

1. Ans. B.

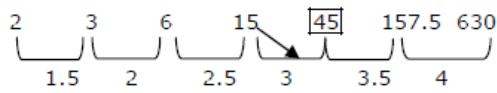
2. Ans. B.

3. Ans. C.

4. Ans. B.

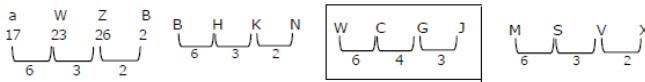
For a very large number of throws, the frequency should be same for unbiased throw. As it not same, then the die is biased.

5. Ans. B.



$\frac{\text{2nd number}}{\text{1st number}}$ is in increasing order as shown Above

6. Ans. C.



7. Ans. D.

8. Ans. D.

Eight consecutive odd number = 656

a-6, a-1, a-2, a, a+2, a+4, a+6

a+8=656

a=81

Smallest m=75 ... (1)

Average consecutive even numbers

$$\Rightarrow \frac{a-2+a+a+2+a+4}{4} = 87$$

$$\Rightarrow a=86$$

Second largest number = 88

$$1+2=163$$

9. Ans. D.

Item:2

$$\frac{20}{100} \times 250 \times 10^7$$

$$0.5 \times 10^4 = 5 \times 10^3 \boxed{1}=2$$

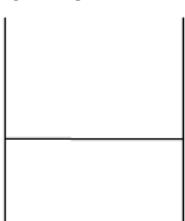
Item:3

$$\frac{23 \times 250 \times 10^7}{19 \times 500 \times 10^3}$$

Item:3

$$\frac{19}{16} = 1.18 = \text{Item 6} \quad \frac{20}{12} = \frac{5}{3} = 1.6 \Rightarrow \boxed{1.6 = \text{Item 5}}$$

10. Ans. A.



$V_{\text{half}} = 30(\text{s})$ drawing rate = s

Total volume = 60 S tank

$$(s^1)(10) - (s)10 = 30s$$

$$s^1(s) - s = 3s$$

$$s1 = 4s$$

$s^1 = 4$ drawing rate

11. Ans. D.

$$|AB| = |A| \cdot |B| = (5) \cdot (40) = 200$$

12. Ans. C.

$$X = 1, 3, 5, \dots, 99 \Rightarrow n = 50$$

(number of observations)

$$\therefore E(x) = \frac{1}{n} \sum_{i=1}^n x_i = \frac{1}{50} [1 + 3 + 5 + \dots + 99]$$

$$= \frac{1}{50} (50)^2 = 50$$

13. Ans. A.

$$f'(t) = e^{-t} + 4e^{-2t} = 0$$

$$\Rightarrow e^{-t} [4e^{-t} - 1] \Rightarrow e^{-t} = \frac{1}{4} \Rightarrow t = \log_e^4$$

and $f'(t) < 0$ at $t = \log_e^4$

14. Ans. C.

$$\lim_{x \rightarrow \infty} \left(1 + \frac{1}{X} \right)^x = e \text{ (standard limit)}$$

15. Ans. A.

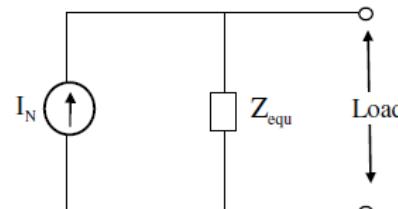
2 For equal roots, Discriminant $B^2 - 4AC = 0$

$$\Rightarrow 4\alpha^2 - 4 = 0$$

$$\Rightarrow \alpha = \pm 1$$

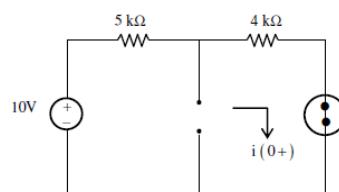
16. Ans. D.

Norton's theorem



17. Ans. B.

For $t = 0+$



For $t = 0 +$

$$i(o+) = \frac{10}{9K} \Rightarrow 1.11mA$$

$$i(o+) = 1.2mA$$

18. Ans. D.

$$N_D = 2.25 \times 10^{15} \text{ Atom/cm}^3$$

$$h_i = 1.5 \times 10^{10} / \text{cm}^3$$

Since complete ionization taken place,

$$h_0 = N_D = 2.25 \times 10^{15} / \text{cm}^3$$

$$P_0 = \frac{n_i^2}{n_0} = \frac{(1.5 \times 10^{10})^2}{2.25 \times 10^{15}} = 1 \times 10^5 / \text{cm}^3$$

19. Ans. B.

20. Ans. D.

21. Ans. B.

By opening the output feedback signal becomes zero. Hence it is current sampling. As the feedback signal v_f is subtracted from the signal same v_s it is series mixing.

22. Ans. B.

A_d does not depend on R_E

A_{cm} decreases as R_E is increased

$$\therefore CMRR = \frac{A_d}{A_{cm}} = \text{Increases}$$

23. Ans. D.

Overall voltage gain,

$$A_v = \frac{V_o}{V_i} = A_{v_1} A_{v_2} \left[\frac{Z_{i_2}}{Z_{i_2} + Z_{0_1}} \right] \left[\frac{R_L}{R_L + Z_{0_2}} \right]$$

$$= 10 \times 5 \left[\frac{5k}{5k + 1k} \right] \left[\frac{1k}{1k + 200} \right]$$

$$A_v = 34.722$$

24. Ans. D.

For an n -variable Boolean function, the maximum number of prime implicants $= 2^{(n-1)}$

25. Ans. D.

In packed BCD (Binary Coded Decimal) typically encoded two decimal digits within a single byte by taking advantage of the fact that four bits are enough to represent the range 0 to 9. So, 1856357 is required 4-bytes to stored these BCD digits

26. Ans. C.

Function Table for Half-subtractor is

X	Y	Difference (N)	Borrow (M)
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Hence, $N = X \oplus$ and $m = \overline{XY}$

27. Ans. C.

Minimum phase system has all zeros inside unit circle
maximum phase system has all zeros outside unit circle
mixed phase system has some zero outside unit circle and some zeros inside unit circle.

$$\text{for } H(z) = 1 + \frac{7}{2}z^{-1} + \frac{3}{2}z^{-2}$$

One zero is inside and one zero outside unit circle hence mixed phase system

28. Ans. B.

Given $x[n] = x[-n]$

$$\Rightarrow x(z) = x(z^{-1})$$

[Time reversal property in z - transform]

\Rightarrow if one zero is $0.5 + j0.25$

$$\text{then other zero will be } \frac{1}{0.5 + j0.25}$$

29. Ans. A.

For a periodic sequence wave, n th harmonic component is $\alpha \frac{1}{n}$

$$\Rightarrow \text{power in } n\text{th harmonic component is } \alpha \frac{1}{n^2}$$

\Rightarrow Ratio of the power in 7th harmonic to power in 5th harmonic for given waveform is

$$\frac{\sqrt[7]{2}}{\sqrt[5]{2}} = \frac{25}{49} \approx 0.5$$

30. Ans. D.

Given $\omega_n = 40 \text{ r/sec}$

$$\xi = 0.3$$

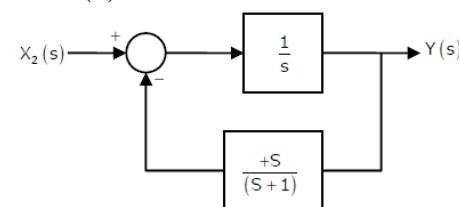
$$\omega_d = \omega_n \sqrt{1 - \xi^2}$$

$$\omega_d = 40 \sqrt{1 - (0.3)^2}$$

$$\boxed{\omega_d = 38.15 \text{ r/sec}}$$

31. Ans. D.

If $X_1(s) = 0$



$\frac{Y(s)}{X_2(s)}$; The block diagram becomes

$$\frac{Y(s)}{X_2(s)} = \frac{\frac{1}{s}}{1 + \frac{1}{s} \cdot \frac{s}{s+1}} = \frac{\frac{1}{s}}{(s+2)/s+1} \Rightarrow \frac{(s+1)}{s(s+2)}$$

32. Ans. A.

$$C = \lim_{\omega \rightarrow \infty} \omega \log_2 \left[1 + \frac{P}{\sigma^2 \omega} \right] = \lim_{\omega \rightarrow \infty} \frac{\omega \ln \left[1 + \frac{P}{\sigma^2 \omega} \right]}{\ln 2}$$

$$= \frac{1}{\ln 2} \lim_{\omega \rightarrow \infty} \frac{\ln \left[1 + \frac{P}{\sigma^2 \omega} \right]}{\frac{P}{\sigma^2 \omega}} \cdot \frac{P}{\sigma^2} = \frac{P}{\sigma^2 \ln 2} \lim_{\omega \rightarrow \infty} \frac{\ln \left[1 + \frac{P}{\sigma^2 \omega} \right]}{\frac{P}{\sigma^2 \omega}}$$

This limit is equivalent to

$$\lim_{x \rightarrow \infty} \frac{\ln[1+x]}{x} = 1 = \frac{P}{\sigma^2 \ln 2} = \ln_2 e \frac{P}{\sigma^2} = 1.44 Kpa$$

33. Ans. B.

$$x_1(t) = -e^{-t}, x_2(t) = 2e^{-t}$$

$$\mu = \frac{A(t)_{\max} - A(t)_{\min}}{A(t)_{\max} + A(t)_{\min}}$$

$$\mu = \frac{3-1}{3+1} = \frac{1}{2} = 0.5$$

34. Ans. C.

Here impedance is matched by using QWT ($\lambda/4$)

$$\therefore Z_0 = \sqrt{Z_L Z_m}$$

$$= \sqrt{100 \times 50} = 50\sqrt{2}$$

$$= z_0 = 70.7 \Omega$$

35. Ans. B.

For TEM wave

Electric field (E), Magnetic field (H) and Direction of propagation (P) are orthogonal to each other.

Here P = + a_x

By verification

$$E = -2a_y, H = -3a_z$$

$$E \times H = -a_y X - a_z = +a_x \rightarrow P$$

36. Ans. B.

$$[A/B] = \left[\begin{array}{ccc|c} 2 & 1 & 3 & 5 \\ 3 & 0 & 1 & -4 \\ 1 & 2 & 5 & 14 \end{array} \right]$$

$$R_2 \rightarrow 2R_2 - 3R_1 \left[\begin{array}{ccc|c} 2 & 1 & 3 & 5 \\ 0 & -3 & -7 & -23 \\ 0 & 3 & 7 & 23 \end{array} \right]$$

$$\xrightarrow{R_3 + R_2} \left[\begin{array}{ccc|c} 2 & 1 & 3 & 5 \\ 0 & -3 & -7 & -23 \\ 0 & 3 & 7 & 23 \end{array} \right]$$

Since, rank (A) rank (A / B) < number of unknowns
∴ Equations have infinitely many solutions.

37. Ans. B.

real part u = e^{-y} cos x and V = ?

$$dv = \frac{\partial v}{\partial x} dx + \frac{\partial v}{\partial y} dy$$

$$= -\frac{\partial u}{\partial y} dx + \frac{\partial u}{\partial x} dy \text{ (Using C - R equations)}$$

$$= e^{-y} \cos x dx - e^{-y} \sin x dy = d[e^{-y} \sin x]$$

Integrating, we get V = e^{-y} sin x

38. Ans. C.

General 2 2 real symmetric matrix is $\begin{bmatrix} y & x \\ x & z \end{bmatrix}$

⇒ det = yz - x² and trace is y + z = 14 (given)

⇒ z = 14 - y.....(*)

Let f = yz - x² (det) = -x² - y² + 14y (using*)

Using maxima and minima of a function of two variables, we have f is maximum at x = 0, y = 7 and therefore, maximum value of the determinant is 49

39. Ans. C.

$$\nabla(\ln r) = \frac{\vec{r}}{r^2} \Rightarrow \operatorname{div}(\vec{r}^2 \nabla(\ln r)) = \operatorname{div}(\vec{r}) = \vec{J}$$

$$\left[\nabla(\ln r) = \sum \hat{a}_x \frac{\partial}{\partial x} \nabla(\ln r) = \sum \hat{a}_x \left(\frac{1}{r} \right) \left(\frac{x}{r} \right) = \frac{1}{r^2} \sum \hat{a}_x x = \frac{\vec{r}}{r^2} \right]$$

40. Ans. D.

The operating frequency (ω_x), at which current leads the supply.

i.e., $\omega_x < \omega_r$

again magnitude of current is half the value at resonance

$$\text{i.e., at } \omega = \omega_x \Rightarrow I_x = \frac{V}{|z|}$$

$$\text{at } \omega = \omega_x \Rightarrow I_{\text{resonance}} = \frac{V}{R}$$

$$I_x = \frac{I_{\text{resonance}}}{2}$$

$$\text{i.e., } \frac{V}{|z|} = \frac{V}{2R} = |Z| = 2R$$

Given $R = 1\Omega$; $L = 1H$; $C = 1F$

$$|Z| = \sqrt{R^2 + \left(\frac{1}{\omega_c} - \omega L \right)^2} = 2$$

$$= R^2 + \left(\frac{1}{\omega_c} - \omega L \right)^2 = 4$$

By substituting R, L & C values,

$$\Rightarrow 1 + \left(\frac{1}{\omega} - \omega \right)^2 = 4 \Rightarrow \omega^2 = \frac{1}{\omega^2} = 5$$

$$\text{Assume } \omega^2 = x, \text{ then, } x + \frac{1}{2} = 5$$

$$\Rightarrow x^2 - 5x + 1 = 0$$

$$x_{1,2} = 4.791, 0.208$$

$$\text{If } x = 4.791 \Rightarrow \omega = 2.18r/\text{sec}$$

$$\text{If } x = 0.208 \Rightarrow \omega = 0.45r/\text{sec}$$

$$\text{But } \omega_x < \omega_r$$

$$\text{So, operating frequency } \omega_x = 0.45r/\text{sec}$$

41. Ans. A.

If two, $\pi - n / ws$ are connected in parallel,
The y-parameter are added

$$\text{i.e., } y_{\text{equ}} = y_1 + y_2$$

$$y_1 = \begin{bmatrix} 2/3 & -1/3 \\ -1/3 & 2/3 \end{bmatrix} y_2 = \begin{bmatrix} 1 & -1/2 \\ -1/2 & 1 \end{bmatrix}$$

$$y_{\text{equ}} = \begin{bmatrix} 5/3 & -5/6 \\ -5/6 & 5/3 \end{bmatrix}$$

$$h = \begin{bmatrix} 1/y_{11} & -y_{12}/y_{11} \\ y_{21}/y_{11} & \Delta y/y_{11} \end{bmatrix}$$

$$\text{where } \Delta y = y_{11}y_{22} - y_{12}y_{21}$$

The value of

$$h_{22} = \Delta y \left[\left(\frac{5}{3} \right) \left(\frac{5}{3} \right) \right] - \left[\left(\frac{-5}{6} \right) \left(\frac{-5}{6} \right) \right]$$

$$\Delta y = 2.0833$$

$$y_{11} = 5/3 \therefore h_{22} = 1.24$$

42. Ans. A.

$$v_c(t) = V_{R2}(t) = V_{\text{final}} + [V_{\text{initial}} - V_{\text{final}}] e^{-\tau/t}$$

$$\tau = R_{\text{equ}} \cdot C_{\text{equ}} \Rightarrow \frac{2}{3} \times 10^3 \times 10^{-6}$$

$$R_{\text{equ}} = 2K \parallel 1K \Rightarrow \frac{2}{3} K\Omega$$

$$C_{\text{equ}} = 1\mu F$$

$$\tau = \frac{2}{3} \text{ msec}$$

$$V_{\text{initial}} = 0 \text{ volts}$$

$$V_{\text{final}} = 0 \text{ Volts}$$

$$V_{\text{final}} = V_{\text{s.s.}} = 5, \frac{2}{3} = \frac{10}{3} \text{ volts}$$

$$V_{R2}(t) = \frac{10}{3} - \frac{10}{3} e^{-\tau/t}$$

$$V_{R2}(t) = \frac{10}{3} \left[1 - e^{-\tau/t} \right] \text{ volts}$$

$$\Rightarrow i_{R2}(t) = \frac{V_{R2}(t)}{2K} = \frac{5}{3} \left[1 - e^{-\tau/t} \right] \text{ mA}$$

43. Ans. D.

Given 56% of the total flux emanating from one coil links to other coil.

$$\text{i.e., } K = 56\% \Rightarrow 0.56$$

$$\text{We have, } K = \frac{M}{\sqrt{L_1 L_2}}$$

$$L_1 = 4H; L_2 = 5H$$

$$M(0.56)\sqrt{20} \Rightarrow m = 2.50H$$

44. Ans. B.

$$\text{Given } q = 1.6 \times 10^{-19}; \frac{kJ}{q} = 2.5mV,$$

$$\mu_n = 1000 \text{ cm}^2/v-s$$

$$\text{From Eindtein relation, } \frac{D_a}{\mu_n} = \frac{kj}{q}$$

$$\Rightarrow D_n = 25mV \times 1000 \text{ cm}^2/v-s$$

$$\Rightarrow 25 \text{ cm}^2/s$$

$$\text{Diffusion current Density } J = qD_n \frac{dn}{dx}$$

$$= 1.6 \times 10^{-19} \times 25 \times 1 \times 10^{21}$$

$$= 4000 A/cm^2$$

45. Ans. C.

Given $x_n = 0.2 \mu m$, $\epsilon_{Si} = 1.044 \times 10^{-12} F / \mu m$

$$N_D = 10^{16} / cm^3$$

$$\text{Peak Electric field, } E = \frac{qN_D x_a}{\epsilon}$$

$$= \frac{1.6 \times 10^{-19} \times 10^{16} \times 0.00002}{1.044 \times 10^{-12}} = 30.66 KV / cm$$

46. Ans. B.

Given $N_A = 9 \times 10^{16} / cm^3$; $N_D = 1 \times 10^{16} / cm^3$

$$\text{Total depletion width } x = x_n + x_p = 3 \mu m$$

$$\epsilon = 1.04 \times 10^{-12} F / cm$$

$$\frac{x_n}{x_p} = \frac{N_A}{N_D} = \frac{9 \times 10^{16}}{1 \times 10^{16}}$$

$$x_n = 9x_p \dots \dots \dots (1)$$

Total Depletion width, $x_n + x_p = 3 \mu m$

$$9x_p + x_p = 3 \mu m$$

$$x_p = 3 \mu m$$

Max. Electric field,

$$E = \frac{qN_A x_p}{\epsilon} = \frac{1.6 \times 10^{-19} \times 9 \times 10^{16} \times 0.3 \mu m}{1.04 \times 10^{-12}}$$

$$= 4.15 \times 10^5 V / cm$$

47. Ans. C.

When V_i makes Diode 'D' OFF, $V_0 = V_i$

$$\therefore V_0(\min) = -5V$$

When V_i makes diode 'D' ON,

$$V_0 = \frac{(V_i - 0.7 - 2)}{R_1 + R_2} V_{on} + 2V$$

$$\therefore V_0(\max) = \frac{(5 - 0.7 - 2)1k}{1k + 1k} + 0.7 + 2V$$

$$= 3.85V$$

48. Ans. C.

$$\text{Given } V_{Th} = 0.8V$$

$$\text{When } V_D = 1.6V, I_D = 0.5mA$$

$$= \frac{1}{2} \mu_n \cos \frac{w}{L} (V_{DS} - V_{Th})^2$$

[\because is in sat]

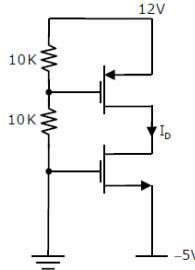
$$\Rightarrow \frac{1}{2} \mu_n \cos \frac{\omega}{L} = 0.78125 \times 10^{-3} A / V^2$$

$$\text{When } V_D = 2V$$

$$I_D = \frac{1}{2} \mu_n \cos \frac{\omega}{L} (V_{DS} - V_{Th})^2$$

$$= 0.78125 \times 10^{-3} (2 - 0.8) 1.125mA$$

49. Ans. D.

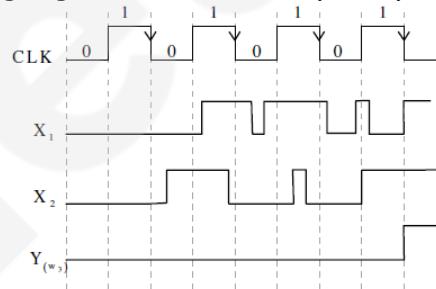


$$\text{Given } |V_t| = 2V, K = \frac{1}{2} \mu \cos \frac{W}{L} = 0.1A / V^2$$

$$\begin{aligned} I_{D_1} &= I_{D_2} = \frac{1}{2} \mu_n \cos \frac{W}{L} (V_{G_{S_1}} - V_t) \\ &= 0.1mA / V^2 (5 - 2)^2 \\ &= 0.9mA \end{aligned}$$

50. Ans. C.

This circuit has used negative edge triggered, so output of the D-flip flop will change only when CLK signal is going from HIGH to LOW (1 to 0)



This is a synchronous circuit, so both the flip flops will trigger at the same time and will respond on falling edge of the Clock. So, the correct output (Y) waveform is associated to w_3 waveform.

51. Ans. D.

Clock	$J_1(\bar{Q}_2)$	$K_1(Q_2)$	$J_2(Q_1)$	$K_2(\bar{Q}_1)$	Q_1	Q_2
Initial \rightarrow	-	-	-	-	0	0
1 st CP \rightarrow	1	0	0	1	1	0
2 nd CP \rightarrow	1	0	1	0	1	1
3 rd CP \rightarrow	0	1	1	0	0	1
4 th CP \rightarrow	0	1	0	1	0	0

So, the output sequence generated at Q2 is 01100....

52. Ans. D.

This circuit diagram indicating that it is memory mapped I/O because to enable the 3-to-8 decoder $\overline{G_{2A}}$ is required active low signal through (I_0 / \overline{m}) and $\overline{G_{2B}}$ is required active low through $(\overline{R_D})$ it means I/o device read the status of device LDA instruction is appropriate with device address.

Again to enable the decoder o/p of AND gate must be 1 and D_{S_2} signal required is 1 which is the o/p of multi-i/p AND gate to enable I/O device.

So,

$$\begin{array}{ccccccccccccccccc} A_{15} & A_{14} & A_{13} & A_{12} & A_{11} & A_{10} & A_9 & A_8 & A_7 & A_6 & A_5 & A_4 & A_3 & A_2 & A_1 & A_0 \\ 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 \end{array}$$

F 8 F 8

Device address = F8F8H

The correct instruction used → LDA F8F8H

53. Ans. A.

$$y[n] = x[n]*x[n]$$

$$y[n] = \sum_{k=0}^n x[k]x[n-k]$$

$$y[4] = \sum_{k=0}^4 x[k]x[G-k]$$

$$= x(0)x(4) + x(1)x(3) + x(2)x(2) \\ + x(3)x(1) + x(4)x(0)$$

$$= 0 + 3 + 4 + 3 + 0 = 10$$

54. Ans. A.

Given system equation as

$$y[n] = \alpha y[n-1] + \beta x[n]$$

$$\Rightarrow \frac{y(z)}{x(z)} = \frac{\beta}{1 - \alpha z^{-1}}$$

$$\Rightarrow H(z) = \frac{\beta}{1 - \alpha z^{-1}}$$

$$h[n] = \beta(\alpha)^n u[n] \quad [\text{causal system}]$$

Also given that $\sum_{n=0}^{\infty} h[n] = 2$

$$\beta \left[\frac{1}{1 - \alpha} \right] = 2$$

$$1 - \alpha = \frac{\beta}{2}$$

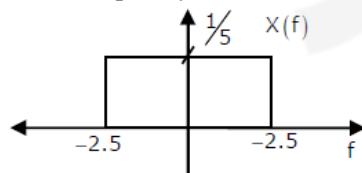
$$\alpha = 1 - \frac{\beta}{2}$$

55. Ans. A.

We can use pasrevalis theorem

$$\text{Let } x(t) \sin(5t) = \frac{\sin 5\pi t}{5\pi t}$$

⇒ in frequency domain



$$\text{Now, } \int_{-\infty}^{\infty} x^2(t) dt = \int_{-\infty}^{\infty} x^2(t) df = \int_{-2.5}^{2.5} \left(\frac{1}{5} \right)^2$$

$$= \frac{1}{25} \times 5 = \frac{1}{5} = 0.2$$

56. Ans. C.

Solution of state equation of $X(t) = L^{-1}[SI - A].X(0)$

$$X(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix} A = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix}$$

$$[SI - A]^{-1} = \begin{bmatrix} S+1 & 0 \\ 0 & S+2 \end{bmatrix}^{-1}$$

$$= \frac{1}{(S+1)(S+2)} \begin{bmatrix} S+2 & 0 \\ 0 & S+1 \end{bmatrix}$$

$$[SI - A]^{-1} = \begin{bmatrix} \frac{1}{S+1} & 0 \\ 0 & \frac{1}{S+2} \end{bmatrix}$$

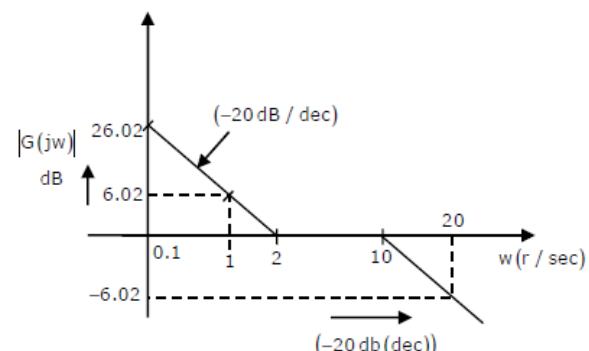
$$[SI - A]^{-1} = \begin{bmatrix} L^{-1}\left[\frac{1}{S+1}\right] & 0 \\ 0 & L^{-1}\frac{1}{S+2} \end{bmatrix}$$

$$L^{-1}\left[(SI - A)^{-1}\right] = \begin{bmatrix} e^{-t} & 0 \\ 0 & e^{-2t} \end{bmatrix}$$

$$\begin{bmatrix} X_1(t) \\ X_2(t) \end{bmatrix} = \begin{bmatrix} e^{-t} & 0 \\ 0 & e^{-2t} \end{bmatrix} \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

$$\begin{bmatrix} X_1(t) \\ X_2(t) \end{bmatrix} = \begin{bmatrix} -e^t \\ -e^{-2t} \end{bmatrix} \quad \therefore \frac{X_1(t)}{X_2(t)} = \frac{e^{-t}}{-e^{-2t}} = -e^{t-2}$$

57. Ans. B.



→ Due to initial slope, it is a type-1 system, and it has non zero velocity error coefficient

$$(K_v)$$

→ The magnitude plot is giving 0dB at 2r/sec.

Which gives K_v

$$\therefore K_v = 2$$

$$\text{The steady state error } e_{ss} = \frac{A}{K_v}$$

given unit ramp input; A 1

$$e_{ss} = \frac{1}{2}$$

$$e_{ss} = 0.50$$

58. Ans. A.

From the given signal flow graph, the state model is

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ a_3 & a_2 & a_1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u$$

$$Y = [C_1 C_2 C_3] \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ a_3 & a_2 & a_1 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}; C = [C_1 C_2 C_3]$$

Controllability:

$$Q_c = [B \quad AB \quad A^2B]$$

$$Q_c = \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & a_1 \\ 1 & a_1 & a_2 + a_1^2 \end{bmatrix}$$

$$|Q_c| = 1 \neq 0$$

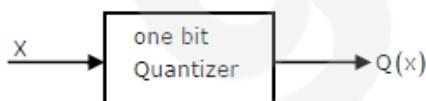
observability

$$Q_o = \begin{bmatrix} C \\ CA \\ CA^2 \end{bmatrix} \Rightarrow \begin{bmatrix} C_1 & C_2 & C_3 \\ a_3 c_3 & c_1 + a_2 c_3 & c_2 + a_1 c_3 \\ c_2 a_3 + c_3 (a_1 a_3) & a_2 c_2 + c_3 (a_1 a_2 + a_3) & c_3 + a_1 c_2 + c_3 (a_1^2 + a_2) \end{bmatrix}$$

$|Q_o| \Rightarrow$ depends on a_1, a_2, a_3 & c_1 & c_2 & c_3

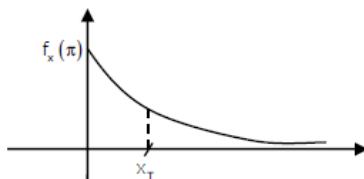
it is always controllable

59. Ans. B.



One bit quantizer will give two levels.

Both levels have probability of $\frac{1}{2}$ Pd of input X is



Let x_T be the threshold

$$Q(x) = \begin{cases} x_1 & x \geq x_T \\ x_2 & x < x_T \end{cases}$$

Where x_1 and x_2 are two levels

$$P\{Q(r) = x_1\} = \frac{1}{2}$$

$$\Rightarrow \int_{x_T}^{\infty} 2e^{-2x} dx = \frac{1}{2}$$

$$2 \cdot \left. \frac{e^{-2x}}{-2} \right|_{x_T}^{\infty} = \frac{1}{2}$$

$$-e^{-2\infty} + e^{-2x_T} = \frac{1}{2}$$

$$e^{-2x_T} = \frac{1}{2}$$

$$-2x_T = \ln \frac{1}{2}$$

$$-2x_T = -0.693$$

$$x_T = 0.35$$

60. Ans. C.

For Binary F_{SK}

$$\text{Bit error probability} = Q\left(\sqrt{\frac{E}{N_o}}\right)$$

E → Energy per bit [No. of symbols = No. of bits]

$$E = \frac{A^2 T}{2}, A = 4 \times 10^{-3}, T = \frac{1}{500 \times 10^3} [\text{inverse of data rate}]$$

$$\Rightarrow E = \frac{16 \times 10^{-6} \times 2 \times 10^{-6}}{2} = 16 \times 10^{-12}$$

$$N_o = 1 \times 10^{-12}$$

$$\Rightarrow P_e = Q\left(\sqrt{\frac{16 \times 10^{-12}}{1 \times 10^{-12}}}\right) = Q(4)$$

61. Ans. B.

$$\text{Given } S_x(f) = \begin{cases} \frac{1}{w}, & |f| \leq w \\ 0, & |f| \geq w \end{cases}$$

$$R_x(\tau) = \int_{-w}^w \frac{1}{w} \cdot e^{j2\pi f t} df$$

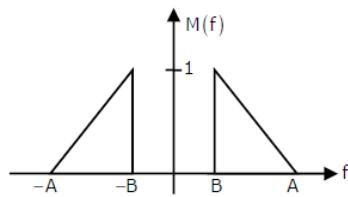
$$= \frac{1}{w} \frac{e^{j2\pi w t} - e^{-j2\pi w t}}{j2\pi t} = \frac{1}{w} \left(\frac{\sin(2\pi w t)}{\pi t} \right)$$

$$\text{Now, } E\left[\pi \times (t) \cdot x\left(t - \frac{1}{4w}\right)\right] = \pi R_x\left(\frac{1}{4w}\right)$$

$$\Rightarrow \pi \cdot \frac{1}{w} \cdot \frac{\sin(2\pi w \cdot \frac{1}{4w})}{\pi \cdot \frac{1}{4w}} = \frac{4}{1}$$

62. Ans. B.

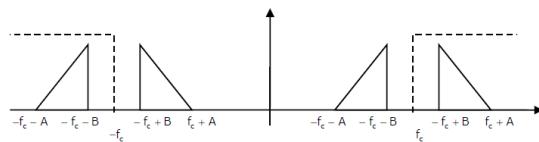
$$m(t) \leftrightarrow M(f)$$



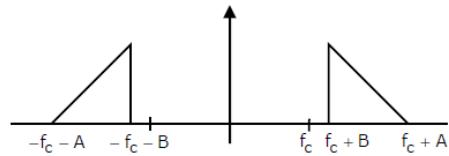
After multiplication with $V(t) = \cos(2\pi f_c t)$

Let $w^1(t) = m(t)V(t)$

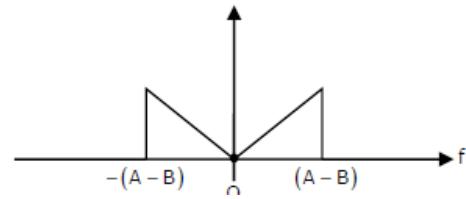
$\Rightarrow W^1(f)$ (spectrum of $w^1(t)$) is



After high pass filter



After multiplication with $\cos(2\pi(f_c + A)t)$ and low pass filter of cut off f_c



$$\text{Bandwidth} = A - B \\ = 100 - 40 = 60$$

63. Ans. A.

$$E(z,t) = 3\cos(\cot - kz + 30^\circ)a_x - 4\sin(\omega t - kz + 45^\circ)a_y$$

$$E_x = 3\cos(\omega t - kz + 30^\circ)$$

$$E_y = -4\cos(\omega t - kz + 45^\circ)$$

$$\text{At } z = E_x = 3\cos(\omega t + 30^\circ)$$

$$E_y = -4\sin(\omega t + 45^\circ)$$

$|E_x| \neq |E_y| \rightarrow$ so Elliptical polarization

$$Q = 30^\circ - 135^\circ = -105^\circ$$

\therefore left hand elliptical (LEP)

64. Ans. B.

$$\text{Here } l = \frac{\lambda}{2}$$

$$Z_{in} \left(l = \frac{\lambda}{2} \right) = Z_L = 50\Omega$$

$$\therefore Z_{in} = (100 \parallel 50) = \frac{100}{3} = 33.33\Omega$$

65. Ans. B.

$$t_{c10} = \frac{C}{2} \sqrt{\left(\frac{1}{a}\right)^2}$$

$$t_{c10} = K \left(\frac{1}{a} \right); \quad t_{c20} = K \left(\frac{2}{a} \right)$$

$$t_{c11} = K \sqrt{\frac{1}{a^2} + \frac{1}{b^2}}$$

$$\text{Given } t_{c11} = \frac{f_{c10} + f_{c20}}{2}$$

$$K \sqrt{\frac{1}{a^2} + \frac{1}{b^2}} = \frac{K}{2} \left[\frac{1}{a} + \frac{2}{a} \right]$$

$$\sqrt{\frac{1}{a^2} + \frac{1}{b^2}} = \frac{3}{2a}$$

$$\frac{1}{5} + \frac{1}{b^2} = \frac{9}{4(5)} \Rightarrow -\frac{1}{5} + \frac{9}{20} = \frac{1}{b^2}$$

$$-0.2 + 0.45 = \frac{1}{b^2}$$

$$\therefore \frac{1}{b^2} = \frac{1}{2^2} \Rightarrow b = 2\text{cm}$$
