Test NO. 13

NAME :-

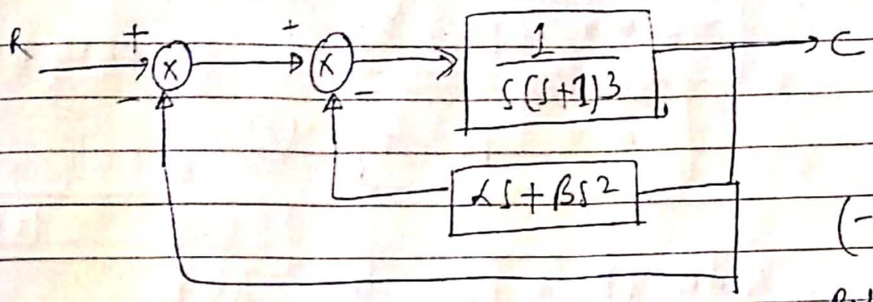
Roll NO :-

DATE

Q.1

(i)

Sol^n :-



$(-1 \pm 2j)$

↓

Poles of system

$$\frac{C}{R} = \frac{\frac{1}{s(s+1)^3}}{1 - \left[-\left[\frac{\alpha s + \beta s^2}{s(s+1)^3}\right] - \frac{1}{s(s+1)^3} \right]}$$

$$= \frac{\frac{1}{\cancel{s(s+1)^3}}}{\frac{s(s+1)^3 + \alpha s + \beta s^2 + 1}{\cancel{s(s+1)^3}}} \Rightarrow \frac{1}{s(s+1)^3 + \alpha s + \beta s^2 + 1}$$

$$q(s) \Rightarrow s(s+1)^3 + \alpha s + \beta s^2 + 1 = 0$$

Put $s = -1+2j$, & $-1-2j$ in $q(s)$.

$$(-1+2j)(\cancel{-1}+2j+\cancel{1})^3 + \alpha(-1+2j) + \beta(-1+2j)^2 + 1 = 0$$

$$-8j(-1+2j) + (-\alpha) + 2\alpha j + \beta(1-4-4j) + 1 = 0$$

$$8j + 16 + 2\alpha j - \alpha - 3\beta - 4\beta j + 1 = 0$$

$$(17 - \alpha - 3\beta) + j(8 + 2\alpha - 4\beta) = 0$$

$17 - \alpha - 3\beta = 0$

$\boxed{\alpha + 3\beta = 17}$ - (1)

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$8 + 2\alpha - 4\beta = 0$

$\boxed{-2\alpha + 4\beta = 8}$

$\boxed{-\alpha + 2\beta = 4}$ - (2)

Add (1) & (2), we get

$5\beta = 21 \Rightarrow \boxed{\beta = 21/5}$

put $\Rightarrow \beta = 21/5$ in (2), we get

$-\alpha + 2\left(\frac{21}{5}\right) = 4$

$-\alpha = 4 - \frac{42}{5} = \frac{20-42}{5} = \frac{-22}{5}$

$\boxed{\alpha = \frac{22}{5}}$ ✓

12

(b) sol^n:

$(-307.1875)_{10} \Rightarrow -(\quad\quad)$

single precision format (32 bit) format

S	E	M
1	8	23

$\downarrow$ (under E)

excess 127 format

$s = 1$ (since negative) ✓

2	307	
2	153	1
2	76	1
2	38	0
2	19	0
2	9	1
2	4	1
2	2	0
2	1	0
	0	1

$0.1875 \times 2 = 0.375$

$0.375 \times 2 = 0.75$

$0.75 \times 2 = 1.5$

$0.5 \times 2 = 1.0$

$(307.1875)_{10} = (100110011.0011)_2$

$= \boxed{1.\boxed{0011\ 0011\ 0011} \times 2^8}$

Mantissa (1. Normalised form)

exponent $= 8 + 127 = 135 = (10000111)_2$

2	135	
2	67	1
2	33	1
2	16	1
2	8	0
2	4	0
2	2	0
2	1	0
	0	1

1	1000 0111	0011 0011 0011 0 0

11 times

$(C3999800)_H$

double precision format (64 bit) format

S	E	M
1	11	52

+1023

Normalized form

$-(307.1875)_{10} =$

$S = 1$ (∵ negative number)

$(307.1875)_{10} = 1.\underbrace{\boxed{0011\,0011\,0011}}_{\text{mantissa}} \times 2^8$

$E = 8 + 1023 = 1031 = (1000\ 0000\ 111)_2$

2	1031	
2	515	1
2	257	1
2	128	1
2	64	0
2	32	0
2	16	0
2	8	0
2	4	0
2	2	0
2	1	0
	0	1

S	E	
1	1000 0000 111	0011 0011 ...

40 bits

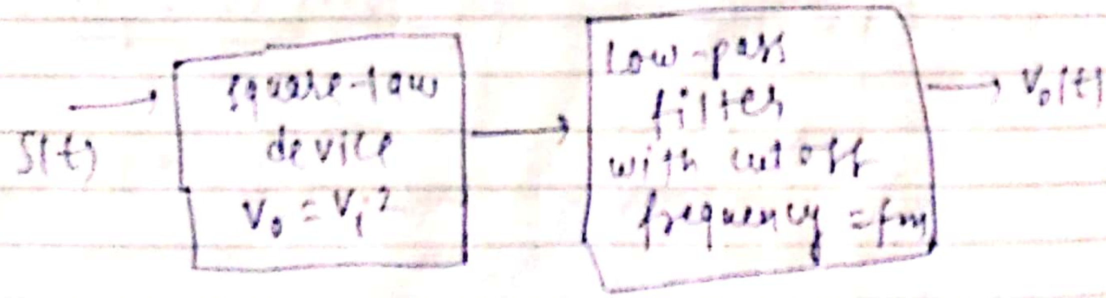
⇓

(C 0 7 3 3 3 0 0 0 0 0 0 0 0 ...)

11

(c)

Sol =



$s(t) = [1 + m(t)] \cos w_c t$

SLD o/p $= V_0 = V_i^2 = [(1 + m(t)) \cos w_c t]^2$

$V_0 \rightarrow [[1 + m^2(t) + 2m(t)] \cos^2 w_c t]$

$V_0 \rightarrow \cos^2 w_c t + m^2(t) \cos^2 w_c t + 2m(t) \cos^2 w_c t$

$\cos^2 w_c t = \frac{1+\cos 2w_c t}{2}$

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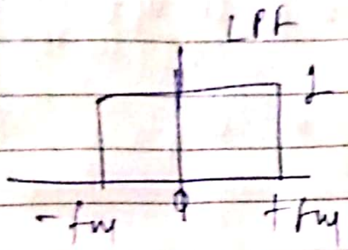
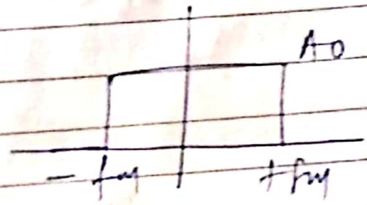
$$SLD\ o/p = \frac{1}{2} + \frac{1}{2}\cos 2w_c t + m^2(t)\left[\frac{1+\cos 2w_c t}{2}\right] + 2\,m(t)\left[1+\cos 2w_c t\right]$$

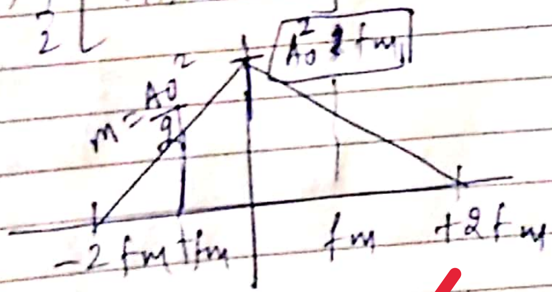


$$V_0(t) = \frac{1}{2} + \frac{m^2(t)}{2} + m(t)$$
(o/p of filter)

$m(t) \xrightarrow{F.T} M(f)$

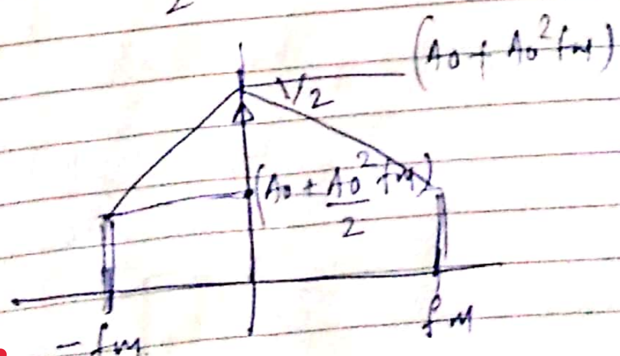


$\frac{1}{2}\,m(t)\cdot m(t) \longrightarrow \frac{1}{2}\left[M(f) \otimes M(f)\right]$



$\frac{1}{2}\delta(t) \longrightarrow \frac{1}{2}\delta(f)$

$V_0(f) \longrightarrow$



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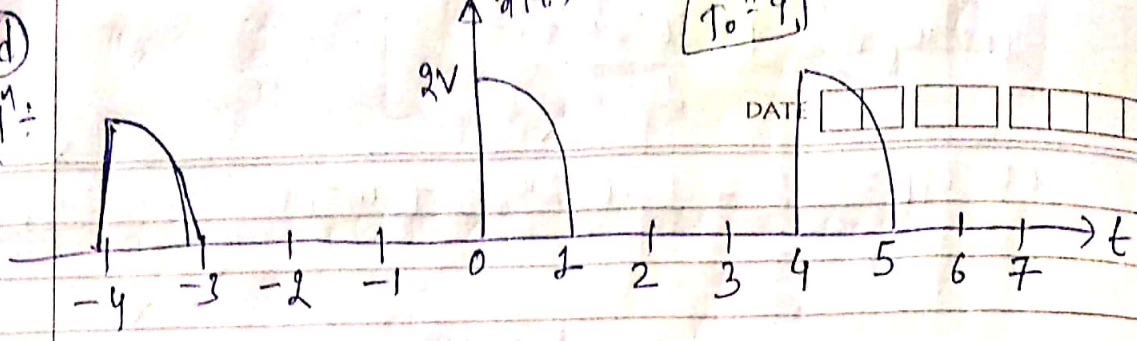
(d)

Sol^n:



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$$x(t) = \begin{cases} 2\cos w_0 t & 0 \le t \le 1 \\ 0 & 1 \le t \le 4 \end{cases}$$

$\boxed{T_0 = 4}$

$$\boxed{x(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos(n w_0) t + b_n \sin(n w_0) t}$$

$$a_0 = \frac{1}{T_0} \int_0^{T_0} x(t)\, dt$$

$$a_0 = \frac{1}{4} \int_0^{4} x(t)\, dt$$

$$= \frac{1}{4} \left[\int_0^1 2\cos w_0 t \, dt + \int_1^4 \cancel{0}^{\,0}\, dt \right]$$

$$\Rightarrow \frac{2}{4} \left[\frac{\sin w_0 t}{w_0} \right]_0^1$$

$$\Rightarrow \frac{1}{2} \left[\frac{\sin w_0 - \cancel{\sin 0}^{\,0}}{w_0} \right]$$

$$w_0 \Rightarrow \frac{2\pi}{T_0} = \frac{2\pi}{4} = \boxed{\pi/2}$$

$$\boxed{a_0} = \frac{1}{2} \cdot \frac{\sin(\pi/2)}{\frac{\pi}{2}} \Rightarrow \boxed{\frac{1}{\pi}}$$

$$a_n = \frac{2}{T_0}\int_0^{T_0} x(t)\cos(n\omega_0 t)\,dt$$

$$a_n = \frac{\cancel{2}}{\cancel{4}\,T_0}\int_0^{4} x(t)\cos(n\omega_0 t)\,dt$$

$$a_n = \frac{1}{\cancel{2}}\left[\int_0^1 \cancel{2}\cos\omega_0 t\,\cos(n\omega_0 t)\,dt\right]$$

$$a_n = \frac{1}{2}\left[\int_0^1 \left[\cos(n+1)\omega_0 t + \cos(n-1)\omega_0 t\right]dt\right]$$

$$\boxed{2\cos A\cos B = \cos(A+B) + \cos(A-B)}$$

$$a_n = \frac{1}{2}\left[\left[\frac{\sin(n+1)\omega_0 t}{(n+1)\omega_0}\right]_0^1 + \left[\frac{\sin(n-1)\omega_0 t}{(n-1)\omega_0}\right]_0^1\right]$$

$$a_n = \frac{1}{2}\left[\frac{\sin[(n+1)\omega_0\times 1]}{(n+1)\omega_0} - \cancel{\frac{\sin(n+1)\omega_0\times 0}{(n+1)\omega_0}}^{\,0}\right.$$

$$\left. + \frac{\sin(n-1)\omega_0\times 1}{(n-1)\omega_0} - \cancel{\frac{\sin(n-1)\omega_0\times 0}{(n-1)\omega_0}}^{\,0}\right]$$

$$a_n = \frac{1}{2\omega_0}\left[\frac{\sin(n+1)\omega_0}{n+1} + \frac{\sin(n-1)\omega_0}{n-1}\right]$$

$$a_n = \frac{1}{\cancel{2}\times\frac{\pi}{\cancel{2}}}\left[\frac{\sin\left(\frac{\pi}{2}+\frac{\pi n}{2}\right)}{n+1} + \frac{\sin\left(\frac{n\pi}{2}-\frac{\pi}{2}\right)}{n-1}\right]$$

$$a_n = \frac{1}{\pi}\left[\frac{\cos(\frac{\pi}{2}n)}{n+1} - \frac{\cos(\frac{\pi}{2}n)}{n-1}\right]$$

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$$a_n = \frac{\cos(\pi/_2 n)}{\pi}\left[\frac{n-1-(n+1)}{n^2-1}\right]$$

$$\boxed{a_n} = \boxed{-\frac{2}{\pi}\frac{\cos(\pi/_2 n)}{n^2-1}}$$

$$b_n = \frac{2}{T_0}\int_0^{T_0} x(t)\sin(n w_0 t)\,dt$$

$$b_n = \frac{2}{4}\int_0^{4} x(t)\sin(n w_0 t)\,dt$$

$$b_n = \frac{1}{2}\left[\int_0^{1} 2\cos w_0 t \sin(n w_0 t)\,dt\right]$$

$$b_n = \frac{1}{2}\left[\int_0^{1}[\sin(n+1)w_0 t + \sin(n-1)w_0 t]\,dt\right.$$

$$\boxed{2\sin A\cos B = \sin(A+B)+\sin(A-B)}$$

$$b_n = \frac{1}{2}\left[\left[\frac{-\cos(n+1)w_0 t}{(n+1)w_0}\right]_0^1 + \left[\frac{-\cos(n-1)w_0 t}{(n-1)w_0}\right]_0^1\right]$$

$$b_n = \frac{1}{2}\left[\frac{-\cos(n+1)w_0 \times 1 + \cos 0}{(n+1)\,w_0} - \frac{\cos(n-1)w_0 \times 1 + \cos 0}{(n-1)w_0}\right]$$

classmate

$$b_n = \frac{1}{2\omega_0}\left[\frac{\sin(n\pi/2)}{(n+1)} + \frac{1}{n+1} - \frac{\sin(n\pi/2)}{n-1} + \frac{1}{n-1}\right]$$

$$b_n = \frac{1}{\pi}\left[\sin(n\pi/2)\left[\frac{1}{n+1} - \frac{1}{n-1}\right] + \frac{1}{n+1} + \frac{1}{n-1}\right]$$

$$b_n = \frac{1}{\pi}\left[\frac{-2\sin(n\pi/2)}{n^2-1} + \frac{2n}{n^2-1}\right]$$

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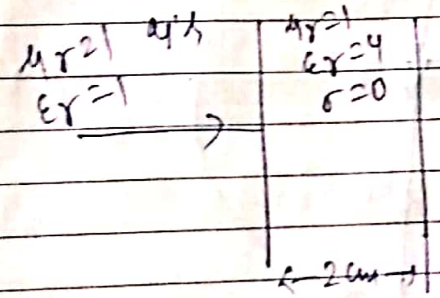
$$\boxed{b_n = \frac{2}{\pi(n^2-1)}\left[n - \sin(n\pi/2)\right]}$$

(e) (a) :



$\boxed{f = 3GHz}$

$$\Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} = \frac{\sqrt{\frac{\mu_r\mu_0}{\varepsilon_r\varepsilon_0}} - \sqrt{\frac{\mu_0}{\varepsilon_0}}}{\sqrt{\frac{\mu_r\mu_0}{\varepsilon_r\varepsilon_0}} + \sqrt{\frac{\mu_0}{\varepsilon_0}}}$$

$$= \frac{\frac{1}{\sqrt{4}} - 1}{\frac{1}{\sqrt{4}} + 1} = \frac{\frac{1}{2} - 1}{\frac{1}{2} + 1} = \frac{-\frac{1}{2}}{\frac{3}{2}}$$

$$\boxed{\Gamma = -1/3} = \frac{E_r}{E_i}$$

$$E_r = \frac{-300}{3} = -100\ mV/m$$

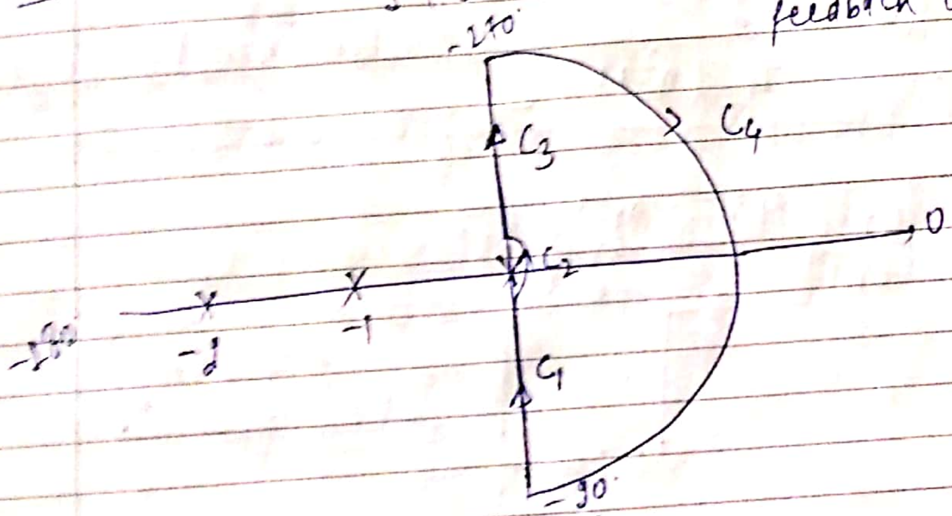
$$|E_r| = 100\ mV/m$$

$\tau = 1 + \Gamma$

$\tau = 1 - 1/3 = 2/3 = \frac{E_t}{E_i}$

$E_t = \frac{2}{3} \times 300^{100} = \boxed{200\ mV/m}$ 11

Q2.
(b)
Sol - (i) $G(s) = \frac{K}{s(s+1)(s+2)}$ (open loop transfer function of unity feedback control system)



Nyquist contour

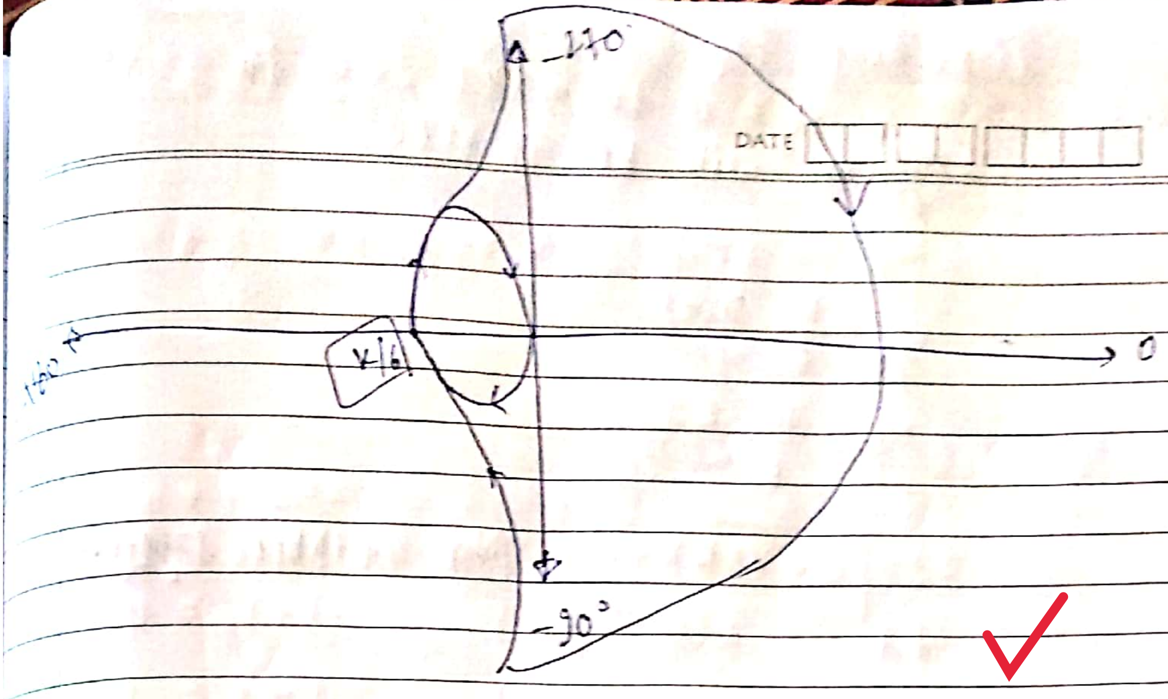
$C_1 - s = -j\omega$, $\theta = -90 + 0 + 90°$, $\omega = \infty$ to 0

$C_2 : s = \lim_{r \to \infty} r e^{j\omega}$, $\theta = -90° + 0 + 90°$

$C_3 = s = +j\omega$, $\omega = 0$ to ∞

$C_4 = s = \lim_{r \to \infty} r e^{j\omega}$ $\theta = +90° - 90°$

ω	M	$\phi = -90° - \tan^{-1}(\omega) - \tan^{-1}(\frac{\omega}{2})$
0	∞	$-90°$
↓	↓	↓
∞	0	$-270°$



$$-180^\circ = -90 - \tan^{-1}(\omega) - \tan^{-1}(\omega/2)$$

$$90^\circ = \tan^{-1}(\omega) + \tan^{-1}(\omega/2) \quad \Big| \quad \tan^{-1}x + \tan^{-1}y = \tan^{-1}\left(\frac{x+y}{1-xy}\right)$$

$$90 = \tan^{-1}\left(\frac{\omega + \omega/2}{1 - \omega^2/2}\right)$$

$$1 - \frac{\omega^2}{2} = 0 \qquad \boxed{\omega_{pc} = \sqrt{2}\ \text{rad/sec}}$$

$$M = \frac{K}{\omega\sqrt{1+\omega^2}\sqrt{4+\omega^2}} = \frac{K}{\sqrt{2}\sqrt{3}\sqrt{6}}$$

$$\boxed{M = \frac{K}{6}}$$

(ii) $N = P - Z$

~~N = No of encirclement~~

P = open-loop poles on the right side

Z = closed-loop poles on the right side

$P = 0,$

$\therefore N = 0$ to make $Z = 0$, so system will be stable.

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$$-\frac{K}{6} > -1$$

$$\frac{K}{6} < 1$$

$$\boxed{0 < K < 6}$$: for stable system.

(iii) sol^n:

$GM \Rightarrow M \Big|_{\omega = \omega_{pc}} = \boxed{\frac{K}{6}}$

$$20 \log_{10} \frac{1}{K/6} = 20 \log_{10} \frac{6}{K} = 0$$

$$\frac{6}{K} = 1$$

$$\boxed{K = 6}$$

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Scanned with CamScanner

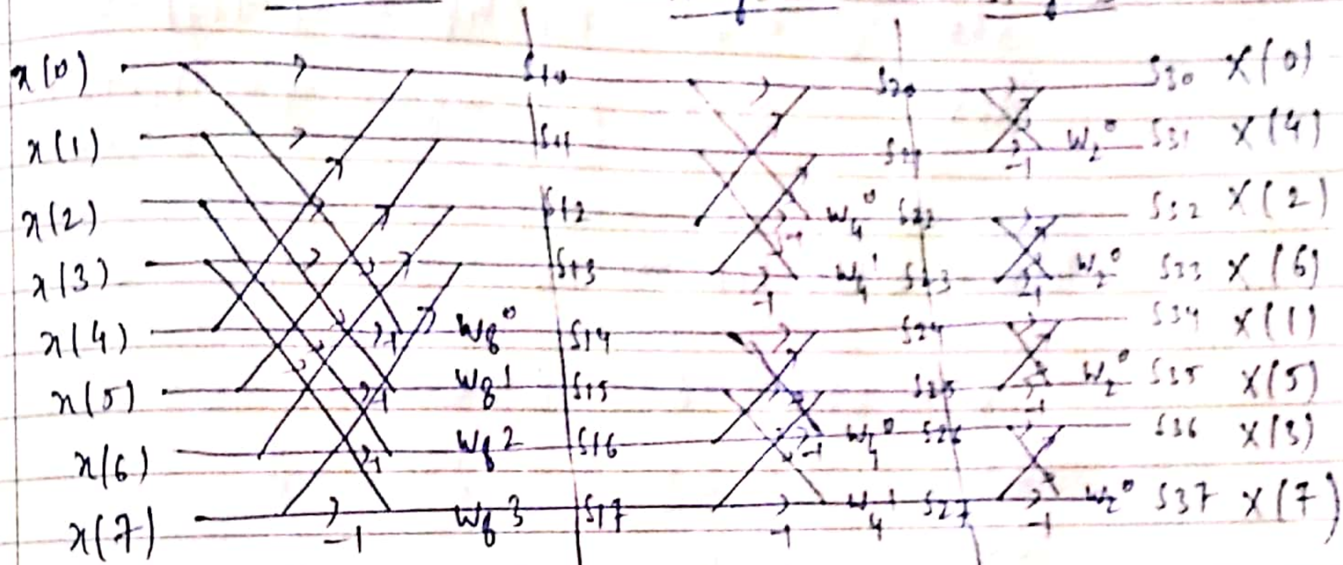
(b)

Sol:

Decimation in frequency FFT algorithm

$x(n) = \{1, -1, -1, -1, 1, 1, 1, -1\}$

Stage-1 Stage-2 Stage-3



0 0 0	0	0	0	0			
0 0 1	1	0	0	4			
0 1 0	0	1	0	2			
0 1 1	1	1	0	6			
1 0 0	0	0	1	1			
1 0 1	1	0	1	5			
1 1 0	0	1	1	3			
1 1 1	1	1	1	7			

First stage o/p →

$W_8^0 = 1$

$W_8^1 = \frac{(1-j)}{\sqrt{2}}$

$W_8^2 = -j$

$W_8^3 = -\frac{(1+j)}{\sqrt{2}}$

$S_{10} = x(0) + x(4)\,W_8^0 = 1 + 1 = 2$

$S_{11} = x(1) + x(5) = -1 + 1 = 0$

$S_{12} = x(2) + x(6) = -1 + 1 = 0$

$S_{13} = x(3) + x(7) = -1 - 1 = -2$

$S_{14} = x(0) - x(4)\,W_8^0 = 1 - 1 = 0$

$S_{15} = x(1) - x(5)\,W_8^1 = (-1) - 1\left(\frac{1-j}{\sqrt{2}}\right) = \frac{-(1+\sqrt{2})+j}{\sqrt{2}}$

$S_{16} = x(2) - x(6)\,W_8^2 = -1 - 1(-j) = -1+j$

$S_{17} = x(3) - x(7)\,W_8^3 = -1 - (-1)\left(\frac{1+j}{\sqrt{2}}\right) = \frac{-\sqrt{2}+1+j}{\sqrt{2}}$

Second stage o/p → $W_4^0 = 1 \quad W_4^1 = -j$

$S_{20} = S_{10} + S_{12} = 2 + 0 = 2$

$S_{21} = S_{11} + S_{13} = 0 - 2 = -2$

$S_{22} = S_{10} - S_{12} = 2 - 0 = 2$

$S_{23} = S_{11} - j S_{13} = 0 - j(-2) = 2j$

$S_{24} = S_{14} + S_{16} = 0 + (-1+j) = -1+j$

$S_{25} = S_{15} + S_{17} = -(2+\sqrt{2})$

$S_{26} = S_{14} - S_{16} = 1 - j$

$S_{27} = S_{15} - j S_{17} = -\frac{(1+\sqrt{2})(1-j) + j - 1}{\sqrt{2}}$

$\Rightarrow -(\sqrt{2}+1) + j(\sqrt{2}+1)$

classmate

Third stage output $W_2^0 = 1$

$S_{30} = S_{20} + S_{21} = 2 - 2 = 0$

$S_{31} = S_{20} - S_{21} = 4$

$S_{32} = S_{22} + S_{23} = 2 + 2j$

$S_{33} = S_{22} - S_{23} = 2 - 2j$

$S_{34} = S_{24} + S_{25} = -(3+\sqrt{2}) + j$

$S_{35} = S_{24} - S_{25} = (1+\sqrt{2}) + j$

$S_{36} = S_{26} + S_{27} = -\sqrt{2} + \sqrt{2}j$

$S_{37} = S_{26} - S_{27} = (2+\sqrt{2}) - j(2+\sqrt{2})$

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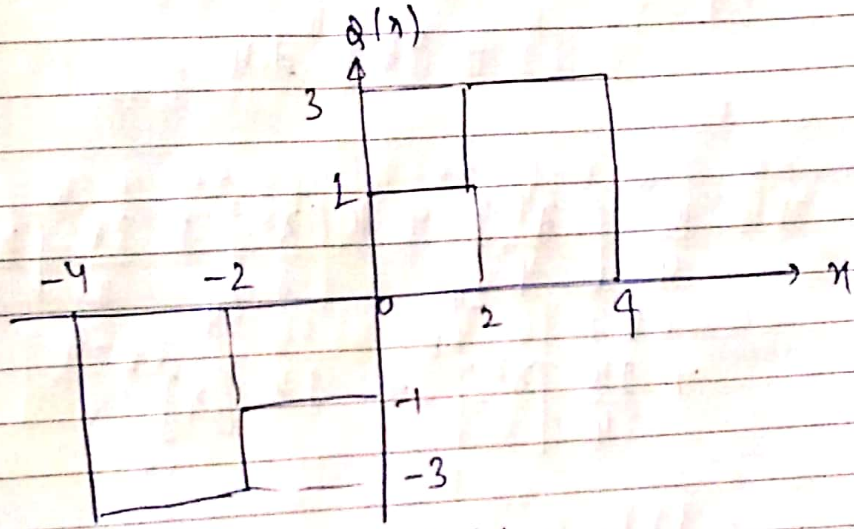
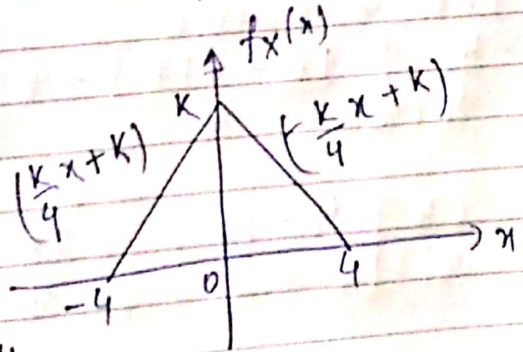
(c)

Sol^n:-





$$Q = \int_{-4}^{4} (x - x_q)^2 \, f_x(x)\, dx$$

$$Q = \underbrace{\int_{-4}^{-2} (x+3)^2 \left(\frac{k}{4}x + k\right) dx}_{q_1} + \underbrace{\int_{-2}^{0} (x+1)^2 \left(\frac{k}{4}x + k\right) dx}_{q_2}$$

$$+ \underbrace{\int_{0}^{2} (x-1)^2 \left(-\frac{k}{4}x + k\right) dx}_{q_3} + \underbrace{\int_{2}^{4} (x-3)^2 \left(-\frac{k}{4}x + k\right) dx}_{q_4}$$

$$q_1 = \int_{-4}^{-2} (x+3)^2 \left(\frac{k}{4}x + k\right) dx$$

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$$= \int_{-4}^{-2} (x^2+6x+9)\left(\frac{k}{4}x + k\right) dx$$

$$\Rightarrow \int_{-4}^{-2} \left[\frac{k}{4}x^3 + kx^2 + \frac{6k}{4}x^2 + 6kx + \frac{9k}{4}x + 9k\right] dx$$

$$\Rightarrow \frac{k}{4}\left[\frac{x^4}{4}\right]_{-4}^{-2} + k\left[\frac{x^3}{3}\right]_{-4}^{-2} + \frac{3k}{2}\left[\frac{x^3}{3}\right]_{-4}^{-2} + 6k\left[\frac{x^2}{2}\right]_{-4}^{-2} + \frac{9k}{4}\left[\frac{x^2}{2}\right]_{-4}^{-2} + 9k\left[x\right]_{-4}^{-2}$$

$$\Rightarrow \frac{k}{4}\left[\frac{16-256}{4}\right] + k\left[\frac{-8+64}{3}\right] + \frac{3k}{2}\left[\frac{-8+64}{3}\right] + 6k\left[\frac{4-16}{2}\right] + \frac{9k}{4}\left[\frac{4-16}{2}\right] + 9k\left[-2+4\right]$$

$$\Rightarrow -15k + 18.66k + 28k - 36k - 13.5k + 18k$$

$$\Rightarrow \boxed{18k - 17.84k} = 0.16k$$

$$q_2 = \int_{-2}^{0} (x^2+2x+1)\left(\frac{k}{4}x + k\right) dx$$

$$\Rightarrow \int_{-2}^{0} \left(\frac{k}{4}x^3 + x^2k + \frac{2k}{4}x^2 + 2kx + \frac{k}{4}x + k\right) dx$$

classmate

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$$\Rightarrow \left[\frac{k}{4}\left[\frac{x^4}{4}\right]_{-2}^{0} + k\left[\frac{x^3}{3}\right]_{-2}^{0} + \frac{k}{2}\left[\frac{x^3}{3}\right]^{0} + 2k\left[\frac{x^2}{2}\right]^{0} + \frac{k}{4}\left[\frac{x^2}{2}\right]^{0} + k\left[x\right]_{-2}^{0}\right.$$

$$\Rightarrow \frac{k}{4}\left[\frac{0-16}{4}\right] + k\left[\frac{0-(-8)}{3}\right] + \frac{k}{2}\left[\frac{0-(-8)}{3}\right] + 2k\left[\frac{0-4}{2}\right] + \frac{k}{4}\left[\frac{0-4}{2}\right] + k\left[0+2\right]$$

$$\Rightarrow -k + \frac{8}{3}k + \frac{8k}{6} - 4k - \frac{k}{2} + 2k$$

$$\Rightarrow \boxed{\frac{k}{2}}$$

$$\boxed{q_3} = \int_0^2 (x-1)^2 \left(-\frac{k}{4}x + k\right) dx$$

$$q_3 = \int_0^2 (x^2 - 2x + 1)\left(-\frac{k}{4}x + k\right) dx$$

$$q_3 = \int_0^2 \left(-\frac{k}{4}x^3 + kx^2 + \frac{2k}{4}x^2 - 2kx - \frac{k}{4}x + k\right) dx$$

$$q_3 = -\frac{k}{4}\left[\frac{x^4}{4}\right]_0^2 + k\left[\frac{x^3}{3}\right]_0^2 + \frac{k}{2}\left[\frac{x^3}{3}\right]_0^2 - 2k\left[\frac{x^2}{2}\right]_0^2 - \frac{k}{4}\left[\frac{x^2}{2}\right]_0^2 + k\left[x\right]_0^2$$

$$\Rightarrow -\frac{k}{4}\left[\frac{16-0}{4}\right] + k\left[\frac{8-0}{3}\right] + \frac{k}{2}\left[\frac{8}{3}\right] - 2k \times \frac{4}{2} - \frac{k}{\cancel{4}} \times \frac{\cancel{4}}{2} + k(2)$$

$$\Rightarrow -k + \frac{8k}{3} + \frac{8k}{6} - 4k - \frac{k}{2} + 2k$$

$$\Rightarrow \left(k/2\right)$$

$$q_4 = \int_2^4 (x^2-6x+9)\left(-\frac{k}{4}x+k\right) dx$$

$$\Rightarrow \int_2^4 \left[-\frac{k}{4}x^3 + kx^2 + \frac{6k}{4}x^2 - 6kx - \frac{9k}{4}x + 9k\right] dx$$

$$\Rightarrow -\frac{k}{4}\left[\frac{x^4}{4}\right]_2^4 + k\left[\frac{x^3}{3}\right]_2^4 + \frac{3k}{2}\left[\frac{x^3}{3}\right]_2^4 - 6k\left[\frac{x^2}{2}\right]_2^4$$

$$-\frac{9k}{4}\left[\frac{x^2}{2}\right]_2^4 + 9k\left[x\right]_2^4$$

$$\Rightarrow -\frac{k}{4}\left[\frac{256-16}{4}\right] + k\left[\frac{64-8}{3}\right] + \frac{3k}{2}\left[\frac{64-8}{3}\right]$$

$$-6k\left[\frac{16-4}{2}\right] - \frac{9k}{4}\left[\frac{16-4}{2}\right] + 9k\left[2\right]$$

$$\Rightarrow -15k + 18.66k + 28k - 36k - 13.5k + 18k$$

$$= 0.16k$$

$$Q = q_1 + q_2 + q_3 + q_4$$

$$= 0.16k + 0.16k + k/2 + k/2$$

$$\Rightarrow k + 0.32k = \boxed{k(1.32)}$$

Total Area under pdf $= 1$

$$\frac{1}{\cancel{2}}(\overset{4}{\cancel{8}})(k) = 1$$

$$\boxed{k = 1/4}$$

$$Q = \frac{1}{4}(1.32) = \boxed{0.33}$$

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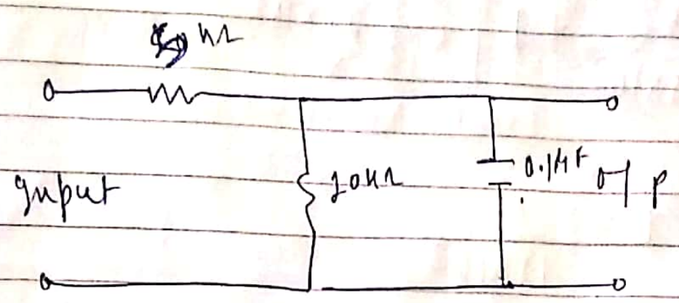
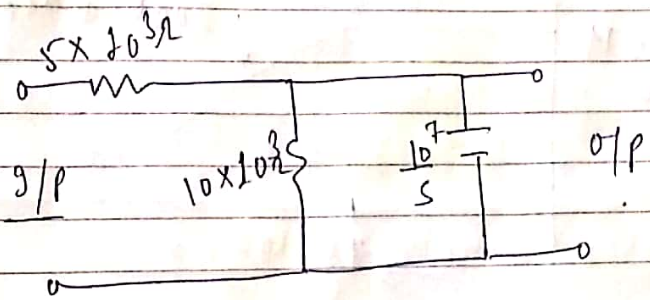
Q4.

(a)

Sol^n:



Laplace domain



$$H(s)\ \frac{o/p}{i/p} = \frac{\left(10^7/s\right) \,||\, (10^4)}{\left(10^7/s \,||\, 10^4\right) + 5\times10^3}$$

$$\frac{10^7}{s} \,||\, 10^4 = \frac{\frac{10^{11}}{s}}{\frac{10^7}{s} + \frac{10^4 s}{s}} \Rightarrow \frac{10^{11-4}}{10^3+s} = \frac{10^7}{10^3+s}$$

$$H(s) = \frac{\frac{10^7}{s+10^3}}{\frac{10^7}{s+10^3} + \frac{5\times10^3(s+10^3)}{(s+10^3)}} \Rightarrow \frac{10^7}{10^7 + 5\times10^3 s + 5\times10^6}$$

$$\Rightarrow \frac{10^4}{5s + 10^4 + 5\times10^3} = \left[\frac{10^4}{5s + 15\times10^3}\right]$$

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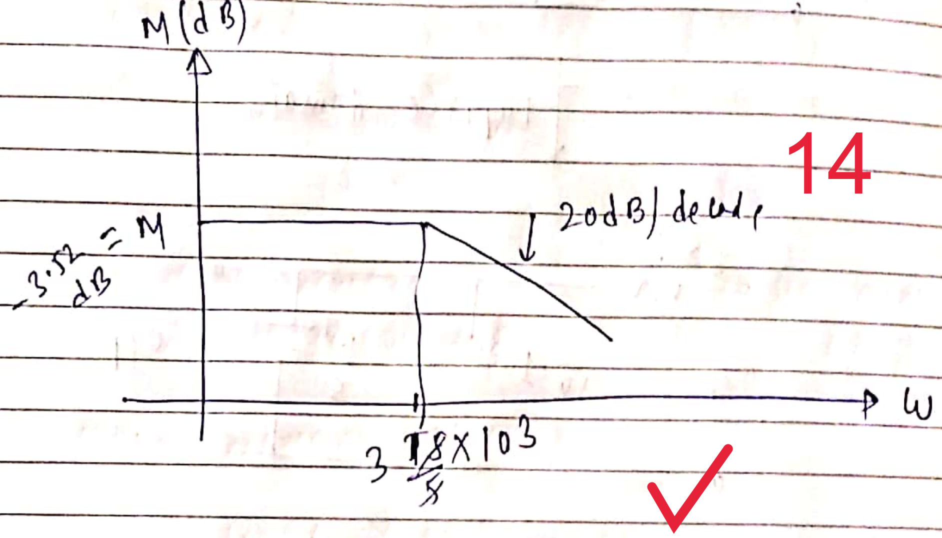
$$H(s) = \frac{\frac{10^4}{15\times10^3}}{\left[\frac{s}{\frac{1}{3}15\times10^3}+1\right]} = \frac{2/3}{\frac{s}{3\frac{15\times10^3}{8}}+1}$$

$$T = \frac{1}{15\times10^3}$$



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$$M = 20\log_{10} 2/3$$

(b)

(i) $y[n] = n\,y[n-1] + 4[n]$

$4_1[n] \rightarrow 9\,4[n]$

$y_1[n] = n\,y.[n-1] + 9\,4[n]$ $\neq$ Not equal

$y_2[n] = 9\,y[n] = 9n\,y[n-1] + 9\,4[n]$

$\therefore$ NON-Linear

$4_1[n] = 4[n-n_0]$

$y_1[n] = n\,y[n-1] + 4[n-n_0]$ ① $\neq$

$y[n-n_0] = n\,y[n-n_0-1] + 4[n-n_0]$ ②

Time - ~~inv~~ variant

(ii) $y(n) = x[2(n-1)]$

$x_1(n) = a\,x(n)$

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$y_1(n) = a\,\boxed{x[2(n-1)]} = a\,y(n)$

$y_2[n] = x_2(n) = b\,x(n)$

$y_2[n] = b\,x[2(n-1)] = b\,y(n)$

$x_1(n) + x_2(n) = (a+b)\,x(n)$

$y_3(n) = (a+b)\,x[2(n-1)] = a+b\,(y(n))$

$= a\,y(n) + b\,y(n)$

$= y_1(n) + y_2(n)$

∴ Linear

$x_1(n) = x(n-n_0)$

$y_1(n) = x[2(n-n_0-1)] = x[2(n-n_0-1)]$

$y_2(n-n_0) = x[2(n-n_0-1)]$

Time-invariant

(iii) $y[n] = \sum_{k=0}^{n} x[k]$

Since Σ operator is linear therefore $y(n)$ is linear

$x_1(k) = x(k-k_0)$

$y_1[n] = \sum_{k=0}^{n} x[k-k_0]$ — (1)

~~$k-k_0=t$~~ $\quad k-k_0 = t$

$k = t + k_0$

$\sum_{-k_0}^{n-k_0} x(t)$

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$$y_2(n) = \sum_{k=0} y(k)$$

$y_1(n) \neq y_2(n)$

$\therefore$ Time variant

12

(c)

Sol:

64 blocks — 16 blocks, 16 blocks, 16 blocks, 16 16

Main memory 4096 blocks

Cache memory 64 blocks

i) Main memory address :

4096×128

$2^{12} \times 2^{7} \Rightarrow \boxed{2^{19}} = \boxed{19 \text{ bits}}$

ii) M.M

10 bit	2 bit	7 bit
tag	set	block

C.M

6 bit	7 bit
block	block offset

9

iii) Size of cache memory $= 2^{13} \times 16$

16384 B

$\Rightarrow$

$\Rightarrow \boxed{16 \text{ KB}}$

classmate

Section-B

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Q05.

(b)

sol^n:- $f = 100\,MHz$, $v_p = 2 \times 10^7 \lambda^{2/3}$ m/s

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{100 \times 10^6} \Rightarrow \boxed{3m}$$

$$v_p = 2 \times 10^7 \times (3)^{2/3} = 4.16 \times 10^7 \text{ m/s}$$

$$\boxed{v_p \cdot v_g = c^2}$$

05

$$v_g = \frac{3 \times 3 \times 10^{16}}{4.16 \times 10^7} = \boxed{2.16 \times 10^9 \text{ m/s}}$$

(c)

sol^n:- Cellular system area $= 2100\, km^2$

area of single cell $= 6\, km^2$

No. of cells $\Rightarrow \frac{2100}{6} = \boxed{350}$

Total No. of clusters $= \frac{350}{7} = 50$

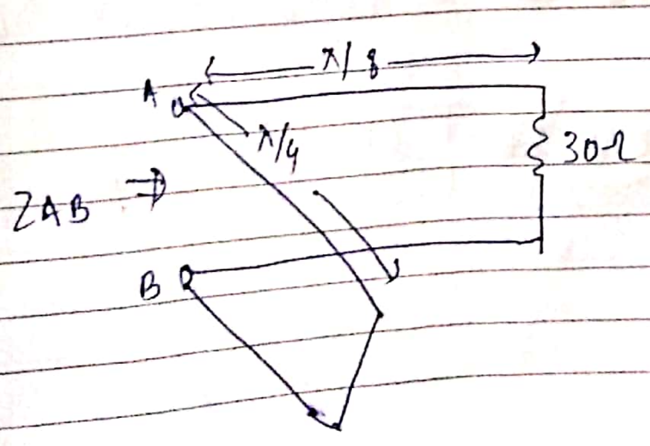
$\therefore$ system capacity $= 50 \times 1001$

$\Rightarrow \boxed{50050}$

09

(d)

sol^n:-



$\boxed{Z_0 = 60\Omega}$

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$$Z_1 = Z_0 \left[\frac{Z_L \cos(\beta l) + j Z_0 \sin(\beta l)}{Z_0 \cos(\beta l) + j Z_L \sin(\beta l)} \right]$$

$$\beta l = \frac{2\pi}{\lambda} \times \frac{\lambda}{8} \Rightarrow \boxed{\pi/4}$$

$$Z_1 = 60 \left[\frac{30 \times \cancel{1/\sqrt{2}} + j\,60 \times \cancel{1/\sqrt{2}}}{60 \times \cancel{1/\sqrt{2}} + j\,30 \times \cancel{\frac{1}{\sqrt{2}}}} \right]$$

$$\Rightarrow 60 \times \frac{30}{30} \left[\frac{1 + 2j}{2 + j} \right]$$

$$Z_1 \Rightarrow 60 \times 1 \angle 36.86^\circ$$

$$Z_2 = Z_0 \left[\frac{Z_L \cancel{\cos(\beta l)} + j Z_0 \sin(\beta l)}{Z_0 \cancel{\cos(\beta l)} + j Z_L \sin\beta l} \right]$$

$$\beta l = \frac{2\pi}{\lambda} \times \frac{\lambda}{4} = \pi/2$$

$$Z_2 = 60 \left[\frac{60}{0} \right] = \boxed{\infty}$$

$$Z_{AB} \Rightarrow Z_1 \,||\, Z_2 \Rightarrow (60 \angle 36.86 \,||\, \infty)$$

$$Z_{AB} \Rightarrow \boxed{60 \angle 36.85^\circ}$$

09

(f)

Sol^n:- $f_m = 6000\,Hz$

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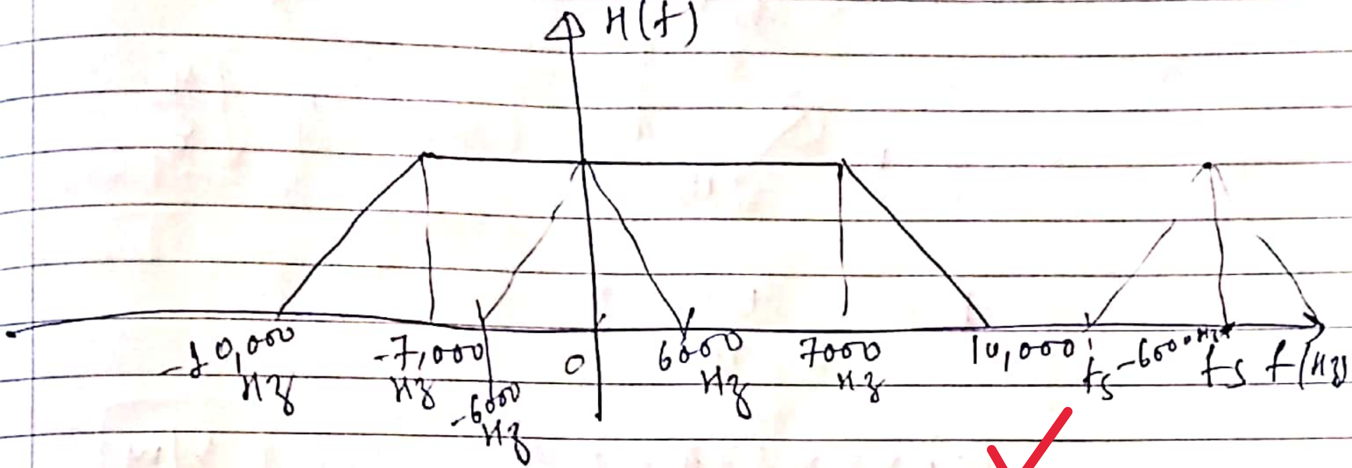
$$H(f) = \begin{cases} K & |f| \le 7000 \\ K\left[1 - \dfrac{|f| - 7000}{3000}\right] & 7000 < |f| < 10{,}000 \\ 0 & \text{otherwise} \end{cases}$$



$f_s \ge 10{,}000 + GB$

$f_s \ge 10{,}000 + 2000$

$f_s \ge 12{,}000$

$\boxed{f_s \ge 12\,KHz}$

$f_s - 6000 \ge 10{,}000 + 2000$
(GB)

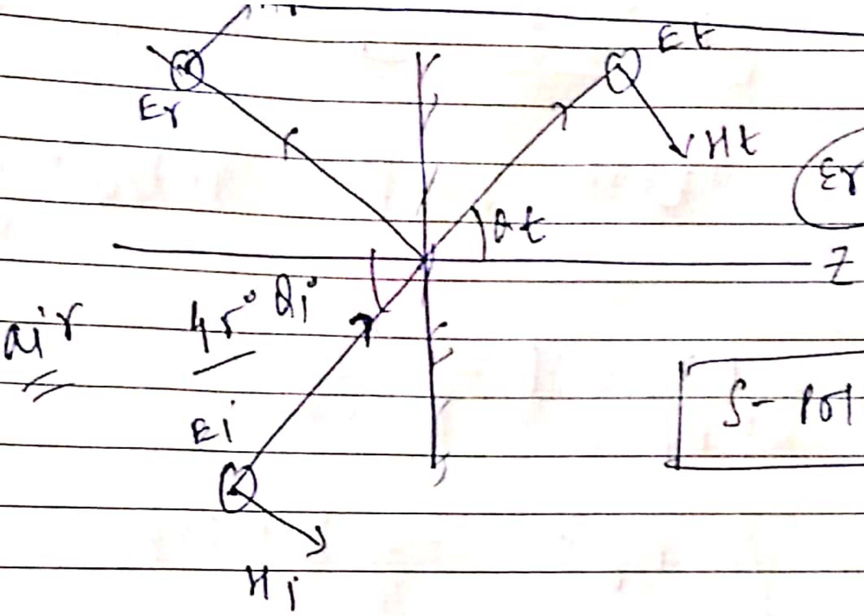
$f_s \ge 18{,}000$

$\boxed{f_s \ge 18\,KHz}$

03

07.

Q7 (a) Sol^n:



$\varepsilon_r = 25$

$\boxed{\text{S-polarized}}$

$$P = \frac{1}{2}\frac{E^2}{\eta}$$

$$E = \sqrt{2P\eta} = \sqrt{2 \times 20 \times 377}$$

$$\boxed{E_i} = \boxed{122.8 \text{ V/m}}$$

By Snell's law

$$n_1 \sin\theta_i = n_2 \sin\theta_t$$

$$1 \sin 45^\circ = 5 \times \sin\theta_t$$

$\sin\theta_t = \frac{1}{5\sqrt{2}}$

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$\boxed{\theta_t = 8.13^\circ}$

$$\Gamma = \frac{\eta_g \sec\theta_t - \eta_1 \sec\theta_i^\circ}{\eta_g \sec\theta_t + \eta_1 \sec\theta_i^\circ}$$

$$= \frac{\frac{1.01}{5} - 1.414}{\frac{1.01}{5} + 1.414} \Rightarrow \frac{-1.212}{1.616}$$

$\boxed{\Gamma = -3/4}$

$\tau = 1 + \Gamma = 1 - 3/4 = \boxed{1/4}$

$\frac{E_r}{E_i} = \Gamma = -3/4$

$$\boxed{E_r = \frac{-3}{4} \times 122.8 = -92.1 \text{ V/m } \hat{a}_y}$$

$\frac{E_t}{E_i} = \tau = 1/4$

$$\boxed{E_t = \frac{122.8}{4} = 30.7 \text{ V/m } \hat{a}_y}$$

(ii)

$|E|, |H|$ | $|E|, |H|$

$z=1m$ | $z=1m$

LHS air | dielectric RHS

$$E_{LHS} = E_i + E_r = (122.8 - 92.1)\, a_y$$

$$= |30.7|\, a_y \ (V/m)$$

$$\frac{E_{LHS}}{H_{LHS}} = \eta =$$

$$\frac{30.7}{377} = H_{LHS} = \underline{\underline{0.081}} \quad (V/m)$$

$$E_{RHS} = E_r = \boxed{\underline{\underline{92.1\ V/m}}}$$

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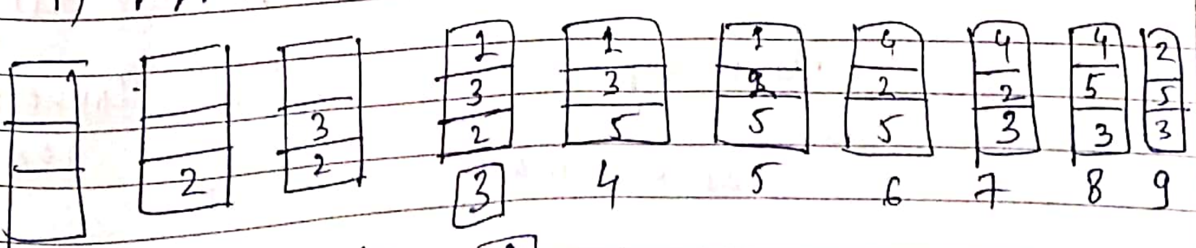
$$H_{RHS} = \frac{E_{RHS}}{\eta_2} = \frac{92.1}{\frac{120\pi}{5}} = \boxed{1.22\ A/m}$$

$\therefore$ attenuation on both sides is $\underline{\text{zero}}$.

(b) 2, 3, 2, 1, 5, 2, 4, 5, 3, 2, 5, 2

Sol^n:

i) FIFO



& ~~total fault~~ = $\boxed{9}$

(ii) LRU :- 2, 3, 2, 1, 5, 2, 4, 5, 3, 2, 5, 2

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			1	1	4	4	2
		3	3	5	5	5	5
	2	2	2	2	2	3	3
0	1	2	3	4	5	6	7

$\boxed{\text{Total fault} = 7}$

(iii) optimal :- (2, 3, 2, 1, 5, 2, 4, 5, 3, 2, 5, 2

			1	5	5	5
		3	3	3	3	3
	2	2	2	2	4	2
	1	2	3	4	5	6

$\boxed{\text{Total fault} = 6}$

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(C) Sol :-

LED T_x = 850 nm, $\boxed{P_{in} = -10\ dBm}$

$a = 50\ \mu m$, $\alpha = 2.5\ dB/km$, $(\Delta T)_{mat} = 3\ ns/km$

$(\Delta T)_{modal} = 1\ ns/km$, $(P_r) = -42\ dBm$

$BER = 10^{-9}$ $(t_r)_s = 11\ ns$ $(t_r)_R = 12\ ns$

Slice loss = 0.5 dB/slice, connector loss = 1 dB

link margin = 6 dB

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(i)

$(P_{in} - P_R) = \alpha L + (L-1)0.5 + 2dB + 6dB$

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$-10 - (-42) = 2.5L + (L-1)0.5 + 8$

$32 - 8 = 3L - 0.5$

$\frac{24.5}{3} = L = \boxed{8.16 \text{ km}}$

09

(ii)

BER :

$\boxed{BER = \frac{Pr}{BW}}$

$10^{-9} =$