1. Ans. C.
Diversity is shown in terms of difference language

2. Ans. B.

3. Ans. B.

4. Ans. C.

$81-54=27;27\times\frac{2}{3}=18$

$54-36=18;18\times\frac{2}{3}=12$

$36-24=12;12\times\frac{2}{3}=8$

$\therefore 24-8=16$

5. Ans. D.

6. Ans. B.

7. Ans. D.
It is not mentioned that elephant is the largest animal

8. Ans. B.
4 km/hr.
Speed of man=8
Left distance =d

Time taken $=\frac{d}{8}$

<u>Upstream</u>
Speed of stream = s
⇒ speed upstream = S′ = (8 – s)

$t'=\left(\frac{d}{8-s}\right)$

<u>Downstream:</u>

speed downstream $=t''=\frac{d}{8+s}$

$\Rightarrow 3t'=t''$

$\Rightarrow \frac{3d}{8-s}=\frac{d}{8+s}$

$\Rightarrow \frac{3d}{8-s}=\frac{d}{8+s}$

$\Rightarrow s=4km/hr$

9. Ans. B.

Total expenditure $==\frac{15}{100}\times=4,50,000$

$x=3\times10^6$
Profit=10 lakhs
So, total selling price =40,00,000 … (1)
Total purifies=200 … (2)
S.P of each purifier=(1)/(2)=20,000

10. Ans. C.

Probability for one bulb to be non defective is $\frac{95}{100}$

∴ Probabilities that none of the bulbs is defectives

$\left(\frac{95}{100}\right)^4=0.8145$

11. Ans. A.

$f^1(x)=0\Rightarrow\frac{1}{1+x}-1=0$

$\Rightarrow\frac{-x}{1+x}=0\Rightarrow x=0$

$and\ f^{11}(x)=\frac{-1}{(1+x)^2}<at\ x=0$

12. Ans. A.

A) $\frac{dy}{dx}+xy=e^{-x}$ is a first order linear equation (non-homogeneous)

B) $\frac{dy}{dx}+xy=0$ is a first order linear equation

(homogeneous (C), (D) are non linear equations

13. Ans. B.

14. Ans. C.
P[fourth head appears at the tenth toss] = P [getting 3 heads in the first 9 tosses and one head at tenth toss]

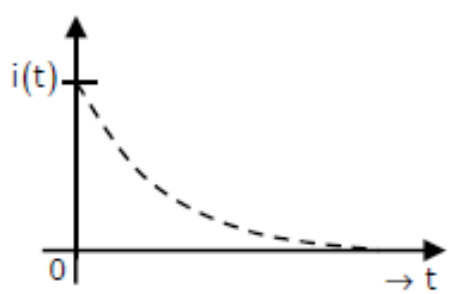
$=\left[9c_3.\left(\frac{1}{2}\right)^9\right]\times\left[\frac{1}{2}\right]=\frac{21}{256}=0.082$

15. Ans. C.

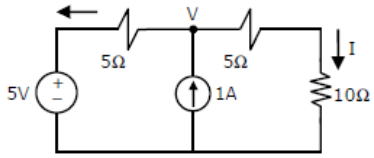
$\frac{\partial z}{\partial x}=y\left[x\times\frac{1}{xy}\times y+\ln xy\right]=y(1+\ln xy)$

$and\ \frac{\partial z}{\partial y}=x(1+\ln xy)\Rightarrow x\frac{\partial z}{\partial x}=y\frac{\partial z}{\partial y}$

16. Ans. A.
In a series RC circuit,
→ Initially at t = 0, capacitor charges with a current of $\frac{V_s}{R}$ and in steady state at $t=\infty$, capacitor behaves like open circuit and no current flows through the circuit
→ So the current i(t) represents an exponential decay function



17. Ans. C.



Apply KCL at node $V, \frac{V-5}{5} - 1 + \frac{V}{15} = 0$

$$\Rightarrow V = \frac{30}{4} volts$$

$$\Rightarrow \text{current } I = \frac{V}{15} \Rightarrow \frac{2}{4} \Rightarrow 0.50 \text{ Amperes}$$

18. Ans. C.

19. Ans. D.

Recombination rate, $R = B\left(n_{n_0} + n_n\right)\left(P_{n_0} + P_n\right)$ Electron and hole concentrations respectively under thermal equilibrium

n_{n_0} & P_{n_0} Excess elements and hole concentrations respectively

20. Ans. C.

From Einstein relation,

$$\frac{DP}{\mu_P} = \frac{kJ}{q}$$

$$\Rightarrow D_P = 26mV \times 500cm^2 / v - s = 13cm^2 / s$$

21. Ans. A.

Trans conductance amplifier must have $z_1 = \infty \, and \, z_0 = \infty$ ideally

22. Ans. A.

KVL in base loop gives,

$$I_B = \frac{10 - 0.7}{100K} = 93\mu A$$

$$\Rightarrow I_C = \beta I_B = 50 \times 93\mu A = 4.65 mA$$

from figure, $V_0 = I_C R_C$

$$\Rightarrow R_C = \frac{V_0}{I_C} = \frac{5V}{4.65mA} = 1.075\Omega$$

23. Ans. C.

$$V_{dc} = V_m - \frac{I_{dc}}{4fc}$$

$$I_{dc} R_L = V_m - \frac{I_{dc}}{4fc}$$

$$\Rightarrow I_{dc} = \frac{10}{100 + \frac{1}{4 \times 50 \times 4 \times 10^{-3}}} = 0.09A$$

24. Ans. B.

Maximum quantization error is $\frac{step - size}{2}$

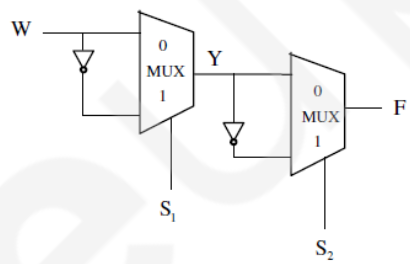
$$\text{step-size} = \frac{8-10}{16} = \frac{1}{2} = 0.5V$$

$$\text{Quantization error} = 0.25V$$

25. Ans. D.

Latches are used to construct Flip-Flop. Latches are level triggered, so if you use two latches in cascaded with inverted clock, then one latch will behave as master and another latch which is having inverted clock will be used as a slave and combined it will behave as a flip-flop. So given circuit is implementing Master-Slave D flip-flop

26. Ans. D.



Output of first MUX = $w\bar{s}_1 + w\bar{s}_2 = w \oplus s_1$

$$Let \, Y = w \oplus s_1$$

Output of second MUX = $Y\bar{s}_2 + \bar{Y}s_2$

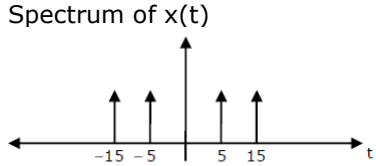
$$= Y \oplus s_2$$

$$= w \oplus s_1 + s_2$$

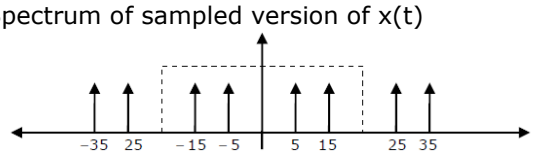
27. Ans. A.

$x(t) = \cos(10\pi t) + \cos(30\pi t), F_s = 20Hz$

Spectrum of x(t)



Spectrum of sampled version of x(t)



After LPF, signal will contain 5 and 15Hz component only

28. Ans. B.

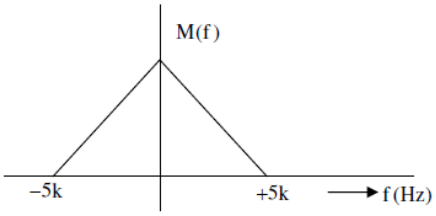
For an all pass system, pole $= \frac{1}{zero*}$ or $zero = \frac{1}{pole*}$

$$pole = a$$

$$zero = \frac{1}{b}$$

$$\Rightarrow \frac{1}{2} = \frac{1}{a*} or \, b = a*$$

29. Ans. A.
Since m(t) is a base band signal with maximum frequency 5 KHz, assumed spreads as follows:



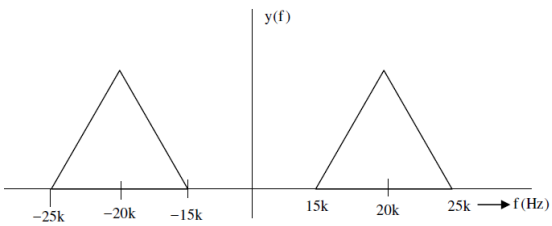
$$m(t) \xrightarrow{f} M(f)$$

$$\because \quad i(t)\cos(40000\pi t) \xrightarrow{7} m(f)\frac{*1}{2}$$

$$[\delta(f-20k)+\delta(f+20k)]$$

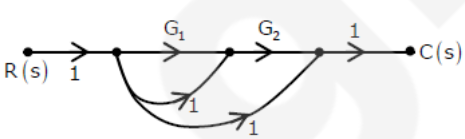
$$\therefore y(f)=\frac{1}{2}[M(f-20k)+M(f+20k)]$$

Thus the spectrum of the modulated signal is as follows:



If y(t) is sampled with a sampling frequency 'f_s' then the resultant signal is a periodic extension of successive replica of y(f) with a period 'fs'.
It is observed that 10 KHz and 20 KHz are the two sampling frequencies which causes a replica of M(f) which can be filtered out by a LPF.
Thus the minimum sampling frequency (f_s) which extracts m(t) from g(f) is 10 KHz.

30. Ans. C.
By drawing the signal flow graph for the given block diagram



Number of parallel paths are three
$Gains\ P_1=G_1G_2, P_2=G_2, P_3=1$
By mason's gain formula,

$$\frac{C(s)}{R(s)}=P_1+P_2+P_3$$

$$\Rightarrow \boxed{G_1G_2+G_2+1}$$

31. Ans. A.

$$\frac{Y(s)}{X(s)}=\frac{S-2}{S+3}$$

$$\Rightarrow SY(s)+3Y(s)=S\times(s)-2X(s)$$

Due to initial condition, we can write above equation as

$$Sy(s)-y(0)+3y(s)=sx(s)-x(0^-)-2x(s)$$

$$y(0^-)=-2, x(0^-)=0 \quad [x(t)=3e^{2t}u(t)]$$

$$\Rightarrow Sy(s)+2+3y(s)=(s-2)\left(\frac{-3}{s-2}\right)$$

$$(s+3)y(s)=-3-2 \Rightarrow y(s)=\frac{-5}{5+3}$$

$$\Rightarrow y(t)=-5e^{-3t}u(t)$$

$$y(\infty)(steady\ sate)=0$$

Alternative Way:

$$H(s)=\frac{s-2}{s+3}; X(t)=-3e^{2t}.u(t)$$

$$\therefore X(s)=\frac{-3}{s-2} \Rightarrow Y(s)=\frac{-3}{s+3}$$

$$y(t)\big|_{at\ t=\infty} \Rightarrow y(\infty)=\lim_{\delta\to 0} S.y(s)=\lim_{\delta\to 0}\frac{-3}{s+3}$$

$$y(\infty)=0$$

32. Ans. C.
Phase response of pass band waveform

$$\phi(f)=2\pi\alpha(f-f_c)-2\pi\beta f_c$$

$$\text{Group delay } t_y=\frac{-d\phi(f)}{2\pi\, df}=\alpha$$

Thus 'α' is actual signal propagation delay from transmitter to receiver

33. Ans. A.
Instantaneous phase

$$\phi_1(t)=2\pi f_c t+\beta_1\sin 2\pi f_1+\beta_2\sin 2\pi f_t$$

$$\text{Instantaneous frequency } f_i(t)=\frac{d}{dt}\phi_i(t)\times\frac{1}{2\pi}$$

$$=f_c+\beta_1 f_1\cos 2\pi f_1 t+\beta_2 f_2\cos 2\pi f_2 t$$

Instantaneous frequency deviation

$$=\beta_1 f_1\cos 2\pi f_1 t+\beta_2 f_2\cos 2\pi f_2 t$$

$$\text{Maximum } \Delta F=\beta_1 f_1+\beta_2 f_2$$

34. Ans. C.

$$f_c(TE_{21}) = \frac{C}{2}\sqrt{\left(\frac{2}{9}\right)^2 + \left(\frac{1}{b}\right)^2}$$

$$= \frac{3\times10^{10}}{2}\sqrt{\left(\frac{2}{5}\right)^2 + \left(\frac{1}{3}\right)^2}$$

$$= 1.5\times10^{10}\sqrt{0.16+0.111}$$

$$= 0.52\times1.5\times10^{10}$$

$$= 7.81GHz$$

$$= 7810MHz$$

35. Ans. C.
Signal distortion implies impedance mismatch at both ends. i.e.,

$$Z_T \neq Z_0$$

$$Z_R \neq Z_0$$

36. Ans. C.

$$f^1(x) = 6x^2 - 18x + 12 = 0 \Rightarrow x = 1,2 \in [0,3]$$

$$Now\, f(0) = -3; f(3) = 6\, and\, f(1) = 2; f(2) = 1$$

Hence, f(x) is maximum at x = 3 and the maximum value is 6

37. Ans. B.

Consider, $A\begin{bmatrix} -1 & 1 \\ 1 & -1 \end{bmatrix}$ which is real symmetric matrix

Characteristic equation is $|A - \lambda 1| = 0 \quad \Rightarrow (1+\lambda)^2 - 1 = 0$

$$\Rightarrow \lambda + 1 = \pm 1$$

$$\therefore \lambda = 0, -2 \text{ (not positive)}$$

(B) is not true (A), (C), (D) are true using properties of eigen values

38. Ans= B
Let the first toss be Head.
Let x denotes the number of tosses(after getting first head) to get first tail.
We can summarize the even as:

Event	x	Probability(p(x))
(After getting first H)		
T	1	1/2
HT	2	1/2*1/2=1/4
HHT	3	1/8
and so on.....		

$$E(x) = \sum_{x=1}^{\infty} xp(x) = 1x\frac{1}{2} + 2x\frac{1}{2} + 3x\frac{1}{8}...$$

$$Let, S = 1x\frac{1}{2} + 2x\frac{1}{2} + 3x\frac{1}{8}.. \qquad (I)$$

$$\Rightarrow \frac{1}{2}S = \quad \frac{1}{4} + 2x\frac{1}{8} + 3x\frac{1}{16}... \qquad (II)$$

$$(I - II)\, gives$$

$$\left(1 - \frac{1}{2}\right)S = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + ...$$

$$\Rightarrow \frac{1}{2}S = \frac{\frac{1}{2}}{1 - \frac{1}{2}} = 1$$

$$\Rightarrow S = 2$$

$$\Rightarrow E(x) = 2$$

i.e. The expected number of tosses (after first head) to get first tail is 2 and same can be applicable if first toss results in tail.
Hence the average number of tosses is 1+2 = 3.

39. Ans. B.
Given $x_1 x_2\, and\, x_3$ be independent and identically distributed with uniform distribution on [0,1]

$$Let\, z = x_1 + x_2 - x_3$$

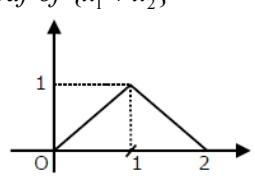
$$\Rightarrow P\{x_1 + x_2 \leq x_3\} = P\{x_1 + x_2 - x_3 \leq 0\}$$

$$= P\{z \leq 0\}$$

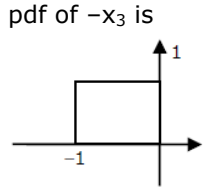
Let us find probability density function of random variable z.
Since Z is summation of three random variable $x_1, x_2\, and - x_3$

Overall pdf of z is convolution of the pdf of $x_1, x_2\, and - x_3$

$$pdf\, of\, \{x_1 + x_2\}$$

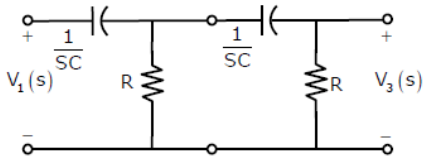


pdf of $-x_3$ is



$$P\{z \leq 0\} = \int_{-1}^{0} \frac{(z+1)^2}{2} dz = \left.\frac{(z+1)^3}{6}\right|_{-1}^{0} = \frac{1}{6} = 0.16$$

40. Ans. B.
Two blocks are connected in cascade, Represent in s-domain,



$$F = W\overline{X} + \overline{W}X + \overline{Y}Z$$

$$\frac{v_3(s)}{v_1(s)} = \frac{R.R}{\frac{1}{sc}\left[R + R + \frac{1}{SC}\right] + R\left[\frac{1}{SC} + R\right]}$$

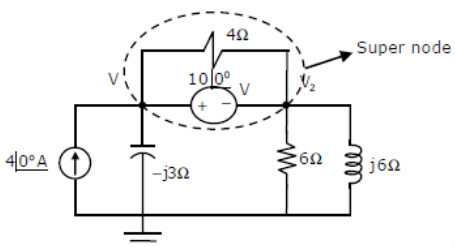
$$= \frac{R.R}{\frac{1}{SC}.\frac{1}{SC}\left[2R(SC)+1\right] + \frac{R}{SC}\left[1 + RSC\right]}$$

$$= \frac{S^2C^2.R.R}{\left[1+2R(SC)\right] + RSC + R^2S^2C^2}$$

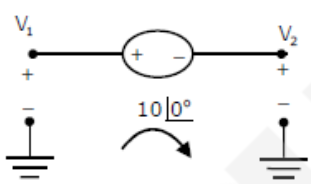
$$= \frac{S^2.100\times100\times10^{-6}\times10^{-6}\times10\times10\times10^3\times10^3}{S^2\times100\times10^6\times10^4\times10^{-12} + 3S + 100\times10^{-6}\times10^4 + 1}$$

$$\frac{v_3(s)}{v_1(s)} = \frac{S^2}{1+3S+S^2}$$

41. Ans. D.



$KVL\ for\ V_1\ \&\ V_2$:



$$V_1 - V_2 = 10\underline{|0°} \qquad ...(1)$$

$$\boxed{V_1 = V_2 + 10\underline{|0°}}$$

KCL at super node:

$$-4\underline{|0°} + \frac{V_1}{-j3} + \frac{V_2}{6} + \frac{V_2}{j6} = 0 \qquad ...(2)$$

$$\frac{V_1}{-j3} + \frac{V_2}{6} + \frac{V_2}{j6} = -4\underline{|0°}$$

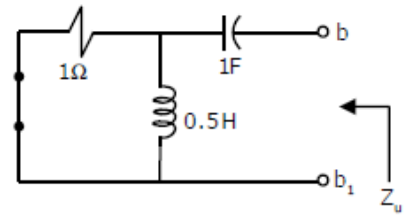
$$from\,(1)\,\&\,(2), \frac{V_2 + 10\underline{|0°}}{-j3} + \frac{V_2}{6} + \frac{V_2}{j6} = 4\underline{|0°}$$

$$V_2\left[\frac{1}{-j3} + \frac{1}{6} + \frac{1}{j6}\right] = 4\underline{|0°} + \frac{10}{j3}$$

$$\therefore V_2 = (2 - j22)\,Volts$$

42. Ans. A.

Norton's equivalent impedance



$$Z_N = \frac{1 * j\omega.\frac{1}{2}}{1 + j\omega.\frac{1}{2}} + \frac{1}{j\omega.1}$$

$$= \frac{j\omega}{2 + j\omega} + \frac{1}{j\omega}$$

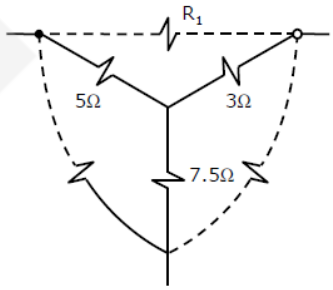
$$Z_N = \frac{\left(2 - \omega^2\right) + j\omega}{\left[2j\omega - \omega^2\right]}$$

$$\Rightarrow Z_N = \frac{\left[\left(\omega^2 - 2\right) - j\omega\right].\left[\omega^2 + 2j\omega\right]}{\left[\omega^4 + 4\omega^2\right]}$$

Equating imaginary term to zero i.e., $\omega^3 - 4\omega = 0$

$$\Rightarrow \omega\left(\omega^2 - 4\right) = 0 \Rightarrow \boxed{\omega = 2r/\sec}$$

43. Ans. B



$$R_1 = \frac{(7.5)(5) + (3)(5) + (7.5)(3)}{7.5}\Omega$$

$$R_1 = 10\Omega$$

44. Ans. D.

$$V_{bi} = V_T 1n\frac{N_A N_D}{n_i^2} = 26mv1n\left[\frac{5\times10^{18}\times1\times10^{16}}{\left(1.5\times10^{10}\right)^2}\right]$$

$$= 0.859V$$

$$W = \sqrt{\frac{2\varepsilon_S V_{bi}}{q}\left[\frac{N_A + N_D}{N_A N_D}\right]} = 3.34\times10^{-5}\,cm$$

45. Ans. C.

In linear region, $I_D = k\left[\left(V_{GS} - V_T\right)V_{DS} - \frac{V_{DS}^2}{2}\right]$

$$\frac{\partial I_D}{\partial V_{GS}} = 10^{-3} = kV_{DS} \because \qquad \text{ıall}, \frac{V_{DS}^{\ 2}}{2} \text{ is neglected}$$

$$\Rightarrow K = \frac{10^{-3}}{0.1} = 0.01$$

In saturation region, $I_D = \frac{1}{2}k\left(V_{GS} - V_T\right)^2$

$$\sqrt{I_D} = \sqrt{\frac{k}{2}}\left(V_{GS} - V_T\right)$$

$$\frac{\partial\sqrt{I_D}}{\partial V_{GS}} = \sqrt{\frac{k}{2}} = \sqrt{\frac{0.01}{2}} = 0.07$$

46. Ans. C.

$$E_s = \frac{2\times 0.2}{0.5} = 0.8v/\mu m$$

$$E_{ox} = \frac{E_s}{E_{ox}}E_s = 2.4v/\mu m$$

47. Ans. B.
KVL in base loop,

$$5 - I_B\left(50k\right) - 0.7 = 0$$

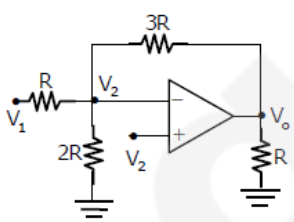
$$I_B = \frac{5-0.7}{50k} = 80\mu A$$

$$\Rightarrow I_C = \beta I_B = 50\times 86\mu A = 4.3mA$$

$$\therefore R_C = \frac{10 - V_{CE}\left(sat\right)}{I_C} = \frac{10-0.2}{4.3mA}$$

$R_C = 2279\Omega$ and the BJT is in saturation

48. Ans. D.
Virtual ground and KCL at inverting terminal gives



$$\frac{V_2 - V_1}{R} + \frac{V_2}{2R} + \frac{V_2 - V_0}{3R} = 0$$

$$\frac{V_0}{3R} = \frac{V_2}{R} + \frac{V_2}{3R} + \frac{V_2}{2R} - \frac{V_1}{R}$$

$$V_0 = -3V_1 + \frac{11}{2}V_2$$

49. Ans. B.
Transistor m_1 switch from saturation to linear

$$\Rightarrow V_{DS} = V_{GS} - V_T; where V_{DS} = V_0 \text{ and } V_{GS} = V_i$$

$$\therefore V_{DS} = V_0 = V_i - V_T$$

Drain current $I_D = \frac{1}{2}\mu_n \cos\frac{w}{L}\left(V_{GS} - V_T\right)^2$

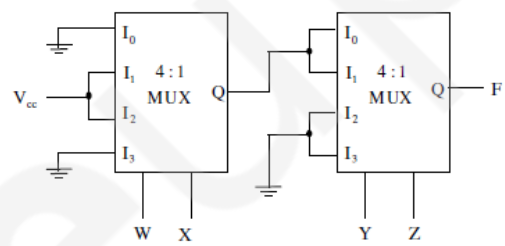
$$\frac{V_{DD} - V_0}{10K} = \frac{1}{2}\times 100\times 10^{-6}\times 2\left(V_{GS} - 0.5\right)^2$$

$$\frac{2-\left(V_i - 0.5\right)}{10K} = 100\times 10^{-6}\left(V_i - 0.5\right)^2$$

$$\Rightarrow V_i = 1.5V$$

50. Ans. B.
For an SRAM construction four MOSFETs are required (2-PMOS and 2-NMOS) with interchanged outputs connected to each CMOS inverter. So option (B) is correct.

51. Ans. C



The output of the first MUX $= \overline{W}\times V_{cc} + W\overline{X}.V_{cc}$

$$\overline{W}X + W\overline{X}\left(\because \qquad \text{ɜic}1\right)$$

$$= W \oplus X$$

$$Let\, Q = W \oplus X$$

The output of the second MUX $= Q.\overline{Y}\overline{Z} + Q.\overline{Y}Z$

$$= Q.\overline{Y}\left(\overline{Z} + Z\right)$$

$$= Q.\overline{Y}.1 = Q.\overline{Y}$$

Put the value of Q in above expression

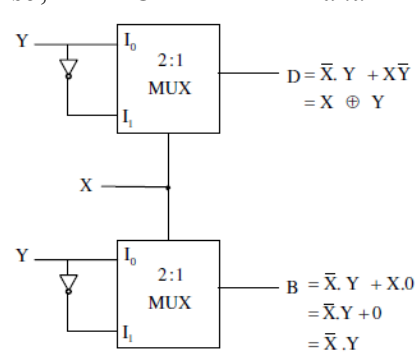
$$= \left(\overline{W}X + W\overline{X}\right).\overline{Y}$$

$$= \overline{W}X.\overline{Y} + \overline{W}X.\overline{Y}$$

52. Ans. A.

X	Y	D	B
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

$$so, D = X \oplus Y = \overline{X}Y + X\overline{Y} \text{ and } B = \overline{X}.Y$$



53. Ans. B.

$$H_1(z)=\left(1-Pz^{-1}\right)^{-1}$$

$$H_2(z)=\left(1-qz^{-1}\right)^{-1}$$

$$H(z)=\frac{1}{\left(1-Pz^{-1}\right)}+r\frac{1}{\left(1-qz^{-1}\right)}$$

$$=\frac{1-qz^{-1}r\left(1-Pz^{-1}\right)}{\left(1-Pz^{-1}\right)\left(1-Pz^{-1}\right)}=\frac{(1+r)(q+rp)z^{-1}}{\left(1-Pz^{-1}\right)\left(1-Pz^{-1}\right)}$$

$$Zero\,of\,H(z)=\frac{q+rp}{1+r}$$

Since zero is existing on unit circle

$$\Rightarrow\frac{q+rp}{1+r}=1\,or\,\frac{q+rp}{1+r}=-1$$

$$\frac{-\frac{4}{2}+\frac{r}{2}}{1+r}=1\,or\,\frac{-\frac{4}{2}+\frac{r}{2}}{1+r}=-1$$

$$-\frac{4}{2}+\frac{r}{2}=1+r\quad or\quad -\frac{4}{2}+\frac{r}{2}=-1-r$$

$$\Rightarrow r=-\frac{5}{2}\Rightarrow\frac{r}{2}=-\frac{5}{4}\quad or\quad\frac{3}{4}=\frac{-3r}{2}\quad r=-1/2\Rightarrow r=-0.5$$

$$r=-\frac{5}{2}\text{is not possible}$$

54. Ans. A.

$$h(t)\Leftrightarrow H(s)=\frac{1}{s+1}\Rightarrow h(t)=e^{-t}u(t)$$

S_1: System is stable (TRUE)
Because h(t) absolutely integrable

$S_2:\dfrac{h(t+1)}{h(t)}$ is independent of time (TRUE)

$\dfrac{e^{-(t+1)}}{e^{-t}}\Rightarrow e^{-1}$ (independent of time)

S_3: A non-causal system with same transfer function is stable

$\dfrac{1}{s+1}\Leftrightarrow -e^{-t}u(-t)$ (a non-causal system) but this is not absolutely integrable thus unstable.

Only S_1 and S_2 are TRUE

55. Ans. B.

$$X(z)=\frac{1}{\left(1-2z^{-1}\right)}=\frac{1}{\left(1-2z^{-1}\right)}\frac{1}{\left(1-2z^{-1}\right)}$$

$$x[n]=2^n u[n]*2^n u[n]$$

$$x[n]=\sum_{k=0}^{n}2^K.2^{(n-k)}$$

$$\Rightarrow x[2]=\sum_{k=0}^{n}2^K.2^{(2-k)}=2^0.2^2+2^1.2^1+2^2.2^0$$

$$=4+4+4=12$$

Alternative Way:

$$X(z)=\frac{1}{\left(1-2Z^{-1}\right)^2}=\frac{Z^2}{(Z-2)^2}$$

$$X(n)=Z^{-1}\left[\underset{\substack{\downarrow\\ u(z)}}{\frac{Z}{Z-2}}.\underset{\substack{\downarrow\\ v(z)}}{\frac{Z}{Z-2}}\right]$$

$$=\sum_{m=0}^{n}u_m.V_{n-m}$$

$$\left(\text{using conduction theorem and } u_a=2^n;v_n=2^n\right)$$

$$=\sum_{m=0}^{n}2^m.2^{n-m}=2^n(n+1)$$

$$\therefore x(2)=12$$

56. Ans. A.

$$Given\,G(s)=\frac{4}{s+2};H(s)=\frac{2}{s+4}$$

For unit step input,

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

$$k_p=\lim_{s\to 0}\left(\frac{4}{s+2}\right)\left(\frac{2}{s+4}\right)$$

$$\boxed{k^p=1}$$

$$\text{steady state error } e_{ss}=\frac{A}{1+k_p}$$

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

$$e_{ss}=\frac{1}{2}\Rightarrow 0.50$$

57. Ans. B.

Apply linearity principle,

$$\begin{bmatrix}3\\5\end{bmatrix}=a\begin{bmatrix}1\\-1\end{bmatrix}+b\begin{bmatrix}0\\1\end{bmatrix}s$$

$$a=3;b=8$$

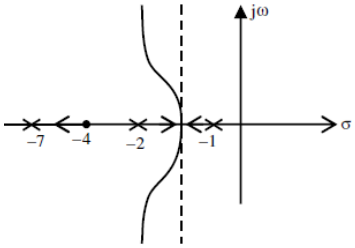
$$x(t)=\begin{bmatrix}e^{-t} & -e^{-2t}\\ -e^{-t} & 2e^{-2t}\end{bmatrix}$$

$$\Rightarrow x(t)=\begin{bmatrix}11e^{-t}-8e^{-2t}\\ -11^{-t}+16e^{-2t}\end{bmatrix}$$

58. Ans. B.

For transfer function $\dfrac{(s+4)}{(s+1)(s+2)(s+3)}$

From pole zero plot



59. Ans. C.
Shifting in time domain does not change PSD. Since PSD is Fourier transform of autocorrelation function of WSS process, autocorrelation function depends on time difference.

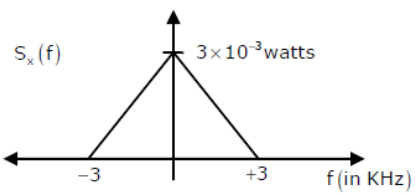
$$X(t) \leftrightarrow R_x(z) \leftrightarrow S_x(f)$$

$$Y(t) = X(2t-1) \leftrightarrow R_y(2\zeta) \leftrightarrow \frac{1}{2} S_x\left(\frac{f}{2}\right)$$

[time scaling property of Fourier transform]

60. Ans. C.

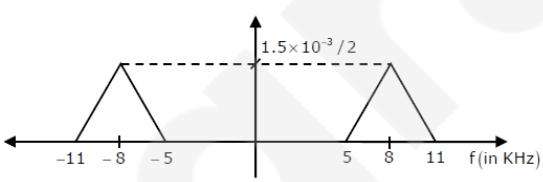
$$S_x(f)$$



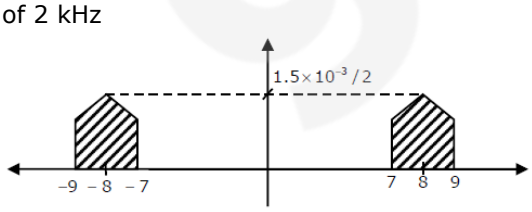
After modulation with cos(16000 πt)

$$S_y(f) = \frac{1}{4}\left[S_x(f-f_c) + S_x(f-f_c)\right]$$

This is obtain the power spectral density Random process y(t), we shift the given power spectral density random process x(t) to the right by f_c shift it to be the left by f_c and the two shifted power spectral and divide by 4.



After band pass filter of center frequency 8 KHz and BW of 2 kHz



Total output power is area of shaded region

$$= 2[\text{Area of one side portion}]$$

$$= 2[\text{Area of triangle} + \text{Area of rec tangle}]$$

$$= \frac{2\left[-\frac{1}{2}\times 2\times10^{3}\times 0.5\times10^{-3} + 2\times10^{3}\times 1\times10^{-3}\right]}{2}$$

$$= [0.5+2] = 2.5\,watts$$

61. Ans. D.
Nyquist rate = 2×50Hz
=100 samples / sec

$$\Delta = \frac{m(t)_{\max} - m(t)_{\max}}{L} \Rightarrow L = \frac{\sqrt{2}-(-\sqrt{2})}{0.75}$$

$$L = \frac{2\sqrt{2}}{0.75} = 3.774 = 4$$

No. of bits required to encode '4' levels = 2 bits/level
Thus, data rate = 2×100 = 200 bits / sec

62. Ans. A.

$$Let\, P\{x=2\} = \frac{1}{3}, P\{x=0\} = \frac{2}{3}$$

to find $H(Y_1)$ we need to know

$$P\{y_1=0\} \text{ and } P\{y_2=0\}$$

$$P\{y_1=0\} = P\{y_1=0/x_1=0\}$$

$$P\{x_1=0\}P\{y_1=0/x_1=1\}P\{x_1=1\}$$

$$= \frac{1}{2}.\frac{1}{3} + \frac{1}{2}\times\frac{2}{3} = \frac{1}{2}$$

$$P\{y_1=0\} = \frac{1}{2}$$

$$\Rightarrow H(y_1) = \frac{1}{2}\log_2{}^2 + \frac{1}{2}\log_2{}^2 = 1$$

Similarly

$$P\{y_2=0\} = \frac{1}{2}\, and\, P\{y_2=0\} = \frac{1}{2}$$

$$\Rightarrow H\{y_2\} = 1$$

$$\Rightarrow H\{y_1\} + H\{y_2\} = 2bits$$

63. Ans. A.

$$Curl\,\vec{A}\begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ \cos x\sin y & \sin x\cos y & 0 \end{vmatrix}$$

$$= 0$$

$$\therefore \left|Curl\,\vec{A}\right| = 0$$

Alternative Way:

$$Given\, A = \cos x\sin y\hat{a}_x + \sin x\cos y\,\hat{a}_y$$

$$\nabla \times A = \begin{vmatrix} a_x & a_y & a_z \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ \cos x \sin y & \sin x \cos y & 0 \end{vmatrix}$$

$$= a_x(0) - a_y(0) + a_z(\cos x \cos y - \cos x \cos y) = 0$$

$$\therefore |\nabla \times A| = 0$$

64. Ans. D.

Given medium (1) is perfect conductor

Medium (2) is air

$\therefore \quad H_1 = 0$

From boundary conditions

$$(H_1 - H_2) \times a_n = K_S$$

$$\left.\begin{matrix} H_1 = 0 \\ a_n = a_y \end{matrix}\right| K_S = 2\hat{a}_x$$

$$-H_2 \times a_y = 2\hat{a}_x$$

$$-(H_x a_x + H_y a_y + H_z a_z) \times a_y = 2a_x$$

$$-H_x a_z + H_z a_x = 2a_x$$

$$\therefore H_z = 2$$

$$\boxed{H = 2a_z}$$

65. Ans. A.

$$Given\ E = 10\cos\left(\omega t - 3x - \sqrt{3}z\right)a_y$$

$$E = E_0 e^{-j\beta(x\cos\theta_x + y\cos\theta_y + z\cos\theta_z)}$$

$$So, \beta_x = \beta\cos\theta_x = 3$$

$$\beta_y = \beta\cos\theta_y = 0$$

$$\beta_z = \beta\cos\theta_z = \sqrt{3}$$

$$\beta_x{}^2 + \beta_y{}^2 + \beta_z{}^2 = \beta^2$$

$$9 + 3 = \beta^2 \Rightarrow \beta = \sqrt{13}$$

$$\beta\cos\theta_2 = \sqrt{3} \Rightarrow \cos\theta_z = \sqrt{\frac{3}{13}} \Rightarrow \theta_z = 61.28 = \theta_i$$

$$\frac{\sin\theta_t}{\sin\theta_i} = \sqrt{\frac{E_2}{E_1}} \Rightarrow \frac{\sin 61.28}{\sin\theta_t} = \sqrt{\frac{3}{1}} \Rightarrow \frac{0.8769}{\sqrt{3}} = \sin\theta_t$$

$$\theta_t = 30.4 \Rightarrow \theta_t \simeq 30°$$

***