All India Mock GATE Test Series
Test series 4
Electronics & Communication Engineering

Answer Keys and Explanations

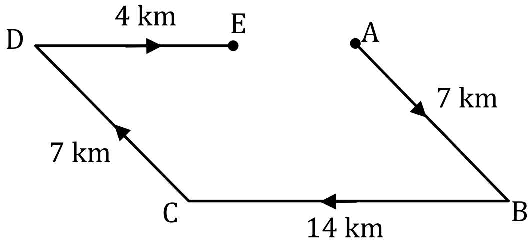
General Aptitude:

1. **[Ans. A]**
Meaning: slow to move or act
Part of Speech: Adjective

2. **[Ans. *] Range: 9 to 9**
Clearly $5 \times 2 = 10, 10 \times 2 = 20, 20 \times 2 = 40, \ldots$
So, the series is a G.P. in which $a_1 = 5$ and $r = 2$
To find the n^{th} term of a Geometric progression, the formula is $a_n = a_1 r^{n-1}$
Let 1280 be the n^{th} term of the series
Then, $5 \times 2^{n-1} = 1280 \Leftrightarrow 2^{n-1} = 256 = 2^8 \Leftrightarrow n - 1 = 8 \Leftrightarrow n = 9$

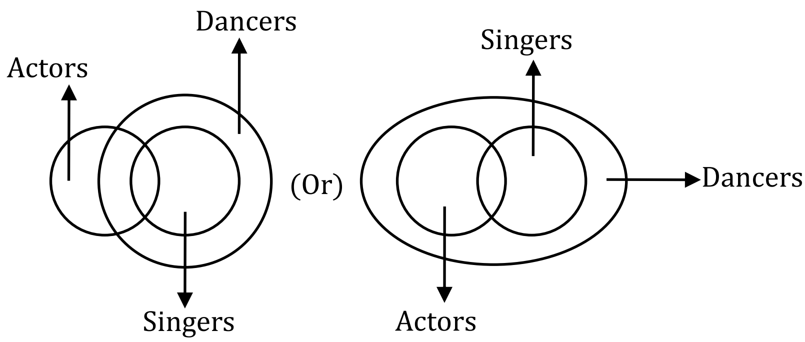
3. **[Ans. A]**
For this type of question take the LCM of speeds and assume the LCM as the distance
Then the time taken at speed of 60 km/hr $= \frac{300}{60} = 5$ hrs
Again the time taken at speed of 50 km/hr $= \frac{300}{50} = 6$ hrs
Thus we see that in place of 5 hrs trains take 6 hrs. Its means train takes 1 hr extra and this one hour is stopping period in the total time of 6 hrs. Thus in 6 hrs train halts for 1 hr. so in 1 hr train will stop for $^1/_6$ hours or 10 minutes.

4. **[Ans. *] Range: 10 to 10**
Let assume, Radha is at Point 'A'



Required distance = AE = AD − DE
Since ABCD is a parallelogram
AD= BC
$\therefore$ AE = BC − DE
= 14 − 4 = 10

5. **[Ans. A]**



Only (1) Follows

6. **[Ans. *] Range: 6 to 6**

Given:

$$\left.\begin{array}{l} R \rightarrow x+10 \\ L \rightarrow x+6 \\ B \rightarrow x+5 \\ H \rightarrow x+4 \\ A \rightarrow x \end{array}\right] \begin{array}{l} x \\ x \\ x+ \\ x \\ x \end{array} \;(25)\; \left]\begin{array}{l} x+5 \\ x+5 \\ x+5 \\ x+5 \\ x+5 \end{array}\right] \begin{array}{l} \textcircled{5}^{+} \\ \textcircled{1}^{+} \\ \textcircled{1}^{-} \\ \textcircled{5}^{-} \end{array}$$

Thus total 6 coins have to be transferred.

7. **[Ans. B]**

The numbers are given in pair of 4 and 9.

The unit digit of each pair is 4, and there are 50 such pairs which are mutually multiplied together.

Unit digit $\underbrace{4 \times 9^2}_{4} \times \underbrace{4^3 \times 9^4}_{4} \times \underbrace{4^5 \times 9^6}_{4} \times \ldots . \underbrace{4^{99} \times 9^{100}}_{4}$

Again $4 \times 4 \times 4 \times 4 \ldots 4$(upto 50 times)

i.e., the unit digit of 4^{50}, which is 6

[Since unit digit of 4^{2n} is 6 for $n = 1, 2, 3, \ldots$etc]

8. **[Ans. B]**

16.66   18.75

17.5

(Boys)   (Girls)

$\frac{50}{3}\times\frac{4}{4}$ $\frac{75}{4}\times\frac{3}{3}$ … … (Making Denominator equal)

$\Rightarrow$ $\frac{35}{2}\times\frac{6}{6}$

B   G

200/12   225/12

$\Rightarrow$ 210/12

15/12   10/12

$\Rightarrow$ 3 : 2

$\therefore$ Boys = 3x; Girls = 2x

Given $3x - 2x = 8$

$\therefore x = 8$

Thus the number of Girls = 16 and number of Boys = 24

9. **[Ans. D]**

Let there be x voters and k votes goes to loser then

$0.8x - 120 = k + (k + 200)$ … … . ①

Also, $k + 200 = 0.41x$ … … . ②

From equation ① and ②

$0.8x - 120 = 0.41x - 200 + 0.41x$

$0.02x = 80$

$x = 4000$

$\therefore k = 0.41 \times 4000 - 200$

$\Rightarrow k = 1440$

And $(k + 200) = 1640$

Number of voters voted = $x - 0.2x$

$0.8x = 0.8 \times 4000 = 3200$

Therefore, percentage of votes for defeated candidates $= \frac{1440}{3200} \times 100 = 45\%$

10. **[Ans. *] Range: 40 to 40**

Given

$W_2 = 1.5\ W_1$ ……. (50% Increase in walk)

$D_1 = D_2$

$\because \frac{M_1 \times D_1}{W_1} = \frac{M_2 \times D_2}{W_2}$

$\therefore M_2 = 1.5\ M_1$

$\therefore$ If the efficiency of M_1 and M_2 is same, then 50% more work force is required.

But it is given the productivity of new labour is 25% more (i.e., 5/4 times efficient)

$\therefore$ Actual % increase in work force required $= \frac{50\%}{5/4} = 40\%$

Technical:

1. **[Ans. B]**

Writing characteristics equation for A

$$\begin{bmatrix} a-\lambda & 1 & 0 & 0 \\ 1 & a-\lambda & 0 & 0 \\ 0 & 0 & 1-\lambda & -1 \\ 0 & 0 & -1 & 1-\lambda \end{bmatrix} = (a-\lambda)\left((a-\lambda)\begin{vmatrix} 1-\lambda & -1 \\ -1 & 1-\lambda \end{vmatrix}\right) - 1\left(1.\begin{vmatrix} 1-\lambda & -1 \\ -1 & 1-\lambda \end{vmatrix}\right)$$

$$= ((a-\lambda)^2 - 1)\begin{vmatrix} 1-\lambda & -1 \\ -1 & 1-\lambda \end{vmatrix} ((a-\lambda)^2 - 1)(\lambda^2 - 2\lambda) = 0$$

Which can be expressed as?

$(a-\lambda^2) - 1 = 0$ or $\Rightarrow (a-\lambda) = \pm 1$

$(\lambda^2 - 2\lambda) = 0 \Rightarrow \lambda = a+1, \lambda = a-1$

$\Rightarrow \lambda(\lambda - 2) = 0$

$\lambda = 0, \lambda = 2$

So, $\lambda = a+1, \lambda = a-1, \lambda = 0, \lambda = 2$

Alternative Method:

Sum of Eigen values $= 2a + 2$

Only (B) satisfies

2. **[Ans. A]**

$$\oint_c \frac{f(z)}{(z-z_0)^{n+1}} dz = 2\pi i \frac{f^n(z_0)}{n!}$$

$$= 2\pi i \frac{81 \cos h(0)}{4!}$$

$$= \frac{27}{4}\pi i$$

3. **[Ans. *] Range: 2 to 2**

Rank $(A^T A)$ = rank (A)

$$\begin{pmatrix} 1 & 3 & 1 & -4 \\ -1 & -3 & 1 & 0 \\ 2 & 6 & 2 & -8 \end{pmatrix} \begin{matrix} R_2 \to R_2 + R_1 \\ R_3 \to R_3 - 2R_1 \end{matrix}$$

$$\begin{pmatrix} 1 & 3 & 1 & -4 \\ 0 & 0 & 2 & -4 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

Rank (A) = 2

$\therefore$ Rank $(A^T A) = 2$

4. **[Ans. *] Range: 9 to 9**

The curve intersects the x-axis at x = 1

$\left((x-1)^{1/3} = 0 \Rightarrow x = 1\right)$

Given

$$\int_1^k (x-1)^{1/3}\,dx = 12$$

$$\left.\frac{(x-1)^{\frac{4}{3}}}{\frac{4}{3}}\right|_1^k = 12$$

$$\frac{(k-1)^{\frac{4}{3}}}{\frac{4}{3}} - 0 = 12$$

$\Rightarrow k = 9$

5. **[Ans. D]**

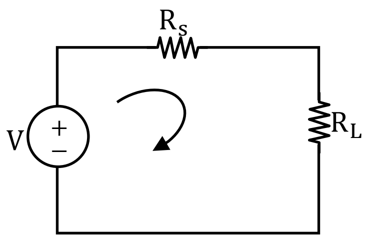
The direction of steepest ascent of z(x, y) is given by $\nabla z|_{\text{at P }(3,-6)}$

$$\nabla z = i\frac{\partial z}{\partial x} + j\frac{\partial z}{\partial y}$$

$$= -8xi - 2yj\,|_{(3,-6)}$$

$$= -24i + 12j$$

6. **[Ans. C]**



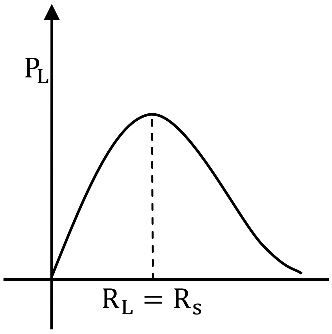
$P_L = i_L^2 \times R_L$

$$P_L = \left(\frac{V}{R_s + R_L}\right)^2 R_L$$

$P_{L_{max}} = \dfrac{V^2}{4R_L}$ at $R_L = R_s$ ← maximum power transfer theorem

When $R_L = 0$, $P_L = 0$

$R_L = \infty$, $i_L = 0$ so $P_L = 0$



7. **[Ans. *]Range: 4.20 to 4.50**

For first order RC Circuit

$$V_C(t) = V_C(\infty) - [V_C(\infty) - V_C(0^+)]e^{-t/RC}$$

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

$$i_C(t) = \frac{1}{RC}[V_C(\infty) - V_C(0^+)]e^{-t/RC}$$

$$i_C(0) = \frac{1}{RC}[V_C(\infty) - V_C(0^+)] = 5A$$

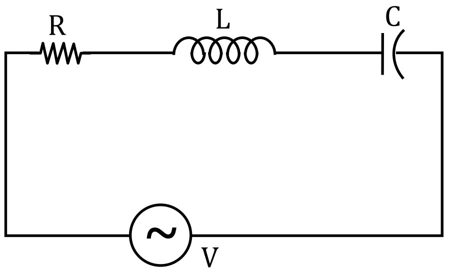
At t=3ms

$$i(t) = 2.5 = 5e^{-3m/RC}$$

$$\frac{1}{2} = e^{-\frac{3m}{C}}; R = 1$$

$$C = \left[\frac{3m}{\ln(2)}\right] = 4.328mF$$

8. **[Ans. B]**



$$Z = R + j\omega_L - \frac{j}{\omega_C}$$

$$Y = \frac{1}{R + j(\omega L - 1/\omega C)}$$

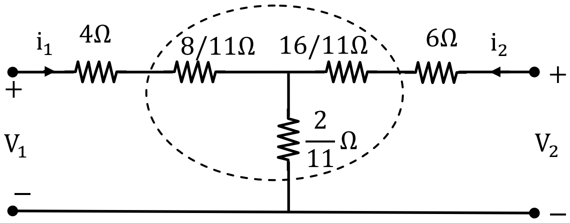
$$= \frac{1}{\omega C} > \omega L[\text{at lower frequency}]$$

$$\text{So}, Y = \frac{1}{R - jX} \qquad |X| = [\omega L - 1/\omega C]$$

$$Y = \frac{R + jX}{R^2 + X^2} \quad \rightarrow \text{Inductive load}$$

9. **[Ans. B]**

Convert inner delta into star:



By applying KVL in both side

$$V_1 = \left(4 + \frac{10}{11}\right) i_1 + \frac{2}{11} i_2 \cdots\cdots (1)$$

$$V_2 = \frac{2}{11} i_1 + \left(6 + \frac{18}{11}\right) i_2 \cdots\cdots (2)$$

$$h_{21} = \left.\frac{i_2}{i_1}\right|_{V_2=0}$$

By equation (2)

$$-\frac{2}{11} i_1 = \frac{66 + 18}{11} i_2$$

$$\frac{i_1}{i_2} = -\frac{84}{2} = -42; \ \frac{i_2}{i_1} = \frac{-1}{42}$$

10. **[Ans. *]Range: 9.3 to 9.5**

$$H(\omega) = 9\int_{-\infty}^{\infty}\left|\frac{\sin\left(\frac{\omega}{3}\right)}{\omega}\right|^2 d\omega$$

Let,

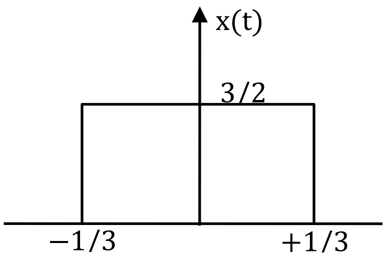
$$x(\omega) = \left(\frac{\sin\left(\frac{\omega}{3}\right)}{\left(\frac{\omega}{3}\right)}\right) = \text{Sa}\left[\frac{\omega}{3}\right]$$

$$x^2(\omega) = \left(\frac{\sin\left(\frac{\omega}{3}\right)}{\left(\frac{\omega}{3}\right)}\right)^2 = \text{Sa}^2\left[\frac{\omega}{3}\right]$$

$$H(\omega) = 1\int_{-\infty}^{\infty}\text{Sa}^2\left[\frac{\omega}{3}\right]\cdot d\omega$$

Perceval's Theorem:

$$\int_{-\infty}^{\infty}|x(t)|^2 dt = \frac{1}{2\pi}\int_{-\infty}^{\infty}|x(\omega)^2 d\omega|$$



$$\overset{\text{F·T}}{\longleftrightarrow} \quad |x(\omega) = \text{Sa}\left(\frac{\omega}{3}\right)$$

$$A\tau = 1$$

$$\tau/2 = 1/3$$

$$\tau = 2/3$$

$$\Rightarrow \int_{-\infty}^{\infty}\text{Sa}^2\left(\frac{\omega}{3}\right)\cdot d\omega = 2\pi\int_{-\infty}^{\infty}\left(x(t)\right)^2 dt$$

$$= 2\pi\int_{-1/3}^{+1/3}\left(\frac{3}{2}\right)^2 dt \Rightarrow 2\pi\frac{9}{4}[t]_{-1|3}^{+1|3}$$

$$\Rightarrow 2\pi\times\frac{9}{4}\times\left[\frac{2}{3}\right]$$

$$\Rightarrow 3\pi = 9.42$$

11. **[Ans. A]**

12. **[Ans. *] Range: 1.210 to 1.215**

$$I_D = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)\left(V_{gs} - V_t\right)^2 [\text{When no} - \text{channel length modulation envolved}]$$

$$I_D = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)\left[V_{gs} - V_t\right]^2 (1 + \lambda V_{DS}) \text{ Where } \lambda \text{ is channel length modulation}$$

$$I_{D(sat)} = 1.2\text{ mA (Without } \lambda)$$

$$I_D = 1.2\,(1 + 0.002\times 5) = 1.212\text{ mA}$$

13. **[Ans.*]Range: 79 to 81**

$I_{knee} + I_R = \frac{10-6}{50} = \frac{4}{50} = 80mA$

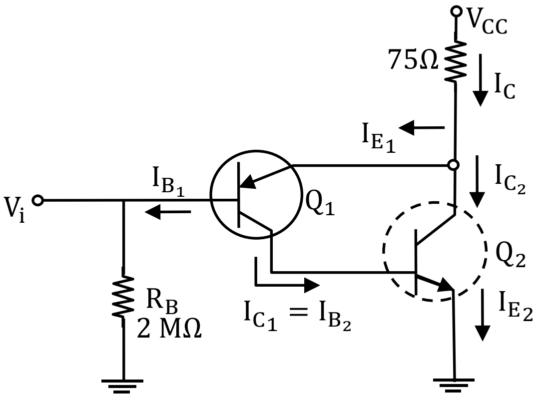
$I_R = 80mA - I_{knee}$

$= 80 - 5 = 75mA$

Now $I_R \times R = 6$

$\Rightarrow R = \frac{6}{75mA} = 80\Omega$

14. **[Ans. A]**



$I_{E_1} + I_{C_2} = I_C$

$\approx I_{C_1} + I_{C_2}$

$= I_{B_2} + I_{C_2}$

$\approx I_{C_2}$

$\therefore V_{CC} - I_C R_C - V_{EB_1} - I_{B_1} R_B = 0$

$\Rightarrow V_{CC} - I_{C_2} R_C - V_{EB_1} - I_{B_1} R_B = 0$

$\Rightarrow V_{CC} - \beta_2 I_{B_2} R_C - V_{EB_1} - I_{B_1} R_B = 0$

$\Rightarrow V_{CC} - \beta_2 I_{C_1} R_C - V_{EB_1} - I_{B_1} R_B = 0$

$\Rightarrow V_{CC} - \beta_1 \beta_2 I_{B_1} R_C - V_{EB_1} - I_{B_1} R_B = 0$

$\Rightarrow I_{B_1} = \frac{V_{CC} - V_{EB_1}}{R_B + \beta_1 \beta_2 R_C}$

$= \frac{18 - 0.7}{2M\Omega + (140)(180)(75)}$

$= \frac{17.3}{3.89 \times 10^6} = 4.45\ \mu A$

15. **[Ans. C]**

$I_E = \frac{4\ V - 0.7}{3.3\ k} = 1\ mA$

$\therefore r_e = \frac{26\ mV}{1\ mA} = 26\ \Omega$

$\therefore A_V = -\alpha \frac{R_C}{r_e} = -\frac{\beta}{1+\beta} \cdot \frac{R_C}{r_e} = -\frac{150}{26} \cdot \frac{4k}{26} = -153$

16. **[Ans. D]**

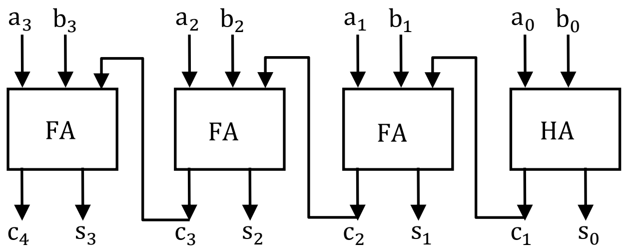
A positive noise spike can drive the voltage above 1.0 V level if the amplitude is greater than $V_{NL} = V_{IL(max)} - V_{OL(max)} = 1 - 0.1 = 0.9V$

A negative noise spike can drive the voltage below 3.5 V if the amplitude is greater than $V_{NH} = V_{OH(min)} - V_{IH(min)} = 4.9 - 3.5 = 1.4V$

17. **[Ans. D]**

May be 3,3+16,3+16+16 or 3+16+16+16+16

18. **[Ans. D]**



$\because$ No initial carry

$\equiv$ 3FA + 1HA

1FA =2HA +1-OR gate

3FA=6HA + 3-OR gate

Total=7HA +3-OR gate

19. **[Ans. C]**

Method 1:

$$R(s) = \frac{1}{s} \rightarrow \text{Unit step}$$

$$C(s) = \frac{1}{s} + \frac{0.2}{s+60} - \frac{1.2}{s+10}$$

$$C(s) = \frac{s^2 + 70s + 600 + 0.2(s^2 + 10s) - 1.2(s^2 + 60s)}{s(s+60)(s+10)}$$

$$C(s) = \frac{600}{s[s^2 + 70s + 600]}$$

$$\text{Transfer Function } = \frac{C(s)}{R(s)} = \frac{600}{s^2 + 70s + 600}$$

$$\text{Standard equation} \Rightarrow \text{Transfer Function} = \frac{\omega_{n^2}}{s^2 + 70s + 600} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

$\omega_n = \sqrt{600} = 24.5$ rad/s

$2\xi\omega_n = 70$

$$\xi = \frac{70}{2 \times 24.5}$$

$\xi = 1.42 \because \xi > 1 \rightarrow$ Over damped response

Method 2:

$$\frac{C(s)}{R(s)} = \frac{600}{(s+10)(s+60)}$$

System two real, negative and different poles so system is over damped

20. **[Ans. *]Range: 0.99 to 1.01**

Open Loop Transfer Function $G(s)H(s) = \dfrac{4}{s(s-2)}$

To construct Nyquist plot

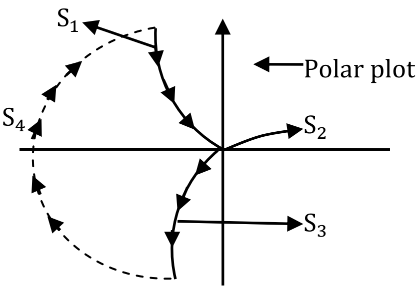
$s_1 \Rightarrow$ Polar plot

$$G(j\omega)H(j\omega) = \frac{4}{j\omega(j\omega - 2)}$$

$$|G(j\omega)H(j\omega)| = \frac{4}{\omega\sqrt{\omega^2 + 4}}$$

$$\angle G(j\omega) = -90 - 180 + \tan^{-1}\left(\frac{\omega}{2}\right)$$

$\omega \rightarrow$	0		∞
$\angle G(j\omega)$	∞		0
$\angle G(j\omega)$	-270		-180



s_2 :→ at origin

s_3:→ Inverse polar plot

s_4:→ Put $s = \lim_{R\to 0} Re^{j\theta} \rightarrow \left\{\theta \Rightarrow \dfrac{-\pi}{2} \text{ to } \dfrac{+\pi}{2}\right\}$

$$G(s) \Rightarrow \frac{4}{s(-2)}$$

$$-1 = e^{j\pi}$$

$$L(s) = \lim_{R\to 0} \frac{2}{R\, e^{j\theta}\, e^{j\pi}}$$

$$= \infty \left[e^{-j\,(\theta+\pi)}\right]$$

$$\Rightarrow \infty\, e^{-j\,\pi/2} \text{ to } e^{-j3\,\pi/2}$$

(One time encirclement in clockwise direction)

21. **[Ans. C]**

Let's say there is a source X having n symbols with entropy H(X)

$0 \leq H(X) \leq \log_2 n$

Entropy can be zero if any of the symbols has probability

22. **[Ans.*]Range: 3.5 to 3.5**

For PCM

$R_b = nf_s$

Where R_b = bit rate

n = number of bits required to encode alevel

f_s = sampling frequency

$\Rightarrow f_s = \dfrac{56 \times 10^6}{8} = 7 \times 10^6$ Hz

To avoid aliasing

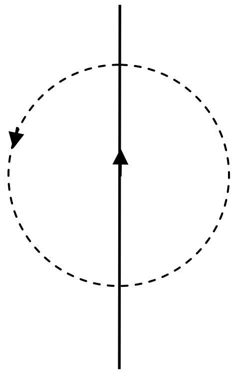
$f_s \geq 2\, f_m$, where f_m = message band with

$\Rightarrow f_m \leq \dfrac{f_s}{2}$

$\Rightarrow f_m \leq 3.5 \times 10^6$ Hz

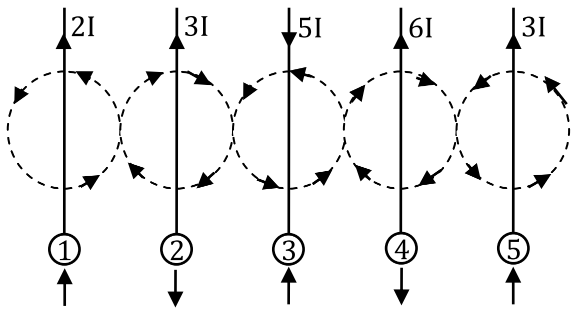
Hence maximum value of message bandwidth can be 3.5 MHz

23. **[Ans. B]**



$\oint_C H \cdot dl = I$

Given,



Actual Current,

$$I \oint_{\text{Total}} H \cdot dl = \oint_{①} H \cdot dl + \oint_{②} H \cdot dl + \oint_{③} H \cdot dl + \oint_{④} H \cdot dl + \oint_{⑤} H \cdot dl$$

Given Actual Direction is same: Positive current.

Given Actual Direction is same: Opposite negative current.

$\therefore\ (2 - 3 - 5 - 6 + 3)I = -9I$

24. **[Ans. B]**

From above equation

$\omega = 10^8$ rad/sec

$\beta = \frac{1}{\sqrt{3}}$ rad/m

$\therefore v = \frac{C}{\sqrt{\epsilon_r}} = \frac{\omega}{\beta}$

or $\frac{3 \times 10^8}{\sqrt{\epsilon_r}} = \frac{10^8}{\frac{1}{\sqrt{3}}}$

or, $\sqrt{3} = \sqrt{\epsilon_r}$

$\therefore \epsilon_r = 3$

25. **[Ans. C]**

Number of modes of an optical fiber is obtained by cut off condition known as normalized frequency or V number. Therefore for this fiber,

$$\text{Number of modes} = \frac{1}{2}|V|^2 = \frac{1}{2} \times 3.5^2 = 6.125$$

26. **[Ans. D]**

Let $x = \sqrt{3}$

$x^2 = 3$

$x^2 - 3 = 0$

$f(x) = x^2 - 3$

$f'(x) = 2x$

Newton Raphson's formula is

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

$$x_{n+1} = x_n - \frac{x_n^2 - 3}{2x_n}$$

$$x_{n+1} = \frac{2x_n^2 - x_n^2 + 3}{2x_n}$$

$$x_{n+1} = \frac{x_n^2 + 3}{2x_n} = \frac{1}{2}\left[x_n + \frac{3}{x_n}\right]$$

27. **[Ans. *] Range: 0 to 0**

For odd 'n' order of matrix determinant of an n × n Skew symmetric matrix has the value 0.

28. **[Ans. *] Range: 0.6 to 0.6**

Problem is related to Binomial distribution with parameters $n = 3, p = 4/20$

Expected value for Binomial distribution is given by $np = 3\left(4/_{20}\right) = 3/_{5} = 0.6$

(Or)

Let x denote number of detective items in the sample. The possible values of x and their mass function is given below.

X	0	1	2	3
$p(x = n)$	$3C_0\left(\frac{4}{20}\right)^0\left(\frac{16}{20}\right)^3$	$3C_1\left(\frac{4}{20}\right)^1\left(\frac{16}{20}\right)^2$	$3C_2\left(\frac{4}{20}\right)^2\left(\frac{16}{20}\right)^1$	$3C_3\left(\frac{4}{20}\right)^3\left(\frac{16}{20}\right)^0$

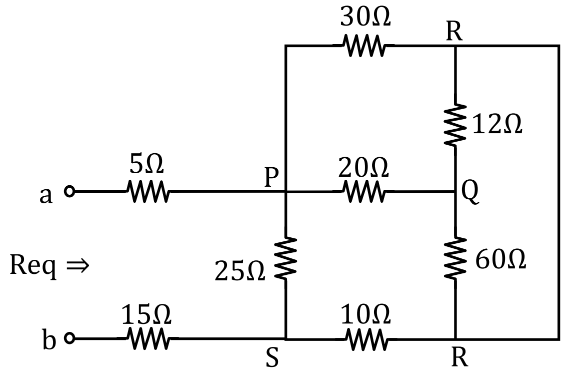
$$E(x) = 0.p(x = 0) + 1.p(x = 1) + 2.p(x = 2) + 3.p(x = 3)$$

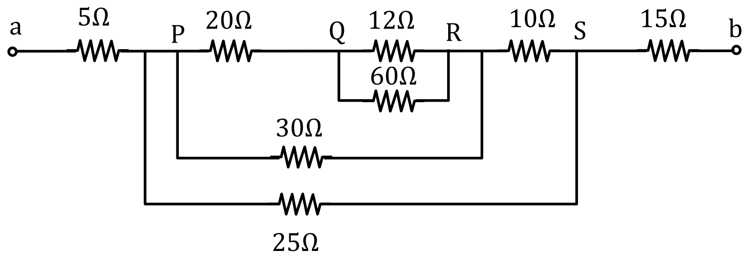
$$= \frac{3}{5} = 0.6$$

29. **[Ans. D]**

1. We know that a linear system of equation is consistent when rank $(A/b) = \text{Rank}(A)$ option C is correct
2. $[0\ 0\ 0 \ldots 0|\alpha]$
   $\Rightarrow 0x_1 + 0x_2 + \ldots 0x_n = \alpha$
   There is no $(x_1, x_2, \ldots x_n)$ satisfying
   $0x_1 + 0x_2 + \ldots 0x_n = \alpha$
   Option A is correct
3. 'B' does not contain a pivot. Hence b is a non-basic column in [A/b]
   Hence Option D is correct

30. **[Ans. *]Range: 32.4 to 32.6**





$\text{Resistance}_{QR} = 12 \parallel 60 = 10\Omega$

$\text{Resistance}_{PR} = (10 + 20) \parallel 30 = 15\Omega$

$\text{Resistance}_{PS} = (15 + 10) \parallel 25 = 12.5\Omega$

$\text{Resistance}_{ab} = 5 + 12.5 + 15 = 32.5\Omega$

31. **[Ans. C]**

Two port interconnection is series-shunt. So, we can add h-parameter to get net h-parameter.

$z = \begin{bmatrix} 30 & 20 \\ 20 & 20 \end{bmatrix}$

$V_1 = 30i_1 + 20i_2 \cdots\cdots (i)$

$V_2 = 20i_1 + 20i_2 \cdots\cdots (ii)$

h-parameter

$V_1 = h_{11}i_1 + h_{12}V_2$

$i_2 = h_{21}i_1 + h_{22}V_2$

$h_{11} = \frac{V_1}{i_1}\bigg|_{V_2=0} \quad h_{12} = \frac{V_1}{V_2}\bigg|_{i_1=0}$

$h_{21} = \frac{i_2}{i_1}\bigg|_{V_2=0} \quad h_{22} = \frac{i_2}{V_2}\bigg|_{i_1=0}$

Put these conditions on the given parameter equation (i) and (ii)

$V_2 = 0 \quad$ Then $i_1 = -i_2$

$h_{21} = \frac{i_2}{i_1} = -1$, from (i)

$V_1 = 30i_1 - 20i_1$

$V_1 = 10i_1$

$\frac{V_1}{i_1} = 10 = h_{11}$

$i_1 = 0$

$V_1 = 20i_2$

$V_2 = 20i_2$

$h_{12} = \frac{V_1}{V_2} = 1$

$h_{22} = \frac{i_2}{V_2} = \frac{1}{20}$

$h = \begin{bmatrix} 10 & 1 \\ -1 & \frac{1}{20} \end{bmatrix}$

Net $h = \begin{bmatrix} 20 & 2 \\ -2 & 0.1 \end{bmatrix}$

32. **[Ans. *]Range: 2.3 to 2.5**

$$\frac{d^2y(t)}{dt^2}+\frac{3dy(t)}{dt}+2y(t)=\frac{10dx(t)}{dt}+15x(t)$$

Take L.T. both sides,

$$\frac{y(s)}{x(s)}=\frac{10s+15}{s^2+3s+2}=\frac{10s+15}{(s+1)(s+2)}$$

$$H(s)=\frac{5}{s+1}+\frac{5}{s+2}$$

$$H(s)=(5e^{-t}+5e^{-2t})u(t)$$

Sampling frequency=10 Hz

$$T_s=\frac{1}{10}$$

$$h(n)=\left(5e^{-nT_s}+5e^{-2nT_s}\right)u(n)$$

$$h(n)=(5e^{-0.1n}+5e^{-0.2n})u(n)$$

$$H(z)=\left[\frac{5}{1-e^{-0.1}z^{-1}}+\frac{5}{1-e^{-0.2}z^{-1}}\right]$$

$$=\frac{10-5[e^{-0.2}+e^{-0.1}]z^{-1}}{1-[e^{-0.1}+e^{-0.2}]z^{-1}+e^{-0.1}e^{-0.2}z^{-2}}$$

$$H(z)\Rightarrow\frac{10-5[e^{-0.2}+e^{-0.1}]z^{-1}}{1-[1.722]z^{-1}+0.740z^{-2}}$$

$$H(z)=\frac{10-8.61z^{-1}}{1-az^{-1}+bz^{-2}}$$

$a=1.722$

$b=0.740$

$a+b=2.462$

33. **[Ans. *]Range: 0.99 to 1.01**

$x(n) = \{2, \underset{\uparrow}{1}, 3, 1, 2, 0\}$

$y(e^{j\omega}) = e^{j\omega} x(e^{j\omega})$

$\because x(n) \overset{DTFT}{\longleftrightarrow} x(e^{j\omega})$

$\because x(n+1) \overset{DTFT}{\longleftrightarrow} e^{j\omega} x(e^{j\omega})$

$\therefore y(n) = x(n+1)$

$y(n) = \{2, 1, \underset{\uparrow}{3}, 1, 2, 0\}$

$y(e^{j\omega}) = 2e^{+j\omega} + 1 + 3e^{-j\omega} + e^{-2j\omega} + 2e^{-3j\omega}$

$y(e^{j\omega}) = e^{-j\omega}\left[2e^{2j\omega} + e^{j\omega} + 3 + e^{-j\omega} + 2e^{-2j\omega}\right]$

$y(e^{j\omega}) = e^{-j\omega}[4\cos 2\omega + 2\cos\omega + 3]$

$y\left(e^{\frac{j\pi}{2}}\right) = e^{\frac{-j\pi}{2}}\left[4\cos\frac{2\pi}{2} + 2\cos\frac{\pi}{2} + 3\right]$

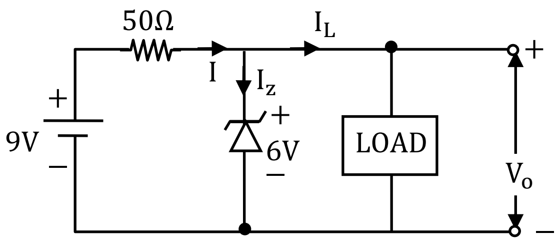
$y\left(e^{\frac{j\pi}{2}}\right) = -j[-4 + 0 + 3]$

$= -j[-1]$

$y\left(e^{\frac{j\pi}{2}}\right) = +j$

$y\left(e^{\frac{j\pi}{2}}\right) \Rightarrow 1$

34. **[Ans. C]**



$I = \frac{9-6}{50} = \frac{3}{50} = 60\text{mA}$

Now when load current is maximum then

$I_z = I_{Knee}$

$\therefore I_{knee} + I_{Lmax} = I$

$\Rightarrow 5\text{ mA} + I_{Lmax} = 60\text{mA} \Rightarrow I_{Lmax} = 55\text{mA}$

Now, maximum power dissipation in zener diode is

$P_{zmax} = V_z . I_{zmax}$

$\therefore I_{zmax} = \frac{300\text{mW}}{6} = 50\text{mA}$

When I_z is maximum then I_L will be minimum

$\therefore I_{zmax} + I_{Lmin} = 60\text{ mA}$

$\therefore I_{Lmin} = 60\text{mA} - I_{zmax} = 60 - 50 = 10\text{ mA}$

35. **[Ans. *] Range: 70 to 72**

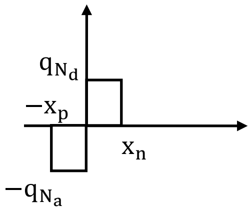
$n_{surface} = n_{bulk}\, e^{\frac{\psi s}{\phi t}}; \phi_t = \text{Thermal Voltage}$

$n_{bulk} = \frac{n_i^2}{NA} = \frac{(1.8 \times 10^{10})^2}{10^{17}}$

$n_{surface} = 3240\, e^{0.2/26m}$

$= 7.1 \times 10^6 = 71 \times 10^5$

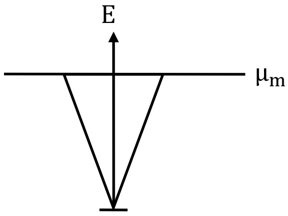
36. **[Ans. *] Range: 1.15 to 1.25**



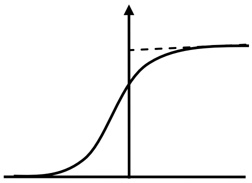
$\frac{\partial E}{\partial x} = \frac{\rho_v}{\epsilon} = \frac{qN_d}{\epsilon}$

$E = \frac{-qN_d x_n}{\epsilon}$ [For n − side]

$V = -\int E.\, dl$ [Area Under curve of E]



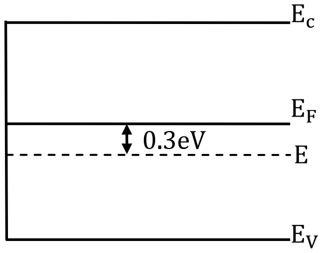
$-\frac{qN_d x_n}{\epsilon} = \frac{-qN_a x_p}{\epsilon}$



$= -\frac{1}{2} \times \left(-\frac{qN_d x_n}{\epsilon}\right)(x_n + x_p)$

$= \frac{\frac{1}{2} \times 1.6 \times 10^{-19} \times 10^{17} \times 0.1 \times 10^{-4} \times 0.2 \times 10^{-4}}{15 \times 8.85 \times 10^{-14}} = 1.20\text{ V}$

37. **[Ans. *]Range: 893 to 895**



Probability to not have any electron below 0.32 eV than Fermi level is 0.02. So probability to have an electron will be $1 - 0.02 = 0.98$

$E_f - E = 0.3$ eV

Now with Fermi probability distribution (Fermi Dirac function)

$F(E) = \dfrac{1}{1 + e^{(E-EF)/kT}}$ where k is in eV/k

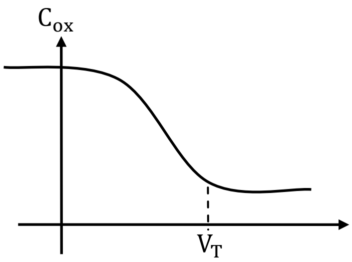
$0.98 = \dfrac{1}{1 + e^{\frac{-0.3}{kT}}}$ $\quad k\left(\dfrac{eV}{k}\right) = \dfrac{1.38 \times 10^{-23}}{1.6 \times 10^{-19}} = 8.62 \times 10^{-5} eV/k$

$0.98\, e^{\frac{-0.3}{kT}} = 1 - 0.98$

$e^{-\frac{0.3}{kT}} = \dfrac{0.02}{0.98} \Rightarrow \dfrac{0.3}{kT} = 3.89$

$T = \dfrac{0.3}{3.89 \times 8.62 \times 10^{-5}} = 894.67 \approx 894$

38. **[Ans. C]**



In first figure curve is becoming flatter at $V_{GB} = 2$ V

$V_{T_1} = 2$ V

$V_{T_2} = 4$ V

First one is having less threshold voltage which means less voltage required to generate inversion charge.

At any particular voltage first will generate more inversion charge compared to second one.

So $V_{T_1} < V_{T_2}$ and $\theta_{i_1} > \theta_{i_2}$

39. **[Ans. A]**

$$\frac{V_0}{V_i}=\frac{\dfrac{50\times10^3\times\frac{1}{0.15\times10^{-6}j\omega}}{(50\times10^3)+\frac{1}{0.15\times10^{-6}j\omega}}}{50\times10^3+\left(\frac{50\times10^3}{0.15\times10^{-6}\omega}\right)/\left[50\times10^3+\frac{1}{0.15\times10^{-6}j\omega}\right]}$$

$$\Rightarrow\frac{V_0(j\omega)}{V_i(j\omega)}=\frac{10}{5\times0.15\times10^2+1+10}$$

putting $\omega=100\text{rad/sec}$

$$\frac{V_0(j100)}{V_i(j100)}=\frac{10}{0.75j+11}$$

$$\Rightarrow\left|\frac{V_0(j\omega)}{V_i(j\omega)}\right|=\frac{10}{\sqrt{(0.75)^2+(11)^2}}=\frac{10}{11.02}$$

$$V_m=\frac{10}{11.02}\times1\simeq1V$$

40. **[Ans. A]**

To determine the value of R_L that will turn the zener diode on

$$R_{Lmin}=\frac{RV_z}{V_i-V_z}=\frac{1\times10}{50-10}=\frac{10k\Omega}{40}=250\Omega$$

$$V_R=V_i-V_z=40V$$

$$I_R=\frac{40}{1k\Omega}=40\text{ mA}$$

$$I_{Lmin}=I_R-I_{zm}=40-32=8mA$$

$$R_{Lmax}=\frac{V_z}{I_{Lmin}}=\frac{10V}{8mA}=1.25k\Omega$$

41. **[Ans.*]Range: 10 to 10**

$100dB=10\log_{10}PSSR$

$\Rightarrow PSSR=10^{10}$

Power αu^2

So, $VSSR=\sqrt{10^{10}}=10^5$

Now , $10^5=\dfrac{1\text{volt}}{\text{Input offset voltage}}$

$\Rightarrow$ Input offset voltage $=\dfrac{1}{10^5}=10\mu V$

42. **[Ans. B]**

RST X

Vector Address = 8X= $(\quad)_{16}$

RST 5.5 $=8\times5.5=(44)_{10}=(002C)_H$

43. **[Ans. *]Range: 8 to 8**

Maximum conversion time of an 8 bit digital ramp ADC is

$2^n\ T_{CLK} = 2^8 \times 10\mu\ sec = 2560\ \mu s\ = T_1$

Maximum conversion time of successive approximation ADC is

$T_2 = n\ T_{CLK} = 8 \times 10\ \mu s = 80\mu s$

Maximum conversion time of a flash types ADC is $= T_{CLK}$

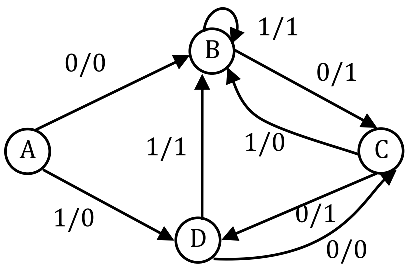
$T_3 = 10\ \mu s$

$$P = \frac{T_1}{T_2} = 32$$

$$Q = \frac{T_1}{T_3} = 256$$

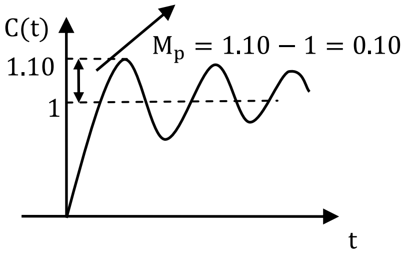
$$\frac{Q}{P} = \frac{256}{32} = 8$$

44. **[Ans. B]**



→ If A is start state, shortest sequence is 10 or 00 to reach C.
→ If B is start state, shortest sequence is 0 to reach C.
→ If C is start state, shortest sequence is 10 or 00 to reach C.
→ If D is start state, shortest sequence is 0 to reach C.
Option (B) is correct as no option are there only 0.

45. **[Ans. *]Range: 1.67 to 1.71**



$M_P = e^{-\xi\pi/\sqrt{1-\xi^2}} = 0.10$

$\xi = 0.59$

$\omega_d = 3.23\ \text{rad/s}$

$\omega_d = \omega_n\sqrt{1-\xi^2}$

$3.23 = \omega_n\sqrt{1-(0.59)^2}$

$\omega_n = 4\ \text{rad/s}$

settling time $t_s = \dfrac{4}{\xi\omega_n}$

$t_s = \dfrac{4}{0.59 \times 4}$

$t_s = 1.69$

46. **[Ans. A]**

Magnitude

$\left|\dfrac{2-\omega^2}{\sqrt{\omega^2+1}\,\sqrt{\omega^2+9}}\right| = 0$

$2 - \omega^2 = 0$

$\omega = \pm\sqrt{2}$

$\omega = \sqrt{2}\ \text{rad/sec}$

47. **[Ans. A]**

From Diagram

Calculation of ω

$5.105\ \text{dB} - 0 = -20[\log(\omega) - \log(90)]$

$5.105 = -20\log(\omega) + 20\log 90$

$5.105 = -20\log(\omega) + 39.08$

$\omega \simeq 50\ \text{r/s}$

Calculation of k:

$y - 5.105 = -40[\log(20) - \log(50)]$

$y - 5.105 = -52.04 + 67.95$

$y = 21.02\ \text{dB}$

$y = mx + c$

$21.02 = -20\log(20) + c$

$21.02 = -26.02 + c$

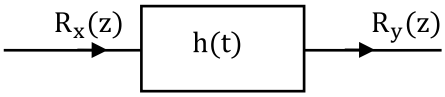
$c = 47.021$

$c = 20\log k$

$47.04 = 20\log k$

$\Rightarrow k = 224.96$

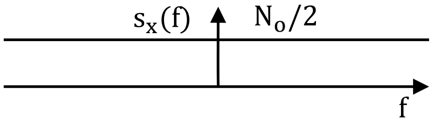
48. **[Ans. B]**

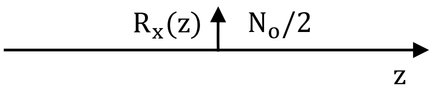


Where $R_x(z)$ and $R_y(z)$ are autocorrelation of u(t) and y(t) respectively $R_x(z) \xrightarrow{F.T} S_x(f)$

$S_x(f) = \frac{N_0}{2}$

$\Rightarrow R_x(z) = \frac{N_0}{2}\delta(z)$





Now

$R_y(z) = R_x(z) * h(z) * h(-z)$

$= \frac{N_o}{2}\delta(z) * h(z)h(-z)$

$= \frac{N_o}{2}\{h(z) * h(-z)\}$

Since $R_H(z) = h(z) * h(-z)$[Auto corellation of pulse h(t)]

$\Rightarrow R_y(z) = \frac{N_0}{2}R_H(z)$

Now, o/p power $= R_y(0) = \frac{N_0}{2}R_H(0)$

where $R_H(0)$ is the energy of the pulse h(t)

$\Rightarrow R_H(0) = \int_0^2 h^2\,(t)dt = \frac{1}{4}\int_0^2 t^2\ dt = \frac{1}{12}[t^3]_0^2 = \frac{2}{3}$

$\Rightarrow$ o/p power $= \frac{2}{3}\frac{N_0}{2} = \frac{N_0}{3}$

49. **[Ans. C]**

Without using raised cosine original band width $= \frac{2\,R_b}{M}$

Where R_b = bit rate

After using raise cosine

Band width $= \frac{\text{original Band width}}{2}(1+\alpha)$

Where α = roll off factor

if excess band width = 50%

$\alpha = 0.5$

Now for distortion less transmission signal Band with $\leq$ channel band with

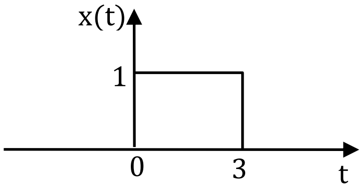
$\Rightarrow \frac{\frac{2R_b}{M}}{2}(1+\alpha) \leq 3000$

$\Rightarrow \frac{16000}{3000} \times 6 \leq M$

$\Rightarrow M \geq 32$

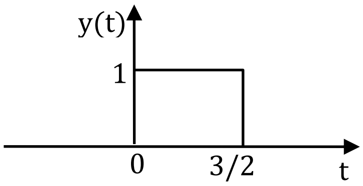
50. **[Ans. *]Range: 1.5 to 1.5**

$x(t) = u(t) - u(t-3)$



$y(t) = x(-2t+3)$

$x(t) \xrightarrow[\text{by } 3]{\text{advance}} x(t+3) \xrightarrow[\text{by } -2]{\text{Scale}} x(-2t+3) = y(t)$



$R_y(0) = \text{Energy of } y(t) = \int_0^{3/2} y^2(t)dt$

$= \frac{3}{2} = 1.5$

51. **[Ans.*]Range: 1.5 to 1.6**

We know

$$H(y) = P(y_1)\log_2\left\{\frac{1}{P(y_1)}\right\} + P(y_2)\log_2\left\{\frac{1}{p(y_2)}\right\} + P(y_3)\log_2\left\{\frac{1}{p(y_3)}\right\}$$

$$P(y_1) = P(x_1)P\left(\frac{y_1}{x_1}\right) + P(x_2)P\left(\frac{y_1}{x_2}\right)$$

and $P\left(\frac{y_1}{x_1}\right) + P\left(\frac{y_2}{x_1}\right) + P\left(\frac{y_3}{x_1}\right) = 1$

$$P\left(\frac{y_3}{x_1}\right) = \frac{1}{4}$$

Similarly $P\left(\frac{y_1}{x_2}\right) = \frac{1}{2}$

$$P(y_1) = \frac{1}{2}\times\frac{1}{4}+\frac{1}{2}\times\frac{1}{2} = \frac{3}{8}$$

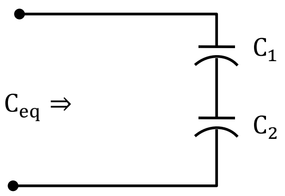
Similary $P(y_2) = \frac{1}{2}\times\frac{1}{2}+\frac{1}{2}\times\frac{1}{4} = \frac{3}{8}$

and $P(y_3) = \frac{1}{2}\times\frac{1}{4}+\frac{1}{2}\times\frac{1}{4} = \frac{1}{4}$

$$H(y) = -\left\{\frac{3}{8}\log_2\left(\frac{3}{8}\right) + \frac{3}{8}\log_2\left(\frac{3}{8}\right) + \frac{1}{4}\log_2\left(\frac{1}{4}\right)\right\}$$

$= 1.561$ bit/symbol

52. **[Ans. *] Range: 25.2 to 25.6**



$$C_{eq} = \frac{C_1+C_2}{C_1C_2}$$

$$C_1 = \frac{\epsilon_1 A}{d_1}$$

$$C_2 = \frac{\epsilon_2 A}{d_2}$$

$$C_{eq} = \frac{\frac{\epsilon_1 A}{d_1}\frac{\epsilon_2 A}{d_2}}{\frac{\epsilon_1 A}{d_1}+\frac{\epsilon_2 A}{d_2}}$$

$$d_1 = d_2 = \frac{d}{2}$$

$$C_{eq} = \frac{2\epsilon_0 A}{d}\left[\frac{\epsilon_1\epsilon_2}{\epsilon_1+\epsilon_2}\right]$$

$$C_{eq} = \frac{2\times 8.85\times 10^{-12}\times 30\times 10^{-4}}{5\times 10^{-3}}\times\left[\frac{4\times 6}{10}\right] = 25.488\times 10^{-12}$$

$$C_{eq} = 25.48\text{ pF}$$

53. **[Ans. B]**

$Z_{oc} = 40\Omega$

$Z_{sc} = 5.625\Omega$

$Z_o = \sqrt{Z_{oc} \cdot Z_{sc}}$

$= \sqrt{40 \times 5.625}$

$= 15\Omega$

$Z_L = 50\Omega$

$\beta l = \frac{2\pi}{\lambda} \times \frac{\lambda}{12} = \frac{\pi}{6}$

$Z_{in} = Z_o \left[\frac{Z_L \cos\beta l + jZ_o \sin\beta l}{Z_o \cos\beta l + jZ_L \sin\beta l}\right]$

$= 15\left[\frac{50 \times \frac{\sqrt{3}}{2} + j\,15 \times \frac{1}{2}}{15 \times \frac{\sqrt{3}}{2} + j\,50 \times \frac{1}{2}}\right]$

Find $\angle Z_{in} = \tan^{-1}\left(\frac{7.5}{25\sqrt{3}}\right) - \tan^{-1}\left(\frac{25}{7.5\sqrt{3}}\right)$

$= -0.92$

Only (B) satisfies

54. **[Ans. *]Range: 3.3 to 3.6**

$\Gamma = \frac{Z_L - Z_O}{Z_L + Z_O} e^{-2j\beta x}$

$|\Gamma| = \left|\frac{Z_L - Z_O}{Z_L + Z_O}\right|$

$= \left|\frac{j400}{600 + 400j}\right|$

$= \frac{400}{\sqrt{36 + 16}} = \frac{4}{\sqrt{52}} = 0.5547$

$V\delta WR = \frac{1 + |\Gamma|}{1 - |\Gamma|} = 3.491$

55. **[Ans. A]**

As the line charge lies along x direction $E_x = 0$

Now, $\vec{E} = \frac{\rho_L}{2\pi\epsilon_o \rho}\overrightarrow{a_\rho}$

Where, $\vec{\rho} = (2 - 0)\overrightarrow{a_y} + (1 - 0)\overrightarrow{a_z}$

$= 2\overrightarrow{a_y} + \overrightarrow{a_z}$

$\therefore |\vec{\rho}| = \sqrt{2^2 + 1^2} = \sqrt{5}$

And, $\overrightarrow{a_\rho} = \frac{\vec{\rho}}{|\rho|} = \frac{2}{\sqrt{5}}\overrightarrow{a_y} + \frac{1}{\sqrt{5}}\overrightarrow{a_z}$

$\therefore \vec{E} = \frac{10 \times 10^{-6}}{2\pi \times 8.854 \times 10^{-12} \times \sqrt{5}} \cdot \left[\frac{2\overrightarrow{a_y} + \overrightarrow{a_z}}{\sqrt{5}}\right]$

$= 71.9\overrightarrow{a_y} + 35.97\overrightarrow{a_z}$ kV/m