times\frac{1}{s}$$

$$\Rightarrow \quad \frac{100}{125} = 0.8$$

❂❂❂

CHAPTER 3

STABILITY

OBJECTIVE QUESTIONS

1. The number of roots of the equation $2s^4 + s^3 + 2s^2 + 5s + 7 = 0$ that lie in the right half of s-plane is:
(a) 2 (b) 3 (c) 1 (d) 0

2. The loop gain GH of a closed loop system is given by the following expression $\frac{K}{s(s+2)(s+4)}$. The value of K for which the system just becomes unstable is :
(a) 10 (a) 30 (c) 48 (d) 100

3. Stability and transient response can be best determined by which of the following techniques?
(a) Root locus (b) Time response analysis
(c) Bode Plot (d) Nyquist plot
[UPPCL JE - 2018]

4. For the equation $s^3 - 4s^2 + s + 6 = 0$. The number of roots in left half of s-plane will be
(a) 0 (b) 1 (c) 2 (d) 3
[TNPSC AE - 2018]

5. The system with characteristic equation $s^3 + Ks^2 + 9s + 18 = 0$ has capability to have sustained oscillations. Then the value of K and frequency of sustained oscillation ω_n are respectively
(a) 4, 5 (b) 4, 6 (c) 2, 3 (d) 2, 5
[TNPSC AE - 2018]

6. 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) $0 < K < \frac{ab}{(a+b)}$
(c) $0 < K < ab(a+b)$ (d) $0 < K < \frac{a}{b}(a+b)$

7. In order to use the Routh's Hurwitz criterion for determining the stability of sampled data system the characteristics equation $1 + G(z)\,H(z) = 0$, should be modified by using bilinear transform of
(a) $z = r + 1$ (b) $z = r - 1$
(c) $z = \frac{r-1}{r+1}$ (d) $z = \frac{r+1}{r-1}$

8. The characteristics equation of a system is given by $3s^4 + 10s^3 + 5s^2 + 2 = 0$. This system is
(a) Stable (b) Marginal stable
(c) Unstable (d) Data is insufficient

9. A linear discrete time system has the characteristic equation, $z^3 - 0.81z = 0$, the system
(a) Is stable
(b) Is marginally stable
(c) Is unstable
(d) Stability cannot be assessed from the given information

10. For a discrete time system to be stable, all the poles of the Z-transfer functions should lie
(a) Within a circle of unit radius
(b) Outside the circle of unit radius
(c) On left-half of Z-plane
(d) On right-half of Z-plane

11. The first two rows of Routh's tabulation of a fourth-order system are

$$\begin{array}{c|ccc} s^4 & 1 & 10 & 5 \\ s^3 & 2 & 20 & \end{array}$$

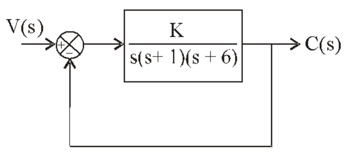
The number of roots of the system lying on the right half of s-plane is-
(a) 0 (b) 2 (c) 3 (d) 4

12. The first element of each of the rows of a Routh-Hurwitz stability test showed the sign as follows-

Rows	***1***	***2***	***3***	***4***	***5***	***6***	***7***
Signs	+	–	+	+	+	–	+

The number of roots of the system lying in the right half of s-plane is -
(a) 2 (b) 3 (c) 4 (d) 5

13. The feedback system shown below is stable for all values of K given by



(a) $K > 0$ (b) $K < 0$
(c) $0 < K < 42$ (d) $0 < K < 60$

14. The system with characteristic equation $s^4 + 3s^3 + 6s^2 + 9s + 12 = 0$

(a) Stable (b) Unstable

(c) Marginally stable (d) Marginally unstable

15. A system is said to be BIBO stable if Bounded Inputs always yield Bounded outputs, by this criterion

(a) An integrator is stable but a differentiator is not

(b) A differentiator is stable but an integrator is not

(c) Neither the differentiator nor the integrator is stable

(d) Both the differentiator and integrator are stable

16. The root locus branches of the system with characteristic equation

$$1 + \frac{-50}{s^5 + 2s^4 + 24s^3 + 48s^2 - 25s} = 0$$

Cross the jω-axis at

(a) $\pm j3$ (b) $\pm j5$ (c) $\pm j4$ (d) $\pm j\sqrt{5}$

17. The number of roots of the equation $s^6 - 2s^5 - s^4 - 2s^2 + 8s + 8 = 0$ in the right half plane is

(a) Two (b) Zero (c) Three (d) Four

18. The closed loop transfer function of a system is given by $G(s) = 1/[(s+2)(s^2+4)]$. The system is

(a) Completely unstable (b) Completely stable

(c) Marginally stable (d) Conditionally stable

19. The characteristic equation for a closed loop system with a forward gain K is $s^4 + 4s^3 + 8s^2 + 6s + K = 0$. The critical gain value K_c for stability should not exceed

(a) 3.25 (b) 9.75 (c) 13.0 (d) 23.3

20. For a linear system having the characteristic equation $s^4 + s^3 + 2s^2 + 2s + 3 = 0$ roots in the right-half of s-plane is

(a) 4 (b) 3 (c) 2 (d) 1

21. The performance specifications for a unity feedback control system having an open-loop transfer function $G(s) = \frac{K}{s(s+1)(s+2)}$ are

1. Velocity error coefficient $K_v > 10$
2. Stable closed-loop operation.

The value of K, satisfying the above specifications, is

(a) K < 6 (b) 6 (c) K > 10 (d) None

22. If the characteristic equation of a system is $s^3 + 14s^2 + 56s + K = 0$ then it will be stable only if

(a) 0 < K < 784 (b) 1 < K < 64

(c) 10 > K > 660 (d) 4 < K < 784

23. Consider the following statements-

The roots of the characteristic equation of a control system lead to its instability if they lie

1. On the imaginary axis of the s-plane.
2. On the negative real axis of the s-plane.
3. In the right-half of the s-plane.

Which of the above are correct?

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

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

24. Consider the equations $2s^4 + 3s^2 + 5s + 10 = 0$

The number of roots of this equation lie in the right-half of s-plane is

(a) One (b) Two (c) Three (d) Four

25. The unit step response of the system is $1 - e^{-t}(1 + t)$. The system is

(a) Unstable

(b) Stable

(c) Critically stable

(d) Stability depends upon the input

[TNPSC AE - 2018]

26. The instrument used for plotting the root locus is called

(a) Slide rule (b) Spirule (c) Synchro (d) Selsyn

27. The root locus plot of the system having the loop transfer function $G(s).H(s) = \frac{k}{s(s+4)(s^2+4s+5)}$ has

(a) No breakaway point

(b) Three real breakaway point

(c) Only one breakaway point

(d) One real and two complex breakaway points

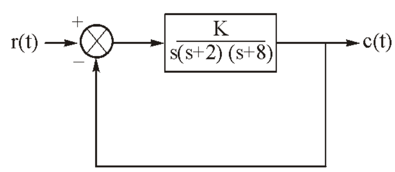
28. Consider the loop transfer function

$$G(s).H(s) = \frac{K(s+6)}{(s+3)(s+5)}$$

In the root-locus diagram, the centroid will be located at

(a) –4 (b) –1 (c) –2 (d) –3

29. By a suitable choice of the scalar parameter 'K' the system shown in figure given below can be made to oscillate continuously at a frequency of



(a) 1 rad/sec (b) 2 rad/sec (c) 4 rad/sec (d) 8 rad/sec

30. Which one of the following techniques is utilized to determine the actual point at which the root locus crosses the imaginary axis ?

(a) Nyquist technique (b) Routh-Hurwitz criterion

(c) Nichol's criterion (d) Bode technique

82. The third order polynomial system

$P(s) = a_1s^3 + a_2S^2 + a_3\ s + a_o$ is stable, if

(a) $a_2a_0 > a_1a_3$ (b) $a_2a_3 < a_0a_1$

(c) $a_2a_0 < a_1a_3$ (d) $a_2a_3 > a_0a_1$

[TSSPDCL-2015]

83. The range of k for which the system with the following characteristic equation is stable, is

$s^3 + ks^2 + (k + 2)\ s + 3 = 0$:

(a) $k > 0$ (b) $k > 1$ (c) $-3 < k < 1$ (d) $1 < k < 3$

[TSNPDCL-15]

84. A transfer function has a second order denominator and constant gain in the numerator

(a) The system has two zeros at the origin

(b) The system has two finite zeros

(c) The system has two zeros at infinity

(d) The system has one zero at infinity

[APGENCO-2012]

85. A unity feed-back system has open-loop transfer function $GH(s) = \frac{K}{s(s+4)(s+16)}$. It's root locus plot intersects the Jω axis at

(a) + j2

(b) ± j4

(c) ± j8

(d) Does not intersect the jw axis

[APGENCO-2012]

86. The breakaway point of the root from the real axis for a closed loop system with loop gain GH(s) H(s) = $\frac{K(s+10)}{(s+2)(s+5)}$ lies

(a) Between –10 and $-\infty$

(b) At $-\infty$

(c) Between –2 and origin

(d) Between –2 and –5

[APSPDCL-2012]

87. There are three zeros and two poles of GH(s). There will be

(a) Three root loci

(b) Two root loci

(c) Five root loci

(d) One root loci

[APTRANSCO-2012]

88. A unity-feedback system has forward-path transfer function $G(s) = \frac{K}{s(s+4)(s+5)}$. The break-away point lies between–

(a) –4 and $-\infty$

(b) –4 and –5

(c) 0 and –5

(d) 0 and –4

[APSPDCL-2014]

❑❑❑

ANSWERS AND EXPLANATIONS

1. ***Ans. (a)***

By Routh Array

s^4	2	2	7
s^3	1	5	0
s^2	–8	7	0
s^1	$\frac{-47}{-8}$	0	
s^0	7		

Two sign change

2. ***Ans. (c)***

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

$$s^3 + 6s^2 + 8s + K = 0$$

By Routh Array

s^3	1	8
s^2	6	K
s^1	$\frac{48-K}{6}$	
s^0	K	
for	K = 48	

System is marginal stable because all complete odd row is zero.

3. ***Ans. (a)***

4. ***Ans. (b)***

s^3	1	1
s^2	–4	6
s^1	2.5	
s^0	6	

two sign change in first column hence 2 roots in right half and 1 root in left half.

5. ***Ans. (c)***

s^3	1	9
s^2	K	18
s^1	$\frac{9K-18}{K}$	
s^0	18	

So, for oscillation: $\frac{9K-18}{K} = 0$

$$9K = 18$$

$$K = 2$$

A.E $\Rightarrow$ $2s^2 + 18 = 0$

$$2s^2 = -18$$

$$s^2 = -9$$

$$s = \pm 3\,j$$

6. ***Ans. (c)***

The characteristic equation is

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

$$\Rightarrow \quad 1 + \frac{k}{s(s+a)(s+b)} = 0$$

$$\Rightarrow \quad s(s+a)(s+b) + k = 0$$

$$\Rightarrow \quad s^3 + s^2(a+b) + abs + k = 0$$

For stability by Routh's array

s^3	1	ab
s^2	a + b	k
s^1	$\frac{(a+b)ab-k}{a+b}$	
s^0	k	

$\therefore$ $k > 0$ and $\frac{(a+b)ab-k}{a+b} > 0$

$\Rightarrow$ $(a + b)ab > k$

$\therefore$ for stability $0 < k < (a + b)\,ab$.

7. ***Ans. (d)***

8. ***Ans. (c)***

9. ***Ans. (a)***

$$z^3 - 0.81z = 0$$

or, $z\left(z^2 - 0.9^2\right) = 0$

Hence, z = 0, 0.9, –0.9 roots lie inside the circle, so, system stable.

10. ***Ans. (a)***

11. ***Ans. (b)***

12. ***Ans. (c)***

13. ***Ans. (c)***

14. ***Ans. (b)***

15. ***Ans. (c)***

16. ***Ans. (b)***

17. ***Ans. (a)***

18. ***Ans. (c)***

19. ***Ans. (b)***

20. ***Ans. (c)***

21. ***Ans. (d)***

76. ***Ans. (b)***

77. ***Ans. (b)***

From R-H criteria.

$$\begin{array}{c|ccc} S^4 & 1 & 1 & 1 \\ S^3 & 4 & 8 & \\ S^2 & -1 & 1 & \\ S^1 & 12 & & \\ S^0 & 1 & & \end{array}$$

Two sign changes in first column of RH table hence two roots lie in the right side of the s-plane.

78. ***Ans. (c)***

Given that,

$$\begin{array}{ccc} s^3 & 1 & 1 \\ s^2 & 2 & 2 \\ s^1 & 0 & 0 \\ s^o & 1 & \end{array}$$

$$A.E = 2s^2 + 2$$
$$= s^2 + 1 \Rightarrow 0$$
$$s = \pm j$$

There are total '3' roots as order of the equation is '3'. Auxialary equation roots are $\pm j$ lies on imaginary axis & one root in the left half s-plane, as there is no sign change in the RH first column.

79. ***Ans. (c)***

Given characteristic equation

$s^4 + 2s^3 + 6s^2 + 8s + 8 = 0$

from RH criteria.

$$\begin{array}{c|ccc} S^4 & 1 & 6 & 8 \\ S^3 & 2 & 8 & \\ S^2 & 2 & 8 & \\ S^1 & & & \\ S^0 & & & \end{array}$$

$$A.E = 2s^2 + 8 = 0$$
$$s^2 = -4$$
$$s = \pm j2$$

80. ***Ans. (b)***

81. ***Ans. (b)***

$$\begin{array}{cccc} s^4 & 1 & 10 & 5 \\ s^3 & 2 & 20 & \\ s^2 & O_{(\zeta)} & 5 & \\ s^2 & \frac{20\zeta-10}{\zeta}(-Ve) & & \\ s^o & 5 & & \end{array}$$

$\zeta \cong 0$, two sign changes in the first column of RH table so, the number of roots of the system lying on the right half of s-plane is '2'

82. ***Ans. (d)***

R-H table

$$\begin{array}{c|cc} S^3 & a_1 & a_3 \\ S^2 & a_2 & a_0 \\ S^1 & \frac{a_2a_3 - a_0a_1}{a_2} & 0 \\ S^0 & a_0 & \end{array}$$

For stability, all the elements in the first column of Routh table should not have sign changes.

$$a_1 > 0$$
$$a_2 > 0$$
$$a_0 > 0$$
$$\frac{a_2a_3 - a_0a_1}{a_2} > 0$$
$$a_2a_3 > a_0a_1$$

So option (d) is the correct choice.

83. ***Ans. (b)***

Given characteristic equation

$s^3 + Ks^2 + (K + 2)s + 3 = 0$ from R-H criteria.

$$\begin{array}{c|cc} S^3 & 1 & (K+2) \\ S^2 & K & 3 \\ S^1 & \frac{K(K+2)-3}{K} & \\ S^0 & 3 & \end{array}$$

For stability, first column of R-H table should be +ve.

$$K > 0$$

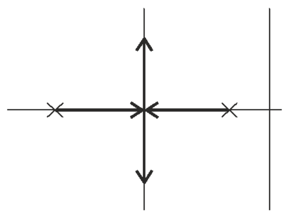
and $\dfrac{K(K+2)-3}{K} > 0$

$$(K + 3)(K - 1) > 0$$
$$K + 3 > 0$$
$$K > 1$$
$$\therefore \quad K > 1$$

84. ***Ans. (c)***

Given Transfer Function $\dfrac{K}{(s+a)(s+b)}$

Pole zero diagram



The system has two zeros at infinity