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ESE- 2018 (Prelims) - Offline Test Series-Test-13

ELECTRICAL ENGINEERING

SUBJECT: Control Systems, Basic Electronics Engineering and Analog & Digital Electronics

SOLUTIONS

01. Ans: (a)

Sol: Binary zero has unique representation in 2's complement representation. So this representation is widely used.

02. Ans: (b)

03. Ans: (c)

04. Ans: (c)

Sol: The given state diagram detects 01,001,001,00001,……..

05. Ans: (d)

06. Ans: (a)

07. Ans: (c)

08. Ans: (b)

Sol: (a), (c) are not valid instructions .

SBI 98H $\Rightarrow$ subtract immediate with borrow

SUI 98H $\Rightarrow$ subtract immediate (no borrow)

09. Ans: (a)

Sol: XTHL exchanges the contents of L register with the contents of memory location specified by the stack, pointer the contents of the H register are exchanged with the contents of stack pointer +1

10. Ans: (a)

11. Ans: (a)

12. Ans: (d)

Sol: All are the properties of EEPROM. EEPROM'S are fabricated using NMOS /CMOS, where as PROMS and ROMS use bipolar TTL. Hence EEPROM'S have longer delays.

13. Ans: (c)

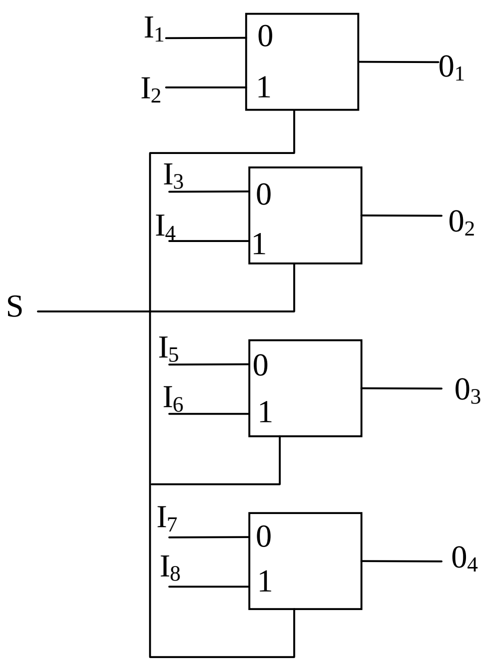
Sol: 64K ⇒ $2^{16} = 2^8 \times 2^8$ (Coincident decoding)

$= 256 \times 256$

Each decoder is 8×256 side

14. Ans: (a)

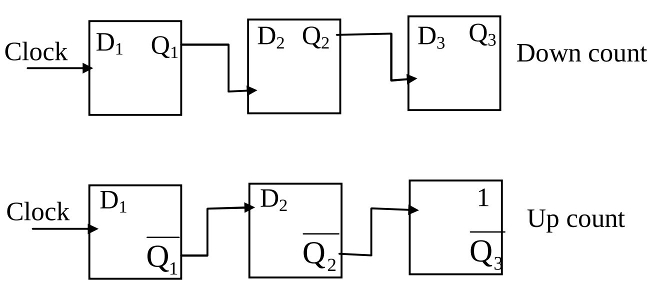
Sol:



Total 9 input 4 outputs so ROM side $= 2^9 \times 4$ ($2^{\text{no of inputs}}$ X no of outputs)

15. Ans: (c)

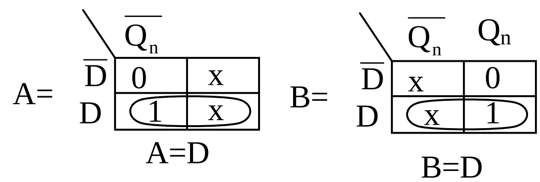
Sol: both statements are correct

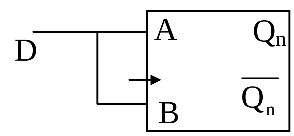


16. Ans: (a)

Sol:

D	Q_m	Q_n	A	B
0	0	0	0	X
0	1	0	X	0
1	0	1	1	X
1	1	1	X	1



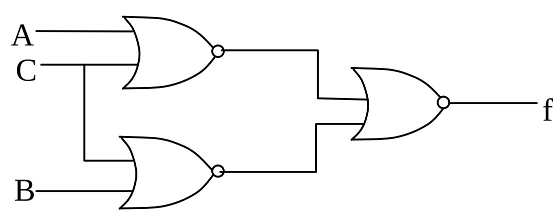


17. Ans: (b)

Sol: f = AB+C

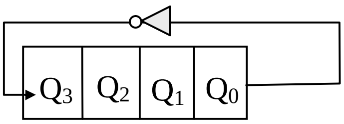
f = (A+C) (B+C)

To implement using NOR gates, go for POS form.



18. Ans: (d)

Sol:

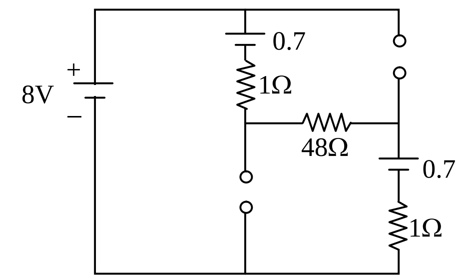


Clock	0	0	0	0
1	1	0	0	0 (8)
2	1	1	0	0 (12)
3	1	1	1	0 (14)
4	1	1	1	1 (15)
5	0	1	1	1 (7)
6	0	0	1	1 (3)
7	0	0	0	1 (1)
8	0	0	0	0 (0)

19. Ans: (b)

20. Ans: (c)

Sol:



By KVL

$8 - 0.7 - i - 48i - 0.7 - i = 0$

$8 - 1.4 = 50i$

$i = \frac{6.6}{50}$

$i = 0.132$

$i = 132$ mA

21. Ans: (a)

22. Ans: (d)

Sol: $(\text{gain})_{dB} = 10\log_{10}^{26/13}$

$= 10\log_{10}^{2}$

$= 3\text{dB}$

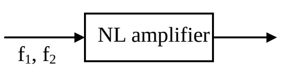
23. Ans: (a)

Sol: $C_1 = 1\text{nf}$, $C_2 = 10\text{nf}$ & $L = 0.1\mu H$

$$|A| \ge \frac{C_2}{C_1} = \frac{10\text{nf}}{1\text{nf}} = 10 .$$

24. Ans: (d)

Sol:



The output frequency component

$= nf_1 \pm mf_2$

25. Ans: (d)

Sol: $$\frac{dA_f}{A_f} = \frac{dA}{A}\left(\frac{1}{1+A\beta_f}\right)$$

$$\frac{0.1}{100} = \frac{10}{1000}\left[\frac{1}{1+1000.\beta_f}\right]$$

$1+1000.\beta_f = 10$

$$\beta_f = \frac{9}{1000}.$$

26. Ans: (b)

Sol: gain = 30 dB

$$30\text{dB} = 10\log_{10}^{\left(\frac{P_o}{Pi}\right)}$$

$$3 = \log_{10}^{\left(\frac{P_o}{Pi}\right)}$$

$$\frac{Po}{Pi} = 10^3$$

$P_0 = 10^3 \times P_i$

$P_0 = 10^3 \times 1 \times 10^{-6}$

$P_0 = 10^{-3}$ W

$P_0 = 1$mW

$P_{0\ \text{in dB}} = 10\log_{10}^{1} = 0\text{dBm}$

27. Ans: (d)

28. Ans: (c)

Sol: Ripple factor in LC filter = $\frac{\sqrt{2}}{3}\frac{1}{4\omega^2 CL}$

For frequency of 50Hz

ripple factor $(\gamma) = \frac{1.194}{LC}$

So, it remains constant.

29. Ans: (a)

30. Ans: (d)

31. Ans: (d)

Sol: For an ideal feedback circuit to have sustained oscillation the loop gain is 1. For practical feedback circuit the loop gain varies from 1.01 to 1.05 (slightly greater than one) for sustained oscillation.

32. Ans: (b)

Sol: $R_H = \dfrac{p\mu_p^2 - n\mu_n^2}{(n\mu_n + p\mu_p)^2 q}$

If $p\mu_p^2 > n\mu_n^2$, then R_H is positive

33. Ans: (d)

Sol: Zener diode: can be used as Voltage stabilizer & Voltage reference.

Tunnel diode: High speed switching

: Micro wave switching

: Oscillator

: Negative Resistance region

Gunn diode : micro wave oscillator

: Conductive negative region

: Zero junction (junction less)

PIN diode: High speed switching

34. Ans: (b)

35. Ans: (d)

Sol: Fabrication of a buried layer n-p-n transistor, the processes involved are:

1. Lithography (Lithography)
2. Oxidation
3. Epitaxy
4. Diffusion

36. Ans: (a)

37. Ans: (c)

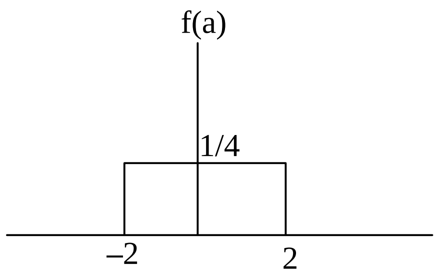
38. Ans: (c)

39. Ans: (a)

Sol: given $x(t) = a\,e^{j\omega t}$

Auto correlation function $R(t_1,t_2) = E\,[x(t_1)\,x^*(t_2)]$

Given random variable uniformly distributed between –2 to 2



$$R_x(t_1,t_2) = E\left[ae^{j\omega t_1}.ae^{-j\omega t_2}\right]$$

$$= E\left(a^2\right)e^{j\omega(t_1-t_2)}$$

$$= \left[\int_{-2}^{2} a^2 f(a)da\right]e^{j\omega(t_1-t_2)}$$

$$= \frac{1}{4}\left[a^3/3\right]_{-2}^{2} e^{j\omega(t_1-t_2)}$$

$$= \frac{4}{3}e^{j\omega(t_1-t_2)}$$

40. Ans: (d)

Sol: $C = B\log_2\left(1+\frac{S}{N}\right)$

$= 4k\log_2(1+7) = 4\,k\log_2 2^3 = 12\,k$

Bandwidth is reduced to 25% = $\frac{25}{100}\times 4 = 1k$

$$C = B\log_2\left(1+\frac{S}{N}\right)$$

$$12\,k = 1k\log_2\left(1+\frac{S}{N}\right)$$

$$\frac{S}{N} = 4095$$

41. Ans: (d)

Sol: given continuous signal $x(t) = 8\cos 200\pi t$

Discrete time signal $x(nT_s) = 8\cos 200\pi nT_s$

$$= 8\cos\frac{200\pi n}{150}$$

$$\left[\because T_s = \frac{1}{f_s} = \frac{1}{150}\right]$$

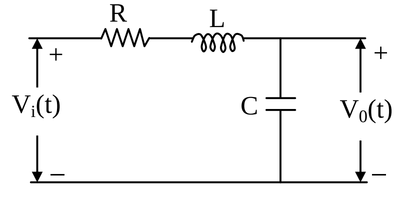
$$= 8\cos\frac{4\pi n}{3}$$

$$= 8\cos\left(2\pi - \frac{2\pi}{3}\right)n$$

$$= 8\cos\left(\frac{2\pi n}{3}\right)$$

42. Ans: (d)

Sol: Given circuit is shown in below figure.



$$\frac{V_0(s)}{V_i(s)} = \frac{\frac{1}{Cs}}{R + Ls + \frac{1}{Cs}} = \frac{1}{RCs + LCs^2 + 1}$$

CE is $LCs^2 + RCs + 1 = 0$

$\Rightarrow s^2 + \frac{R}{L}s + \frac{1}{LC} = 0$ …… (1)

We know for standard second order characteristic equation

$s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$ …… (2)

$\zeta = 0$ for undamped system

$0 < \zeta < 1$ for under damped system

For system poles to be on real axis, $\zeta > 1$

For system poles to be on complex plane, $\zeta < 1$.

Compare (1) , (2) we get

$$\omega_n = \frac{1}{\sqrt{LC}}, \zeta = \frac{R}{2}\sqrt{\frac{C}{L}}$$

For R $= 0 \Rightarrow \zeta = 0$

For R = 1Ω, L = 1H, C = 1F, $\zeta = \frac{1}{2} < 1$

For $\zeta > 1 \Rightarrow R > 2\sqrt{\frac{L}{C}}$

For $\zeta < 1 \Rightarrow R < 2\sqrt{\frac{L}{C}}$

From all above conclusions

Statements 1, 2, 3 are correct

43. Ans: (c)

Sol: C.L.T.F. = $\dfrac{\frac{s^2}{2s+1}}{1 + \frac{s^2}{2s+1}} = \dfrac{s^2}{s^2 + 2s + 1}$

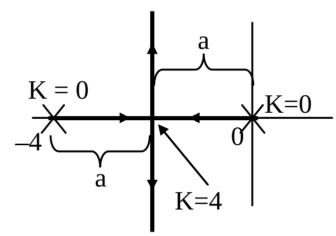
C.E is $s^2+2s+1 = 0 \Rightarrow s = -1, -1 \Rightarrow$ system is critically damped.

Order of the system is two

$\therefore$ Both statements are correct.

44. Ans: (d)

Sol: Root Locus plot is as shown below



'K' at break point = (a) (a) = a^2

$\Rightarrow a^2 = 4$

$\Rightarrow a = 2$

$\therefore$ s = –2

System is over damped for poles on real axis i.e $0 < k < 4$ only.

As two branches are there, so it is second order system.

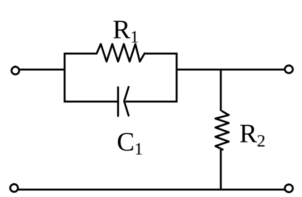
System to be under damped, poles should be on complex plane.

$\therefore 4 < k < \infty$.

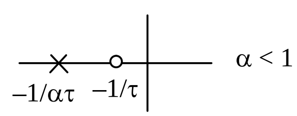
So Statements 1, 4 are true.

45. Ans: (b)

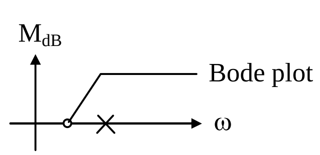
Sol:

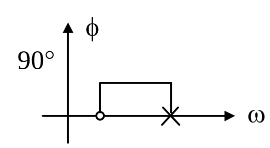


$$TF_{lead} = \frac{\tau s + 1}{\alpha \tau s + 1} \quad \alpha < 1$$



It adds a dominate zero





- It adds positive phase angle
- The system is always stable as the pole is in LHP
- Its magnitude will vary with frequency as shown in bode plot

∴ 1, 2, 3 are correct

46. Ans: (d)

Sol: All the statements are true. Therefore correct option is (d).

47. Ans: (a)

Sol: $k = -(s(s+4)(s^2+4s+8))$

$k = -(s^4+8s^3+24s^2+32s)$

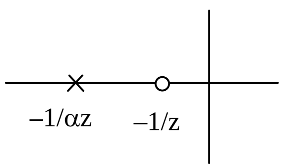
$$\frac{dk}{ds} = -\left(4s^3+24s^2+48s+32\right) = 0$$

$s = -2, -2, -2$

$s = -2$ is a break point.

48. Ans: (a)

Sol: The compensator is lead

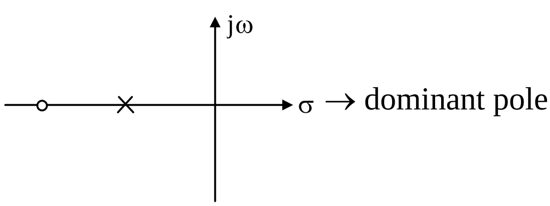


$\omega_n = \sqrt{1\times 10} = \sqrt{10}$ rad/sec

The maximum phase angle is obtained at $\sqrt{10}$ rad/sec

49. Ans: (b)

Sol: Lag compensator, pole-zero diagram



Lag compensator decreases, ω_{gc}, bandwidth.

50. Ans: (c)

Sol: $CLTF = \frac{C(s)}{R(s)} = \frac{KG}{1+KGH}$

$$S_K^{CLTF} = \frac{1}{1+KGH}$$

$$S_G^{CLTF} = \frac{1}{1+KGH}$$

$$S_H^{CLTF} = \frac{-KGH}{1+KGH}$$

If loop gain is high

$KGH \to \infty$

y $S_K^{CLTF} = 0, \quad S_G^{CLTF} = 0, \quad S_H^{CLTF} = -1$

51. Ans: (d)

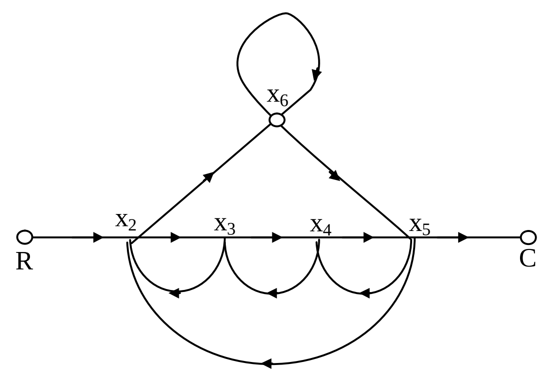
Sol: $M_p = e^{-\pi\zeta/\sqrt{1-\zeta^2}}$

$\zeta = \cos\theta$

$$= e^{-\pi\frac{\cos\theta}{\sin\theta}} = e^{-\pi\cot\theta}$$

52. Ans: (b)

Sol: Given signal flow graph is as shown below

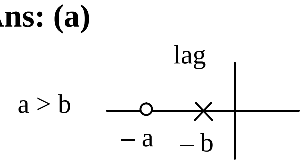


Forward paths are

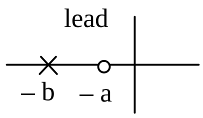
$$\Rightarrow \left.\begin{matrix}(R,\ x_2,\ x_3,\ x_4, x_5, C)\\ (R,\ x_2,\ x_6,\ x_5,\ C)\end{matrix}\right\}\text{two forward paths}$$

53. Ans: (a)

Sol:



a < b

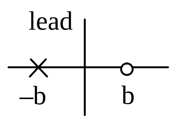


b = 0

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

$\therefore$ PI controller

a = – b $\quad \frac{s-b}{s+b}$



All pass system

Therefore 1,2,3,4 are correct

54. Ans: (b)

Sol: TF from root locus is $= \frac{k}{s(s+a)(s+b)}$,

where a, b are +ve

- The system is 3^{rd} order
- It has break point between (0, –a)
- The system will be marginally stable for some k

There fore only 1, 2 are correct

55. Ans: (a)

Sol: Forward path going are H_1G_1, $H_2G_1G_2$

- Loop gains are $-H_1G_1$, $-H_2G_1G_2$
- Both loops are touching loops so 3 is incorrect

56. Ans: (b)

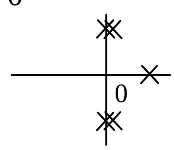
Sol: From RH criteria

s^5	1	2	1	
s^4	–1	–2	–1	$\rightarrow AE_1$
s^3	(0) –4	(0) –4	0	$\rightarrow$ Row of zero
s^2	–1	–1	0	$\rightarrow AE_2$
s^1	(0) –2	0		$\rightarrow$ Row of zero
s^0	–1			

No sign change below AE so all four roots of AE equation lies on jω axis.

$AE = -s^4 - 2s^2 - 1 = 0$

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



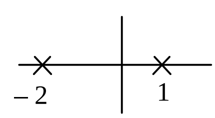
0 Poles $\rightarrow$ LHP

4 Poles $\rightarrow$ jω –axis

1 Pole $\rightarrow$ RHP (one sign change on first column)

57. Ans: (c)

Sol: $G(s) = \frac{10}{(s-1)(s+2)}$



So, G(s) is unstable

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)} = \frac{10}{(s-1)(s+2)+10}$$

$$= \frac{10}{s^2 - 2 + 2s - s + 10}$$

$$= \frac{10}{s^2 + s + 8}$$

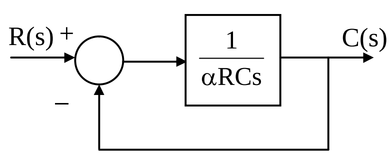
C.E $= s^2 + s + 8 = 0$

s^2	1	8
s^1	1	0
s^0	8	

There is no sign changes in the first column of RH criteria table. Therefore the closed loop $\frac{C(s)}{R(s)}$ is stable

58. Ans: (a)

Sol:



$$\frac{V_0(s)}{V_I(s)} = \frac{1}{\alpha RCs + 1}$$

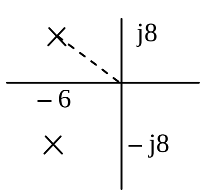
$$k_v = \underset{s\to 0}{Lt}\ s.G(s) = \underset{s\to 0}{Lt}\ s\frac{1}{\alpha RCs} = \frac{1}{\alpha RC}$$

$$e_{ss} = \frac{1}{k_v} = \alpha RC$$

59. Ans: (d)

Sol: Compare $C(t) = ke^{-\alpha t}\sin\omega_d t\ u(t)$

We get $\alpha = 6$, $\omega_d = 8$



The radial distance $\omega_n = 10\text{rad/sec}$

$$\cos\theta = \zeta = \frac{6}{10} = 0.6$$

$\omega_d = 8$ rad /sec

60. Ans: (c)

61. Ans: (c)

Sol:. $e_{ss} = \frac{A}{1+k_p}$ for step input

$e_{ss} = \frac{A}{k_v}$ for ramp input

$e_{ss} = \frac{A}{k_a}$ for parabolic input

Where

$k_p = \underset{s\to 0}{Lt}\ G(s), k_v = \underset{s\to 0}{Lt}\ sG(s), k_a = \underset{s\to 0}{Lt}\ s^2G(s)$

For type 0- system, k_p = finite $\Rightarrow e_{ss}$ is finite

For type 2-system, $k_v = \infty \Rightarrow e_{ss} = 0$

k_a = finite $\Rightarrow e_{ss}$ = finite

For type-1 system, $k_p = \infty \Rightarrow e_{ss} = 0$

$\therefore$ statements 1,2 are correct

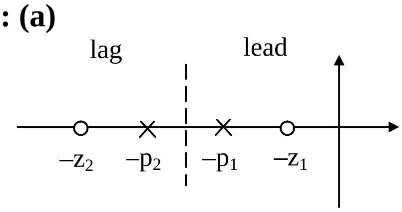
62. Ans: (d)

Sol: System is under damped when poles are on complex plane.

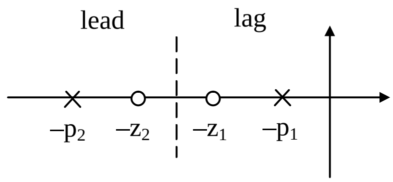
$\therefore$ For $0.7 < k < 14$ system is under damped.

63. Ans: (a)

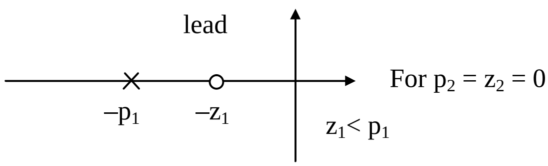
Sol:

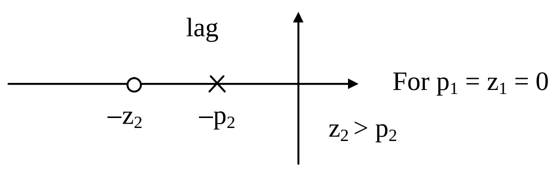


$z_1 < p_1 < p_2 < z_2$



$p_1 < z_1 < z_2 < p_2$



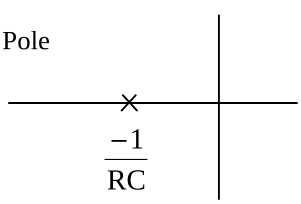


So, 1, 2, 3 correct.

64. Ans: (b)

Sol: The circuit is 1st order RC network

$$TF = \frac{1}{RCs+1}$$



→ For whatever RC value the pole location is on real axis

∴ It will never produce oscillations.

→ Since pole of the system is on real axis and the system has only one pole.

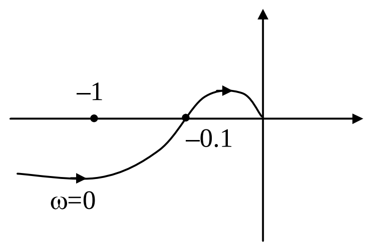
It will produce –ve phase angle for sin input,

1, 3, 4 are correct.

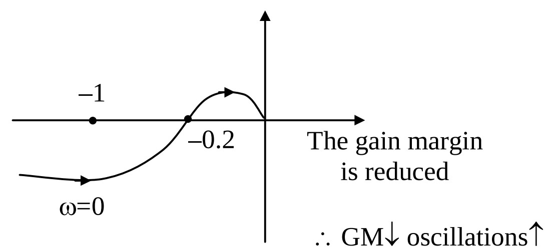
65. Ans: (c)

Sol: The plot is given for k = 1

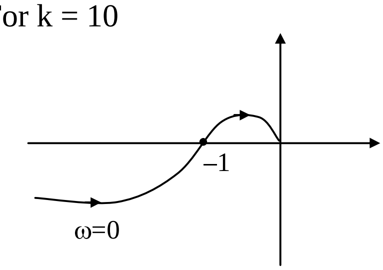
For k = 1



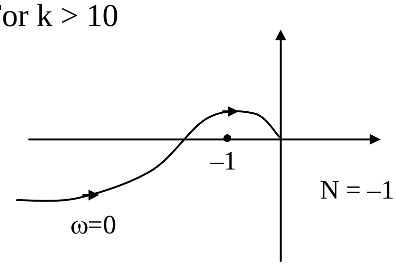
For k = 2



For k = 10



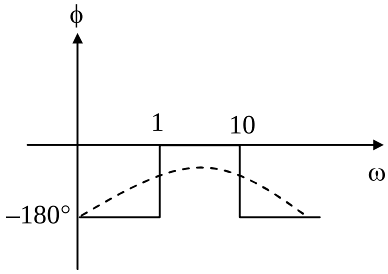
For k > 10



(–1, 0) is enclosed therefore system is unstable.

66. Ans: (b)

Sol:

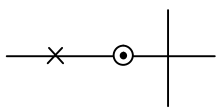


The phase plot of the system $\omega = 10, -90°$

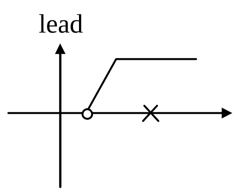
67. Ans: (a)

Sol: Controller **Lead**

Pole-zero plot:



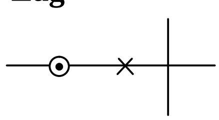
Plot:



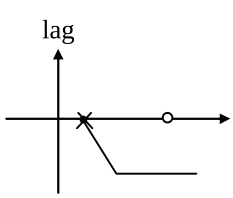
Filter: HPF

Controller **Lag**

Pole-zero plot:



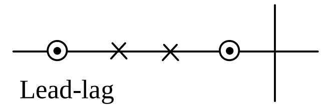
Plot:



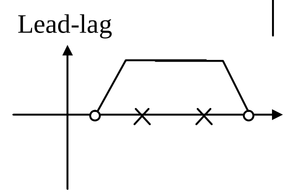
Filter: LPF

Controller **Lead-Lag**

Pole-zero plot:



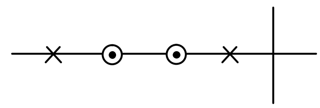
Plot:



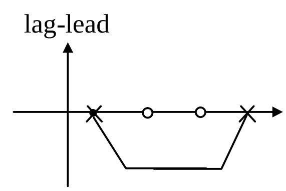
Filter: BPF

Controller **Lag-Lead**

Pole-zero plot:



Plot:



Filter: BRF

68. Ans: (a)

69. Ans: (a)

Sol: C.E = $|sI - A| = 0$

C.E = $(s^2 + 2s + 1)(s + 3) = 0$

$= s^3 + 5s^2 + 7s + 3 = 0$

70. Ans: (a)

71. Ans: (a)

Sol: Slew Rate (SR) = $\left.\frac{dV_0}{dt}\right|_{max}$

In ideal Op – Amp Slew Rate is Very high

72. Ans: (a)

73. Ans: (c)

74. Ans: (d)

Sol: Ex: Open loop system transfer function is

$G(s) = \frac{10}{s-2}$ ……. (1),

System is unstable

H(s) = 1, closed loop transfer function is

$\frac{C(s)}{R(s)} = \frac{10}{s+8}$ …….. (2), system is stable.

By observing above two equations,

$\therefore$ If open loop system is unstable, closed loop system need not be unstable

75. Ans: (d)

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1 IN NAVEEN
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2 CE PUNEET KHANNA
2 IN RAHUL MAHATO
2 IN SHUBHAM BANSAL
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3 EC KARUN
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3 ME PRADIP BOBADE
3 CS RAVI SHANKAR
3 CE ANKUR TRIPATHI
4 EC SONU SHARMA
4 EE SARFRAJ NAWAZ
4 CE CHIRAG MITTAL
4 ME GAUSH ALAM
4 IN MONTI
4 PI Sanghamitra Adhikari
5 IN VRAJESH SHAH
5 PI ANKIT TIWARI
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6 IN RAMESH KAMULLA
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8 ME DIVYANSHU JHA
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10 EC AMIT RAWAT
10 ME
10 EE SURAJ DASH
10 IN
10 IN
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EE
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