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

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	$\frac{210}{360}\times 12 = 7\text{ hrs}$	$\frac{210}{360}\times 12 = 8\text{ hrs}$
Breaks	15 minutes each	20 minute break
	(2 breaks)	(1 break)
	= 30 minutes	= 20 minutes

$\therefore$ paid working hours = 7 hrs + 8 hrs – 30 minutes – 20 minutes

= 14 hrs 10 minutes

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

$\therefore$ Paid = 2833.33

$\therefore$ 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.

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

ln z at z = 0 → ln(0) = –∞ → does not exists

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

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,

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

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

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

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 $E_N = 1$

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

So this CMOS will act as not gate

∴ F will be D

∴ Option (A) is correct.

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

∴ distinct eigen values are three

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

When n = –1

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

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

∴lny = – ln(x) + ln(c)

∴ ln(xy) = ln(c)

∴xy = c

This represents rectangular hyperbola.

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

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

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

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

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

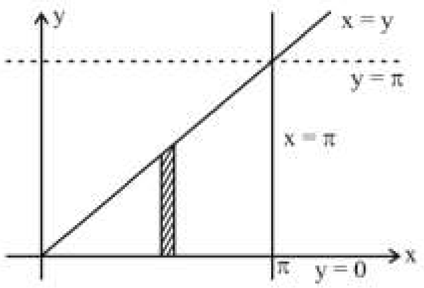
$z_3 = 1 - j$

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

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

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

Now frequency is constant

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

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

= 2 × 1%

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

10. y(s) is unit step response

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

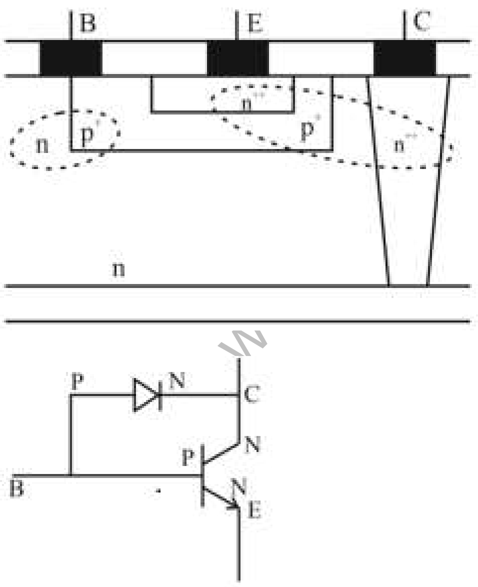
$$= \frac{3-s}{s(s+1)(s+3)}$$

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

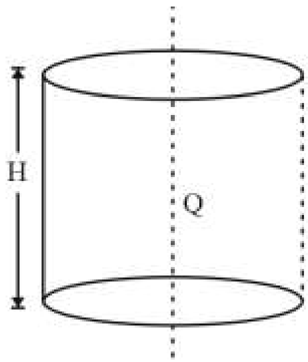
$$\therefore y(s) = \frac{1}{s} - \frac{2}{s+1} + \frac{1}{s+3}$$

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

11.



12.



If we consider a total cylinder then by gauss law

○ ›sed

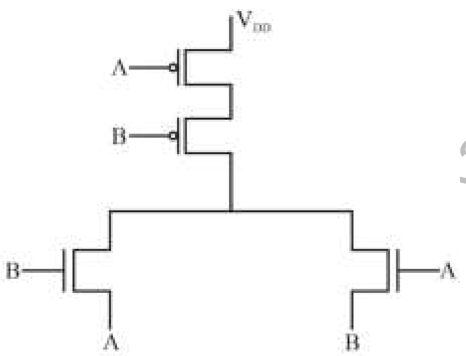
But $Q_{enclosed} = Q \cdot H$

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,



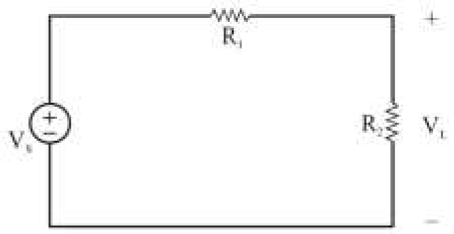
Truth table:

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

So it is XNOR gate.

14. When V_S is +ve

Diode will be reserve biased



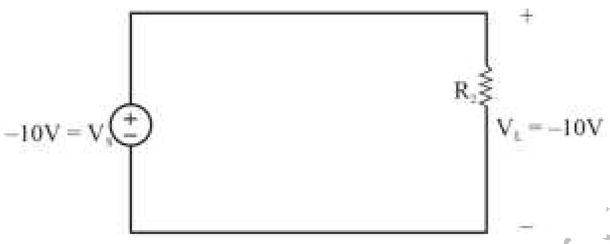
$$V_L = \frac{R_2}{R_1 + R_2} V_S$$

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

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

16. We know that

$$NM_L = V_{IL} - V_{OL}$$

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

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

At $F = 10^6$ we have one pole

$\therefore$ Total poles $N_P = 6$

And total zeros $N_Z = 3$

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

$\therefore Q(t) = 2\pi fct + km(t)$

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

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

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

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

$$\therefore fi_{max} = 50\text{ kHz} + 5\times\frac{1-(-1)}{(7-6)\times 10^{-3}}$$

$\therefore fi_{max}$ = 50 kHz + 10 kHz

$\therefore fi_{max}$= 60 kHz

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

$$50\text{kHz} + 5\times\frac{-1-1}{(9-7)\times 10^{-3}}$$

= 50 kHz – 5kHz

fi_{min} = 45 kHz

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

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

$D_2 = Q_1$

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)

$$\begin{array}{l} 0001 \rightarrow 0000111 \\ 0011 \rightarrow 1100110 \\ \hline 0010 \rightarrow 1100001 \end{array}$$

22. Ans. 0367

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

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

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

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

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

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

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

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

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

So it is equivalent to find time period of

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

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

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

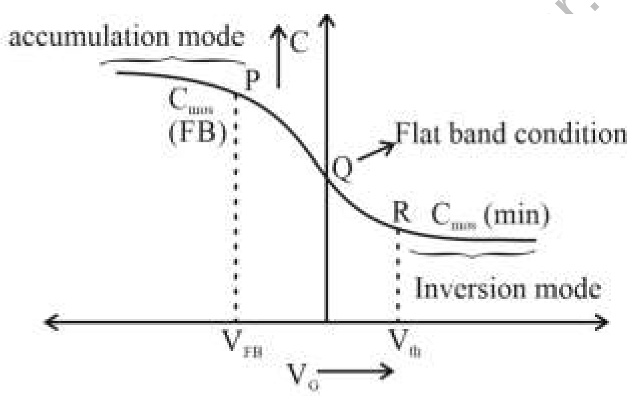
$$\omega_3 = \frac{\pi}{2} \qquad T_3 = \frac{2\pi}{\omega_3} = 4 \text{ second}$$

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

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

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

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

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

∴ M = $A \odot$

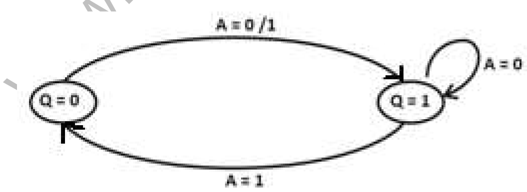
And D = $\overline{MQ}$

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

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

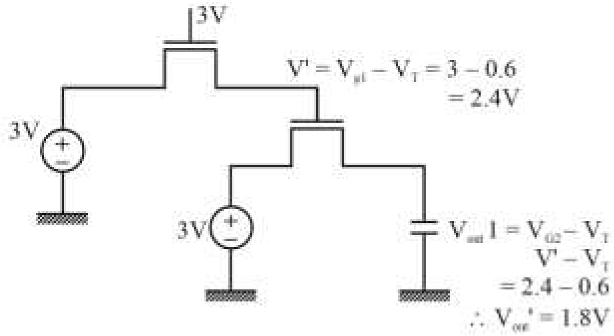
Present State	Input	Next State
Q	A	Q^+ = D
0	0	1
0	1	1
1	0	1
1	1	0

State Diagram:-

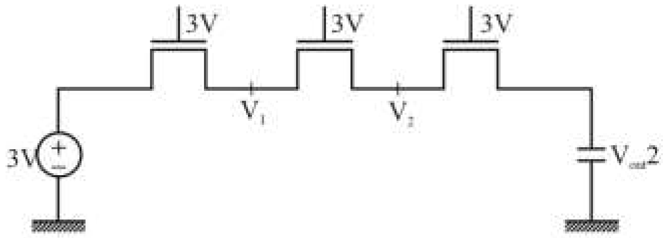


27. Given V_{TN} = 0.6V, V_{SB} = 0 and λ = 0

In figure (i)



In figure (ii)



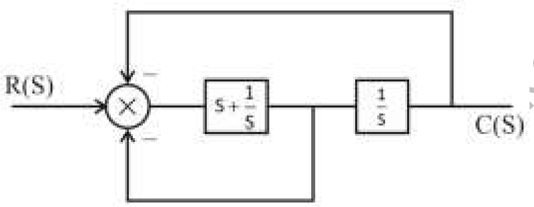
Ever MOS transistor has same V_G = 3V

∴ $V_1 = V_2$ = Vout 2 = VG – VT

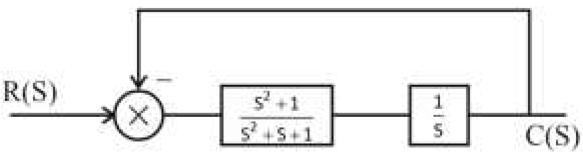
= 3 – 0.6

∴ Vout 2 = 2.4 V

28.



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



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

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

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

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

$P_1(1 + N < Vth)$

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

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

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

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

$P_e = 0.25 + 0.15Vth$

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

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

$I_D = 150\ \mu A$

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

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

$\therefore$ gm = 300×10^{-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

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

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

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

a = 0, b = 1

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

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

$\therefore I_D = 25.5$ 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 $$\eta = \frac{I_{P/q}}{P_{in/h\nu}}$$

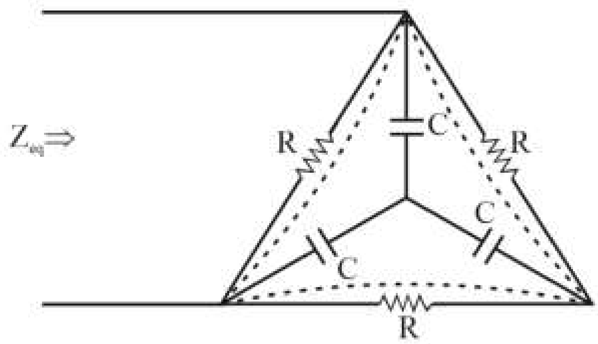
So $\eta = \dfrac{I_{P/q}}{P_{in/h\nu}} = \dfrac{I_P h\nu}{qP_{in}} = \dfrac{h\nu R}{q}$

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

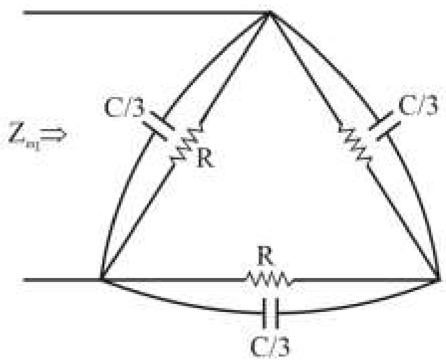
$q = 1.6 \times 10^{-19}$c, $h = 6.63 \times 10^{-34}$Js, $C = 3 \times 10^{8}$ m/s

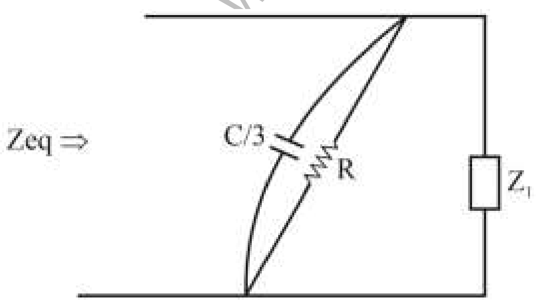
$$R = \frac{\eta\lambda}{1.24}$$

36.



Performing star to delta conversion





 www.FirstRanker.com

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

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

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

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

$\therefore Z_{eq} = 0.66 - 0.2178j$

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

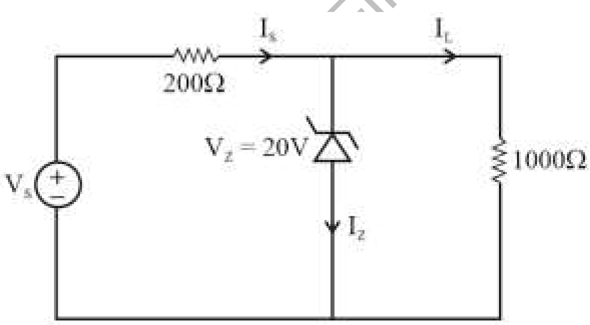
$$= \frac{2\sin(1000t)}{0.66 - 0.2178j}$$

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

= 3.16 sin(1000t + 18.43°)

∴ I ≈ 3 sin(1000t) + cos (1000t)

37.



I_{Zmax} = 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

$$\text{Now } I_S = \frac{V_S - V_Z}{200}$$

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

$\therefore V_S$ = 24V

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

= 60 + 20

I_{Smax} = 80 mA

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

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

$\therefore V_S$ = 36 V

38.

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

For wire ω_1

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

For wire ω_2

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

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

$H = H_1 + H_2$

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

Now $B = \mu_o H$

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

39.

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

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

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

$$V_g = \frac{\frac{1}{\omega}}{c\sqrt{\omega^2-\omega_0^2}} = 2\times10^8 \Rightarrow \frac{c\sqrt{\omega^2-\omega_0^2}}{\omega} = 2\times10^8$$

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

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

$$V_p = \frac{3}{2}\times3\times10^8 = 4.5\times10^8 m/s$$

$$\boxed{V_p = 4.5\times10^8 m/s}$$

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

∴ 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 → ∞ stedy state will occur

$\therefore C(\infty) = 1$

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

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

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

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

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

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

44. Same current will flow through both NMOS & PMOS

$\therefore$ ID1 = ID2

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

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

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

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

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

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

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

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

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

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

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

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

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

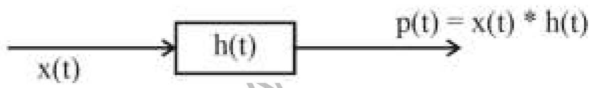
$$\Rightarrow \frac{b^2}{a^2} = \frac{1}{3}$$

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

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

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

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.

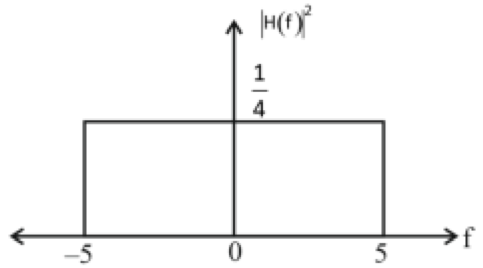
$\therefore S_{yy}(f) = S_{zz}(f) + S_{pp}(f)$

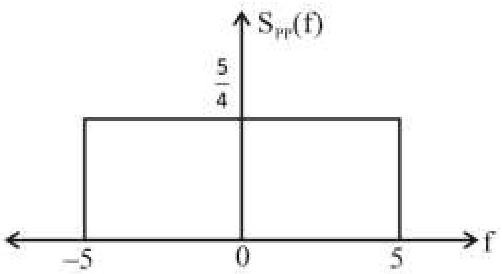
now power of y(t)=

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

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

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





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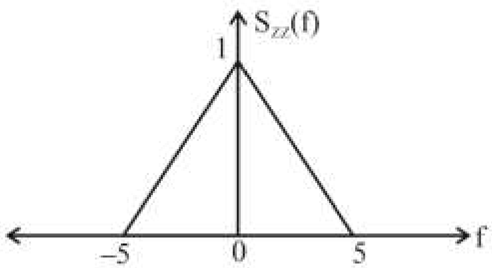


$$\therefore P = \frac{5}{4} \times 10 + \frac{1}{2} \times 10 \times 1$$

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

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

= -27

48. $I_r = 0.75\ I_S$

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

$\therefore I_S(e^{vo/nvt} - 1) = -0.75\ I_s$

Now Take n = 1

$\therefore e^{vo/vT} = 0.25$

$\therefore V_D = V\,T\,l\,n\ (0.25)$

$\therefore V_R = -V\,T\,l\,n\ (0.25)$

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

$\therefore V_R$ = 35.87 mv

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

So let $x = e^z$ $\therefore z = \ln x$

The differential equation can be written as,

D (D –1) – 3D + 3 = 0

$\therefore D^2 - 4D + 3 = 0$

$\therefore D = 1, 3$

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

$\therefore y = C_1x + C_2x^3$

Now y (1) = 1

$\therefore C_1 + C_2 = 1$ ...(i)

And y(2) = 14

$\therefore 2C_1 + 8C_2 = 14$ ...(ii)

From (i) and (ii)

$C_1 = -1, C_2 = 2$

$\therefore y = -x + 2x^3$

$\therefore y(1.5) = -1.5 + 2(1.5)^3$

$\therefore y(1.5) = 5.25$

50. We know that,

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

And capacitor will be charged by the following equation

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

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

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

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

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

$= 0.099$

$I_C(t) \approx 0.1$ 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

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

$\int xdy - ydx = \bigcirc \quad\quad dxdy$

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

$2\bigcirc$

$\bigcirc$ = 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 $G_C(s) = \dfrac{K}{s(s^2+3s+2)}$

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

$$\begin{array}{c|cc} s^3 & 1 & 2 \\ s^2 & 3 & k \\ s^1 & \frac{6-k}{3} & \\ s^0 & k & \end{array}$$

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

55.

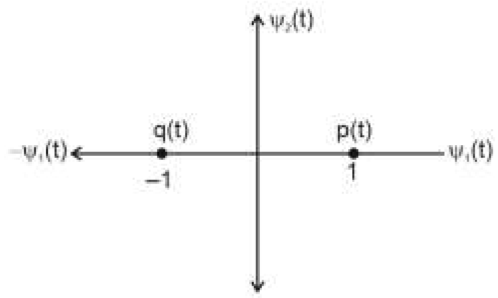
0 is represented by p(t)

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 $q(t) = -\psi_1(t)$

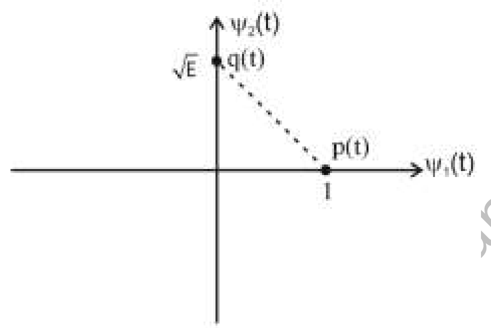
So signal space diagram will be,



$\therefore d_{min_1} = 2$

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

So signal space diagram will be



$\therefore d_{min_2} = \sqrt{E+1}$

Now bit error probability is same in both cases

$\therefore d_{min_1} = d_{min_2}$

$\sqrt{1+E} = 2$

$\therefore E = 3$