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GATE_SOLUTION

GA

1. The strategies that the company uses to sell its products include house to house marketing.
2. The boat arrived at down
3. As the positions of book R & S are fixed. The books P, Q and T can be arranged in 3! = 6 ways
4. When he did not come home, she pictured him lying dead on the roadside somewhere.
5. Let *t* be the time taken by the machines when they work simultaneously.

$$\therefore \frac{1}{t} = \frac{1}{4} + \frac{1}{2}$$

$$\therefore \frac{1}{t} = \frac{3}{4}$$

$$\therefore t = \frac{4}{3}$$

6. Given is the % of illiterates

   So % of literates will be

	F	M
2001	40%	50%
2011	60%	60%

   And population distribution is

	F	M
2001	40%	60%
2011	50%	50%

   Let total population in both the years as T.

   So total literate in 2001 will be

   $0.4 \times 0.4 + 0.5 \times 0.6 = 0.46T$

   And total literate in 2011 will be

   $0.5 \times 0.6 + 0.5 \times 0.6 = 0.6T$

   $\therefore$ Increase = $0.6T - 0.46T = 0.14T$

   $$\therefore \%\ \text{increase} = \frac{0.14T}{0.46T} \times 100 = 30.43$$

7. Lohit Seema Rahul Mathew

   Doctor Dancer Teacher Engineer

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8. As first line says Indian history was written by British historians was extremely well documented and researched, but not always impartial.

   So option (C) can be interfered from given passage.

9.

	P	Q
Start time	8 AM	8 AM
Working	$\frac{210}{360}\times 12 = 7$ hrs	$\frac{210}{360}\times 12 = 8$ hrs
Breaks	15 minutes each (2 breaks) = 30 minutes	20 minute break (1 break) = 20 minutes

∴ paid working hours = 7 hrs + 8 hrs – 30 minutes – 20 minutes

= 14 hrs 10 minutes

∴ Paid = $14 \times 200 + \frac{10}{60}\times 200$

∴ Paid = 2833.33

∴ Budget left = 3000 – 2833.33 = 166.67

10. As it is given that R is sharing an office with T. So only option (D) is correct.

Electronics Engineering

1. A function F(z) is said to be analytic at a point z = a then F(z) has a derivative at z = a and derivative exists at each neighbouring point of z = a in domain D.

   $e^{\frac{1}{z}}$ at $z = 0 \longrightarrow e^{\infty} \longrightarrow$ No derivative

   ln z at z = 0 → ln(0) = $-\infty$ → does not exists

   $\frac{1}{1-z}$ at $z = 1 \rightarrow \frac{1}{0} = \infty \rightarrow$ does not exists

   But cos z exists for all values of z so it is analytic over the entire complex plane.

2. As no supply is connected hence fermi level will be constant.

   In P type semiconductor Fermi level should be closer to EV.

   In N type semiconductor Fermi level should be closer to EC.

   In P^{++} type semiconductor due to large doping Fermi level enters into valance band.

   Hence answer is (B).

3. By reciprocity theorem,

$$\frac{1}{5}=\frac{I}{5}$$

$\therefore I = 1A$

4. let output of NAND gate is M and output of NOR gate is N

$$\therefore M=\overline{E_N \cdot D}$$

And $N=\overline{\overline{E_N}+D}$

$$\therefore N=E_N \cdot \bar{D}$$

When $E_N = 0$

M = 1 and N = 0

So both PMOS and NMOS will be OFF

So F will be at high impedance

When $E_N = 1$

$$M=\bar{D} \ \& \ N=\bar{D}$$

So this CMOS will act as not gate

$\therefore$ F will be D

$\therefore$ Option (A) is correct.

5. Since it is a upper triangular matrix eigen values will bee 2, 1, 3, 2

$\therefore$ distinct eigen values are three

6. $$\frac{dy}{dx}=-\left(\frac{x}{y}\right)^n$$

When n = –1

$$\frac{dy}{dx}=-\frac{x}{y}$$

$$\therefore \frac{dy}{y}=-\frac{dx}{x}$$

$\therefore \ln y = -\ln(x) + \ln(c)$

$\therefore \ln(xy) = \ln(c)$

$\therefore xy = c$

This represents rectangular hyperbola.

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Now for n = +1

$$\frac{dy}{dx} = -\frac{x}{y}$$

$\therefore ydy = -x\,dx$

$$\therefore \frac{y^2}{2} = \frac{-x^2}{2} + c$$

$\therefore x^2 + y^2 = 2c$

This represents family of circles.

7. $$\text{let } H(z) = \frac{(z-a)(z-b)}{(z-c)(z-d)}$$

$$\therefore H\left(\frac{1}{z}\right) = \frac{\left(\frac{1}{z}-a\right)\left(\frac{1}{z}-b\right)}{\left(\frac{1}{z}-c\right)\left(\frac{1}{z}-d\right)}$$

$$\therefore H\left(\frac{1}{z}\right) = \frac{\left(z-\frac{1}{a}\right)\left(z-\frac{1}{b}\right)}{\left(z-\frac{1}{c}\right)\left(z-\frac{1}{d}\right)}$$

$$\therefore H(z)\cdot H\left(\frac{1}{z}\right) = \frac{(z-a)(z-b)\left(z-\frac{1}{a}\right)\left(z-\frac{1}{b}\right)}{(z-c)(z-d)\left(z-\frac{1}{c}\right)\left(z-\frac{1}{d}\right)}$$

$\therefore$ zeros are $a, b, \frac{1}{a}, \frac{1}{b}$

given zero is $a = \frac{1}{2} + \frac{1}{2}j$

as h(n) is real valued signal another zero must be complex conjugate of this

$$\therefore b = \frac{1}{2} - \frac{1}{2}j$$

Now $z_3 = \frac{1}{a} = \frac{1}{\frac{1}{2}+\frac{1}{2}j}$

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

$$= \frac{2(1-j)}{2}$$

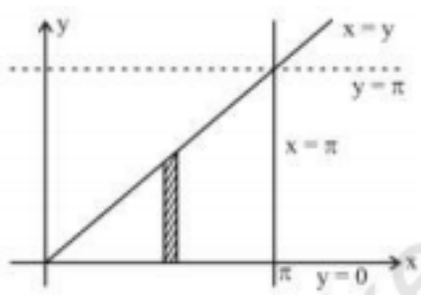
$z_3 = 1 - j$

as h(n) is real valued signal another zero must be complex conjugate of this

$z_4 = 1 + j$

$$\therefore z_1 = \frac{1}{2} + \frac{1}{2}j \quad z_2 = \frac{1}{2} - \frac{1}{2}j \quad z_3 = 1 - j \quad z_4 = 1 + j$$

8.



By changing order of integration

$$\int_{x=0}^{x=\pi} \left(\int_{y=0}^{y=x} dy \right) \frac{\sin x}{x} dx$$

$$\therefore \int_{x=0}^{\pi} x \frac{\sin x}{x} dx$$

$$\therefore \int_{x=0}^{\pi} x \sin x \, dx$$

$$\therefore [-\cos x]_0^{\pi} = 2$$

9. $R_{rad} = 80\pi^2 \left(\frac{dl}{\lambda} \right)^2$

$$80\pi^2 \left(\frac{dlf}{C} \right)^2$$

$\therefore R_{rad} \propto l^2 f^2$

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Now frequency is constant

$\therefore R_{rad} \propto f^2$

$$\therefore \frac{\Delta R}{R} = 2\frac{\Delta l}{l}$$

$= 2 \times 1\%$

$$\therefore \frac{\Delta R}{R} = 2\%$$

10. y(s) is unit step response

$$\therefore y(s) = G(s) \times \frac{1}{s}$$

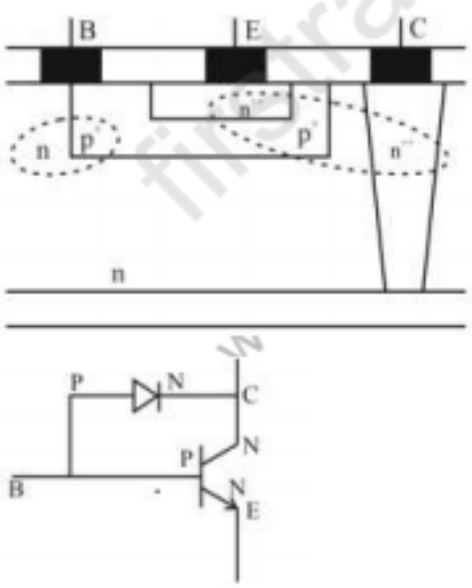
$$= \frac{3-s}{s(s+1)(s+3)}$$

$$= \frac{A}{s} + \frac{B}{s+1} + \frac{C}{s+3}$$

$$\therefore y(s) = \frac{1}{s} - \frac{2}{s+1} + \frac{1}{s+3}$$

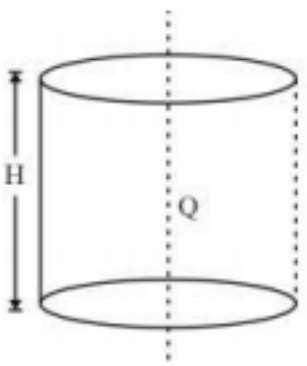
$\therefore y(t) = u(t) - 2e^{-t}u(t) + e^{-3t}u(t)$

11.



12.

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If we consider a total cylinder then by gauss law

○ ısed

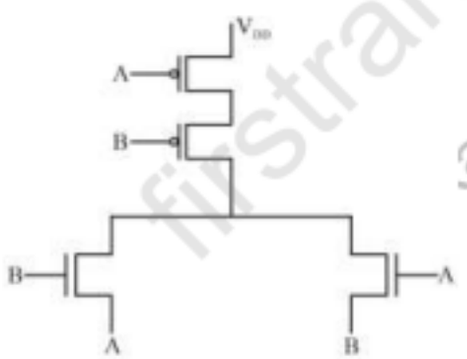
But $Q_{enclosed} = Q \cdot H$

And we are considering only $\frac{1}{4}$ th of the cylinder

$$\therefore D = \frac{Q \cdot H}{4}$$

$$\therefore E = \frac{Q \cdot H}{4 \in_0}$$

13. By rearranging the circuit,



Truth table:

A	B	F
0	0	1
0	1	0
1	0	0
1	1	1

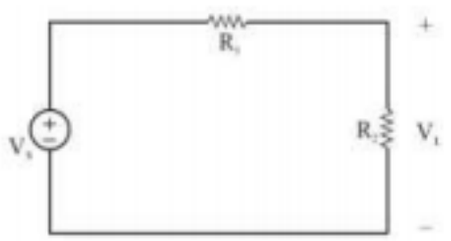
So it is XNOR gate.

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14. When V_S is +ve

Diode will be reserve biased



$$V_L = \frac{R_2}{R_1 + R_2} V_S$$

$$\therefore V_L = \frac{50}{50+50} \times 8$$

$\therefore V_L = 4V$ ...(i)

When V_S is –ve

Diode will be forward biased



$\therefore VL = VS = -10V$ ...(ii)

From (i) and (ii)

$$\text{Average value} = \frac{4 + (-10)}{2} = -3$$

$\therefore$ Average value = –3

15. We know that

E[AX + BY] = AE[X] + BE[Y]

$\therefore$ E[2X + Y] = 2E[X] + E[Y] = 0 ...(i)

And E[X + 2Y] = E[X] + 2E[Y] = 33 ...(ii)

Adding (i) and (ii)

3E[X] + 3E[Y] = 33

$\therefore$ E[X] + E[Y] = 11

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16. We know that

$$NM_L = V_L - V_{O_L}$$

$$NM_H = V_{OH} - V_{IH}$$

Now, $V_{IL} = \dfrac{2V_0 - |V_{TP}| - V_{DD} + kV_{Tn}}{1+k}$

$$V_{OL} = V_{in} - V_{TP} + \sqrt{(V_{in} - V_{DD} - V_{TP})^2 + k(V_{in} - V_{TP})^2}$$

$$V_{OH} = V_{in} - V_{Tn} + \sqrt{(V_{in} - V_{Tn})^2 + \frac{1}{k}(V_{in} - V_{DD} - V_{TP})^2}$$

$$V_{IH} = \frac{V_{DD} + V_{TP} + k(2V_O + V_{TP})}{1+k}$$

Where $k = \dfrac{(w/L)n}{(w/L)P}$

$\therefore$ as $W_P \uparrow \rightarrow NM_L \uparrow$ and $NM_H \downarrow$

17. $\nabla \cdot \bar{D} = \rho_V$

This is Gauss law

$$\nabla \times \bar{E} = -\frac{\partial \bar{B}}{\partial t}$$

This is faraday law of electromagnetic induction

$$\nabla \times \bar{B} = 0$$

This is Gauss law in magnetostatics which states magnetic monopole does not exists.

$$\nabla \times \bar{H} = \bar{J} + \frac{\partial \bar{D}}{\partial t}$$

This is modified form of ampere's circuital law.

18. at F = 10 Hz we have one pole

At F = 10^2 Hz we can see two more poles are added as slope is decreased by 40 dB/decade

At F = 10^3 Hz we have a zero

At F = 10^4 Hz we have two zero's

At F = 10^5 Hz we have two pole's

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At F = 10^6 we have one pole

∴ Total poles $N_P = 6$

And total zeros $N_Z = 3$

19. $x(t) = \cos(2\pi fct + km(t))$

∴ $Q(t) = 2\pi fct + km(t)$

And $fi = \frac{1}{2\pi}\frac{\partial}{\partial t}(Q(t))$

$= \frac{1}{2\pi}\frac{\partial}{\partial t}[2\pi fct + km(t)]$

$fi = fc + \frac{k}{2\pi}\frac{\partial}{\partial t}m(t)$

$\therefore fi_{max} = fc + \frac{k}{2\pi}\left[\frac{\partial}{\partial t}m(t)\right]_{max}$

$\therefore fi_{max} = 50\ kHz + 5\times\frac{1-(-1)}{(7-6)\times10^{-3}}$

∴fi_{max} = 50 kHz + 10 kHz

∴fi_{max}= 60 kHz

And $fi_{min} = fc + \frac{k}{2\pi}\left[\frac{\partial}{\partial t}(m(t))\right]_{min}$

$50kHz + 5\times\frac{-1-1}{(9-7)\times10^{-3}}$

= 50 kHz – 5kHz

fi_{min} = 45 kHz

$\therefore \frac{f_{min}}{f_{max}} = \frac{45}{60} = 0.75$

20. $D_1 = \overline{Q}_1 \cdot \overline{Q}_2$

$D_2 = Q_1$

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Present State		Excitation		Next state	
Q_1	Q_2	D_1	D_2	Q_1^+	Q_2^+
0	0	1	0	1	0
1	0	0	1	0	1
0	1	0	0	0	0

As three states are there

Frequency of output = Frequency of Q_2 = $\frac{12\text{ kHz}}{3}$ = 4 kHz

21. As it is given that it is linear hamming code addition of two codes will produce another code.

(Here we are talking about mod 2 addition)

$$0\,0\,0\,1 \rightarrow 0\,0\,0\,0\,1\,1\,1$$
$$0\,0\,1\,1 \rightarrow 1\,1\,0\,0\,1\,1\,0$$
$$\overline{0\,0\,1\,0} \rightarrow \overline{1\,1\,0\,0\,0\,0\,1}$$

22. Ans. 0367

Sol. Probability density function (Pdf) = $\frac{d}{dx}(\text{CDF})$

$$\therefore \text{Pdf} = \begin{cases} e^{-x} & , \quad x \geq 0 \\ 0 & , \quad x < 0 \end{cases}$$

Now $\Pr(z>2|z>1) = \frac{\Pr[(z>2)\cap(z>1)]}{\Pr(z>1)}$

$$= \frac{\Pr(z>2)}{\Pr(z>1)}$$

$$= \frac{\int_2^\infty e^{-x}\,dx}{\int_1^\infty e^{-x}\,dx}$$

$$= \frac{-1\left(e^{-\infty} - e^{-2}\right)}{-1\left(e^{-\infty} - e^{-1}\right)}$$

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

$$\therefore \Pr(Z > 2 | Z > 1) = 0.367$$

23. DC value and phase shift does not affect time period of a signal.

So it is equivalent to find time period of

$$x(t) = 2\cos(\pi t) + 3\sin\left(\frac{2\pi}{3}\right) + 4\cos\left(\frac{\pi}{2}t\right)$$

$$\therefore \omega_1 = \pi \qquad T_1 = \frac{2\pi}{\omega_1} = 2 \text{ second}$$

$$\omega_2 = \frac{2\pi}{3} \qquad T_2 = \frac{2\pi}{\omega_2} = 3 \text{ second}$$

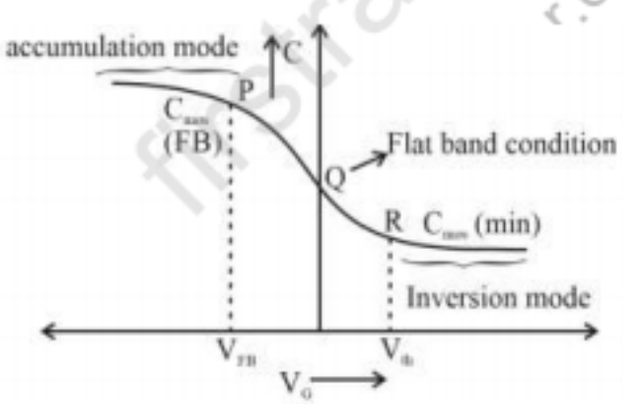
$$\omega_3 = \frac{\pi}{2} \qquad T_3 = \frac{2\pi}{\omega_3} = 4 \text{ second}$$

Now overall T = LCM (T_1, T_2, T_3)

= LCM (2, 3, 4)

∴ overall T = 12 seconds

24.



25. $$\frac{1}{2\pi i}\oint_{|z|=1} \frac{(z^2-1)^2}{z^2}\,dz$$

For poles :

Consider $z^2 = 0 \Rightarrow \boxed{z = 0,0}$

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Now $f(z) = (z^2 + 1)^2$

$$\oint_C \frac{f(z)}{(z-a)^n}dz = \frac{2\pi i}{(n-1)!}f^{n-1}(a)$$

$$= \frac{1}{2\pi i}\left[\frac{2\pi i}{(2-1)!}f^{2-1}(a)\right] = f'(a) = f'(0)$$

Now $f'(z) = 2(z^2 + 1)(2z)$

$f'(0) = 2(0 + 1)(0) = 0$

∴ So answer is zero.

26. Let output of MUX is M

So $M = \bar{A}\bar{Q} + AQ$

$\therefore M = A \odot$

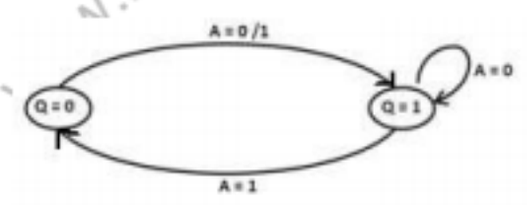
And $D = \overline{MQ}$

$= \bar{M} + \bar{Q}$

$D = A \oplus Q + \bar{Q}$

Present State	Input	Next State
Q	A	Q⁺ = D
0	0	1
0	1	1
1	0	1
1	1	0

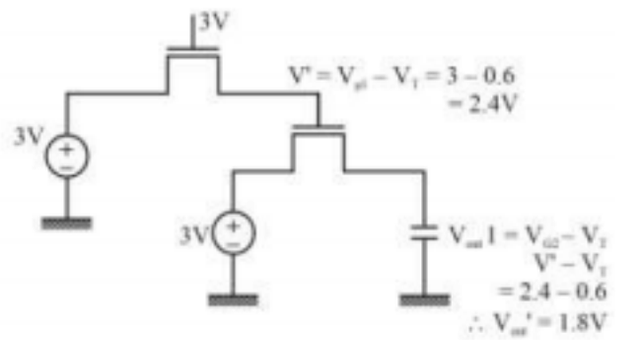
State Diagram:-



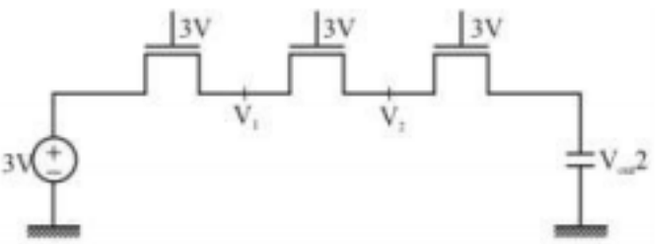
27. Given $V_{TN} = 0.6V$, $V_{SB} = 0$ and $\lambda = 0$

In figure (i)

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In figure (ii)



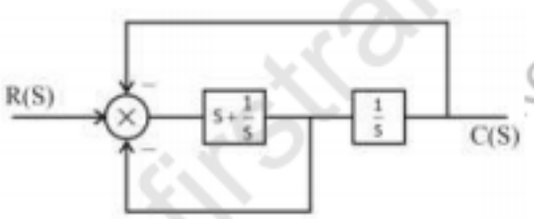
Ever MOS transistor has same $V_G = 3V$

$\therefore V_1 = V_2 = V_{out\,2} = V_G - V_T$

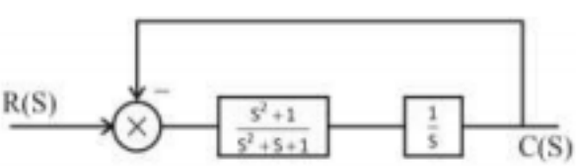
$= 3 - 0.6$

$\therefore V_{out\,2} = 2.4\ V$

28.



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



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$$TF = \frac{\frac{s^2+1}{s\left(s^2+s+1\right)}}{1+\frac{s^2+1}{s\left(s^2+s+1\right)}}$$

$$\therefore TF = \frac{s^2+1}{s^3+2s^2+s+1}$$

29. $P_o(-1+N>Vth)$

$$P_o(N>Vth+1) = \int_{vth+1}^{2} \frac{1}{4}\,dx = \frac{1}{4}[2-Vth-1] = \frac{1}{4}(1-Vth)$$

$P_1(1 + N < Vth)$

$$P_1(N<Vth-1) = \int_{-2}^{Vth-1} \frac{1}{4}dx = \frac{1}{4}[Vth-1+2] = \frac{1}{4}(Vth+1)$$

$P_e = P(0)P_o(N > Vth + 1) + P(1)\,P_1(N < Vth - 1)$

$$P_e = 0.2\times\frac{1}{4}(1-Vth) + 0.8\times\frac{1}{4}(Vth+1)$$

$=0.05 - 0.5Vth + 0.2Vth + 0.2$

$P_e = 0.25 + 0.15Vth$

For Vth = 0 → Pe = 0.25

For Vth = 1 → Pe = 0.4

For Vth = –1 → Pe = 0.1

∴ Minimum probability of error = 0.1

30. Ans. 0.231

Sol. $1 - e^{-\alpha x} = 0.5$

$e^{-\alpha x} = 0.5$

now $\alpha = 3 \times 10^4\ cm^{-1}$

$$\therefore x = \frac{-\ln(0.5)}{3\times10^4}$$

31. $$I_D = \frac{1}{2}\mu_p cox\left(\frac{\omega}{L}\right)_p \left(V_{GSP} - |V_{TP}|\right)^2$$

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$$=\frac{1}{2}\times 30\times 10^{-6}\times 10\times (2-1)^2$$

$I_D = 150\ \mu A$

Now, $g_m = \sqrt{2I_D\mu_n C_{ox}\left(\frac{\omega}{L}\right)_N}$

$$g_m = \sqrt{2\times 150\times 10^{-6}\times 60\times 10^{-6}\times 5}$$

$\therefore gm = 300 \times 10^{-6}\ s$

Now $A_v = -gm\ (r_{ds} \,||\, r_{ds})$

$$=-300\times 10^{-6}\left(\left(6\times 10^{6}\right)\| \qquad\right)$$

$= -300 \times 10^{-6} \times 3 \times 10^{6}$

$\therefore A_v = -900$

32. Given that

$h(0) = 1$, $h(1) = a$, $h(2) = b$ and $h(n) = 0$ otherwise

$$\therefore H(e^{jw}) = 1 + ae^{-jw} + be^{-j2w}$$

Now $y(n) = 0$ for all n

Now $x(n) = C_1 e^{\left(\frac{-j\pi n}{2}\right)} + C_2 e^{\left(\frac{j\pi n}{2}\right)}$

If we consider $C_1 e^{\left(\frac{-j\pi n}{2}\right)}$ as input then

$$\text{Output} = C_1\left[1 + ae^{+j\frac{\pi}{2}} + be^{-j2\left(-\frac{\pi}{2}\right)}\right]$$

$$\text{Output} = C_1\left[1 + ae^{j\frac{\pi}{2}} + be^{j\pi}\right] \qquad \text{...(i)}$$

If we consider $C_2 e^{\left(\frac{j\pi n}{2}\right)}$ as input then

$$\text{Output} = C_2\left[1 + ae^{-j\frac{\pi}{2}} + be^{-j2\left(\frac{\pi}{2}\right)}\right]$$

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$$= C_2\left[1 + ae^{-j\frac{\pi}{2}} + be^{-j\pi}\right] \quad \text{...(ii)}$$

Both output (i) and (ii) will be zero if

a = 0, b = 1

33. $$I_D = \frac{\mu_n C_{ox}}{2} \cdot \left(\frac{\omega}{L}\right) \cdot \left(V_{gs} - V_T\right)^2$$

$$= \frac{300 \times 3.45 \times 10^{-7}}{2} \times \left(\frac{10}{1}\right) \times (5 - 0.7)^2$$

$\therefore I_D = 25.5$ mA

34. Current through FET having $\left(\frac{\omega}{L}\right) = 3$ will be I_1

$$\therefore I_1 = \frac{(\omega/L)_2}{(\omega/L)_1} \times 1\text{mA}$$

$$\therefore I_1 = \frac{3}{2}\text{mA}$$

Now,

$$I_{out} = \frac{(\omega/L)4}{(\omega/\ )_3} \times I_1$$

$$= \frac{40}{10} \times \frac{3}{2}\text{mA}$$

$\therefore I_{out} = 6$mA

35. Quantum Efficiency $\eta = \frac{R_e}{R_p}$

R_e = Corresponding Electron Rate (electrons/sec)

Rp = Incident Photon Rate (Photons/sec)

$$R_e = \frac{I_p}{q},\ R_p = \frac{P_{in}}{h\nu},\quad R = \frac{I_p}{P_{in}}$$

Now $$\eta = \frac{I_{p/q}}{P_{in/h\nu}}$$

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$$\eta = \frac{I_{P/q}}{P_{in/h\nu}} = \frac{I_p h\nu}{qP_{in}} = \frac{h\nu R}{q}$$

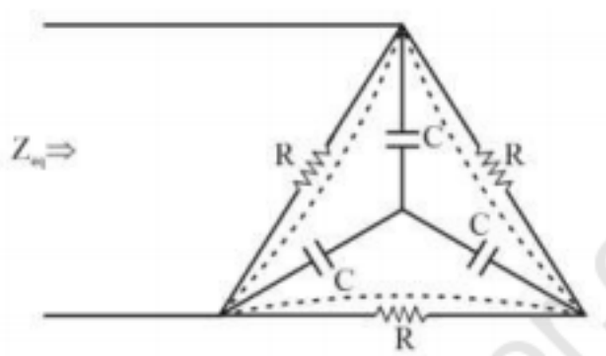
So

$$\Rightarrow R = \frac{q\eta}{h\nu} = \frac{q\eta\lambda}{hc} = \eta \times \left(\frac{q}{hc}\right)$$

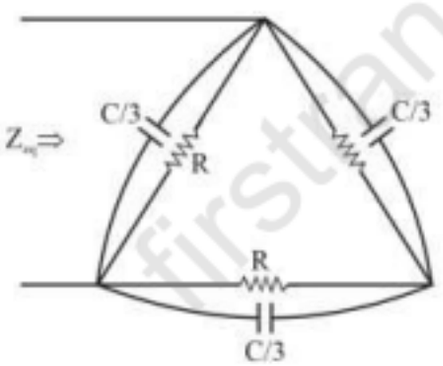
$q = 1.6 \times 10^{-19}c$, $h = 6.63 \times 10^{-34}$Js, $C = 3 \times 10^{8}$ m/s

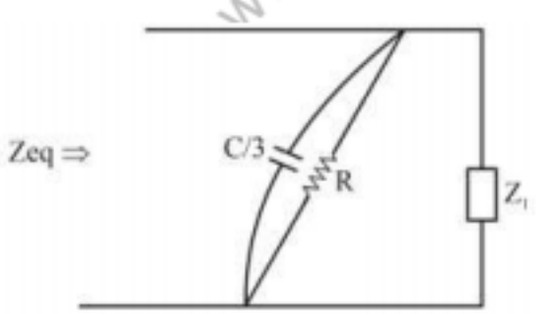
$$R = \frac{\eta\lambda}{1.24}$$

36.



Performing star to delta conversion





$$\text{Where } Z_1 = 2\left[\frac{R}{1+\frac{jWCR}{3}}\right]$$

$$\therefore Z_{eq} = Z_1 \| \left(\frac{\quad}{1+\frac{\quad}{3}}\right)$$

$$\therefore Z_{eq} = \frac{2}{3}\left(\frac{R}{1+\frac{jWCR}{3}}\right)$$

Now R = 1kW, C = 1μF and W=1000 rad/sec

∴Zeq = 0.66 – 0.2178j

$$\therefore I = \frac{V}{Z_{eq}}$$

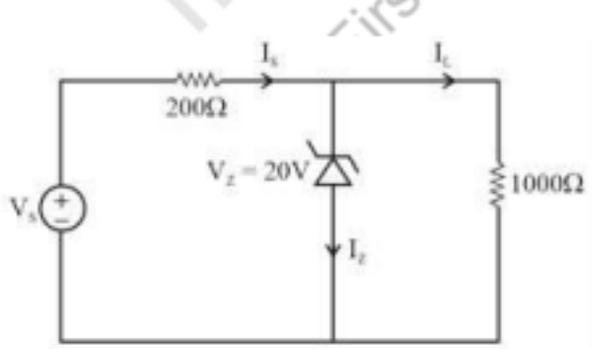
$$= \frac{2\sin(1000t)}{0.66-0.2178j}$$

$$= \frac{2}{\sqrt{0.66^2+0.2178^2}} \cdot \sin\left(1000t - \tan^{-1}\left(\frac{1}{3}\right)\right)$$

= 3.16 sin(1000t + 18.43°)

∴ I ≈ 3 sin(1000t) + cos (1000t)

37.



I_{2max} = 60 mA

$$I_L = \frac{20}{1000} = 20mA$$

As I_{Zmin} not given,

$I_{Zmin} = 0$ mA

Now $I_S = I_Z + I_L$

$\therefore I_{Smin} = I_{Zmin} + I_L$

$= 0 + 20$ mA

$\therefore I_{Smin} = 20$ mA

Now $I_S = \dfrac{V_S - V_Z}{200}$

$\therefore 20\text{mA} = \dfrac{V_S - 20}{200}$

$\therefore V_S = 24\text{V}$

Now $I_{Smax} = I_{Zmax} + I_L$

$= 60 + 20$

$I_{Smax} = 80$ mA

$\therefore I_S = \dfrac{V_S - V_Z}{200}$

$\therefore 80\text{mA} = \dfrac{V_S - 20}{200}$

$\therefore V_S = 36$ V

38.

Sol. $H = \dfrac{I}{2\pi\rho}a\rho$

For wire ω_1

$H_1 = \dfrac{I}{2\pi r}$

For wire ω_2

$H_2 = \dfrac{2I}{2\pi 3r}$

Magnetic field will be circular and can be find out by right hand rule

Both fields will add at middle region

$\therefore$ at dotted line

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$H = H_1 + H_2$

$$\therefore H = \frac{5I}{6\pi r}$$

Now $B = \mu_o H$

$$B = \frac{\mu_o 5I}{6\pi r}$$

39.

Sol. $$V_g = \frac{d\omega}{d\beta}$$

Now, $$\frac{d\beta}{d\omega} = \frac{dk(\omega)}{d\omega} = \frac{d}{d\omega}\cdot\frac{1}{c}\sqrt{\omega^2-\omega_0^2} = \frac{1}{2c\sqrt{\omega^2-\omega_0^2}}\times 2\omega$$

$$\boxed{\frac{d\beta}{d\omega} = \frac{\omega}{c\sqrt{\omega^2-\omega_0^2}}}$$

$$V_g = \frac{\frac{1}{\omega}}{c\sqrt{\omega^2-\omega_0^2}} = 2\times 10^8 \Rightarrow \frac{c\sqrt{\omega^2-\omega_0^2}}{\omega} = 2\times 10^8$$

$$\Rightarrow \boxed{\sqrt{\omega^2-\omega_0^2} = \frac{2\omega}{3}}$$

Now, $$V_p = \frac{\omega}{\beta} = \frac{\omega}{k} = \frac{\omega}{\frac{1}{c}\sqrt{\omega^2-\omega_0^2}} = \frac{\omega c}{2\frac{\omega}{3}} = \frac{3c}{2}$$

$$V_p = \frac{3}{2}\times 3\times 10^8 = 4.5\times 10^8 m/s$$

$$\boxed{V_p = 4.5\times 10^8 m/s}$$

40. $f(-1) = 0$

So only option (B) and (C) are possible

Let's try option (B)

$f(x) = 2|x+1|$

$$\therefore f(x)=\begin{cases} 2(x+1) & \text{for } x+1>0 \\ -2(x+1) & \text{for } x+1<0 \end{cases}$$

$$\therefore f(x)=\begin{cases} 2(x+1) & \text{for } x>-1 \\ -2(x+1) & \text{for } x<-1 \end{cases}$$

$$\therefore f'(x)=\begin{cases} 2 & \text{for } x>-1 \\ -2 & \text{for } x<-1 \end{cases}$$

$$\therefore |f'(x)|\le 2$$

∴ option (B) is correct.

41. $$G(s)=\frac{C(s)}{R(s)}$$

∴ C(s) = G(s) · R(s)

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

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

$$\therefore C(s)=\frac{A}{s}+\frac{B}{(s+1)}+\frac{C}{(s+1)^2}$$

∴ $A(s+1)^2 + Bs(s+1) + Cs = 1$

∴ $As^2 + 2As + A + Bs^2 + Bs + Cs = 1$

∴ A + B = 0

∴ 2A + B + C = 0

∴ A = 1

So B = −1

And C = −1

$$\therefore C(s)=\frac{1}{s}+\frac{-1}{s+1}+\frac{-1}{(s+1)^2}$$

∴ $C(t) = (1 - e^{-t} - te^{-t})\, u(t)$

At $t \to \infty$ stedy state will occur

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$\therefore C(\infty) = 1$

Now we are asked to find time at which 94% of the steady state value reached.

$\therefore C(t) = 1 - e^{-t} - te^{-t} = 0.94$

$\therefore e^{-t} + te^{-t} = 0.06$

$\therefore e^{-t}(1 + t) = 0.06$

Now from the given options try all option you will get t = 4.50 sec.

42. $$X(k) = \sum_{n=0}^{N-1} x(n)\, W_N^{kn}$$

We are obtaining X(1) correctly

$\therefore k = 1$

$$\therefore x(1) = x(0) + x(1)W_6^1 + x(2)W_6^2 + x(3)W_6^3 + x(4)W_6^4 + x(5)W_6^5$$

We know that

$$W_N^{k+\frac{N}{2}} = -W_N^K$$

$$\therefore W_6^3 = -W_6^0 = -1$$

$$W_6^4 = -W_6^1$$

$$W_6^5 = -W_6^2$$

$\therefore$ comparing with given graph

$a_1 = 1, \quad a_2 = W_6, \quad a_3 = W_6^2$

43. $$H(s) = \frac{1}{s^2 + 3s^2 + 2s + 1}$$

$$\therefore \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} [u]$$

$$\& \; [y] = [1 \quad 0 \quad 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + [0][u]$$

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$$\therefore A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -1 & -2 & -3\end{bmatrix} \text{ and } C=\begin{bmatrix}1 & 0 & 0\end{bmatrix}$$

44. Same current will flow through both NMOS & PMOS

∴ ID1 = ID2

$$\therefore \frac{\mu_n c_{ox}}{2}\cdot\left(\frac{\omega}{L}\right)_N (V_{GSN}-V_{TN})^2=\frac{\mu_p c_{ox}}{2}\cdot\left(\frac{\omega}{L}\right)_p (V_{GSP}-|V_{TP}|)^2$$

$$\therefore 100\times\left(\frac{\omega}{L}\right)_N\cdot(1.5-0.7)^2=400\times\left(\frac{\omega}{L}\right)_p(1.5-0.9)^2$$

$$\therefore \frac{(\omega/L)_N}{(\omega/L)_p}=\frac{9}{16}\times\frac{4}{10}$$

= 0.225

$$\left(\because \quad V_{GSP}=\frac{V_{dd}}{2}=1.5V\right)$$

45.

$$f_c=\frac{V}{2}\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}$$

For $T\varepsilon_{10}$, $m=1,\quad n=0$

$$fc_1=\frac{V}{2}\sqrt{\left(\frac{1}{a}\right)^2}=0=\frac{V}{2a}$$

For $T\varepsilon_{11}$, m = 1, n = 1

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$$f_{c_2} = \frac{V}{2}\sqrt{\frac{1}{a^2}+\frac{1}{b^2}}$$

Given $\frac{f_{c_1}}{f_{c_2}} = \frac{1}{2}$

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

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

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

$$\Rightarrow 4b^2 = a^2 + b^2$$

$$\Rightarrow 3b^2 = a^2$$

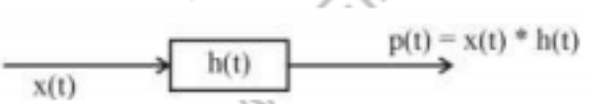
$$\Rightarrow \frac{b^2}{a^2} = \frac{1}{3}$$

$$\Rightarrow \frac{b}{a} = \frac{1}{\sqrt{3}}$$

$$\Rightarrow \frac{a}{b} = \sqrt{3}$$

$$\frac{\text{width}}{\text{hight}} = \sqrt{3} = 1.732$$

46.



and y(t) = z(t) + p(t)

$\therefore R_{yy}(\tau) = R_{zz}(\tau) + R_{pp}(\tau) + R_{pz}(\tau) + R_{zp}(\tau)$

now x(t) & z(t) are uncorrelated.

$\therefore R_{pz}(\tau) = R_{zp}(\tau) = 0$

$\therefore R_{yy}(\tau) = R_{zz}(\tau) + R_{pp}(\tau)$

So the power spectral relation can be given by Fourier transform of the above relation.

$\therefore S_{yy}(f) = S_{zz}(f) + S_{pp}(f)$

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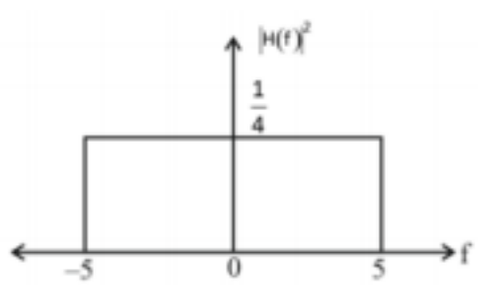
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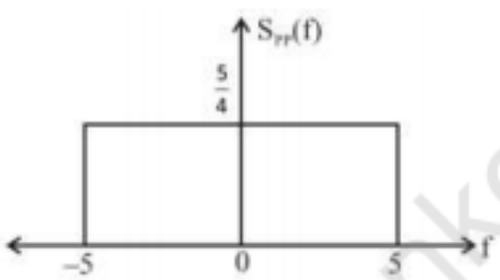
now power of y(t)=

$$\int_{\infty}^{\infty} s_{yy}(f)\,df$$

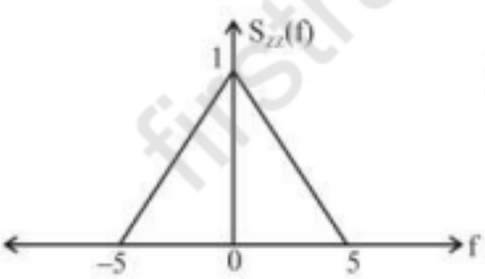
$$\therefore P = \int_{\infty}^{\infty} s_{zz}(f)\,df + \int_{\infty}^{\infty} S_{pp}(f)\,df$$

now $S_{pp}(f) = |H(w)|^2 \times S_{xx}(f)$





&



$$\therefore P = \frac{5}{4}\times 10 + \frac{1}{2}\times 10\times 1$$

$$\therefore P = 17.5 \text{ watt}$$

47. For the minimization of the energy in the error signal there are different approaches like, Prony's method, Pade approximation. As g(n) has three samples.

Consider them as g(-1) , g(0) , g(1) we can minimise E(h,g) by making h(n) = g(n) using rectangular window and Parseval's there of OTFT.

Based on which 10g(-1) + g(1) = 10(-3) + 3

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= -27

48. $I_r = 0.75\ I_S$

∴ Forward current = $I_D = -0.75\ I_S$

∴ $I_S(e^{vo/nvt} - 1) = -0.75\ I_s$

Now Take n = 1

∴ $e^{vo/vT} = 0.25$

∴ $V_D = V\ T\ l\ n\ (0.25)$

∴ $V_R = -V\ T\ l\ n\ (0.25)$

$$= -\frac{1.38\times10^{-23}\times300}{1.6\times10^{-19}}\times-1.386$$

∴ V_R = 35.87 mv

49. Given differential equation is of Cauchy – Euler differential equation type.

So let $x = e^z$ ∴ $z = \ln x$

The differential equation can be written as,

$D(D-1) - 3D + 3 = 0$

∴ $D^2 - 4D + 3 = 0$

∴ $D = 1, 3$

$\therefore y = C_1e^z + C_2e^{3z}$

$\therefore y = C_1x + C_2x^3$

Now y (1) = 1

∴ $C_1 + C_2 = 1$ ...(i)

And y(2) = 14

∴ $2C_1 + 8C_2 = 14$ ...(ii)

From (i) and (ii)

$C_1 = -1, C_2 = 2$

∴ $y = -x + 2x^3$

∴ $y(1.5) = -1.5 + 2(1.5)^3$

∴ y(1.5) = 5.25

50. We know that,

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$$I_C(t) = C\frac{dV_C(t)}{dt}$$

And capacitor will be charged by the following equation

$V_C(t) = V_S(1 - e^{-t/t})$

$$I_C(t) = C \cdot \frac{d}{dt}\left[V_S\left(1 - e^{-t/\tau}\right)\right]$$

$$\therefore I_C(t) = \frac{V_S}{R(t)} e^{-t/R(t)\cdot C}$$

Given $R(t) = R_O\left[1 - \frac{t}{T}\right]$

Now $R_O = 1$ and $C=1$

$\therefore T = 3R_OC = 3$

$$\therefore R(t) = \left[1 - \frac{t}{3}\right]$$

$$\& \; I_C(t) = \frac{1}{\left(1 - \frac{t}{3}\right)} \times e^{\frac{-t}{\left(1-\frac{t}{3}\right)}}$$

At $t = \frac{T}{2} = \frac{3}{2}$ sec

$I_C(t) = 2e^{-3}$

$= 0.099$

$I_C(t) \approx 0.1$ mA

51. $V_S = 10$ V

Voltage across capacitor will be

$V_C(t) = 10(1 - e^{-t/RC})$

$R_C = 500 \times 10 \times 10^{-6} = 5 \times 10^{-3}$ sec

At $t = 2$ ms $= 2 \times 10^{-3}$ sec

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V_C (2 ms) = $10\left(1-e^{\frac{-2}{5}}\right)$

V_C (2 ms) = 3.3 V

For $\frac{T}{2}$ to T diode will be off so capacitor will not charge further

$\therefore V_C$ (3 msec) = 3.3V

52. By greens theorem

$\int xdy - ydx = \oint xdy$

$\int(xdy - ydx) = \oint$

$2\oint$

$\oint$ = area of the region

$= \left[2\times 3 + \frac{\pi(1)^2}{2}\right]$

$\left[6+\frac{\pi}{2}\right]$

$\therefore \int(xdy - ydx) = 12+\pi$

53.

Overall $G_C(s) = \frac{K}{s\left(s^2+3s+2\right)}$

$\therefore q(s) = s^3 + 3s^2 + 2s + k = 0$

s^3	1 2
s^2	3 k
s^1	$\frac{6-k}{3}$
s^0	k

Auxiliary equation is $3s^2 + k = 0$

And for roots on imaginary axis s^1 row = 0

$$\therefore \frac{6-k}{3}=0$$

$\therefore k = 6$

54.

m(t) has frequency range 5 kHz to 15 kHz

Now it is amplitude modulated

$f(t) = A(1 + m(t)) \cos 2\pi f_c t$ where f_c = 600 kHz

$\therefore$ AM signal will have highest frequency = $f_c + f_m$ (max)

= 600 + 15 = 615 kHz

And AM signal will have lowest frequency = $f_c - f_m$ (max)

= 600 – 15 = 585 kHz

It is a band pass signal so we use bandpass sampling

$$f_s = 1.2 \times \frac{2fH}{k}$$

$$K = \frac{f_H}{f_H - f_L}$$

$$= \frac{615}{615-585}$$

K = 20.5

We select K = 20

$$\therefore f_s = 1.2 \times \frac{2 \times 615}{20}$$

$\therefore f_s$ = 73.8 kHz

Now L = 256

And 2^n = L = 256

$\therefore n = 8$

Bitrate = $R_b = nf_s$

$\therefore R_b = 8 \times 73.8 \times 103$

$\therefore R_b$ = 0.59 Mbps

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55.

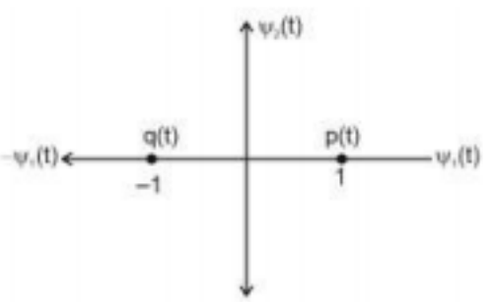
0 is represented by p(t)

And 1 is represented by q(t)

And $\psi_1(t)$ and $\psi_2(t)$ are orthogonal signal set

(i) $p(t) = \psi_1(t)$ and $q(t) = -\psi_1(t)$

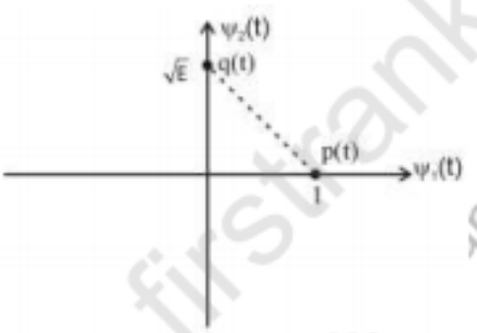
So signal space diagram will be,



$\therefore dmin_1 = 2$

(ii) $p(t) = \psi_1(t)$ and $q(t) = \sqrt{E}\psi_2(t)$

So signal space diagram will be



$\therefore dmin_2 = \sqrt{E+1}$

Now bit error probability is same in both cases

$\therefore dmin_1 = dmin_2$

$\sqrt{1+E} = 2$

$\therefore E = 3$

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