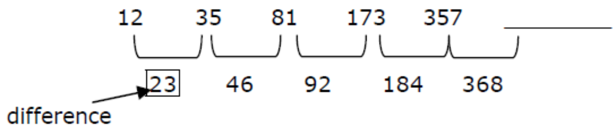
1. Ans. C.

2. Ans. D.

3. Ans. B.

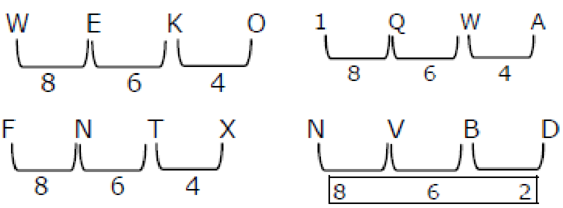
4. Ans. A.
If the standard deviation is less, there will be less deviation or batsman is more consistent

5. Ans. B.



$$\begin{array}{r} 357 \\ \Rightarrow \underline{368} \\ 725 \end{array}$$

6. Ans. D.



Difference of position: D

7. Ans. B.
Resident female in between 8 to 10 lakhs haven[illegible]en mentioned.

8. Ans. D.
For a train to cross a person, it take[illegible] sec[illegible]r its 280m. So, for second 60 seconds. [illegible] di[illegible] travelled should be 840. Includi[illegible] 280 t[illegible] len[illegible] length of plates =840-280=56[illegible]

9. Ans. D.

$2004, \frac{\text{(imports-exports)}}{\text{exports}} [illegible] \frac{10}{[illegible]} = \frac{1}{7}$

$2005, \frac{26}{76} = \frac{2}{7}$

$2006, \frac{20}{100} = \frac{1}{5}$

$2007, \frac{10}{100} = \frac{1}{11}$

10. Ans. B.

11. Ans. D.
Matrix multiplication is not commutative in general.

12. Ans. D.
Let E_1 = one children family
E_2 = two children family and
A = picking a child then by Baye's theorem, required probability is

$$P\left(E_2/A\right) = \frac{\frac{1}{2}.x}{\frac{1}{2}.\frac{x}{2}+\frac{1}{2}.x} = \frac{2}{3} = 0.667$$

(Here 'x' is number of families)

13. Ans. C.
Z = −2j is a singularity lies inside $C:|Z|=3$
∴ By Cauchy's integral formula,

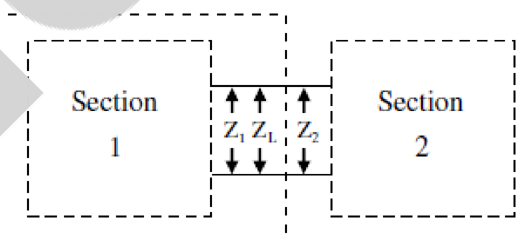
$$\rightarrow \oint_C \frac{z^2 - z + 4j}{z+2j}dz = 2\pi j.\left[Z^2 - Z + 4j\right]_{z=-2j}$$

$$= 2\pi j\left[-4+2j+4j\right] = [illegible] 4\pi\left[3+j2\right]$$

14. Ans. A.
$A^2 = I \Rightarrow A = A^{-1} \Rightarrow$ [illegible] is on eig[illegible] value of A then $\frac{1}{\lambda}$ is also its e[illegible]n value. Sin[illegible] we require positive eigen value. $\therefore \lambda$ [illegible] is the onl[illegible] possibility as no other positive n[illegible] is sel[illegible]vers[illegible]

[illegible]5. An[illegible]D.

1[illegible]ns. C
[illegible]ed sections

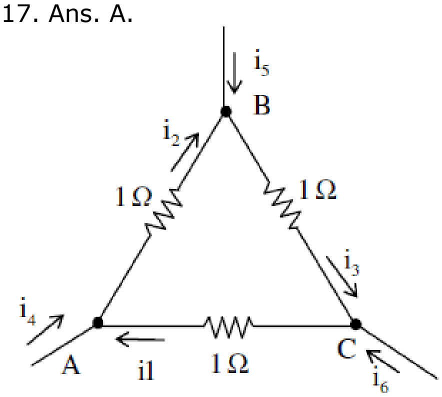


Z_1 = Output impedance of first section
Z_2 = Input impedance of second section
For maximum power transfer, upto 1st section is

$Z_L = Z_1^*$

$Z_L = Z_2 \Rightarrow Z_1^*$

17. Ans. A.



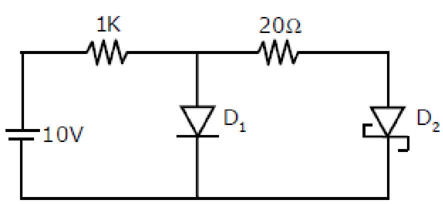
$$Given\, i_1 = 2A$$
$$i_4 = -1A$$
$$i_5 = -4A$$
$$KCL\, at\, node\, A, i_1 + i_4 = i_2$$
$$\Rightarrow i_2 = 2 - 1 = 1A$$

1. $KCL\, at\, node\, B, i_2 + i_5 = i_3$
$$\Rightarrow i_3 = 1 - 4 = -3A$$
$$KCL\, at\, node\, C, i_3 + i_6 = i_1$$
$$\Rightarrow i_6 = 2 - (-3) = 5A$$

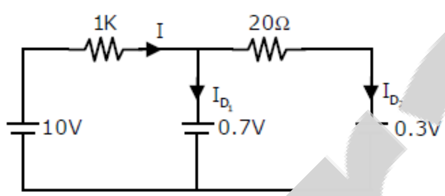
18. Ans. D.

$$\text{Responsivity } (R) = \frac{I_p}{P_0}$$
$$0.8 = \frac{I_p}{10 \times 10^{-6}}$$
$$\Rightarrow I_8 = 8\mu A$$

19. Ans. D.



Figure(1)



Assume both the diode ON.
Then circuit will be as per figure (2)

$$\therefore I = \frac{10 - 0.7}{1K} = 9.3mA$$
$$I_{D_2} = \frac{0.7 - 0.3}{20} = 20mA$$
$$Now, I_{D_1} = I - I_{D_2}$$
$$= -10.7\, mA (\text{Not possible})$$
$$\therefore D_1 \text{ is OFF and hence } D_2 - ON$$

20. Ans. A.

21. Ans. B.

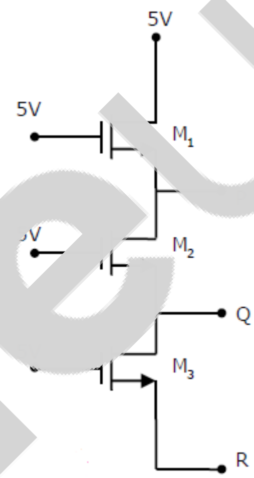
$$\text{Ideal current Buffer has } Z_i = 0$$
$$Z_0 = \infty$$

22. Ans. B.
Output sample is voltage and is added at the input or current
∴ It is voltage – shunt negative feedback i.e, voltage-current negative feedback

23. Ans. C.
f = 5KHz

$$\text{Cut off frequency} (LPF) = \frac{1}{2\pi R_2 C} = 5KHz$$
$$\Rightarrow R_2 = \frac{1}{2\pi \times 5 \times 10^3 \times 10 \times 10^{-9}} \approx 3.18k\Omega$$

24. Ans. C.
Assume al NMOS are in saturation



$$\therefore V_{DS} \geq (V_{GS} - V_T)$$
$$For\, m_1$$
$$(5 - V_p) \geq (5 - V_p - 1)$$
$$(5 - V_p) > (4 - V_P) \Rightarrow Sat$$
$$\therefore I_{D_1} = k(V_{GS} - V_T)^2$$
$$I_{D_1} = K(4 - V_P)^2 \,..........(1)$$
$$For\, m_2,$$
$$I_{D_1} = K(5 - V_Q - 1)^2$$
$$I_{D_1} = K(4 - V_Q)^2 \quad ....(2)$$
$$\therefore I_{D_1} = I_{D_2}$$
$$(4 - V_P)^2 = (4 - V_Q)^2$$
$$\Rightarrow V_P = V_Q \,\&\, V_P = V_Q = 8$$
$$\Rightarrow V_P = V_Q = 4V$$

$For\ m_3,$

$I_{D_3} = K\left(5 - V_R - 1\right)^2$

$\therefore I_{D_2} = I_{D_3}$

$\left(4 - V_Q\right)^2 = \left(4 - V_R\right)^2$

$\Rightarrow V_R = V_Q = 4V$

$\therefore V_P = V_Q = V_R = 4V$

25. Ans. A.

Given Boolean Expression is $(X+Y)(X+\overline{Y})\overline{(X+\overline{Y})+\overline{X}}$

As per the transposition theorem

$\left(A+BC\right) = \left(A+B\right)\left(A+C\right)$

$so, \left(X+Y\right)\left(X+\overline{Y}\right) = X + Y\overline{Y} = X + 0$

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

$= X + (\overline{X}+Y).X = X + \overline{X}X. + Y.X = X + 0 + Y.X$

$\text{Applyabsorption theorem} = X\left(1+Y\right) = X.1 = X$

26. Ans. C.

Given circuit is a Ripple (Asynchrnous) counter. In ripple counter, o/p frequency of each flip-flop is half of the input frequency if their all the states are used otherwise

o/p frequency of the counter is $= \dfrac{\text{input frequency}}{\text{modulus of the counter}}$

So, the frequency at $Q_3 = \dfrac{\text{input frequency}}{16}$

$= \dfrac{1\times10^6}{16} H_z = 62.5kHz$

27. Ans. D.

Assume x[n] to be periodic, (with period N)

$\Rightarrow x[n] = x[n+N]$

$\Rightarrow \sin\left(\pi^2 n\right) = \sin\left(\pi^2 (n+N)\right)$

Every trigonometric function repeats after 2π interval.

$\Rightarrow \sin\left(\pi^2 n + 2\pi k\right) = \sin\left(\pi^2 n + \pi^2 N\right)$

$\Rightarrow 2\pi k = \pi^2 N \Rightarrow N = \left(\dfrac{2}{\pi}\right)k$

Since 'k' is any integer, there is no possible value of 'k' for which 'N' can be an integer, thus non-periodic.

28. Ans. B.

x(t) is band limited to [−500Hz, 500Hz] y(t)is band limited to [−1000Hz, 1000Hz] z(t) = x (t).y(t)

Multiplication in time domain results convolution in frequency domain.

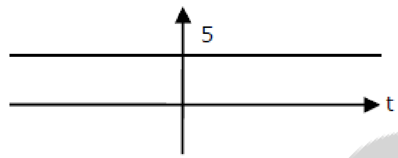
The range of convolution in frequency domain is [−1500Hz, 1500Hz]

So maximum frequency present in z(t) is 1500Hz Nyquist rate is 3000Hz or 3 kHz

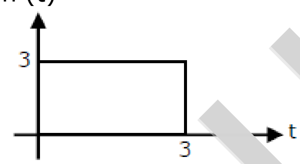
29. Ans. C.

y(t) = x (t)* h(t)

x(t) =



h (t) =



$y(t) = \int_0^3 5\times3\, d\tau = 45(\text{steady state output})$

30. Ans. A.

$Given\ G(s) = \dfrac{K}{\left(s+2\right)\left(s-1\right)}$

and $H(s) = 1$

$\text{Characteristic equation: } 1 + G\left(s\right)H\left(s\right) = 0$

$1 + \dfrac{K}{\left(s+2\right)\left(s-1\right)} = 0$

$\text{The poles are } s_{1,2} = -1 \pm \sqrt{\dfrac{9}{4} - 4K}$

$\text{If } \dfrac{9}{4} - K = 0,$

then both poles of the closed loop system at the same location.

$So, K = \dfrac{9}{4} \Rightarrow 2.25$

31. Ans. D.

For larger values of K, it will encircle the critical point (-1+j0), which makes closed-loop system unstable.

32. Ans. D.

Spreading factor $\left(SF\right) = \dfrac{\text{chip rate}}{\text{symbol rate}}$

This if a single symbol is represented by a code of 8 chips

Chip rate =80×symbol rate

S.F (Spreading Factor) $= \dfrac{8\times\text{symbol rate}}{\text{symbol rate}} = 8$

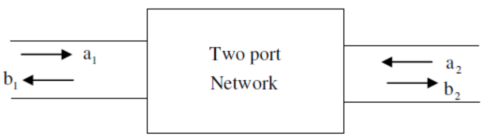
Spread factor (or) process gain and determine to a certain extent the upper limit of the total number of uses supported simultaneously by a station.

33. Ans. A.
Capacity of channel is 1-H(p)
H(p) is entropy function
With cross over probability of 0.5

$$H(p)=\frac{1}{2}\log_2\frac{1}{0.5}+\frac{1}{2}\log_2\frac{1}{0.5}=1$$

$$\Rightarrow \text{Capacity}=1-1=0$$

34. Ans. B.



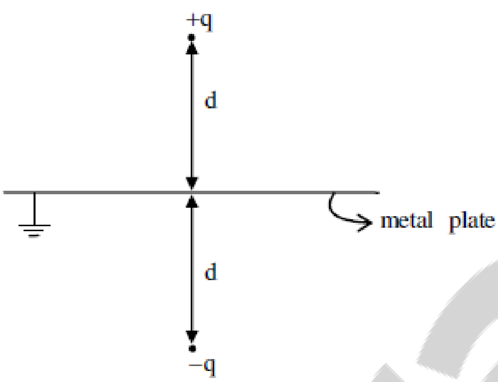
$$b_1=s_{11}a_1+s_{12}a_2$$

$$b_2=s_{21}a_1+s_{22}a_2$$

$$\begin{bmatrix}b_1\\b_2\end{bmatrix}=\begin{bmatrix}s_{11}&s_{12}\\s_{21}&s_{22}\end{bmatrix}\begin{bmatrix}a_1\\a_2\end{bmatrix};\quad S_1=\left.\frac{b_1}{a_1}\right|_{a_2=0}$$

By verification Answer B satisfies.

35. Ans. C.



$$F=\frac{1}{4\pi\in}\frac{Q_1Q_2}{R^2}$$

$$F=\frac{1}{4\pi\in}\frac{9^2}{(2d)^2}=\frac{9^2}{16\pi\in d^2}$$

Since the charges are of opposite polarity the force between them is attractive.

36. Ans. A.

$$3\sin x+2\cos x=3\left(x-\frac{x^3}{3!}+\dots\right)+2\left(x-\frac{x^2}{2!}+\dots\right)$$

$$=2+3x-x^2-\frac{x^3}{2}+\dots$$

37. Ans. B.
Given

$$\int_{-\infty}^{\infty}g(t).e^{jwt}dt=\omega^{-2w^2}\left(let\,G(j\omega)\right)$$

$$\Rightarrow\int_{-\infty}^{\infty}g(t)dt=0$$

$$y(t)=\int_{-\infty}^{t}g(z).dz\Rightarrow y(t)=g(t)*u(t)$$

$[u(t)\text{in unit step function}]$

$$\Rightarrow Y(j\omega)=G(j\omega).U(j\omega)$$

$$Y(j\omega)=\int_{-\infty}^{\infty}y(t).e^{-j\omega t}dt$$

$$\Rightarrow Y(j0)=\int_{-\infty}^{\infty}y(t).e^{-j\omega t}dt$$

$$=\left[\omega.e^{-2w^2}\left[\frac{1}{j\omega}+\pi\delta(\omega)\right]\right]=0$$

$$=\frac{1}{j}=-j$$

38. Ans. D.

$$Volume=\iint_R f(x,y)dydx=\int_{x=0}^{12}\int_{y=0}^{x}(x+y)dydx$$

$$=\int_0^{12}\left[xy+\frac{y^2}{2}\right]_0^x.dx=\int_0^{12}\frac{3}{2}x^2dx=\frac{3}{2}\left[\frac{x^3}{3}\right]_0^{12}=864$$

39. Ans. B.

$Consider,(i)\,Let\,P=I_2+\alpha J_2$

$$=\begin{bmatrix}1&0\\0&1\end{bmatrix}+\alpha\begin{bmatrix}0&1\\1&0\end{bmatrix}=\begin{bmatrix}1&\alpha\\\alpha&1\end{bmatrix}$$

$$\Rightarrow|P|=1-\alpha^2$$

$$(ii)\,Let\,P=I_4+\alpha J_4=\begin{bmatrix}1&0&0&\alpha\\0&1&\alpha&0\\0&\alpha&1&0\\\alpha&0&0&1\end{bmatrix}$$

$$|P|=(1)\begin{vmatrix}1&\alpha&0\\\alpha&1&0\\0&0&1\end{vmatrix}-(\alpha)\begin{vmatrix}0&1&\alpha\\0&\alpha&1\\\alpha&0&0\end{vmatrix}$$

$$=(1-\alpha^2)-(\alpha)\left[\alpha(1-\alpha^2)\right]=(1-\alpha^2)^2$$

Similarly, if $P=I_6+\alpha J_6$ then we get

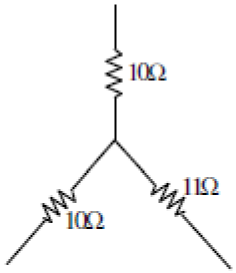
$$|P|=(1-\alpha^2)^3$$

$$|P|=0\Rightarrow\alpha=-1,1$$

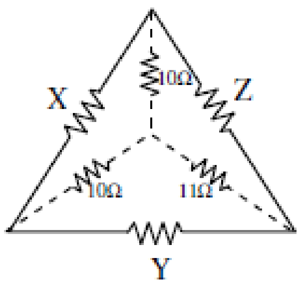
$\because$ negative

$\therefore\alpha=1$

40. Ans. D.



Star Connection



Delta Connection

$$x = 29.09\Omega, y = 32\Omega, z = 32\Omega$$

$$x = \frac{(10)(10)+(10)(11)+(10)(11)}{11}\Omega$$

$$y = \frac{(10)(10)+(10)(11)+(10)(11)}{10}\Omega$$

$$z = \frac{(10)(10)+(10)(11)+(10)(11)}{10}\Omega$$

i.e, lowest value among three resistances is 29.09Ω

41. Ans. B.
Load 1:

$$P = 10$$

$$\cos\phi = 0.8 \qquad S_1 = P - jQ = 10 - j7.5\,KVA$$

$$Q = P\tan\phi = 7.5\,KVAR$$

Load 2: S = 10 KVA

$$\cos\phi = 0.8 \qquad \sin\phi = \frac{Q}{S}$$

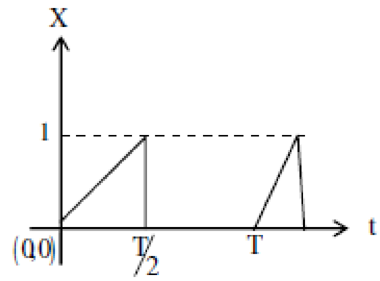
$$\cos\phi = \frac{P}{S}$$

$$0.8 = \frac{P}{10} \rightarrow = 8kw \quad Q = 6KVAR$$

$$S_1 = P + jQ = 8 + j6$$

Complex power delivered by the source is
$S_1 + S_n = 18 - j1.5\,KVA$

42. Ans. C.



$$x_{rms} = \sqrt{\frac{1}{T}\int_0^T (x(t))^2\,dt}$$

$$x(t) = \begin{cases} \frac{2}{T}t & 0 \le t \le T/2 \\ 0 & T/2 \le t \le T \end{cases}$$

$$= \sqrt{\frac{1}{T}\left[\int_0^{T/2}\left(\frac{2}{T}.t\right)^2 dt + \int_{T/2}^{T}(0)^2 .dt\right]}$$

$$= \sqrt{\frac{1}{T}.\frac{4}{T^2}\left[\frac{t^3}{3}\right]_0^{T/2}}$$

$$x_{rms} = \sqrt{\frac{4}{3T^3}.\frac{T^3}{8}} \Rightarrow \sqrt{\frac{1}{6}} \Rightarrow 0.408$$

43. Ans. B.
By KVL,

$$v(t) = Ri(t) + L.\frac{di(t)}{dt} + \frac{1}{C}\int i(t)\,dt$$

Differentiate with respect to time,

$$0 = \frac{R.di(t)}{dt^2} + \frac{R}{L}.\frac{di(ti)}{dt} + \frac{i(t)}{LC} = 0$$

$$\frac{d^2i(t)}{dt^2} + \frac{R}{L}.\frac{di(t)}{dt} + \frac{i(t)}{LC} = 0$$

$$D_{1.2} = \frac{\frac{-R}{L} \pm \sqrt{\left(\frac{R}{L}\right)^2 - \frac{4}{LC}}}{2}$$

$$D_{1.2} = \frac{-R}{L} \pm \sqrt{\left(\frac{R}{2L}\right)^2 - \frac{1}{LC}}$$

For critically damped response,

$$\left(\frac{R}{2L}\right)^2 = \frac{1}{LC} \Rightarrow \boxed{C = \frac{4L}{R^2}}F$$

$$Given, L = 4H;\ R = 40\Omega$$

$$C = \frac{4\times 4}{(40)^2} \Rightarrow 10mF$$

44. Ans. D.

$$V_{BE}=0.7V,\frac{KT}{q}=25mV,I_s=10^{-13}$$

$$\text{Transcondutance, } g_m=\frac{I_C}{V_T}$$

$$I_C=I_S\left[e^{V_{BE}/V_T}-1\right]$$

$$=10^{-13}\left[e^{0.7/25mV}-1\right]=144.625mA$$

$$\therefore g_m=\frac{I_C}{V_T}=\frac{144.625mA}{25mV}=5.785A/V$$

45. Ans. A.

$$\text{Electron concentration}, n\simeq\frac{n_i^2}{N_A}e^{V/V_T}$$

$$=\frac{\left(1.5\times10^{10}\right)^2}{1\times10^{16}}e^{0.3/26mV}$$

$$=2.3\times10^9/cm^3$$

46. Ans. C.

$$Given\,V_T=-0.5V;V_{GS}=2V;V_{DS}=5V;$$

$$W/L=100;C_{0_x}=10^{-8}f/cm$$

$$\mu_n=800cm^2/v-s$$

$$I_D=\frac{1}{2}\mu_nC_{0x}\frac{W}{L}\left[2\left(V_{GS}-V_T\right)V_{DS}-V_{DS}{}^2\right]$$

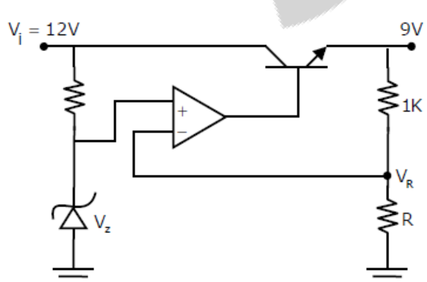
$$\left[\frac{\partial I_D}{\partial V_{DS}}\right]^{-1}=r_{ds}\left[\frac{\partial}{\partial V_{DS}}\left\{\frac{1}{2}\mu_nC_{0x}\frac{W}{L}\left[2\left(V_{GS}-V_T\right)V_{DS}-V_{DS}{}^2\right]\right\}\right]^{-1}$$

$$=\left[\mu_nC_{0x}\frac{W}{L}\left(V_{GS}-V_T\right)-\mu_nC_{0x}\frac{W}{L}V_{DS}\right]^{-1}$$

$$\Rightarrow\left|r_{ds}\right|=\left|\frac{1}{\mu_nC_{0x}\frac{W}{L}\left(V_{GS}-V_T-V_{Ds}\right)}\right|$$

$$=\left|\frac{1}{800\times10^{-8}\times100(2+0.5-5)}\right|=500\Omega$$

47. Ans. C.



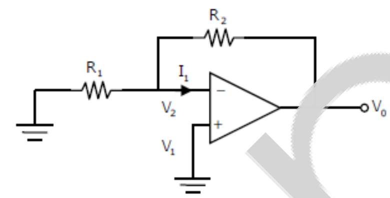
$$Given\,V_{BE}=0.7V,\beta=100,V_Z=4.7V,V_0=9V$$

$$V_R=9\times\frac{R}{R+1k}$$

$$4.7=9\times\frac{R}{R+1k}(\because\quad)$$

$$R=1093\Omega$$

48. Ans. C.



$$Given,Z_i=\infty$$

$$A_{0_L}=\infty$$

$$V_{i_0}=0$$

$$V_2=\left(R_1//R_2\right)I_1$$

$$=\frac{R_1R_2}{R_1+R_2}I_1......(1)$$

KCL at inverting node

$$\frac{V_2}{R_1}+\frac{V_2-V_0}{R_2}=0\quad\left(\therefore Z_i=\infty\right)$$

$$\frac{V_0}{R_2}=V_2\left[\frac{1}{R_1}+\frac{1}{R_2}\right]$$

$$\frac{V_0}{R_2}=\left(\frac{R_1R_2}{R_1+R_2}\right)I_1\left[\frac{R_2+R_1}{R_1R_2}\right]$$

$$\Rightarrow V_0=I_1R_2$$

49. Ans. D.

$$V_{BE}=0.7V,\beta=200,V_T=25mV$$

DC Analysis:

$$V_B=12\times\frac{11k}{11k+33k}=3V$$

$$V_E=3-0.7=2.3V$$

$$I_E=\frac{2.3}{10+1k}=2.277mA$$

$$I_B=11.34\mu A$$

$$I_C=2.26mA$$

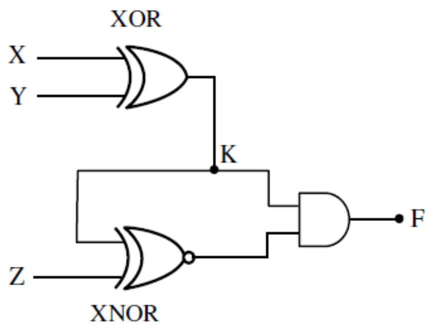
$$r_e=\frac{25mV}{2.277mA}=10.98\Omega$$

$$A_V=\frac{V_0}{V_i}=\frac{-\beta R_C}{\beta r_e+\left(1+\beta\right)\left(R_s\right)}$$

$$=\frac{-200\times5k}{200\times10.98+\left(201\right)10}$$

$$A_V=-237.76$$

50. Ans. A.



Assume dummy variable K as a output of XOR gate

$K = X \oplus Y = \overline{X}Y + X\overline{Y}$

$F = K.(K \odot$ [illegible]

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

$= K.\overline{K}\overline{Z} + K.K.Z$

$= 0 + K.Z(\because$ [illegible] $) and\ K.K = K)$

Put the value of K in above expression

$F = \left(\overline{X}Y + X\overline{Y}\right)Z$

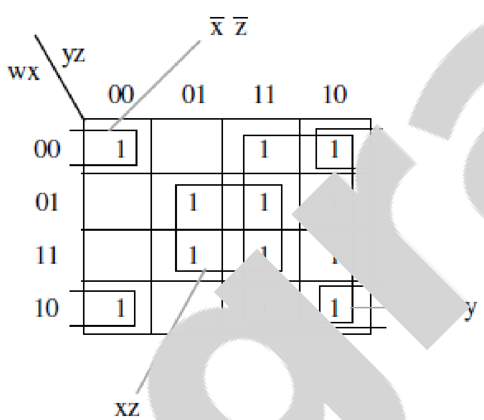
$= \overline{X}YZ + X\overline{Y}Z$

51. Ans. D.

Given Boolean Function is

$F(w,x,y,z) = wy + xy + \overline{w}xyz + w\overline{x}\overline{y} + xz + \overline{x}\overline{y}\overline{z}.$

By using K-map



So, the essenti[illegible] plic[illegible] (EPI) are $y, xz, \overline{x}\overline{z}$

52. Ans. D.

The input of D_2 flip-flop i[illegible]

$D_2 = \overline{Q}_1 s + Q_1 \overline{s}(\because$ [illegible]

The alternate expression for EX-NOR gate is

$= \overline{A \oplus B} = \overline{A} \oplus B = A \oplus \overline{B}$

So, if the Ex-OR gate is substituted by Ex-NOR gate then input A should be connected to $\overline{Q}_1$

$D_2 = \overline{Q}_1 \overline{S} + Q_1 S = \overline{\overline{Q}}_1 \overline{S} + \overline{Q}_1 .S(\because$ [illegible]

$= Q_i \overline{S} + \overline{Q}_1 .S$

53. Ans. C.

$Given\, x[n] = \left(\frac{1}{-9}\right)^n u(n) - \left(-\frac{1}{3}\right)^n u[-n-1]$

$for \left(\frac{-1}{9}\right)^h u[n] R_{oc} in |z| > \frac{1}{9}$

(Right sided sequence, R_{oc} in exterior of circle of radius $1/9$)

Thus overall $R_{oc} in \frac{1}{9} < |z| < \frac{1}{3}$

54. Ans. B.

$Given\, x[n] = \sin\left(\frac{\pi n}{\ }\right); N = 1$ [illegible]

⇒Fourier series co-e[illegible]ents are [illegible] periodic with period N =10

$x[n] = \frac{1}{2j} e$ [illegible] $\frac{-1}{j} e^{-i\frac{2\pi}{10}n}$ [illegible] $_{-1} = a_{-1} + 20$

[illegible] $= \frac{-1}{2j} \Rightarrow a_{-1} = a_{-1+10} = a_9 = \frac{-1}{2j}$

[illegible] $+10$ [illegible] or $a_1 = a_1 + 20$, $a_{-1} = a_{-1} + 20$

$\Rightarrow k = 10m + 1 or\, k = 10.m - 1 \Rightarrow B = 10$

[illegible]. Ans. A.

Given y(t)+ 5y(t) = u (t) and y(0)=1; u (t)is a unit step function.

Apply Laplace transform to the given differential equation.

$Sy(s) - y(0) + 5y(s) = \frac{1}{s}$

$y(s)[s+5] = \frac{1}{s} + y(0)\left[L\left[\frac{dy}{dt}\right] = sy(s) - y(0)\right]$

$\left[L\left[u(t) = 1/s\right]\right]$

$y(s) = \frac{\frac{1}{s} + 1}{(s+5)}$

$y(s) = \frac{\frac{1}{s} + 1}{(s+5)} \Rightarrow \frac{A}{s} + \frac{B}{s+5}$

$A = 1/5; B = 4/5$

$y(s) = \frac{1}{5s} + \frac{4}{5(s+5)}$

Apply inverse Laplace transform,

$y(t) = \frac{1}{5} + \frac{4}{5} e^{-5t}$

$y(t) = 0.2 + 0.8e^{-5t}$

56. Ans. B.

From the given state model,

$$A=\begin{bmatrix}-1 & 1 & 0\\ 0 & -1 & 0\\ 0 & 0 & -2\end{bmatrix} B=\begin{bmatrix}0\\4\\0\end{bmatrix} \quad C=\begin{bmatrix}1 & 1 & 1\end{bmatrix}$$

$$\text{Controllable:} Q_c = c = \begin{bmatrix}B & AB & A^2B\end{bmatrix}$$

$$if\,|Q_c| \neq 0 \rightarrow \text{controllable}$$

$$Q_c = \begin{bmatrix}0 & 4 & -8\\ 4 & -4 & 4\\ 0 & 0 & 0\end{bmatrix} \Rightarrow |Q_c| = 0$$

$\therefore$ uncortrollable

$$\text{Observable:} Q_0 = \begin{bmatrix}C\\ CA\\ CA^2\end{bmatrix}$$

$$If\,|Q_0| \neq 0 \rightarrow \text{observable}$$

$$Q_0 = \begin{bmatrix}1 & 1 & 1\\ -1 & 0 & -2\\ 1 & 2 & 4\end{bmatrix} \Rightarrow |Q_0| = 1$$

$\therefore$ Observable

The system is uncontrollable and observable

57. Ans. D.

$$G(s)=\frac{10}{(s+0.1)(s+1)(s+10)}$$

$$G(s)=\frac{10}{0.1\left[1+\frac{s}{0.1}\right][1+s]\left[1+\frac{s}{10}\right].10}$$

$$G(s)=\frac{10}{[1+10s][1+s][1+0.1s]}$$

By Approximation, $G(s)=\frac{10}{[10s+1]}$

$$\text{Phase Margin} = \phi = 180 + \left[\angle GH\right]_{\omega=\omega_{gc}}$$

$$\omega_{gc} = 1 = \frac{10}{\sqrt{100\omega^2+1}}$$

$$=180-\tan^{-1}\left(\frac{10\times 0.99}{1}\right)$$

$$=100\omega^2=\frac{99}{1\omega}$$

$$\text{Phase Margin} = 95^{\circ}.73$$

$$\Rightarrow \omega^2\frac{\sqrt{99}}{1\omega} \Rightarrow \omega_{gc} = 0.9949 r/sc$$

Asymptotic approximation, Phase margin $=\phi-45^{\circ}=48$

58. Ans. C.

By observing the options, if we place other options, characteristic equation will have 3rd order one, where we cannot describe the settling time.

If C(s) = 2(s+ 4) is considered

The characteristic equation, is

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

$$\Rightarrow s^2+5s+10=0$$

Standard character equation $s^2+2\xi\omega_n s+\omega_n^2=0$

$$\omega_n^2=\sqrt{10};\ \xi\omega_n=2.5$$

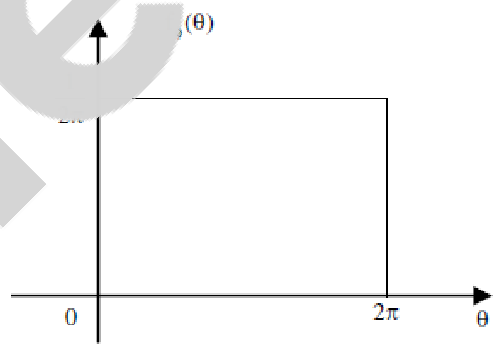
Given, 2% settling time, $\frac{4}{\xi\omega_n}<2 \Rightarrow \xi\omega_n>2$

59. Ans. B.

$V(x)=E(x^2)-\{E(x)\}^2 \geq 0$ i.e. variance cannot be negative

$$\therefore E(x^2) \geq \{E(x)\}^2$$

60. Ans. D.



$$Given\ X(t)=\sqrt{2}\sin(2\pi t+\phi)$$

ϕ in uniformly distributed in the interval $[0,2\pi]$

$$E\left[x(t_1)x(t_2)\right]$$

$$=\int_0^{2\pi}\sqrt{2}\sin(2\pi t_1+\theta)\sqrt{2}\sin(2\pi t_2+\theta)f_\phi(\theta)d\theta$$

$$=2\int_0^{2\pi}\sin(2\pi t_1+\theta)\sin(2\pi t_2+\theta).\frac{1}{2\pi}.d\theta$$

$$=\frac{1}{2\pi}\int_0^{2\pi}\sin(2\pi(t_1+t_2)+2\theta)d\theta$$

$$+\frac{1}{2\pi}\int_0^{2\pi}\cos(2\pi(t_1-t_2)d\theta$$

First integral will result into zero as we are integrating from 0 to 2π.

Second integral result into $\cos\{2\pi(t_1-t_2)\}$

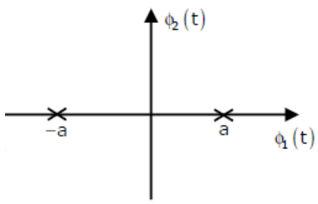
$$\Rightarrow E\left[X(t_1)X(t_2)\right]=\cos(2\pi(t_1-t_2)$$

61. Ans. C.

Bit error rate for BPSK

$$= Q\left(\sqrt{\frac{2E}{NO}}\right).\left\{Q\left[\sqrt{\frac{E}{N_0/2}}\right]\right\}$$

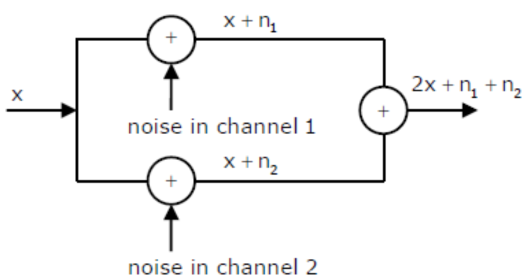
$$\Rightarrow Y = \frac{2E}{N_0}$$



Function of bit energy and noise $P_{SD} \frac{N_0}{2}$

Counterllation diagram of BPSK

Channel is AWGN which implies noise sample as independent



$Let\, 2x + n_1 + n_2 = x^1 + n^1$

$where\, x^1 = 2x$

$n^1 = n_1 + n_2$

$$\text{Now Bit error rate} = Q\left(\sqrt{\frac{2E^1}{N_O^1}}\right)$$

E^1 is energy in x^1

N_O^1 is PSD of n^1

E^1 = 4E [as amplitudes are getting doubled]

N_O^1 = N_0 [independent and identical channel]

$$\Rightarrow \text{Bit error rate} = Q\left(\sqrt{\frac{4E}{N_0}}\right) = Q\left(\sqrt{2}\sqrt{\frac{2E}{N_0}}\right)$$

$$\Rightarrow b = \sqrt{2}\, or\, 1.414$$

62. Ans. B.

In this problem random variable is L

$L\, can\, be\, 1, 2, ...$

$$P\{L=1\} = \frac{1}{2}$$

$$P\{L=3\} = \frac{1}{8}$$

$$H\{L\} = \frac{1}{2}\log_2\frac{1}{1/2} + \frac{1}{4}\log_2\frac{1}{1/4} + \frac{1}{8}\log_2\frac{1}{1/8} + ...$$

$$= 0 + 1.\frac{1}{2} + 2.\frac{1}{4} + 3.\frac{1}{8} + ...$$

[Arithmatic gemometric series summation]

$$= \frac{2}{1 - 1/2} + \frac{1/2 .1}{\left(1 - \frac{1}{2}\right)^2} = 2$$

63. Ans. B.

$$E_\theta = \frac{100}{r}\sin\theta e^{-J\beta r}$$

$$H_Q = \frac{0.265}{r}\sin\theta e^{-J\beta r}$$

$$P = \frac{1}{2}\int E_\theta H_Q^*.ds$$

$$= \frac{1}{2}\int_s \frac{(100)(0.265)}{r^2}\sin^2\theta r^2 \sin\theta\, d\theta\, d\phi$$

$$P_{avt} = \frac{1}{2}\int_s (26.5)\sin^2 d\theta d\phi$$

$$= 13.25\int_{\theta-0}^{\pi/2}\sin^3\theta d\theta \int_{Q=0}^{2\pi} d\phi = 13.25\left(2/3\right)(2\pi)$$

$$P = 55.5\, w$$

64. Ans. B.

$$Z_0 = \frac{276}{\sqrt{\epsilon_r}}\log\left(\frac{d}{r}\right)$$

d → distance between the two plates

so, z_0 – changes, if the spacing between the plates changes.

$V = \frac{1}{\sqrt{LC}}$ → independent of spacing between the plates

65. Ans. B.

$Given,\, l = \lambda/s$

$Z_0 = 50\Omega$

$$Z_{in}\left(l = \lambda/8\right) = Z_0\left[\frac{Z_L + JZ_0}{Z_0 + KZ_L}\right]$$

$$Z_{in} = 50\left[\frac{Z_L + J50}{50 + JZ_L}\right] = 50\left[\frac{Z_L + J50}{50 + JZ_L} \times \frac{50 - JZ_L}{50 - JZ_L}\right]$$

$$Z_{in} = 50\left[\frac{50Z_L + 50Z_L + J\left(50^2 - Z_L^2\right)}{50^2 + Z_L^2}\right]$$

$$Given, Z_{in} \rightarrow \text{Real}$$

$$\text{So, } \text{I}_{mg}\left(Z_{in}\right) = 0$$

$$50^2 - Z_L^2 = 0$$

$$Z_L^2 = 50^2$$

$$R^2 + X^2 = 50^2$$

$$R^2 = 50^2 - X^2 = 50^2 - 30^2$$

$$R = 40\Omega$$

***