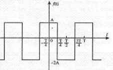
1. (C) The eigen values of a skew-symmetric matrix are either zero or pure imaginary.

2. (C) $f(t)$ = ever function for all $t$



$$f(t) = \begin{cases} A & -\frac{T}{4} < t < \frac{T}{4} \\ -2A & \frac{T}{4} < t < \frac{3T}{4} \\ A & \frac{3T}{4} < t < T \end{cases}$$

$$\text{DC term} = \frac{1}{T}\left[\int_{-T/4}^{T/4} f(t)dt + \int_{T/4}^{3T/4} f(t)dt + \int_{3T/4}^{T} f(t)dt\right]$$

$$= \frac{1}{T}\left[\int_{-T/4}^{T/4} A\,dt + \int_{T/4}^{3T/4} -2A\,dt + \int_{3T/4}^{T} A\,dt\right]$$

$$= \frac{1}{T}\left[A\cdot\frac{T}{2} - 2A\cdot\frac{T}{2} + A\cdot\frac{T}{4}\right]$$

$$= \left[\frac{A}{2} - A + \frac{A}{4}\right]$$

$$= \frac{3A}{4} - \frac{4A}{4} = -\frac{A}{4} \text{ (-ve)}$$

$$a_n = \frac{1}{T}\int f(t)\sin\omega n\,t\,dt = 0$$

$$b_0 = \frac{2\times 1}{T}\int_0^T f(t)\cos\omega n\,t\,dt \neq 0$$

Hence, only cosine terms and negative value for the d.c. component.

3. (D) $\frac{d^2n(x)}{dx^2} - \frac{n(x)}{L^2} = 0$

Given $n(0) = K,\ n(\infty) = 0$

$$D^2 - \frac{1}{L^2} = 0$$

$$D = \pm\frac{1}{L}$$

$$n(x) = \text{C.S.} = c_1 e^{+\frac{1}{L}x} + c_2 e^{-\frac{1}{L}x}$$

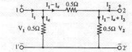
$$n(0) = c_1 + c_2 = K \quad \text{...(i)}$$

$$n(\infty) = c_1 e^{\frac{1}{L}\infty} + c_2 e^{-\frac{1}{L}\infty} = 0$$

It is possible when $c_1 = 0$

Hence, $n(x) = c_2 e^{-\frac{x}{L}} = K e^{-\frac{x}{L}}$

4. (A) The given two-port network




From given circuit

$$V_1 = 0.5\,I_a \quad \text{...(i)}$$

and $$V_1 = (I_1 - I_a)\,0.5 + V_2 \quad \text{...(ii)}$$

and $$V_2 = (I_1 - I_a + I_2)\,0.5 \quad \text{...(iii)}$$

From equation (i) and (ii)

$$V_1 = \left(I_1 - \frac{V_1}{0.5}\right)0.5 + V_2$$

or $$V_1 - 0.5\,I_1 + V_1 - V_2 = 0$$

or $$0.5\,I_1 = 2V_1 - V_2$$

or $$I_1 = 4V_1 - 2V_2 \quad \text{...(iv)}$$

On comparing equation (iv) with the standard equation of Y-parameter *i.e.* short circuit admittance parameter matrix,

$$I_1 = Y_{11}V_1 + Y_{12}V_2, \text{ we get}$$

$$Y_{11} = 4, Y_{12} = -2$$

From the given options we conclude that there is no need to solve further because these parameters are given in option (A) only.

5. (D)


$$\frac{1}{Z} = \frac{1}{SL} + \frac{1}{R} + SC$$

$$\frac{1}{Z} = \frac{S^2LCR + LS + R}{RSL}$$

$$Z(S) = \frac{RLS}{RLC\left[S^2 + \frac{1}{RC}S + \frac{1}{LC}\right]} = \frac{S}{C\left[S^2 + \frac{1}{RC}S + \frac{1}{LC}\right]}$$

$$\text{Bandwidth} = \frac{1}{RC}$$

(i) When R increase BW decrease

(ii) B.W. not depend upon L

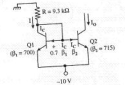
at resonane input impedent is a real quantity.

6. (B) At room temperature

$$\mu_n = 1350 \text{ cm}^2/\text{v} - \text{s}$$

7. (B) Thin gate oxide in a CMOS process is preferably grown using dry oxidation.

8. (B)




$$9{\cdot}3\,I + 0{\cdot}7 - 10 = 0$$

$$I = 1 \text{ mA}$$

$$I = \frac{I_c}{\beta_1} + \frac{I_0}{\beta_2} + I_c = 1$$

$$\frac{I_c}{\beta_1} = \frac{I_0}{\beta_2}$$

$$I_c = \frac{\beta_1}{\beta_2} I_0$$

$$\Rightarrow \quad I = \frac{I_0}{\beta_2} + \frac{I_0}{\beta_2} + \frac{\beta_1}{\beta_2} I_0$$

$$I_c = \frac{\beta_2}{1 + 1 + \beta_1} = \frac{\beta_2}{2 + \beta_1} \bar{A}B + \bar{A}B$$

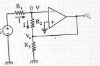
$$I_c = \frac{715}{702} - 2 \text{ mA}$$

9. (A) $R_i = r_\pi + (1 + \beta)R_E$

So, input resistance $R_i$ increase with $R_E$ and gain

$$A_v = -\frac{R_c}{R_E} \text{ gain decrease with } R_E$$

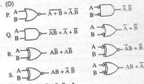
10. (A)




$$\frac{V_i - 0}{R_1} = \frac{0 - V_0}{R_2}$$

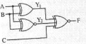
$$\frac{V_0}{V_i} = -\frac{R_2}{R_1}$$

11. (D)




P—4, Q—2, R—3, S—1.

12. (D)




**Applying hit and trail method**

- When $A = 1, B = 1, C = 0$

  then $Y_1 = 0, Y_2 = 1, C = 0$

  We know that output of EX-OR gate will be high o when the even number of inputs are high *i.e.*, 1.

  Since, here the odd number of inputs are h therefore F = 0.

- When $A = 1, B = 0, C = 0$

  then $Y_1 = 1, Y_2 = 0, C = 0$

  Since, here the odd number of inputs are h therefore F = 0.

- When $A = 0, B = 1, C = 0$

  then $Y_1 = 1, Y_2 = 0, C = 0$

  Again, $F = 0$

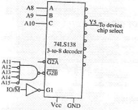
- When A = 0, B = 0, C = 1

  then $Y_1$ = 0, $Y_2$ = 1, C = 1

  Since, here the even number of inputs are high, therefore F = 1.

Hence, alternative (D) is the correct choice.

13. (B) The given circuit




From figure we can write

$\underbrace{A_{15}\ A_{14}\ A_{13}\ A_{12}\ A_{11}}_{\text{Applied inputs in order to make the chip enable}}\ \underset{C}{A_{10}}\ \underset{B}{A_9}\ \underset{A}{A_8}$

From the given circuit we conclude that in order to make the chip enable the output of the five inputs NAND gate must be zero. Therefore in order to make the output of NAND gate zero all the inputs should be high.

Thus, $A_{11}$ should be high *i.e.* 1

$A_{12}$ should be low *i.e.* 0

$A_{13}$ should be high *i.e.* 1

$A_{14}$ should be low *i.e.* 0

$A_{15}$ should be low *i.e.* 0

Also in order to get output at pin no. 5 in a 3 to 8 decoder the inputs

CBA must be 101 *i.e.* 5 in decimal.

Therefore, range can be calculated as follows—

Min.

| $A_{15}A_{14}A_{13}A_{12}$ | $A_{11}A_{10}A_9A_8$ | $A_7\ A_6\ A_5\ A_4$ | $A_3\ A_2\ A_1\ A_0$ |
|---|---|---|---|
| 0 0 1 0 | 1 1 0 1 | X X X X | X X X X |
| 0 0 1 0 | 1 1 0 1 | 0 0 0 0 | 0 0 0 0 |
| 2H | DH | 0H | 0H |

So, minimum value = 2000 H

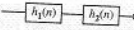
Max. $\underbrace{0\ 0\ 1\ 0}_{2H}\ \underbrace{1\ 1\ 0\ 1}_{DH}\ \underbrace{1\ 1\ 1\ 1}_{FH}\ \underbrace{1\ 1\ 1\ 1}_{FH}$

So, maximum value = 2 DFFH.

Therefore, the range → 2000 – 2 DFF.

14. (A) $X(z) = 5z^2 + 4z^{-1} + 3 \qquad 0 < |z| < \infty$

$x(n) = 5\delta(n+2) + 3\delta(n) + 4\delta(n-1)$

15. (C) 


$h_1[n] = \delta(n-1)\ h_2(n) = \delta(n-2)$

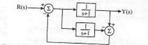
output $= h_1[n] * h_2[n]$

$= \delta(n-1) * \delta(n-2)$

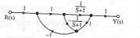
$= \delta(n-2-1) = \delta(n-3)$

16. (C) For an N-point FFT algorithm with N = $2^m$. In place computation requires storage of only 2N node data.

17. (B) The given system




The given system can be easily solve by using signal flow graph as shown below




From above figure

$$\frac{Y(s)}{R(s)} = \frac{\frac{1}{s+1}[1-0]}{1-\left[\frac{1}{s+1}-\frac{1}{s+1}\right]^1}$$

or $$\frac{Y(s)}{R(s)} = \frac{1}{s+1}$$

Hence, alternative (B) is the correct choice.

18. (B) $\frac{Y(s)}{X(s)} = \frac{s}{s+p}$ output $y(t) = \cos\left(2t - \frac{\pi}{3}\right)$

input $x(t) = P\cos\left(2t - \frac{\pi}{2}\right)$

$$Y(t) = \frac{1}{2}\cos 2t + \frac{\sqrt{3}}{2}\sin 2t$$

$$Y(s) = \frac{s}{2(s^2+4)} + \frac{\sqrt{3}}{2}\frac{2}{s^2+4}$$

$$Y(s) = \frac{s + 2\sqrt{3}}{2(s^2+4)}$$

$$x(t) = p\sin(2t)$$

$$X(s) = \frac{2p}{(s^2+4)}$$

$$\frac{Y(s)}{X(s)} = \frac{s+2\sqrt{3}}{4p} = \frac{s}{s+p}$$

$$(s + 2\sqrt{3})(s+p) = 4sp$$

$$s^2 + 2\sqrt{3}s + ps + 2\sqrt{3}p = 4sp$$

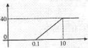
Equating coefficient both side of s.

$$2\sqrt{3} + p = 4p$$

$$3p = 2\sqrt{3}$$

$$p = \frac{2}{\sqrt{3}}$$

19. (A)




$$M(s) = \frac{K\left(\frac{s}{0.1}+1\right)}{\left(\frac{s}{10}+1\right)} = \frac{K(10\,s+1)}{(0.1\,s+1)}$$

$$0 = 20\log_{10}K$$

$$\Rightarrow \quad K = 10^{\circ} = J$$

Hence $M(s) = \left[\frac{10\,s+1}{0.1\,s+1}\right]$

20. (C) $m(t) = 2\cos 2\pi f_m t$

$x_c(t) = A_c \cos 2\pi f_c t$

Conventional AM signal

$$x(t) = A_c[1 + \mu |m(t)|]\cos 2\pi f_c t$$

For without over - modulation

$$\mu < 1$$

$$x(t) = A_c \cos 2\pi f_z t + \frac{A_c}{4} m(t)\cos 2\pi f_c t$$

$$x(t) = A_c\left[1 + \frac{1}{4}m(t)\right]\cos 2\pi f_c t$$

$$= A_c\left[1 + \frac{2}{4}\cos 2\pi f_m t\right]\cos 2\pi f_c t$$

$\mu = \frac{1}{2}$ which is less then 1.

21. (B) $x(t) = 6\cos(2\pi \times 10^6 t + 2\sin(8000\,\pi t) + 4\cos(8000\,\pi t))$

Average power of $x(t)$ is

$$= \frac{A^2}{2} = \frac{6^2}{2} = 18$$

22. (C) $[S] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$

For lossless $S_{11} = S_{22} = 0$

For reciprocal $S_{12} = S_{21}$

Hence, $\begin{bmatrix} 0\cdot 2\angle 0^\circ & 0\cdot 9\angle 90^\circ \\ 0\cdot 9\angle 90^\circ & 0\cdot 1\angle 90^\circ \end{bmatrix}$

not lossless but reciprocal.

23. (D) $Z_0 = 50\Omega$ $R = 0\cdot 1\ \Omega/m$

For distortionless transmission line

$$Z_0 = \sqrt{\frac{R}{G}} = 50$$

$$\frac{R}{50^2} = G$$

$$\gamma = \sqrt{RG} + j\omega\sqrt{RG}$$

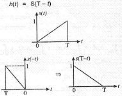
$$= \alpha + j\beta$$

$$\alpha = \sqrt{RG} = \sqrt{\frac{R \cdot R}{50^2}} = \frac{R}{50} = \frac{0\cdot 1}{50}$$

$$\alpha = 0\cdot 002\ \text{(Np/m)}$$

24. (C) For Matched Filter

$$h(t) = S(T - t)$$




25. (C) $\mu_0, \in = \in_r \in_0 = 4\in_0$

$$|E_0| = 1\ \text{v/m} \qquad \eta = \sqrt{\frac{\mu_0}{4\in_0}}$$

$$p_{avg} = \frac{1}{2}\frac{|E_0|^2}{\eta} \qquad = \frac{120\pi}{2} = 60\pi$$

$$= \frac{1}{2} \times \frac{1}{60\pi} = \frac{1}{120\pi}$$

26. (A) $e^y = x^{1/x}$

$$\frac{1}{x}\log_e x = y$$

$$\frac{dy}{dx} = \frac{1}{x^2} - \frac{\log x}{x^2} \Rightarrow x = e$$

$$\frac{d^2y}{dx^2} = \frac{-2}{x^3} - \left\{\frac{1}{x^3} - \frac{2\log x}{x^3}\right\}$$

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

at $x = e$

$$\frac{d^2y}{dx^2} = -\frac{3}{e^3} + \frac{2}{e^3} < 0$$

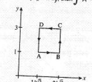
Hence, $y$ is max. at $x = e$.

27. (D) A fair coin is tossed independently 4 time probability of the event coming up head more then the event coming up tails $= {}^4C_3\left(\frac{1}{2}\right)^3\left(\frac{1}{2}\right) + {}^4C_3\left(\frac{1}{2}\right)^4$

$$= 4\frac{1}{(2)^4} + 4\frac{1}{2^4}$$

$$= \frac{5}{16}$$

28. (C) $\vec{A} = xy\hat{a}_x + x^2\hat{a}_y$, then $\oint \vec{A} \cdot \vec{dl}$




$\oint \vec{A} \cdot \vec{dl}$

$$= \int_{AB} \vec{A}\,\vec{dl} + \int_{BC} \vec{A}\,\vec{dl} + \int_{CD} \vec{A}\,\vec{dl} + \int_{DA} \vec{A}\,\vec{dl}$$

$\quad I_1 \qquad I_2 \qquad I_3 \qquad I_4$

$$I_1 = \int_{AB} \vec{A}\,\vec{dl}$$

$$y = 1 \; dy = 0$$

$$I_1 = \int_{\sqrt{3}}^{2/\sqrt{3}} (x\sqrt{a}_x + xdy)(a_x dx + a_y 0)$$

$$= \int_{1/\sqrt{3}}^{2/\sqrt{3}} x\,dx = \frac{x^2}{2}\Big]_{1/\sqrt{3}}^{2/\sqrt{3}}$$

$$= \frac{1}{2}\left[\frac{4}{3} - \frac{1}{3}\right] = \frac{1}{2}$$

$$I_2 = \int_1^3 \left(\frac{2}{\sqrt{3}} y\, a_x + \frac{4}{3} a_y\right)(a_x 0 + a_y d_y)$$

$$= \frac{4}{3}\int_1^3 dy = \frac{4}{3}\cdot 2 = \frac{8}{3}$$

$$I_3 = \int_{2/\sqrt{3}}^{1/\sqrt{3}} (x\cdot 3a_x + x^2 a_y)(a_x dx + 0\cdot d_y)$$

$$= 3\int_{2/\sqrt{3}}^{1/\sqrt{3}} x\,dx = \frac{3}{2}[x^2]_{2/\sqrt{3}}^{1/\sqrt{3}}$$

$$= \frac{3}{2}\left[\frac{1}{3} - \frac{4}{3}\right] = -\frac{3}{2}$$

$$I_4 = \int_3^1 \left(y\frac{1}{\sqrt{3}} a_x + \frac{1}{3} a_y\right)(a_x + a_y dy)$$

$$= \frac{1}{3}\int_3^1 dy = -\frac{2}{3}$$

Hence $\quad I = \frac{1}{2} + \frac{8}{3} - \frac{3}{2} - \frac{2}{3}$

$$= \frac{3+16-9-4}{6} = \frac{19-13}{6} = \frac{6}{6} = 1$$

29. (C) Given complex function

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

The poles are located at $z = 0, 1, 2$.

- **Residue at pole $z = 0$ is**

$$f(z)\cdot z\big|_{\text{at } z=0}$$

or $$\frac{(1-2z)}{z(z-1)(z-2)}\,z\Bigg|_{z=0}$$

or $$\frac{(1-2\cdot 0)}{(0-1)(0-2)} = \frac{1}{2}$$

- **Residue at pole $z = 1$ is**

$$= f(z)\cdot(z-1)|_{z=1}$$

$$= \frac{(1-2z)(z-1)}{z(z-1)(z-2)}\Bigg|_{z=1}$$

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

- **Residue at pole $z = 2$ is**

$$= f(z)(z-2)|_{z=2}$$

$$= \frac{(1-2z)(z-2)}{z(z-1)(z-2)}\Bigg|_{z=2}$$

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

$$= -\frac{3}{2}$$

Hence alternative (C) is the correct choice.

30. (C)

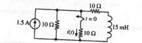
31. (D) $$f(t) = L^{-1}\left[\frac{3s+1}{s^3+4s^2+(K-3)s}\right]$$

$$f(t) = L^{-1}\left[\frac{3s+1}{s(s^2+4s^2+K-3)}\right]$$

$$\lim_{t\to\infty} f(t) = \lim_{s\to 0} sF(s) = \lim_{s\to 0} \frac{3s+1}{s^2+4s^2+K-3} = 1$$

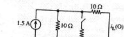
$$\frac{1}{K-3} = 1 \Rightarrow K-3 = 1\; K = 4$$

32. (A)

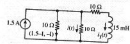



**Case I : $t < 0$**

$$i_L(0^-) = \frac{1\cdot 5}{20} = 0\cdot 75 \text{ amp}$$




**Case II : for $t \geq 0^+$**



$$10 I_1(t) + 15 \times 10^{-3} \frac{d}{dt} i_1(t) - 10 i(t) = 0 \qquad \ldots(i)$$

$$10 i(t) - 10(1.5 - i_1 - i) = 0$$

$$2i(t) + i_1(t) = 1.5$$

$$i_1(t) = 1.5 - 2i_1(t) \qquad \ldots(ii)$$

$$\frac{di_1(t)}{dt} = -2\frac{di(t)}{dt}$$

$$15 - 20 i(t) - 15 \times 10^{-3} \times 2\frac{di(t)}{dt} - 10 i(t) = 0$$

$$\frac{di(t)}{dt} + 1000\, i(t) = 500$$

$$\text{I.F.} = e^{\int 1000\, dt} = e^{1000t}$$

$$i(t) \cdot e^{1000t} = \int e^{1000t} \cdot 500\, dt = c$$

$$i(t) = \frac{1}{2} + ce^{-1000t}$$

$$i_1(t) = 1.5 - 2\left\{\frac{1}{2} + ce^{-1000t}\right\}$$

$$i_1(t) = 0.5 - 2ce^{-1000t}$$

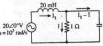
at $t = 0,\ i_1(0) = 0.75$

$$0.75 = 0.5 - 2c$$

$$c = -0.125$$

Hence, $i(t) = 0.5 - 0.125\, e^{-1000t}$

33. (A)




$$X_L = \omega L = 10^3 \times 20 \times 10^{-3}$$

$$= 20\ \Omega$$

$$X_C = \frac{1}{\omega c} = \frac{1}{50 \times 10^{-6} \times 10^3}$$

$$= \frac{1000}{50} = 20\ \Omega$$

$$-20 + j20\, I_1 + I = 0$$

$$-j20\,(I_1 - I) - I = 0$$

$$20\, j I_1 + I\,(20j + 1) = 0$$

$$I_1 = -\frac{(1 - 20j)\, I}{20j}$$

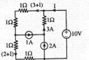
$$-20 - (1 - 20j)\, I + I = 0$$

$$20\, jI = +20$$

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

$$I = -j1 \text{ amp}$$

34. (A)




$$-10 + 2(3 + I) + 2(2 + I) = 0$$

$$5 + 2I = 5$$

$$I = 0$$

Power deliver by $10V = VI = V \times 0 = 0$ watt

35. (B)

| | | |
|---|---|---|
| $p^{++}$ | $n^{+}$ | n |
| $N_E$ | $N_B$ | $N_C$ |

The emitter injection efficiency of the BJT will be close to unity. If $N_E >> N_B$ and $N_B > N_C$.

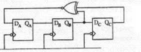
36. (C) p – n junction 1 $\quad N_A = N_D = 10^{14}/\text{cm}^3$

p – n junction 2 $\quad N_A = N_D = 10^{20}/\text{cm}^3$

Reverse Breakdown voltate $\propto \frac{1}{N}$ and depletion capacitance $\propto$ N.

Hence, reverse breakdown voltage is lower and deplation capacitance is higher.

37. (D)

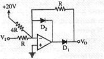



$$D_A = Q_B Q_C + \bar{Q}_B \bar{Q}_C,\ D_B = Q_A,\ D_C = Q_B$$

| $Q_A$ | $Q_B$ | $Q_C$ |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |

$Q_A \rightarrow 01101\ldots\ldots$

38. (B)




Applying KCL at node (I)

$$\frac{V_I - 0}{R} + \frac{20}{4R} = \frac{0 - V_0}{R}$$

$$V_I + 5 = -V_0$$

If $\quad V_I \le -5$ Diode $D_2$ and $D_1$ cut-off

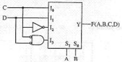
and $\quad V_0 = 0$

and at $\quad V_I = -10$

$\rightarrow \quad V_0 = 5$ volt

Hence, alternative B is the correct choice.

39. (D)




| AB \ CD | 00 | 01 | 11 | 10 | |
|---|---|---|---|---|---|
| 00 | | | 1 | 1 | $I_0$ |
| 01 | | 1 | 1 | | $I_1$ |
| 11 | 1 | | | | $I_3$ |
| 10 | 1 | 1 | | | $I_2$ |

Hence $F(ABCD) = \sum_m (2, 3, 5, 7, 8, 9, 12)$.

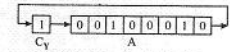
40. (C) Given program

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3000 MVI A, 45 H | : A = 45 H *i.e.* | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 3002 MOV B, A | : B = 45 H *i.e.* | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |

3003 STC : Set carry *i.e.* $cy = 1$

3004 CMC : Complement carry *i.e.* $cy = 0$

3005 RAR : Rotate Accumulator Right through carry




3006 XRAB : X-OR-ing of content of B with Accumulator

and save the result in accumulator *i.e.*

A = 0 0 1 0 0 0 1 0
B = 0 1 0 0 0 1 0 1
XOR B 0 1 1 0 0 1 1 1

Content of A = 6 7

Therefore, A = 67H

Hence alternative (C) is the correct choice.

41. (B) LTI system

$$\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3y(t) = 2\frac{dx(t)}{dt} + 4x(t)$$

zero initial conditions.

Taking Laplas both side

$$s^2Y(s) + 4sY(s) + 3Y(s) = 2sX(s) + 4\,X(s)$$

$$Y(s)\,(s^2 + 4s + 3) = X(s)\,(2s + 4)$$

$$\frac{Y(s)}{X(s)} = \frac{2(s+2)}{(s^2+4s+3)}$$

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

Hence $$Y(s) = \frac{2(s+2)}{(s^2+4s+3)}\,\frac{1}{(s+2)}$$

$$= \frac{2}{s^2+4s+3}$$

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

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

42. (A) $$H(z) = \frac{2 - \frac{3}{4}z^{-1}}{1 - \frac{3}{4}z^{-1} + \frac{1}{8}z^{-2}}$$

$$= \frac{2z - \frac{3}{4}}{z^2 - \frac{3}{4}z + \frac{1}{8}}$$

$$= \frac{2(8z-3)}{8z^2 - 6z + 1}$$

Characterstic eq.

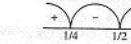
$$8z^2 - 6z + 1 = 0$$

$$8z^2 - 4z - 2z + 1 = 0$$

$$4z(2z-1) - (2z-1) = 0$$

$$z = \frac{1}{2}, \frac{1}{4}$$

and $(2z - 1)(4z - 1) > 0$




Slable and causal

$$|z| > \frac{1}{2}$$

$$|z| < \frac{1}{4}$$

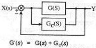
and all pole lie between unit circuit.

43. (C) $$s(t) = \frac{\sin 500\,\pi t}{\pi t} \times \frac{\sin 700\,\pi t}{\pi t}$$

$$\text{max. freq.} = \frac{1200}{2}\text{ Hz} = 600\text{ Hz}$$

$$f_s = 2f_m = 600 \times 2 = 1200\text{ Hz}$$

44. (D)




$$G'(s) = G(s) + G_c(s)$$

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

If (A) $$G_c(s) = \frac{s+1}{s+2}$$

$$K_p = \lim_{s \to 0} [G(s) + G_c(s)]$$

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

$$e_{ss} = \frac{1}{1+1} = \frac{1}{2}$$

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

$$e_{ss} = \frac{1}{3 \cdot 5}$$

(C) $G_c(s) = \frac{(s+1)(s+4)}{(s+2)(s+3)}$

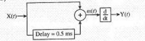
$$e_{ss} = \frac{1}{1+\frac{1}{2}+\frac{2}{3}} = \frac{6}{13}$$

(D) $G_c(s) = 1 + \frac{2}{5} + 3s$

$$e_{ss} = \frac{1}{1+\infty} = 0$$

Hence minimum error gives D.

45. (D)




Given PSD input $S_X(f) > 0\ \forall f$

$$\tau = 0.5\ ms$$

$$m(t) = x(t) + x(t-\tau)$$

$$M(s) = X(s)\,[1 + e^{-\tau s}]$$

$$Y(s) = SM(s)$$

$$\frac{Y(j\omega)}{X(j\omega)} = j\omega\,[1 + e^{-\tau j\omega}]$$

$$H(j\omega) = j\omega\,[1 + \cos\omega\tau - j\sin\omega\tau]$$

$$S_Y(f) = |H(j\omega)|^2 S_X(f)$$

at $f = 0\ H(f) = 0$

Hence $S_Y(f) \neq > 0$ for all $f$

at $|f| > 1\ kH_2\ |H(f)| > 0$ and $S_X(f) > 0$

Hence $S_Y(f) \neq 0$

$$S_Y(f) = 2\pi f\,|[1 + \cos 2\pi f\tau - j\sin 2\pi f\tau]|$$

given $f = nf_0\ \ f_0 = 2 \times 10^3$ kHz

$$S_Y(f) = 2\pi n \times 2 \times 10^3$$

$$\left|\left[1 + \cos 2\pi \times n \times 2 \times \frac{1}{2} - j\sin 2\pi \times 2n \times \frac{1}{2}\right]\right|$$

$$S_Y(f) = 4\pi n 10^3\,|[1 + \cos 2n\pi - j\sin 2n\pi]$$

for $n$ – integer $\cos 2n\pi = 1\ \sin 2n\pi = 0$

and hence $S_y(f) \neq 0$.

$$S_Y(f) = 2\pi\,(2n+1)\,f_0$$

$$\left|\left[1 + \cos 2\pi\,(2n+1)\frac{1}{2} - j\sin 2\pi\,(2n+1)\frac{1}{2}\right]\right|$$

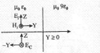
for every $n$ $\cos\pi\,(2n+1) = -1\ \sin\pi\,(2n+1) = 0$.

Hence $S_y(f) = 0$ for every $f$.

46. (A) $E_i = 24\cos(3\times 10^8\,t - \beta y)\,\hat{a}_2$ v/m

$$\mu = \mu_0\ \ \varepsilon = 9\varepsilon_0$$

$$a_y \times a_z = a_x$$




$$H_r = |E|_{or}\cos(3\times 10^8\,t + \beta_y)a_x\ \text{A/m}$$

$$\Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1} = \frac{\frac{120\pi}{3} - 120\pi}{\frac{120\pi}{3} + 120\pi}$$

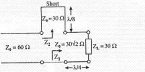
$$\Gamma = \frac{\frac{1}{3} - 1}{\frac{1}{3} + 1} = -\frac{2}{4} = -\frac{1}{2}$$

$$H_0 = \frac{E_0}{\eta} = \frac{24}{120\pi} = \frac{2}{10\pi}$$

$$H_r = \frac{2}{10\pi}\cdot\frac{1}{2}\cos(3\times 10^8\,t + \beta_y)a_x$$

$$H_r = \frac{1}{10\pi}\cos(3\times 10^8\,t + \beta_y)a_x$$

47. (B)




$$Z_1 = \frac{Z_0^2}{Z_L}\ \text{at}\ s = \frac{\pi}{4}$$

$$= \frac{(30\sqrt{2})^2}{30} = 60\ \Omega$$

$$Z_2 = Z_0\left[\frac{Z_L + jZ_0\tan\beta_L}{Z_0 + jZ_L\tan\beta_L}\right] Z_L = 0$$

$$= jZ_0\tan\beta_L \qquad \beta_L = \frac{2\pi}{\pi}\cdot\frac{\pi}{8} = \frac{\pi}{4}$$

$$Z_L = jZ_0 = 30j$$

$$Z = 60 + 30j$$

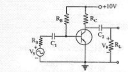
$$|\Gamma| = \left|\frac{Z_L - Z_0}{Z_L + Z_0}\right| = \left|\frac{60 + 30j - 60}{60 + 30j + 60}\right|$$

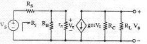
$$|\Gamma| = \frac{30j}{120 + 30j} = \frac{1}{(\sqrt{17})}$$

$$\text{VSMR} = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + \frac{1}{\sqrt{17}}}{1 - \frac{1}{\sqrt{17}}}$$

$$\text{VSWR} = 1.64$$

48. (B)




$R_i = R_s + R_B \parallel r_\pi$

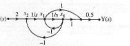
or $\quad R_i = 1 + \frac{93 \times 0.259}{93 + 0.259} = 1258\ \Omega$

49. (B) $f = \frac{1}{2\pi (R_C + R_L) C_2}$

or $\quad f = \frac{1}{2\pi\,[0.25 + 1] \times 4.7 \times 10^{-6}}$

or $\quad f = 27.1$ Hz

50. (D)




$\dot{x}_2 = -x_1 + 2u(t)$

$\dot{x}_1 = -x_1 + x_2$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u(t)$$

$y(t) = 0.5\,x_1 + 0.5\,x_2$

$y(t) = [0.5 \quad 0.5]\,[x]$

51. (C) $M_1 = \frac{2}{s} \cdot \frac{1}{s} \cdot 0.5 = \frac{1}{s^2}$

$M_2 = \frac{2}{s} \cdot 1 \cdot 0.5 = \frac{1}{s}$

$L_{11} = -\frac{1}{s_2} L_{12} = -\frac{1}{s}$

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

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

52. (B) Electric field at $x = 0.5\ \mu$m

$E = 5$ kV/cm

53. (B) $J = qn\mu E \qquad n = N_d = 10^{14}\ \text{cm}^{-3}$

$= 1.6 \times 10^{-19} \times 10^{14} \times 1350 \times 5 \times 10^3$

$J = 1.08 \times 10^4\ \text{A/cm}^2$

54. (B) Given $S_N(f) = \frac{N_0}{2} = 10^{-20}$ W/Hz

Low pass filter is ideal with unity gain

$f_c = 1\ \text{MHz} = 1 \times 10^6$ Hz

The power is given by

$= 2\,S_N(f) f_c$

$= 2 \times \frac{N_0}{2} \times f_c$

$= 2 \times 10^{-20} \times 1 \times 10^6$

$= 2 \times 10^{-14}$ watts

Variance $= \frac{2}{\alpha^2} = \text{Power}$

(since mean is zero given)

So, $\quad \frac{2}{\alpha^2} = 2 \times 10^{-14}$

or, $\quad \alpha = 10^7$

Hence, alternative (B) is the correct.

55. (D) 56. (B) 57. (A) 58. (D) 59. (B) 60. (D)

61. (C) 62. (A) 63. (D) 64. (B) 65. (B)