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S.No.	Name of the Subject	One Mark Questions	Two Marks Questions	Total No. of Questions
1	Networks	2	2	4
2	Signals & Systems	3	2	5
3	Electronic Devices	1	4	5
4	Analog Circuits	5	4	9
5	Digital Circuits & Computer Organization	3	3	6
6	Control Systems	2	4	6
7	Communications	4	4	8
8	Electromagnetics	-	3	3
9	Engineering Mathematics	5	4	9
10	General Aptitude	5	5	10
Total No. Of Questions		**30**	**35**	**65**

General Aptitude
Q.1 – Q.5 Carry ONE mark Each

01. Here are two analogous groups, Group-I and Group-II, that list words in their decreasing order of intensity. Identify the missing word in Group-II.

Group-I: Abuse → Insult → Ridicule

Group-II: ________ → Praise → Appreciate

(a) Extol (b) Prize

(c) Appropriate (d) Espouse

01. Ans: (a)

Sol: Analogous Group Matching

We are given two groups, Group-I and Group-II, where words in Group-I are listed in decreasing order of intensity, and we need to identify the missing word in Group-II.

Group-I: Abuse → Insult → Ridicule

This shows a progression from the harshest to a slightly softer form. "Abuse" is the most intense, followed by "Insult," and finally, "Ridicule," which may not be as severe as the first two.

Group-II: __ → Praise → Appreciate

Here, we are looking for a word that matches the pattern of intensity, in terms of positive or favorable terms. "Praise" is generally a high form of approval, while "Appreciate" is softer and more reserved compared to "Praise."

Option a: Extol – "Extol" means to praise enthusiastically, which fits as a strong form of praise. This makes "Extol" a good candidate as it corresponds to the most intense form of positive approval.

Option b: Prize – This doesn't fit well with "Praise" and "Appreciate" in terms of intensity or meaning.

Option c: Appropriate – This is unrelated to praise or appreciation. It means suitable or fitting.

Option d: Espouse – This means to support or adopt an idea, not directly related to praise or appreciation.

Thus, the most appropriate answer is (a) Extol.

02. Had I learnt acting as a child, I ________ a famous film star.

Select the most appropriate option to complete the above sentence.

(a) will be (b) can be

(c) am going to be (d) could have been

02. Ans: (d)

Sol: Conditional Sentence

The sentence provided is:

Had I learnt acting as a child, I ____ a famous film star.

This is a third conditional sentence, which is used to express hypothetical or unreal situations in the past. The third conditional follows the structure:

If + past perfect, + would have + past participle.

The sentence is implying that if the person had learned acting as a child (but did not), they might have become a famous film star.

Option a: will be – This is a future tense and does not fit the structure of a third conditional sentence.

Option b: can be – This is a present tense form, so it does not fit the third conditional structure.

Option c: am going to be – This is also a future tense construction, which is not suitable for a third conditional sentence.

Option d: could have been – This is the correct form of a third conditional sentence, which indicates a hypothetical outcome in the past. It fits the meaning of the sentence.

Thus, the correct answer is (d) could have been.

03. The 12 musical notes are given as C, $C^{\#}$, D, $D^{\#}$, E, F, $F^{\#}$, G, $G^{\#}$, A, $A^{\#}$, and B. Frequency of each note is $\sqrt[12]{12}$ times the frequency of the previous note. If the frequency of the note C is 130.8 Hz, then the ratio of frequencies of notes $F^{\#}$ and C is:

(a) $\sqrt[6]{12}$ (b) $\sqrt{2}$

(c) $\sqrt[4]{12}$ (d) 2

03. Ans: (b)

Sol:

C $C^{\#}$ D $D^{\#}$ E F $F^{\#}$ G $G^{\#}$ A $A^{\#}$ B

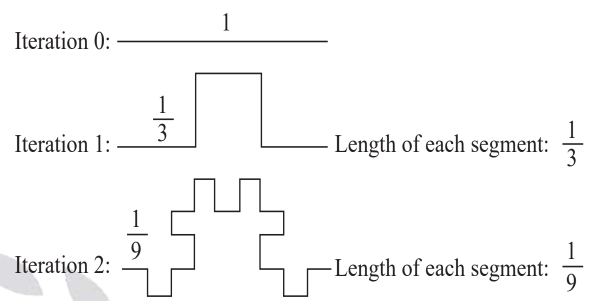
C ↓ 130.8Hz; $F^{\#}$ ↓ ?

$$\text{Frequency at } F^{\#} = \text{Frequency at C} \times \left(\sqrt[12]{2}\right)^6$$

$$\frac{\text{Frequency of } F^{\#}}{\text{Frequency of C}} = 2^{\frac{6}{12}} = 2^{\frac{1}{2}} = \sqrt{2}$$

04. The following figures show three curves generated using an iterative algorithm. The total length of the curve generated after 'Iteration n' is:

Note: The figures shown are representative.

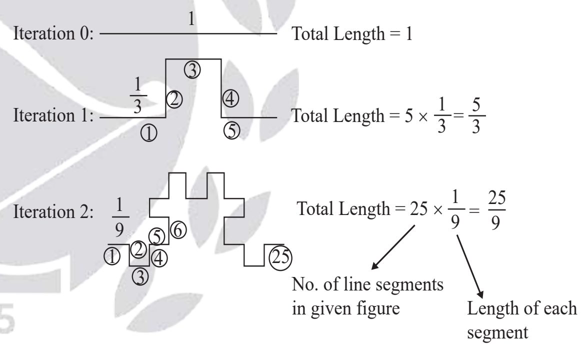


(a) $\left(\frac{5}{3}\right)^{\frac{n}{2}}$ (b) $\left(\frac{5}{3}\right)^{n}$

(c) $\left(\frac{5}{3}\right)^{2n}$ (d) $\left(\frac{5}{3}\right)^{n(2n-1)}$

04. Ans: (b)

Sol:



Segment: 1, $\frac{5}{3}$, $\frac{25}{9}$, - - - - -

from options $\left(\frac{5}{3}\right)^n$ is sequence.

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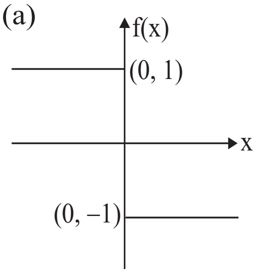
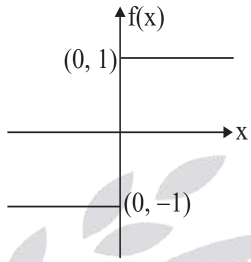
05. Which one of the following plots represents $f(x) = -\frac{|x|}{x}$, , where x is a non-zero real number?
Note: The figures shown are representative.

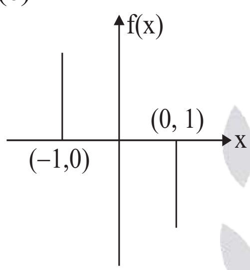
(a)



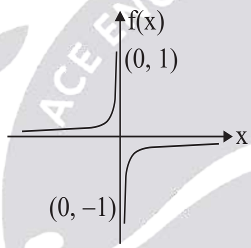
(b)



(c)



(d)



05. Ans: (a)

Sol: Given function

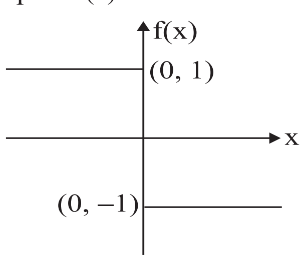
$$f(x) = -\frac{|x|}{x}$$

For non zero (Real)

$$x = -1,\ \ f(x) = -\frac{|-1|}{-1}$$

$$x = 1,\ \ f(x) = \frac{|-1|}{1} = -1$$

option (a)



Q.6 – Q.10 Carry TWO marks Each

06. Identify the option that has the most appropriate sequence such that a coherent paragraph is formed:

P. Over time, such adaptations lead to significant evolutionary changes with the potential to shape the development of new species.

Q. In natural world, organisms constantly adapt to their environments in response to challenges and opportunities.

R. This process of adaptation is driven by the principle of natural selection, where favorable traits increase an organism's chances of survival and reproduction.

S. As environments change, organisms that can adapt their behavior, structure and physiology to such changes are more likely to survive.

(a) $P \rightarrow Q \rightarrow R \rightarrow S$ (b) $Q \rightarrow S \rightarrow R \rightarrow P$
(c) $R \rightarrow S \rightarrow Q \rightarrow P$ (d) $S \rightarrow P \rightarrow R \rightarrow Q$

06. Ans: (b)

Sol: The correct answer is (b) $Q \rightarrow S \rightarrow R \rightarrow P$. Let's analyze why this sequence forms a coherent paragraph:

1. Q (Introduction):
"In natural world, organisms constantly adapt to their environments in response to challenges and opportunities."
This serves as the best opening sentence, introducing the general idea of adaptation in nature.

2. S (Elaboration on adaptation):
"As environments change, organisms that can adapt their behavior, structure and physiology to such changes are more likely to survive."

This logically follows Q, explaining how organisms adjust to environmental changes.

3. R (Natural selection as the driving force):
"This process of adaptation is driven by the principle of natural selection, where favorable traits increase an organism's chances of survival and reproduction."
This sentence introduces the mechanism behind adaptation—natural selection.

4. P (Conclusion on long-term impact):
"Over time, such adaptations lead to significant evolutionary changes with the potential to shape the development of new species."
This provides the final step, explaining the long-term consequence of adaptation.

07. A stick of length one meter is broken at two locations at distances of b_1 and b_2 from the origin (0), as shown in the figure. Note that $0 < b_1 < b_2 < 1$. Which one of the following is NOT a necessary condition for forming a triangle using the three pieces?
Note: All lengths are in meter. The figure shown is representative.

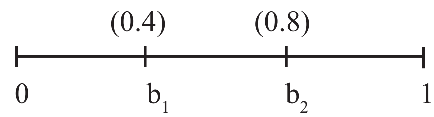
(a) $b_1 < 0.5$ (b) $b_2 > 0.5$
(c) $b_2 < b_1 + 0.5$ (d) $b_1 + b_2 < 1$

07. Ans: (d)

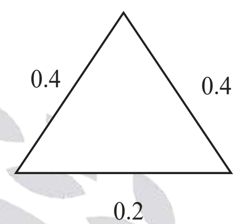
Sol:

from options $b_1 + b_2 < 1$ need not to be a necessary condition for forming a triangle

Ex:

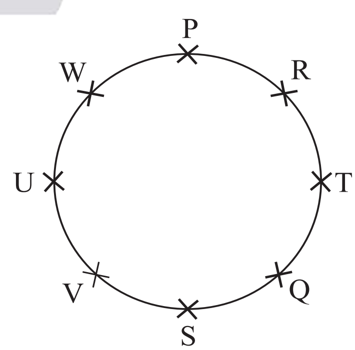


Sides of triangle



$b_1 + b_2 = 0.4 + 0.8 = 1.2 \nless 1$
Answer is option (d)

08. Eight students (P, Q, R, S, T, U, V, and W) are playing musical chairs. The figure indicates their order of position at the start of the game. They play the game by moving forward in a circle in the clockwise direction.
After the 1st round, 4th student behind P leaves the game. After 2nd round, 5th student behind Q leaves the game. After 3rd round, 3rd student behind V leaves the game. After 4th round, 4th student behind U leaves the game. Who all are left in the game after the 4th round?
Note: The figure shown is representative.



(a) P; T; Q; S (b) V; P; T; Q
(c) W; R; Q; V (d) Q; T; V; W

08. Ans: (*)

09. The table lists the top 5 nations according to the number of gold medals won in a tournament; also included are the number of silver and the bronze medals won by them. Based only on the data provided in the table, which one of the following statements is INCORRECT?

Nation	Gold	Silver	Bronze
USA	40	44	41
Canada	39	27	24
Japan	20	12	13
Australia	17	19	16
France	16	26	22

(a) France will occupy the third place if the list were made on the basis of the total number of medals won.
(b) The order of the top two nations will not change even if the list is made on the basis of the total number of medals won.
(c) USA and Canada together have less than 50% of the medals awarded to the nations in the above table.
(d) Canada has won twice as many total medals as Japan.

09. Ans: (c)

Sol:

Nation	Gold	Silver	Bronze	
USA	40	44	41	$\Rightarrow$ 125
Canada	39	27	24	$\Rightarrow$ 90
Japan	20	12	13	$\Rightarrow$ 45
Australia	17	19	16	$\Rightarrow$ 52
France	16	26	22	$\Rightarrow$ 64
	132	128	116	

According to total medal
J < A < F < C < U.S.A
option (c)
U.S.A + Canada = 125 + 90 = 215
J + A + F = 45 + 52 + 64 = 161
option (c) is wrong

10. An organization allows its employees to work independently on consultancy projects but charges an overhead on the consulting fee. The overhead is 20% of the consulting fee, if the fee is up to ₹ 5,00,000. For higher fees, the overhead is ₹ 1,00,000 plus 10% of the amount by which the fee exceeds ₹ 5,00,000. The government charges a Goods and Services Tax of 18% on the total amount (the consulting fee plus the overhead). An employee of the organization charges this entire amount, i.e., the consulting fee, overhead, and tax, to the client. If the client cannot pay more than ₹ 10,00,000, what is the maximum consulting fee that the employee can charge?
(a) ₹ 7,01,438 (b) ₹ 7,24,961
(c) ₹ 7,51,232 (d) ₹ 7,75,784

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10. Ans: (b)

Sol: Let $5,00,000 + x + 1,00,000 + \frac{10}{100}(x)$

$\downarrow$

(extra)

$\Rightarrow 6,00,000 + (1.1)x$

G.ST

$= \frac{18}{100}[6,00,000 + 1.1x] = 1,08,000 + 0.198x$

Total Amount $= 6,00,000 + 1.1x + 1,08,000 + 0.198x$

$= 7,08,000 + 1.298x < 10,00,000$ given

$x = \frac{10,00,000 - 7,08,000}{1.298} \Rightarrow 2,24,961$

Then $50,00,000 + 2,24,961 = 7,24,961$

Technical

Q.11 – Q.35 Carry ONE mark Each

11. Consider the matrix A below:

$$A = \begin{bmatrix} 2 & 3 & 4 & 5 \\ 0 & 6 & 7 & 8 \\ 0 & 0 & \alpha & \beta \\ 0 & 0 & 0 & \gamma \end{bmatrix}$$

For which of the following combinations of α, β, and γ, is the rank of A at least three?

(i) $\alpha = 0$ and $\beta = \gamma \neq 0$.

(ii) $\alpha = \beta = \gamma = 0$.

(iii) $\beta = \gamma = 0$ and $\alpha \neq 0$.

(iv) $\alpha = \beta = \gamma \neq 0$.

(a) Only (i), (iii), and (iv) (b) Only (iv)

(c) Only (ii) (d) Only (i) and (iii)

11. Ans: (a)

Sol: Given that

$$A = \begin{bmatrix} 2 & 3 & 4 & 5 \\ 0 & 6 & 7 & 8 \\ 0 & 0 & \alpha & \beta \\ 0 & 0 & 0 & \gamma \end{bmatrix}$$

(i) Let $\alpha = 0, \beta = \gamma \neq 0$

$$\text{Then } A \sim \begin{bmatrix} 2 & 3 & 4 & 5 \\ 0 & 6 & 7 & 8 \\ 0 & 0 & 0 & \beta \\ 0 & 0 & 0 & \gamma \end{bmatrix} \sim \begin{bmatrix} 2 & 3 & 4 & 5 \\ 0 & 6 & 7 & 8 \\ 0 & 0 & 0 & \beta \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$\Rightarrow \rho(A) = 3$

(ii) Let $\alpha = \beta = \gamma = 0$

$$\text{Then } A \sim \begin{bmatrix} 2 & 3 & 4 & 5 \\ 0 & 6 & 7 & 8 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$\Rightarrow \rho(A) = 2$

(iii) Let $\alpha \neq 0, \beta = \gamma = 0$

$$\text{Then } A \sim \begin{bmatrix} 2 & 3 & 4 & 5 \\ 0 & 6 & 7 & 8 \\ 0 & 0 & \alpha & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

$\Rightarrow \rho(A) = 3$

(iv) Let $\alpha = \beta = \gamma \neq 0$

Then $A \sim \begin{bmatrix} 2 & 3 & 4 & 5 \\ 0 & 6 & 7 & 8 \\ 0 & 0 & \alpha & \alpha \\ 0 & 0 & 0 & \alpha \end{bmatrix}$

$\Rightarrow \rho(A) = 4$

option (a) is TRUE

12. Consider the following series:

(i) $\sum_{n=1}^{\infty} \frac{1}{\sqrt{n}}$

(ii) $\sum_{n=1}^{\infty} \frac{1}{n(n+1)}$

(iii) $\sum_{n=1}^{\infty} \frac{1}{n!}$

Choose the correct option.

(a) Only (ii) converges

(b) Only (ii) and (iii) converge

(c) Only (iii) converges

(d) All three converge

12. Ans: (b)

Sol: (i) $\sum_{n=1}^{\infty} \frac{1}{\sqrt{n}} = \sum \frac{1}{n^{1/2}}$

This is in a form $\sum \frac{1}{n^P}$. $P = \frac{1}{2} < 1$

$\therefore$ By P-test $\sum \frac{1}{\sqrt{n}}$ diverges

(ii) $\sum_{n=1}^{\infty} \frac{1}{n(n+1)} = \frac{1}{1.2} + \frac{1}{2.3} + ... + \frac{1}{n(n+1)}$

$= \left(\frac{1}{1} - \frac{1}{2}\right) + \left(\frac{1}{2} - \frac{1}{3}\right) + ... + \left(\frac{1}{n} - \frac{1}{n+1}\right)$

$= 1 - \frac{1}{n+1} = 1$ as $n \to \infty$

$\therefore \sum \frac{1}{n(n+1)}$ converges

(iii) $\sum_{n=1}^{\infty} \frac{1}{n!}$

$a_n = \frac{1}{n!}$; $a_{n+1} = \frac{1}{(n+1)!}$

$\underset{n\to\infty}{\text{Lt}} \left| \frac{a_{n+1}}{a_n} \right| = \underset{n\to\infty}{\text{Lt}} \frac{1}{(n+1)!} \times n!$

$= \underset{n\to\infty}{\text{Lt}} \frac{n!}{n!(n+1)}$

$= 0 < 1$

$\therefore \sum \frac{1}{n!}$ converges by ratio test

ii, iii converges option (b)

13. A pot contains two red balls and two blue balls. Two balls are drawn from this pot randomly without replacement.

What is the probability that the two balls drawn have different colours?

(a) $\frac{2}{3}$ (b) $\frac{1}{3}$

(c) $\frac{1}{2}$ (d) 1

13. Ans: (a)

Sol:

POT	
2R	2B

Total = 4 balls

$n(s) = {}^4C_2 = 6$

$n(E) = {}^2C_1 \times {}^2C_1 = 4$

Required probability $= \frac{4}{6} = \frac{2}{3}$

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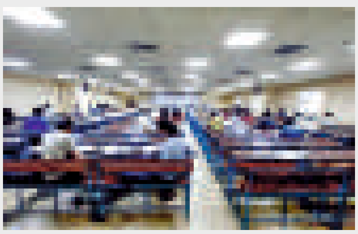


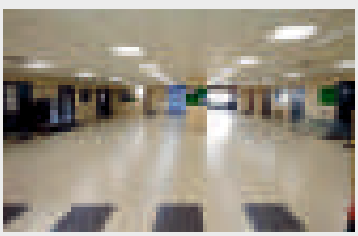

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14. Consider a frequency-modulated (FM) signal $f(t) = A_c\cos(2\pi f_c t + 3\sin(2\pi f_1 t) + 4\sin(6\pi f_1 t))$, where A_c and f_c are, respectively, the amplitude and frequency (in Hz) of the carrier waveform. The frequency f_1 is in Hz, and assume that $f_c > 100f_1$.
The peak frequency deviation of the FM signal in Hz is _______.

(a) $15f_1$ (b) $12f_1$
(c) $4f_1$ (d) $2f_1$

14. Ans: (a)

Sol: $\Delta f_i(t) = \frac{1}{2\pi}\frac{d}{dt}[\Delta\theta_i(t)]$

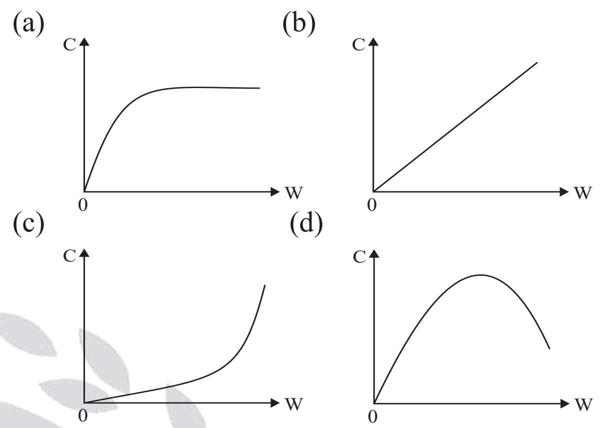
$$\Delta f_i(t) = \frac{1}{2\pi}\frac{d}{dt}\left[3\sin(2\pi f_l t) + 4\sin(6\pi f_l t)\right]$$

$$\Delta f_i(t) = \frac{1}{2\pi}\left[6\pi f_l\cos(2\pi f_l t) + 24\pi f_l\cos(6\pi f_l t)\right]$$

$$\Delta f_i(t) = 3f_l\cos(2\pi f_l t) + 12\pi f_l\cos(6\pi f_l t)$$

$$\therefore \Delta f_{MAX} = 3f_l + 12f_l = 15f_l \text{ Hz}$$

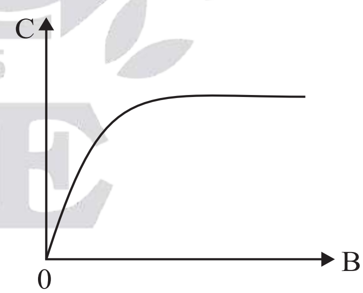
15. Consider an additive white Gaussian noise (AWGN) channel with bandwidth W and noise power spectral density $\frac{N_0}{2}$. Let P_{av} denote the average transmit power constraint.
Which one of the following plots illustrates the dependence of the channel capacity C on the bandwidth W (keeping P_{av} and N_0 fixed)?



15. Ans: (a)

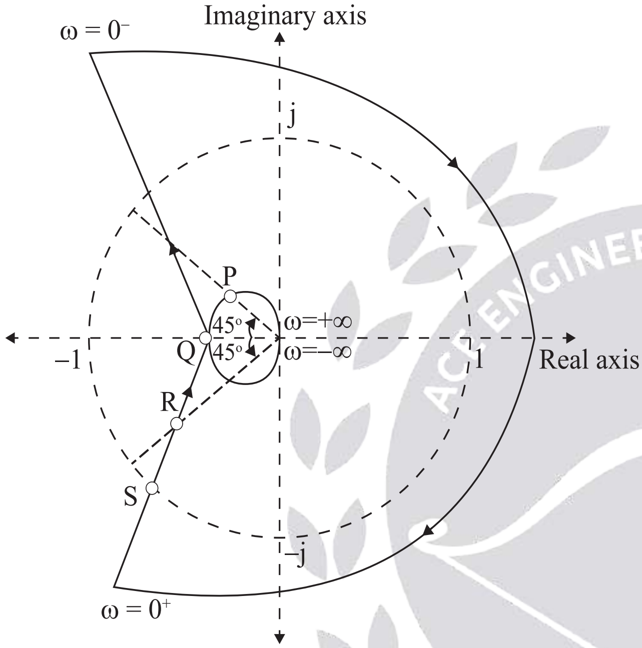
Sol: $C = B\log_2\left(1+\frac{S}{N}\right)$ bps

Since is $\left(\frac{S}{N}\right)$ fixed value
C = B × (Fixed Value)
But as $B \to \infty$
Channel capacity is limited.
Hence 'C' is linearly increasing with 'B' initially but as B increases 'C' will become constant.



option (a) is correct

16. The Nyquist plot of a system is given in the figure below. Let ω_P, ω_Q, ω_R & ω_S be the positive frequencies at the points P, Q, R, and S, respectively. Which one of the following statements is TRUE?



(a) ω_S is the gain crossover frequency & ω_P is the phase crossover frequency
(b) ω_Q is the gain crossover frequency & ω_R is the phase crossover frequency
(c) ω_Q is the gain crossover frequency & ω_S is the phase crossover frequency
(d) ω_S is the gain crossover frequency & ω_Q is the phase crossover frequency

16. Ans: (d)

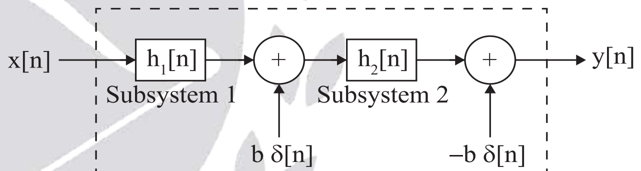
Sol: According to gain cross over frequency [GCOF] definition the frequency at which magnitude intersect unity is called as GCOF. From the plot, the frequency at "s" is GCOF so ω_S is GCOF.

According to phase cross over frequency [PCOF] definition the frequency at which phase intersect -180^o is called as PCOF.

From the given Nyquist plot, the frequency at "Q" is PCOF, So ω_Q is PCOF.

17. Consider the discrete-time system below with input x[n] and output y[n]. In the figure, $h_1[n]$ and $h_2[n]$ denote the impulse responses of LTI Subsystems 1 and 2, respectively. Also, δ[n] is the unit impulse, and b > 0.

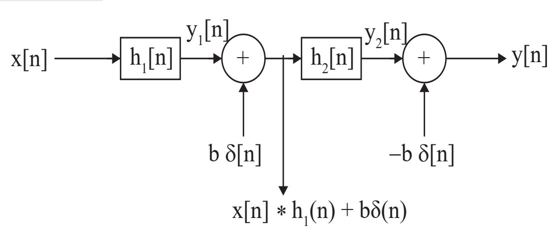
Assuming $h_2[n] \neq \delta[n]$, the overall system (denoted by the dashed box) is ________.



(a) linear and time invariant
(b) linear and time variant
(c) nonlinear and time invariant
(d) nonlinear and time variant

17. Ans: (d)

Sol:



$y_2[n] = \{y_1[n] + b\delta[n]\} * h_2[n]$

Output $y[n] = \{x[n] * h_1[n] + b\delta[n]\} * h_2[n] - b\delta[n]$

$$y(n) = \underbrace{x[n] * h_1[n] * h_2[n]}_{\text{This is LTI}} + \underbrace{b\,h_2[n] - b\delta[n]}_{\text{N.L.terms}}$$

$h_2[n] \neq \delta[n]$

If we consider $h_2[n] = nu[n]$

$y[n]$ is variable function of time $\Rightarrow$ Time variant

So, Non Linear & Time variant.

18. Consider a continuous-time, real-valued signal $f(t)$ whose Fourier transform $F(\omega) = \int_{-\infty}^{\infty} f(t)\exp(-j\omega t)\,dt$ exists.

Which one of the following statements is always TRUE?

(a) $|F(\omega)| \le \int_{-\infty}^{\infty} |f(t)|\,dt$

(b) $|F(\omega)| > \int_{-\infty}^{\infty} |f(t)|\,dt$

(c) $|F(\omega)| \le \int_{-\infty}^{\infty} f(t)\,dt$

(d) $|F(\omega)| \ge \int_{-\infty}^{\infty} f(t)\,dt$

18. Ans: (a)

Sol:

$$F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}\,dt$$

$$|F(\omega)| \le \int_{-\infty}^{\infty} |f(t)e^{-j\omega t}|\,dt$$

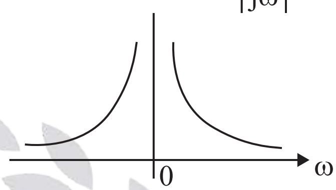
$$\le \int_{-\infty}^{\infty} |f(t)|\,dt$$

option (a) is TRUE

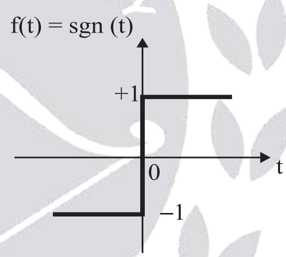
option (b) need not be TRUE

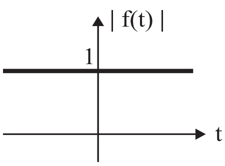
Ex: $\underset{f(t)}{\mathrm{sgn}(t)} \xleftrightarrow{F.T} \underset{F(\omega)}{\dfrac{2}{j\omega}}$

$$|F(\omega)| = \left|\frac{2}{j\omega}\right|$$



But $F(\omega)$ for certain frequencies is less than the area under magnitude of the function.





$$\int_{-\infty}^{\infty} |f(t)|\,dt = \int_{-\infty}^{\infty} (1)\,dt = \infty$$

option (c) need not be TRUE

$$|F(\omega)| \le \underbrace{\int_{-\infty}^{\infty} f(t)\,dt}_{F(0)}$$

$$F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}\,dt$$

$$F(\omega)\big|_{\omega=0} = \int_{-\infty}^{\infty} f(t)\,dt$$

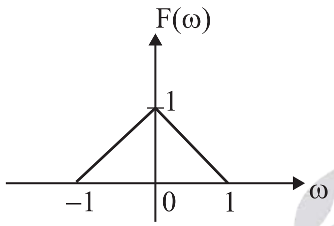
Area under signum function = $F(0) = 0$

But $|F(\omega)|$ has magnitudes defined at most of frequencies.

option (d) need not be TRUE

$$|F(\omega)| \geq \int_{-\infty}^{\infty} f(t)\,dt = F(0)$$

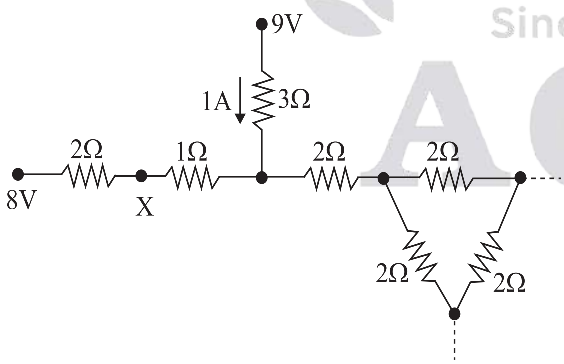
Ex:



In the given spectrum $F(0) = 1$

But $F(\omega)$ at $\omega = 1$ is 0

19. Consider a part of an electrical network as shown below. Some node voltages, and the current flowing through the 3Ω resistor are as indicated.
The voltage (in Volts) at node X is ______.

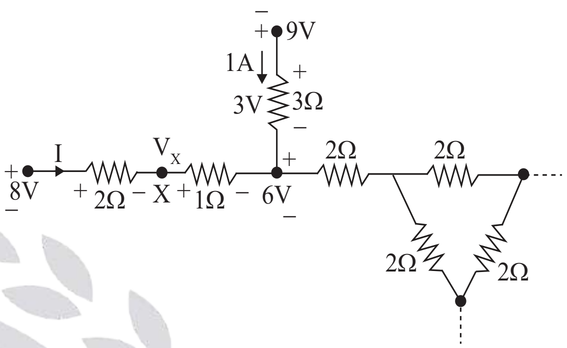


(a) $\frac{20}{3}$ (b) $\frac{32}{3}$

(c) $\frac{22}{3}$ (d) $\frac{2}{3}$

19. Ans: (a)

Sol:



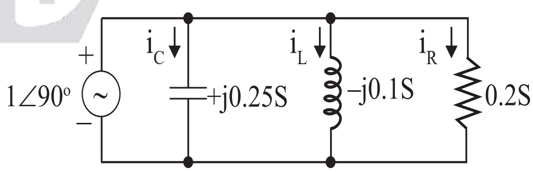
$$I = \frac{8-6}{2+1} = \frac{2}{3}\text{A}$$

By KVL, $-8 + 2I + V_x = 0$

$$V_x = 8 - 2I = 8 - \left(2 \times \frac{2}{3}\right)$$

$$V_x = \frac{24-4}{3} = \frac{20}{3}\text{V}$$

20. Let i_C, i_L, and i_R be the currents flowing through the capacitor, inductor, and resistor, respectively, in the circuit given below. The AC admittances are given in Siemens (S).
Which one of the following is TRUE?



(a) $i_C = 0.25\angle 180^\circ$ A, $i_L = 0.1\angle 0^\circ$ A, $i_R = 0.2\angle 90^\circ$ A
(b) $i_C = 4\angle 180^\circ$ A, $i_L = 10\angle 0^\circ$ A, $i_R = 5\angle 90^\circ$ A
(c) $i_C = 0.25\angle 270^\circ$ A, $i_L = 0.1\angle 90^\circ$ A, $i_R = 0.2\angle 90^\circ$ A
(d) $i_C = 4\angle 90^\circ$ A, $i_L = 10\angle 270^\circ$ A, $i_R = 5\angle 0^\circ$ A

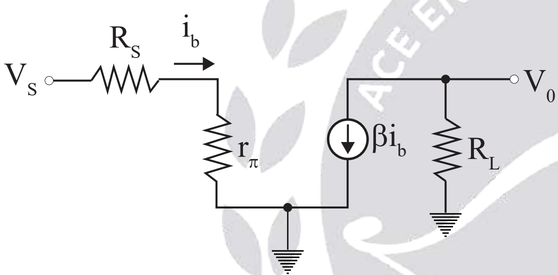
20. Ans: (a)

Sol: $i_C = V(jB_C) = [1\angle 90^o]\,[j0.25] = 0.25\ \angle{+180^o}A$

$i_L = V(-jB_L) = [1\angle 90^o]\,[-j0.1] = 0.1\ \angle 0^o A$

$i_R = V(0.2) = [1\angle 90^o]\,[0.2] = 0.2\ \angle 90^o A$

21. A simplified small-signal equivalent circuit of a BJT-based amplifier is given below.
The small-signal voltage gain v_o/v_s (in V/V) is _______ .

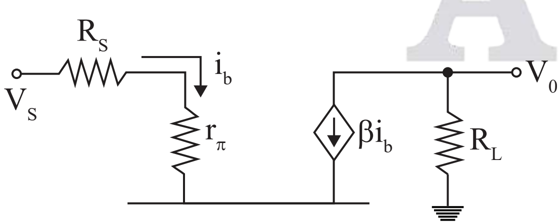


(a) $\dfrac{-\beta R_L}{R_S + r_\pi}$ (b) $\dfrac{+\beta R_L}{R_S}$

(c) $\dfrac{-\beta R_L}{R_S}$ (d) $\dfrac{+\beta R_L}{R_S + r_\pi}$

21. Ans: (a)

Sol:

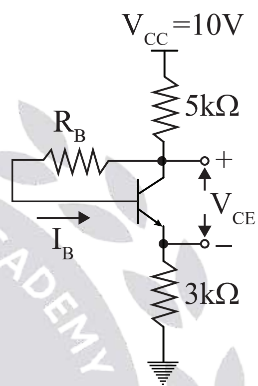


$v_0 = -\beta i_b R_L$

$v_s = i_b (R_S + r_\pi)$

$$\frac{v_0}{v_s} = -\frac{\beta R_L}{R_S + r_\pi}$$

22. The ideal BJT in the circuit given below is biased in the active region with a β of 100.
If I_B is 10 μA, then V_{CE} (in Volts, rounded off to two decimal places) is _______ .



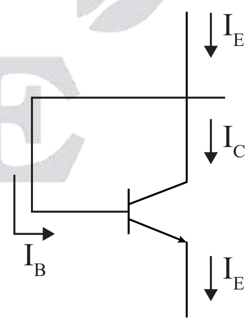
(a) 4.95 (b) 3.03

(c) 1.92 (d) 3.73

22. Ans: (c)

Sol: Given $I_B = 10\mu A$ and $\beta = 100$

$I_E = (\beta + 1)\, I_B = (101)\, 10\mu = 1.01mA$



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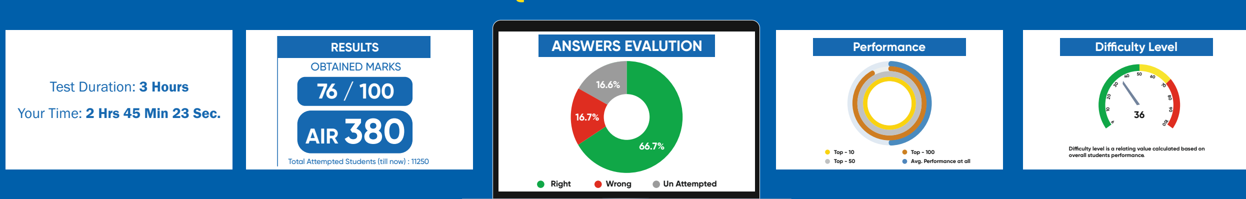
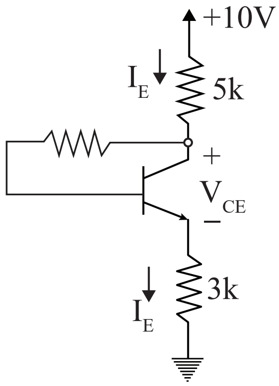




Applying KVL at output loop, we have

$10 = I_E(5k) + V_{CE} + I_E(3k)$

$\Rightarrow V_{CE} = 10 - I_E(8k) = 10 - 1.01m(8k) = 1.92V$

23. A 3-input majority logic gate has inputs X, Y and Z. The output F of the gate is logic '1' if two or more of the inputs are logic '1'. The output F is logic '0' if two or more of the inputs are logic '0'. Which one of the following options is a Boolean expression of the output F?

(a) $XY + YZ + ZX$ (b) $X \oplus Y \oplus Z$

(c) $X + Y + Z$ (d) XYZ

23. Ans: (a)

Sol:

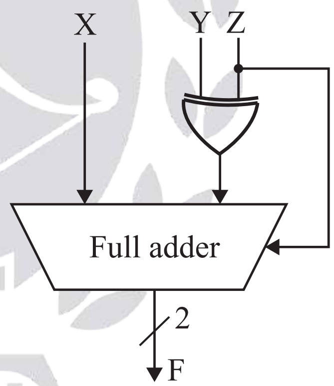
	X	Y	Z	F
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	0
5	1	0	1	1
6	1	1	0	1
7	1	1	1	1

$F = \sum m(3, 5, 6, 7)$

X \ YZ	00	01	11	10
0			1	
1		1	1	1

$F = XY + YZ + ZX$

24. A full adder and an XOR gate are used to design a digital circuit with inputs X, Y, and Z, and output F, as shown below. The input Z is connected to the carry-in input of the full adder.
If the input Z is set to logic '1', then the circuit functions as ________ with X and Y as inputs.



(a) an adder

(b) a subtractor

(c) a multiplier

(d) a binary to Gray code converter

24. Ans: (b)

Sol: In the circuit, when Z is set to 1, the operands to full adder are $X, \overline{Y}$ and input carry is 1

So, $F = X + \overline{Y} + 1$

$= X + 2\text{'s complement of } Y$

$= X - Y$

25. Consider the function f: R → R, defined as $f(x) = 2x^3 - 3x^2 - 12x + 1$.
Which of the following statements is/are correct?
(Here, $\mathbb{R}$ is the set of real numbers.)
(a) f has no global maximizer
(b) f has no global minimizer
(c) $x = -1$ is a local minimizer of f
(d) $x = 2$ is a local maximizer of f

25. Ans: (a; b)

Sol: $f(x) = 2x^3 - 3x^2 + 12x + 1$

$f'(x) = 6x^2 - 6x - 12$

$f''(x) = 12x - 6$

Put $f'(x) = 0 \Rightarrow x^2 - x - 2 = 0$

$\Rightarrow (x - 2)(x + 1) = 0$

$\Rightarrow x = 2, -1$

$f''(2) = 18 > 0 \Rightarrow x = 2$ is a local point of minima

$f''(-1) = -18 < 0 \Rightarrow x = -1$ is a local point of maxima

f has no global maxima
f has no global minima
option a, b

26. Consider the unity-negative-feedback system shown in Figure (i) below, where gain $K \geq 0$. The root locus of this system is shown in Figure (ii) below.
For what value(s) of K will the system in Figure (i) have a pole at $-1 + j1$?

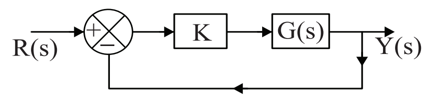


Figure (i)

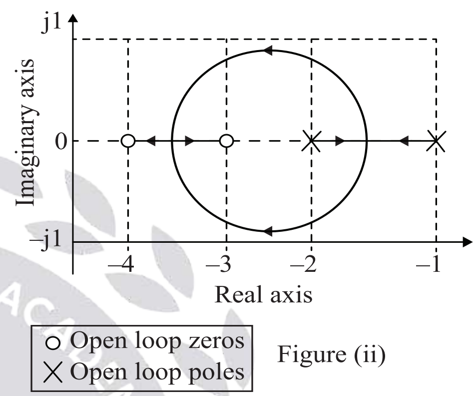


Figure (ii)

(a) K = 5
(b) K = 1/5
(c) For no positive value of K
(d) For all positive values of K

26. Ans: (c)

Sol: From the given root locus figure (ii), for any value of "k", root locus is not going to pass through the pole $(-1 + j1)$
hence option (c) is correct.

27. Let x[n] be a discrete-time signal whose z-transform is X(z).
Which of the following statements is/are TRUE?
(a) The discrete-time Fourier transform (DTFT) of x[n] always exists
(b) The region of convergence (ROC) of X(z) contains neither poles nor zeros
(c) The discrete-time Fourier transform (DTFT) exists if the region of convergence (ROC) contains the unit circle
(d) If $x[n] = \alpha\delta[n]$, where $\delta[n]$ is the unit impulse and α is a scalar, then the region of convergence (RoC) is the entire z-plane

27. Ans: (c; d)

Sol: $x(n) \xleftrightarrow{Z.T} X(z)$

option (a) need not be TRUE
Ex: $2^n u(n)$ has no DTFT

option (b) FALSE
ROC can include zeros but not poles

option (c) TRUE
DTFT exists if ROC includes unit circle
$r = 1 \Rightarrow$ Z.T = D.T.F.T

option (d) TRUE
$x(n) = \alpha\delta(n) \xrightarrow{Z.T} X(z) = \alpha$
ROC entire z-plane

28. Consider a message signal m(t) which is bandlimited to [−W, W], where W is in Hz. Consider the following two modulation schemes for the message signal:
- Double sideband-suppressed carrier (DSB-SC): $f_{DSB}(t) = A_c\, m(t) \cos(2\pi f_c t)$
- Amplitude modulation (AM): $f_{AM}(t) = A_c\,(1+\mu m(t)) \cos(2\pi f_c t)$

Here, A_c and f_c are the amplitude and frequency (in Hz) of the carrier, respectively. In the case of AM, μ denotes the modulation index.
Consider the following statements:
(i) An envelope detector can be used for demodulation in the DSB-SC scheme if m(t) > 0 for all t.
(ii) An envelope detector can be used for demodulation in the AM scheme only if m(t) > 0 for all t.
Which of the following options is/are correct?
(a) (i) is TRUE (b) (i) is FALSE
(c) (ii) is TRUE (d) (ii) is FALSE

28. Ans: (a; d)

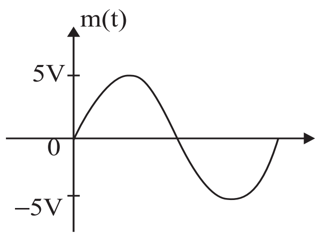
Sol: $f_{AM}(t) = A_C[1 + \mu m(t)]\cos(2\pi f_c t)$

o/p of envelope detector will be $\underset{AM}{|f(t)|}$ and it matches with m(t) only when

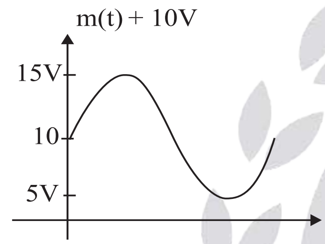
$m(t) + \underset{\text{component}}{DC} \geq 0$

But given only if $m(t) > 0, \forall t$
hence (ii) is FALSE

Eg:



It has negative and positive amplitudes.



This after modulated,
can be demodulated using Envelope detector
(ii) is FALSE

$$\underset{DSB}{f(t)} = A_C m(t)\cos(2\pi f_c t)$$

Output of Envelope Detector is

$$\underset{DSB}{f(t)} = A_C m(t) \quad \alpha\, m(t)$$

only when m(t) is > 0, $\forall t$

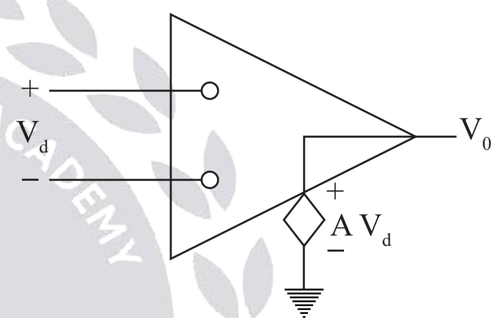
$\therefore$ (i) is TRUE

Both option (a) and (d) are correct

29. Which of the following statements is/are TRUE with respect to an ideal opamp?
(a) It has an infinite input resistance
(b) It has an infinite output resistance
(c) It has an infinite open-loop differential gain
(d) It has an infinite open-loop common-mode gain

29. Ans: (a; c)

Sol:

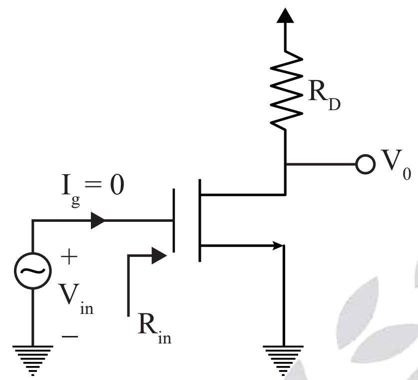


An ideal op-amp has infinite input resistance, zero output resistance, infinite open-loop differential gain (A) and zero common mode gain.
Therefore option (b) and (d) are wrong and option (a) and (c) are correct.

30. Which of the following statements is/are TRUE with respect to ideal MOSFET-based DC-coupled single-stage amplifiers having finite load resistors?
(a) The common-gate amplifier has an infinite input resistance
(b) The common-source amplifier has an infinite input resistance
(c) The input and output voltages of the common-source amplifier are in phase
(d) The input and output voltages of the common-drain amplifier are in phase

30. Ans: (b; d)

Sol: Common source amplifier



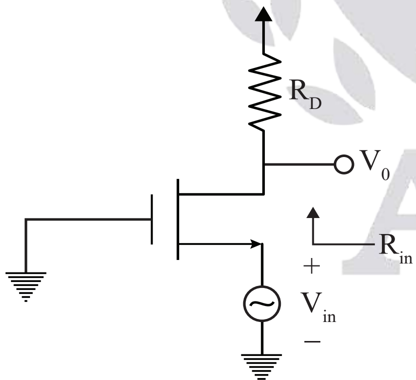
(1) $R_{in} = \frac{V_{in}}{I_g} = \frac{V_{in}}{0} = \infty$

"Option b is correct"

(2) $V_0 = -g_m R_D V_{in}$

"Option c is wrong"

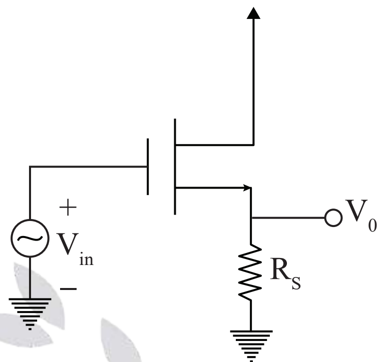
Common gate amplifier



$R_{in} \approx \frac{1}{g_m}$

(3) "Option a is wrong"

Common drain amplifier



$$\frac{V_0}{V_{in}} = \frac{R_S}{R_S + \frac{1}{g_m}}$$

"Option d is correct"

31. Which of the following can be used as an n-type dopant for silicon?

Select the correct option(s).

(a) Arsenic (b) Boron

(c) Gallium (d) Phosphorous

31. Ans: (a; d)

Sol: V Group elements could be used as n-type dopant for Si ⇒ As, Sb, P, Bi,------

∴ Option (a) and option (d) are true.

32. The function y(t) satisfies

$t^2y''(t) - 2ty'(t) + 2y(t) = 0$,

where y′(t) and y″(t) denote the first and second derivatives of y(t), respectively.

Given $y'(0) = 1$ and $y'(1) = -1$, the maximum value of y(t) over [0, 1] is _____ (rounded off to two decimal places).

32. Ans: 0.25 (Range: 0.25 to 0.25)

Sol: Given that $(t^2D^2 - 2tD + 2)y = 0$ - - - (1)

where $D = \frac{d}{dt}$

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& $y''(1) = -1$ - - - (3)

Let $t = e^z$ (or) $\log t = z$

and $tD = \theta$, $t^2D^2 = \theta(\theta - 1)$ - - - (4)

where $\theta = \frac{d}{dz}$

Using (4), (1) becomes

$[\theta(\theta - 1) - 2\theta + 2]y = 0$

$\Rightarrow (\theta^2 - 3\theta + 2)y = 0$

$\Rightarrow f(\theta)\, y = 0$, where $f(\theta) = \theta^2 - 3\theta + 2$

Consider auxillary equation $f(m) = 0$

$\Rightarrow m^2 - 3m + 2 = 0$

$\Rightarrow m = 1, 2$

$\Rightarrow Y_c = C_1 e^z + C_2 e^{2z}$

$\therefore$ The general solution of (1) is

$y = y(t) = C_1.t + C_2.t^2$ - - - - (5)

$y' = y'(t) = C_1 + 2C_2.t$ - - - - (6)

$\therefore y'(0) = 1$

$\Rightarrow C_1 + 0 = 1$

$\therefore y'(1) = -1$ - - - - (7)

$\Rightarrow C_1 + 2C_2 = -1$

$\Rightarrow C_1 + 2C_2 = -1$

$\Rightarrow C_2 = -1$ - - - - (8)

$\therefore$ The solution of (1) from (5), (7) & (8) is

$y = y(t) = t - t^2$

$\Rightarrow y' = y'(t) = 1 - 2t$ and $y'' = y''(t) = -2 < 0$

consider $y'(t) = 0$

$\Rightarrow 1 - 2t = 0$

$\Rightarrow t = 1/2$ is a stationary point and it is a point of maxima.

The maximum value of the solution of the given differential equation at $t = \frac{1}{2}$ is

$y = y\left(\frac{1}{2}\right) = \frac{1}{2} - \left(\frac{1}{2}\right)^2 = \frac{1}{4} = 0.25$

33. The Generator matrix of a (6, 3) binary linear block code is given by $G = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$

The minimum hamming distance d_{min} between code words equals ____ (answer in integer).

33. Ans: 3 (Range: 3 to 3)

Sol:

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{bmatrix}$$

Identity Matrix ⟷ Parity Matrix

$P_1 = d_1 \oplus d_3$

$P_2 = d_2 \oplus d_3$

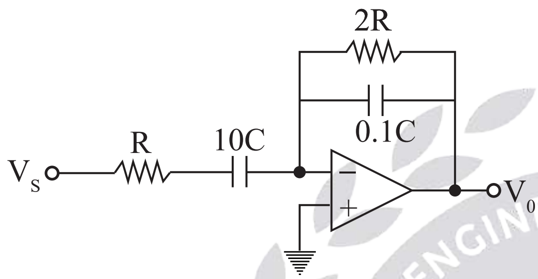
$P_3 = d_1 \oplus d_2$

	d_1	d_2	d_3	P_1	P_2	P_3	Hamming Weight
c_1	0	0	0	0	0	0	0
c_2	0	0	1	1	1	0	3
c_3	0	1	0	0	1	1	3
c_4	0	1	1	1	0	1	4
c_5	1	0	0	1	0	1	3
c_6	1	0	1	0	1	1	4
c_7	1	1	0	1	1	0	4
c_8	1	1	1	0	0	0	3

Minimum Hamming distance is Minimum Hamming weight except for all zero code word.

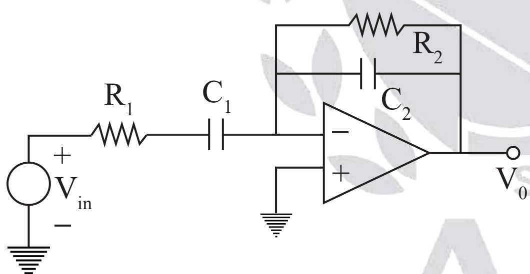
$\therefore d_{min} = 3$

34. All the components in the bandpass filter given below are ideal. The lower −3 dB frequency of the filter is 1 MHz.
The upper −3 dB frequency (in MHz, rounded off to the nearest integer) is ________.



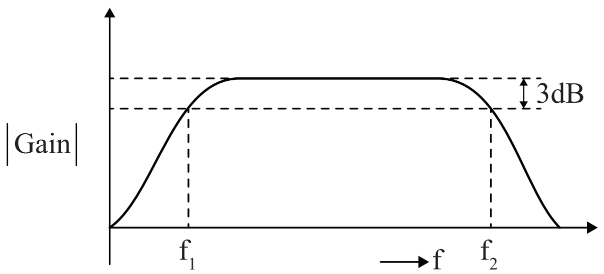
34. Ans: 50 (Range: 50 to 50)

Sol: Figure shows a band pass filter. The shunt RC network decides the upper cutoff frequency and the input series RC network decides the lower cutoff frequency.



$R_2 = 2R$
$C_2 = 0.1C$
$R_1 = R$
$C_1 = 10C$

The frequency response is shown below



Given $f_1 = \frac{1}{2\pi R_1 C_1} = 1\text{MHz}$

$\Rightarrow \frac{1}{2\pi(R)(10C)} = 10^6$

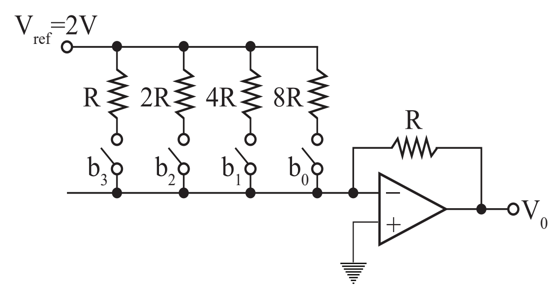
$\Rightarrow RC = \frac{1}{2\pi \times 10^7}$ ______(1)

$f_2 = \frac{1}{2\pi R_2 C_2} \Rightarrow f_2 = \frac{1}{2\pi(2R)(0.1C)} = \frac{1}{0.4\pi RC}$

$= \frac{1}{0.4\pi\left(\frac{1}{2\pi \times 10^7}\right)}$ (from 1)

$= 50\text{MHz}$

35. A 4-bit weighted-resistor DAC with inputs b_3, b_2, b_1, and b_0 (MSB to LSB) is designed using an ideal opamp, as shown below. The switches are closed when the corresponding input bits are logic ‘1’ and open otherwise.
When the input $b_3b_2b_1b_0$ changes from 1110 to 1101, the magnitude of the change in the output voltage V_O (in mV, rounded off to the nearest integer) is ________.



35. Ans: 250 (Range: 250 to 250)

Sol: $V_0 = -R\left(\frac{b_3 V_{REF}}{R} + \frac{b_2 V_{REF}}{2R} + \frac{b_1 V_{REF}}{4R} + \frac{b_0 V_{REF}}{8R}\right)$

$= -\frac{V_{REF} \times R}{R}\left[b_3 + \frac{b_2}{2} + \frac{b_1}{4} + \frac{b_0}{8}\right]$

$= -V_{REF}\left[b_3 + \frac{b_2}{2} + \frac{b_1}{4} + \frac{b_0}{8}\right]$

For the input $b_3\, b_2\, b_1\, b_0 = 1110$, the output voltage,

$V_0 = -2\left(1 + \frac{1}{2} + \frac{1}{4} + 0\right)$
$= -2(1.75)$
$= -3.5V$

For the input $b_3\, b_2\, b_1\, b_0 = 1101$, the output voltage,

$V_0 = -2\left(1 + \frac{1}{2} + 0 + \frac{1}{8}\right)$
$= -2(1.625)$
$= -3.25V$

So, the change in magnitude is 0.25V and it is equal to 250mV.

Q.36 – Q.65 Carry TWO marks Each

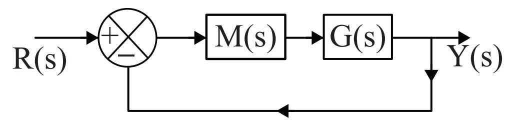
36. Let $G(s) = \frac{1}{10s^2}$ be the transfer function of a second-order system. A controller M(s) is connected to the system G(s) in the configuration shown below.

Consider the following statements.

(i) There exists no controller of the form $M(s) = \frac{K_I}{s}$, , where K_I is a positive real number, such that the closed loop system is stable.

(ii) There exists at least one controller of the form $M(s) = K_P + sK_D$, where K_P and K_D are positive real numbers, such that the closed loop system is stable.

Which one of the following options is correct?



(a) (i) is TRUE and (ii) is FALSE
(b) (i) is FALSE and (ii) is TRUE
(c) Both (i) and (ii) are FALSE
(d) Both (i) and (ii) are TRUE

36. Ans: (d)

Sol: **Statement (i):** Given integral controller, integral controller adds pole at origin result system becomes unstable hence for closed loop system stability no integral controller,
so statement (i) is true.

Statement (ii): Given PD controller, which adds zero result system becomes stable,
hence statement (ii) is also true.

37. Consider the polynomial
$p(s) = s^5 + 7s^4 + 3s^3 - 33s^2 + 2s - 40$. Let (L, I, R) be defined as follows.
L is the number of roots of p(s) with negative real parts.
I is the number of roots of p(s) that are purely imaginary.
R is the number of roots of p(s) with positive real parts.
Which one of the following options is correct?
(a) L = 2, I = 2, and R = 1
(b) L = 3, I = 2, and R = 0
(c) L = 1, I = 2, and R = 2
(d) L = 0, I = 4, and R = 1

37. Ans: (a)

Sol: Given $p(s) = s^5 + 7s^4 + 3s^3 - 33s^2 + 2s - 40$

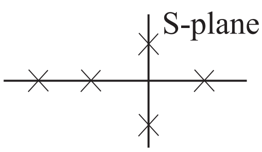
s^5	1	3	2
s^4	7	-33	-40
s^3	$\frac{54}{7}$	$\frac{54}{7}$	0
s^2	-40	-40	0
s^1	0(−80)	0	0
s^0	-40		

Auxiliary equation [A.E] $-40s^2 - 40 = 0$

A.E $\Rightarrow s^2 + 1 = 0 \Rightarrow s^2 = -1 \Rightarrow s = \pm 1j$

So number of imaginary roots [I] = 2

In the RH tabular, number of sign changes in the first column = 1, hence number of poles in the right half of s-plane (or) roots with positive real parts [R] = 1, number of poles in the left half of s-plane [L] = 5 – 2 – 1 = 2



So option (a) is correct.

38. Consider a continuous-time finite-energy signal f(t) whose Fourier transform vanishes outside the frequency interval $[-\omega_c, \omega_c]$, where ω_c is in rad/sec. The signal f(t) is uniformly sampled to obtain

$y(t) = f(t)p(t)$. Here, $p(t) = \sum_{n=-\infty}^{\infty}\delta(t-\tau-nT_s)$,

with $\delta(t)$ being the Dirac impulse, $T_s > 0$, and $\tau > 0$.

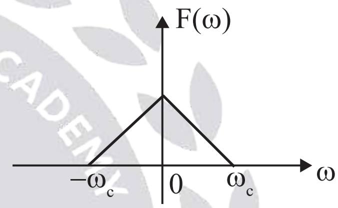
The sampled signal y(t) is passed through an ideal lowpass filter $h(t) = \omega_c T_s \frac{\sin(\omega_c t)}{\pi\omega_c t}$ with cutoff frequency ω_c and passband gain T_s.

The output of the filter is given by ________.

(a) f(t) if $T_s < \pi/\omega_c$
(b) $f(t-\tau)$ if $T_s < \pi/\omega_c$
(c) $f(t-\tau)$ if $T_s < 2\pi/\omega_c$
(d) $T_s f(t)$ if $T_s < 2\pi/\omega_c$

38. Ans: (a)

Sol: Assume $f(t) \leftrightarrow F(\omega)$



$$\sum_{n=-\infty}^{+\infty}\delta(t-nT_s) \leftrightarrow \frac{2\pi}{T_s}\sum_{n=-\infty}^{+\infty}\delta(\omega-n\omega_0)$$

$$p(t) = \sum_{n=-\infty}^{+\infty}\delta(t-T-nT_s)$$

$$h(t) = \omega_c T_s \frac{\sin(\omega_c t)}{\pi\omega_c t}$$

$y(t) = f(t)\, p(t)$

Applying Fourier Transform

$$Y(\omega) = \frac{1}{2\pi}[F(\omega) * P(\omega)]$$

$$= \frac{1}{2\pi}\left[F(\omega) * \frac{2\pi}{T_s}\sum_{n=-\infty}^{+\infty}\delta(\omega-n\omega_0)e^{-jn\omega_0 T}\right]$$

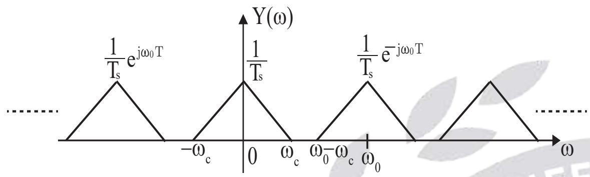
As $X(\omega)\,\delta(\omega-\omega_0) = X(\omega_0)\,\delta(\omega-\omega_0)$

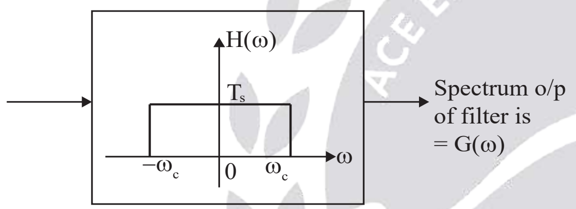
$$= \frac{1}{T_s}\sum_{n=-\infty}^{+\infty}F(\omega-n\omega_0)e^{-jn\omega_0 T}$$

Expand $Y(\omega)$

$$= \frac{1}{T_s}\sum_{n=-\infty}^{\infty} e^{-jn\omega_0 T} F(\omega - n\omega_0)$$

$$= \frac{1}{T_s}\left[- - - - + e^{j\omega_0 T}F(\omega+\omega_0) + F(\omega) + e^{-j\omega_0 T}F(\omega-\omega_0) + - - \right]$$





We can recover f(t) if

$\omega_0 - \omega_c > \omega_c$

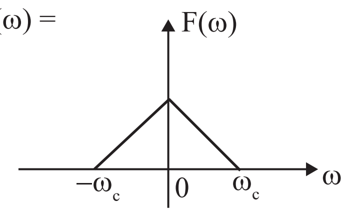
$\omega_0 > 2\omega_c$

$\frac{2\pi}{T_s} > 2\omega_c$

$\frac{\pi}{T_s} > \omega_c \Rightarrow \frac{\pi}{\omega_c} > T_s \Rightarrow T_s < \frac{\pi}{\omega_c}$

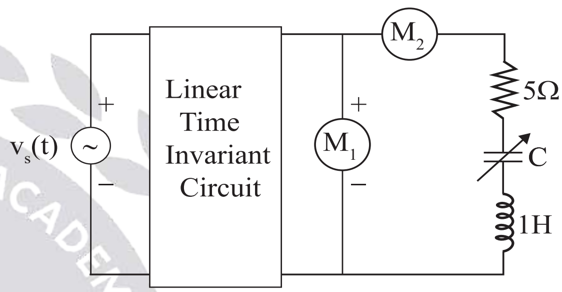
Spectrum of output of filter is

G(ω) =



$g(t) = f(t)$ if $T_s < \frac{\pi}{\omega_c}$

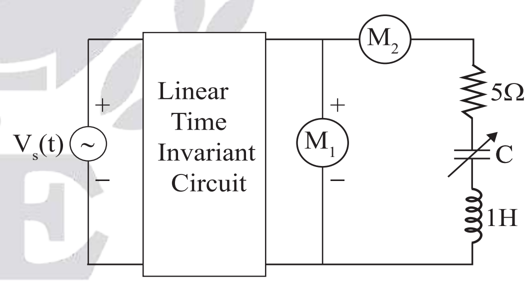
39. In the circuit below, M_1 is an ideal AC voltmeter and M_2 is an ideal AC ammeter. The source voltage (in Volts) is $v_s(t) = 100\cos(200t)$.
What should be the value of the variable capacitor C such that the RMS readings on M_1 and M_2 are 25 V and 5 A, respectively?



(a) 25 μF
(b) 4 μF
(c) 0.25 μF
(d) Insufficient information to find C

39. Ans: (a)

Sol:



$v_s(t) = 100\cos 200t$
RMS readings of M_1 voltmeter = 25V
RMS readings of M_2 ammeter = 5A
Across RLC series circuit
Impedance, $Z = R + j(X_L - X_C)$

$$|Z| = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\frac{M_1}{M_2} = \frac{|V|}{|I|} = \sqrt{R^2 + (X_L - X_C)^2}$$

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$$5 = \frac{25}{5} = \sqrt{5^2 + (\omega L - X_C)^2} = \sqrt{25 + (200 - X_C)^2}$$

$$25 = 25 + (200 - X_C)^2$$

$$200 = X_C \Rightarrow 200 = \frac{1}{\omega C}$$

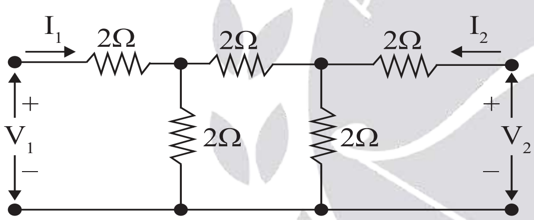
$$C = \frac{1}{200 \times 200} = \frac{10^{-4}}{4} = 25 \times 10^{-6}$$

$$C = 25\mu F$$

40. The Z-parameter matrix of a two-port network relates the port voltages and port currents as follows:

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = Z \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

The Z-parameter matrix (with each entry in ohms) of the network shown below is______

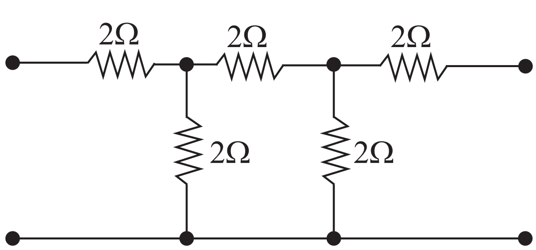


(a) $\begin{bmatrix} \frac{10}{3} & \frac{2}{3} \\ \frac{2}{3} & \frac{10}{3} \end{bmatrix}$ (b) $\begin{bmatrix} \frac{2}{3} & \frac{10}{3} \\ \frac{10}{3} & \frac{2}{3} \end{bmatrix}$

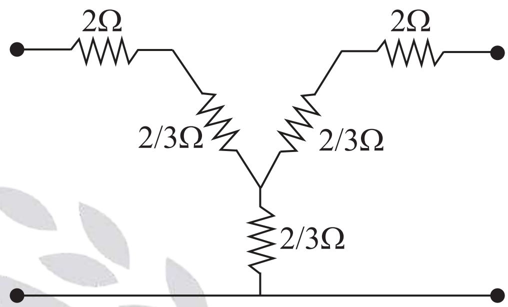
(c) $\begin{bmatrix} 10 & 2 \\ 2 & 10 \end{bmatrix}$ (d) $\begin{bmatrix} \frac{10}{3} & \frac{1}{3} \\ \frac{1}{3} & \frac{10}{3} \end{bmatrix}$

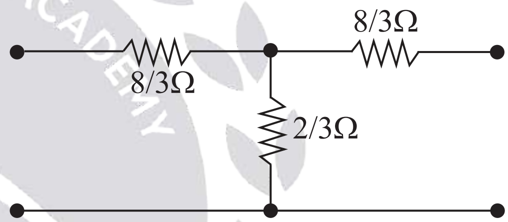
40. Ans: (a)

Sol:



By $\Delta \rightarrow Y$ conversion
$(Z \rightarrow Z/3)$





For T-network, Z-parameters

$$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} \frac{8}{3} + \frac{2}{3} & \frac{2}{3} \\ \frac{2}{3} & \frac{8}{3} + \frac{2}{3} \end{bmatrix}$$

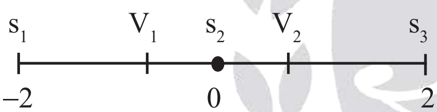
$$[Z] = \begin{bmatrix} \frac{10}{3} & \frac{2}{3} \\ \frac{2}{3} & \frac{10}{3} \end{bmatrix}$$

41. A source transmits symbol S that takes values uniformly at random from the set $\{-2,0,2\}$. The receiver obtains $Y = S + N$, where N is a zero-mean Gaussian random variable independent of S. The receiver uses the maximum likelihood decoder to estimate the transmitted symbol S.
Suppose the probability of symbol estimation error P_e is expressed as follows:
$P_e = \alpha\, P(N > 1)$,
where $P(N > 1)$ denotes the probability that N exceeds 1.
What is the value of α ?

(a) 1/3 (b) 1
(c) 2/3 (d) 4/3

41. Ans: (d)

Sol:



Since ML algorithm is used

$$P(s_1) = P(s_2) = P(s_3) = \frac{1}{3}$$

Threshold voltage between s_1 and s_2

$$= \frac{-2+0}{2} = -1$$

Threshold voltage between s_2 and s_3

$$= \frac{0+2}{2} = 1$$

$P_e\left(\frac{s_2}{s_1}\right)$

$r = s_1 + n$

$-2 + n \geq -1$

$n \geq 1$ (Volts)

$P_e\left(\frac{s_2}{s_3}\right)$

$r = s_3 + n$

$2 + n < 1$

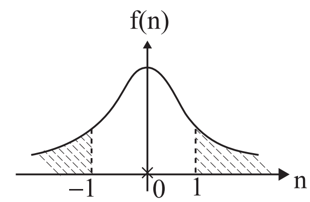
$n < -1$ (Volts)

$P_e\left(\frac{s_1}{s_2}\right)$

$r = s_2 + n$

$0 + n < -1$

$n < -1$ (Volts)



$P_e\left(\frac{s_3}{s_2}\right)$

$r = s_2 + n$

$0 + n \geq 1$

$n \geq 1$ (Volts)

$$P_e = P(s_1)P_e\left(\frac{s_2}{s_1}\right) + P(s_2)P_e\left(\frac{s_1}{s_2}\right) + P(s_2)P_e\left(\frac{s_3}{s_2}\right) + P(s_3)P_e\left(\frac{s_2}{s_3}\right)$$

$$P_e = \frac{1}{3}\int_1^{\infty} f(n)\,dn + \frac{1}{3}\int_{-\infty}^{-1} f(n)\,dn + \frac{1}{3}\int_1^{\infty} f(n)\,dn + \frac{1}{3}\int_{-\infty}^{-1} f(n)\,dn$$

The Areas under all the shaded regions is same

$$\therefore P_e = \frac{4}{3}\int_{-\infty}^{-1} f(n)\,dn \text{ (or) } \frac{4}{3}\int_1^{\infty} f(n)\,dn = \frac{4}{3}P[n > 1]$$

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

42. Consider a real-valued random process

$$f(t) = \sum_{n=1}^{N} a_n\, p(t - nT),$$

where $T > 0$ and N is a positive integer. Here, $p(t) = 1$ for $t \in [0, 0.5T]$ and 0 otherwise. The coefficients a_n are pairwise independent, zero-mean unit-variance random variables.
Read the following statements about the random process and choose the correct option.

(i) The mean of the process f(t) is independent of time t.

(ii) The autocorrelation function $E[f(t)f(t + \tau)]$ is independent of time t for all τ.

(Here, E[·] is the expectation operation.)

(a) (i) is TRUE and (ii) is FALSE

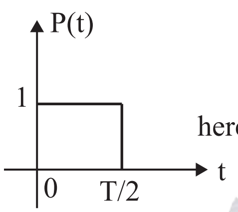
(b) Both (i) and (ii) are TRUE

(c) Both (i) and (ii) are FALSE

(d) (i) is FALSE and (ii) is TRUE

42. Ans: (a)

Sol: $f(t) = \sum_{n=1}^{N} a_n p(t-nT)$



here p(t) is deterministic signal.

$a_n \rightarrow$ Random variables which are independent, zero mean and has unit variance.

$\therefore E[a_n] = \text{ZERO}$

$\rightarrow$ for any value of $n E[1, N]$

$\rightarrow E[a_n^2] = VAR[a_n] = 1$

for $n E [1, N]$

$\rightarrow E[a_n a_m] = E[a_n]E[a_m] = \text{ZERO}$

for $n E [1, N]$

and $m E [1, N]$

(i) $E\{f(t)\} = E\left\{\sum_{n=1}^{N} a_n p(t-nT)\right\}$

$= p(t-nT)\; E\left\{\sum_{n=1}^{N} a_n\right\}$

$= p(t-nT)\;[E\{a_1\} + E\{a_2\} + ----- E\{a_N\}]$

$= p(t-nT)\;[\text{ZERO}]$

= ZERO

MEAN value of RP is constant

(ii)

$$E\{f(t)f(t+\tau)\} = E\left\{\sum_{n=1}^{N} a_n\, p(t-nT) \sum_{n=1}^{N} p(t+\tau-nT)\right\}$$

$$E\{f(t)f(t+\tau)\} = p(t-nT)p(t+\tau-nT)\; E\left\{\sum_{n=1}^{N} a_n \sum_{n=1}^{N} a_n\right\}$$

$$E\{f(t)f(t+\tau)\} = p(t-nT)p(t+\tau-nT)$$
$$[E\{a_1^2 + a_2^2 + a_3^2 + ----- + a_N^2\}$$
$$+ E\{a_1 a_2 + a_1 a_3 ---- + a_1 a_N$$
$$+ a_2 a_1 + a_2 a_3 + ---- + a_2 a_N + ---\}]$$

$$\therefore E\{f(t)f(t+\tau)\} = p(t-nT)p(t+\tau-nT)$$
$$[E(a_1^2) + E(a_2^2) + ----- + E(a_N^2)]$$

All remaining terms expectation is zero as they are independent and zero MEAN RV's.

$$\therefore E\{f(t)f(t+\tau)\} = p(t-nT)p(t+\tau-nT)$$
$$[1 + 1 + ----- + N \text{ times}]$$
$$\leftrightarrow \text{constant } (k) = N(N-1)$$

$$\therefore E\{f(t)f(t+\tau)\} = \underset{k}{\overset{N(N-1)}{\longleftrightarrow}} \quad \underset{\text{This is fucntion of time 't'}}{\overset{p(t-nT)\,p(t+\tau-nT)}{\longleftrightarrow}}$$

$\therefore$ (i) is TRUE

(ii) is FALSE

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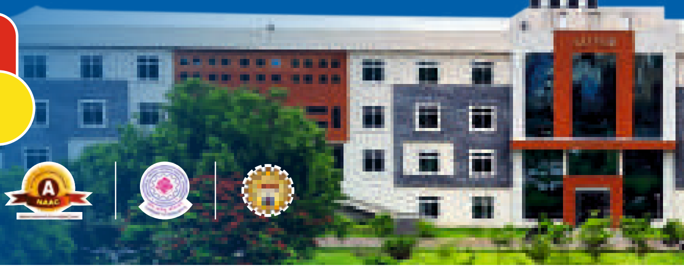

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12 STUDENTS

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DRONALAYA

ACE finishing school

- ARJUNA (Competitive programming)
- VIHAAN (Emerging Technologies)
- KALAM (Soft Skills)

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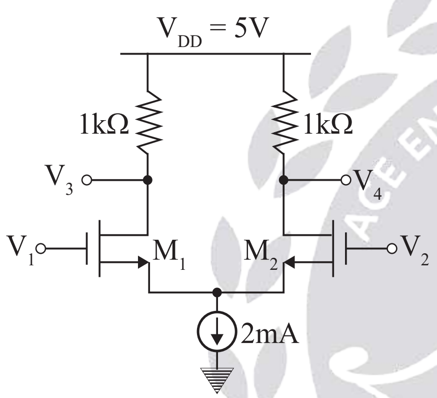
43. The identical MOSFETs M_1 and M_2 in the circuit given below are ideal and biased in the saturation region. M_1 and M_2 have a transconductance g_m of 5 mS.

The input signals (in Volts) are:

$V_1 = 2.5 + 0.01\sin\omega t$

$V_2 = 2.5 - 0.01\sin\omega t$

The output signal V_3 (in Volts) is ________.

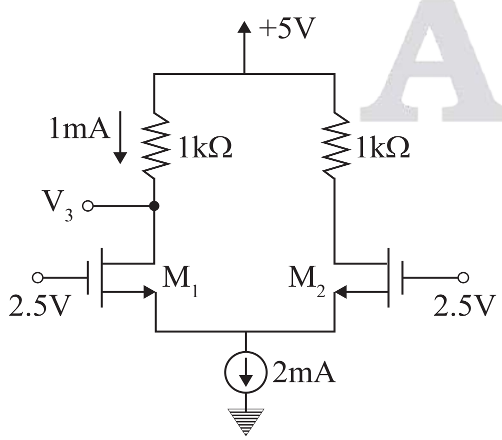


(a) $3 + 0.05\sin\omega t$ (b) $3 - 0.1\sin\omega t$

(c) $4 + 0.1\sin\omega t$ (d) $4 - 0.05\sin\omega t$

43. Ans: (d)

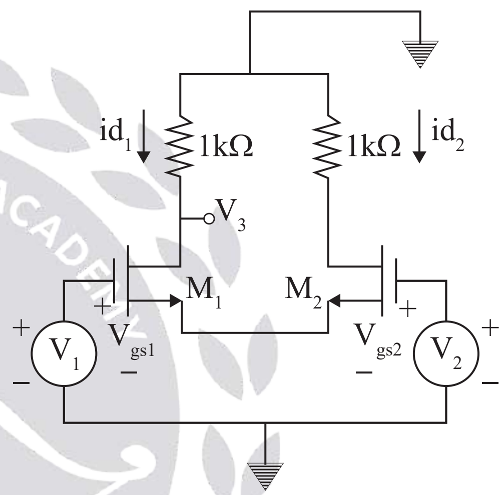
Sol: DC analysis (ac input voltages are considered zero)



$$I_{D1} = I_{D2} = \frac{2mA}{2} = 1mA$$

$$V_{3(DC)} = 5 - 1m(1k) = 4V$$

ac analysis (DC voltages are considered 0V)



$V_3 = -i_{d1}\,(1k\Omega)$ ______(1)

$-V_1 + V_{gs1} - V_{gs2} + V_2 = 0$

$\Rightarrow V_1 - V_2 = V_{gs1} - V_{gs2}$ ______(2)

But $V_{gs1} = -V_{gs2} = V_{gs}$ (in a differential amplifier)

$V_1 = -V_2 = 0.01\sin\omega t$

$i_{d1} = -i_{d2} = i_d$

$\therefore$ From (2)

$0.01\sin\omega t + 0.01\sin\omega t = 2V_{gs}$

$$\therefore \frac{V_3}{V_1 - V_2} = \frac{-i_d(1k)}{2V_{gs}}$$

$$\Rightarrow \frac{V_3}{0.02\sin\omega t} = \frac{1}{2}(-g_m)(1k)$$

$$V_3 = \frac{1}{2}(-5m)(1k)(0.02\sin\omega t)$$

$V_3 = -0.05\sin\omega t$

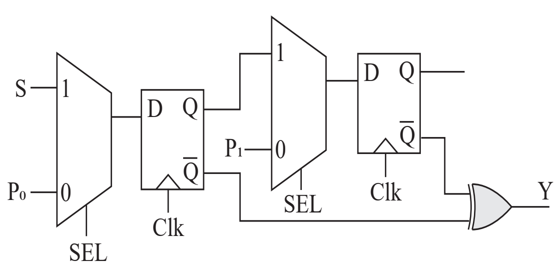
$\therefore V_{3(total)} = V_{3(DC)} + V_{3(ac)} = 4 - 0.05\sin\omega t\,(V)$

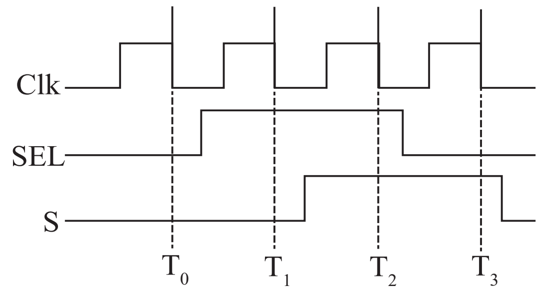
44. A 10-bit analog-to-digital converter (ADC) has a sampling frequency of 1 MHz and a full scale voltage of 3.3 V.
For an input sinusoidal signal with frequency 500 kHz, the maximum SNR (in dB, rounded off to two decimal places) and the data rate (in Mbps) at the output of the ADC are ________, respectively.
(a) 61.96 and 10 (b) 61.96 and 5
(c) 33.36 and 10 (d) 33.36 and 5

44. Ans: (a)

Sol: The maximum SNR for n bit
$= 6.02 \times n + 1.76\text{dB}$
For 10bits $= 6.02 \times 10 + 1.76\text{dB} = 61.96\text{dB}$
The sampling frequency is 1MHz and each sample is converted into 10bits. So, the data rate at the output $= 10 \times 1\text{M}$ bits per second
$= 10\text{Mbps}$

45. A positive-edge-triggered sequential circuit is shown below. There are no timing violations in the circuit. Input P0 is set to logic '0' and P1 is set to logic '1' at all times. The timing diagram of the inputs SEL and S are also shown below.
The sequence of output Y from time T_0 to T_3 is ________.

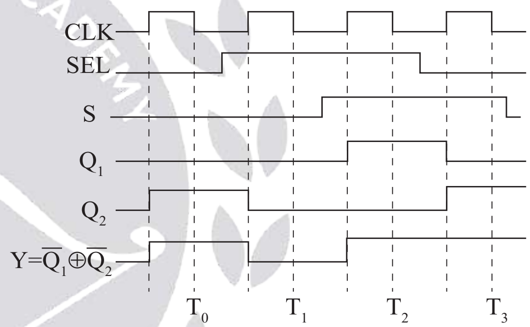




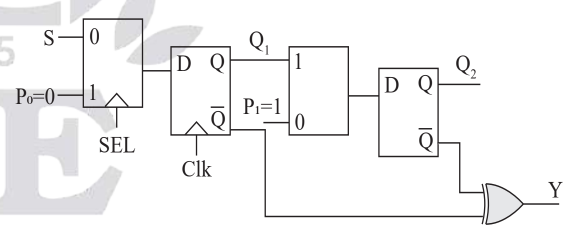
(a) 1011 (b) 0100
(c) 0010 (d) 1101

45. Ans: (a)

Sol:



$T_0\,T_1\,T_2\,T_3 = 1011$



46. The intrinsic carrier concentration of a semiconductor is $2.5\times10^{16}\ /\text{m}^3$ at 300 K.
If the electron and hole mobilities are 0.15 m^2/Vs and 0.05 m^2/Vs, respectively, then the intrinsic resistivity of the semiconductor (in kΩ.m) at 300 K is ________.
(Charge of an electron $e = 1.6\times10^{-19}$ C.)

(a) 1.65 (b) 1.25
(c) 0.85 (d) 1.95

46. Ans: (b)

Sol: Since, Intrinsic resistivity,

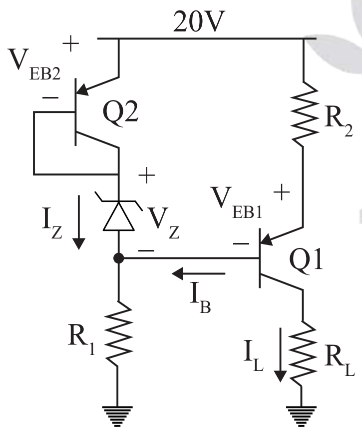
$$\rho_i = \frac{1}{\sigma_i} = \frac{1}{n_i q(\mu_n + \mu_p)}$$

$$= \frac{1}{2.5\times10^{16}\times1.6\times10^{-19}\times(0.15+0.05)}$$

$$= \frac{1}{2.5\times0.2\times1.6\times10^{-19}\times10^{16}}$$

$\therefore\ \rho_i = 1.25\text{k}\Omega\text{-m}$

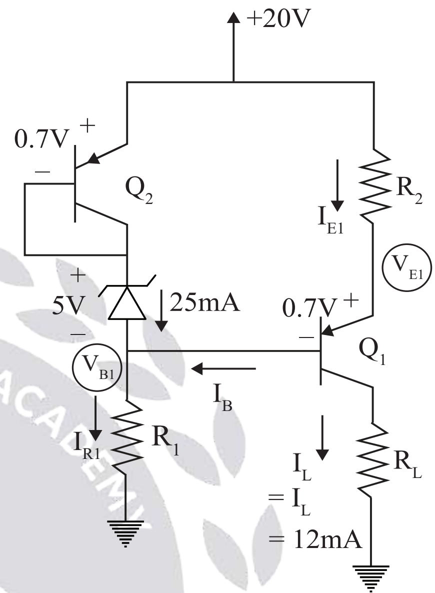
47. In the circuit shown, the identical transistors Q1 and Q2 are biased in the active region with $\beta = 120$. The Zener diode is in the breakdown region with $V_Z = 5$ V and $I_Z = 25$ mA.
If $I_L = 12$ mA and $V_{EB1} = V_{EB2} = 0.7$ V, then the values of R_1 and R_2 (in kΩ, rounded off to one decimal place) are _______, respectively.



(a) 0.6 and 0.4 (b) 1.4 and 2.5
(c) 14.0 and 25.0 (d) 6.0 and 4.0

47. Ans: (a)

Sol:



Given $\beta = 120$ and $I_{C1} = 12$mA

$$\Rightarrow I_{B1} = \frac{12\text{mA}}{\beta} = \frac{12\text{m}}{120} = 0.1\text{mA}$$

$I_{E1} = I_{C1} + I_{B1} = 12.1$mA

$I_{R1} = 25\text{m} + I_{B1} = 25 + 0.1 = 25.1$mA

$V_{B1} = 20 - (0.7 + 5) = 14.3$V

$$R_1 = \frac{V_{B1}}{I_{R1}} = \frac{14.3}{25.1\text{m}} = 0.569\text{k}\Omega \simeq 0.6\text{k}\Omega$$

$V_{E1} = 0.7 + V_{B1} = 0.7 + 14.3 = 15$V

$$R_2 = \frac{20 - V_{E1}}{I_{E1}} = \frac{20-15}{12.1\text{m}} = 0.413\text{k}\Omega \simeq 0.4\text{k}\Omega$$

48. The electron mobility μ_n in a non-degenerate germanium semiconductor at 300 K is 0.38 m²/Vs. The electron diffusivity D_n at 300 K (in cm²/s, rounded off to the nearest integer) is _______.

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81 TIMES AIR 1st IN GATE

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1	XE	GHANSHYAM D
1	EE	MANOJ KUMAR S
1	EE	SHIVAM GARG
1	PI	KUMAR VISHESH
1	EC	RAJA MAJHI
1	ME	SURAJ KUMAR S
1	BM	SANJEEV C
1	IN	RISHABH GUPTA

Ravi Teja	AIR-2 (EC)
Saksham Jain	AIR-2 (ME)
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Paraj Chhatwani	AIR-2 (XE)
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Krishna Kumar D	AIR-3 (PI)
Bharath S. R. A.	AIR-4 (EC)
Srivardhan A	AIR-4 (ME)
Rishabh Gupta	AIR-4 (EE)
E Snehil Rao	AIR-4 (IN)
Atharva Sethi	AIR-4 (ES)
K Pratik Ramkrushna	AIR-4 (PI)
Arnab Rudra	AIR-5 (ME)
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Sidhartha C	AIR-7 (IN)
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& MANY MORE...

TOTAL 206 SELECTIONS IN TOP 100

EC: 37 | EE: 49 | CE: 18 | ES: 4 | ME: 35 | XE: 8

PI: 24 | CS:8 | DA:3 | BM:1 | NM:1 | IN: 18

(Consider the Boltzmann constant $k_B = 1.38\times10^{-23}$J/K and the charge of an electron $e = 1.6\times10^{-19}$ C.)

(a) 26 (b) 98

(c) 38 (d) 10

48. Ans: (b)

Sol: Given: $\mu_n = 0.38\text{m}^2/\text{V-sec}$ at T = 300°K

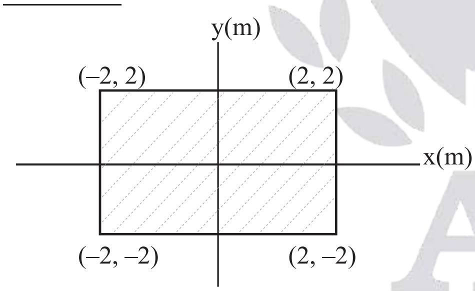
As $D_n = \mu_n V_T = \mu_n . \frac{T}{11600}$

At 300°K, $D_n = 0.38 \times \frac{300}{11600}$

$\therefore D_n = 98.26\text{cm}^2/\text{sec}$

49. A square metal sheet of 4 m × 4 m is placed on the x-y plane as shown in the figure below.

If the surface charge density (in μC/m²) on the sheet is $\rho_s(x, y) = 4|y|$, then the total charge (in μC, rounded off to the nearest integer) on the sheet is ________.



(a) 16 (b) 85

(c) 64 (d) 256

49. Ans: (c)

Sol: $Q = \iint 4|y|\,dxdy = 4\iint 4ydxdy$

$= 16\int dx \int ydy = 16[x]_0^2\left[\frac{y^2}{2}\right]_0^2$

$= 16\times2\times\frac{2^2}{2} = 16\times4 = 64\mu C$

50. An electric field of 0.01 V/m is applied along the length of a copper wire of circular cross-section with diameter 1 mm. Copper has a conductivity of 5.8×10^7 S/m.

The current (in Amperes, rounded off to two decimal places) flowing through the wire is ________.

(a) 0.46 (b) 1.82

(c) 0.58 (d) 1.12

50. Ans: (a)

Sol: $J = \sigma E = 0.01 \times 5.8 \times 10^7$

Current, $I = J\pi r^2$

$= 0.01 \times 5.8 \times 10^7 \times \pi \times (0.5 \times 10^{-3})^2$

$= 0.045 \times 10^7 \times 10^{-6} = 0.46\text{A}$

51. Consider a non-negative function f(x) which is continuous and bounded over the interval [2, 8]. Let M and m denote, respectively, the maximum and the minimum values of f(x) over the interval.

Among the combinations of α and β given below, choose the one(s) for which the inequality

$$\beta \le \int_2^8 f(x)dx \le \alpha$$

is guaranteed to hold.

(a) β = 5m, α = 7M (b) β = 6m, α = 5M

(c) β = 7m, α = 6M (d) β = 7m, α = 5M

51. Ans: (a)

Sol: Given m, M are min and max values of f(x)

$\Rightarrow m \le f(x) \le M$

$$\Rightarrow \int_a^b m dx \le \int_a^b f(x)dx \le \int_a^b M dx$$

$$\Rightarrow \int_2^8 m dx \le \int_2^8 f(x)dx \le \int_2^8 M dx$$

$$\Rightarrow 6m \le \int_2^8 f(x)dx \le \int 6M \quad ----(1)$$

Given $\beta \le \int_2^8 f(x)dx \le \alpha$ ---- (2)

From (1) & (2) possible values of α, β are

(b) β = 6m, α = 5M
(c) β = 7m, α = 6M
(d) β = 7m, α = 5M

52. Which of the following statements involving contour integrals (evaluated counter-clockwise) on the unit circle C in the complex plane is/are TRUE?

(a) $\oint_C e^z dz = 0$

(b) $\oint_C e^n dz = 0$, where n is an even integer

(c) $\oint_C \cos z dz \neq 0$

(d) $\oint_C \sec z dz \neq 0$

52. Ans: (a; b)

Sol:

(a) Let $f(z) = e^z$

Then the function f(z) is every where analytic

⇒ f(z) is analytic at every inside and on the given region $|z| = 1$ (or) unit circle.

∴ By a Cauchy's theorem, we have $\oint_C f(z) = 0$

(b) Let $f(z) = z^n$, where 'n' is an even integers

Then $f(z) = \begin{cases} z^n, & n > 0 \\ \frac{1}{z^n}, & n < 0 \end{cases}$

for n > 0, $I_1 = \oint_C z^n dz = 0$

∴ ($f(z) = z^n$ is analytic every point inside and on a given region $|z| = 1$).

for n < 0, $I_2 = \oint_C \frac{1}{z^n} dz$

$\Rightarrow I_2 = \oint_C \frac{1}{(z-0)^n} dz \quad \left(\because \int_C \frac{\phi(z)}{[z-z_0]^n} dz = \oint_C f(z)dz\right)$

$\Rightarrow I_2 = \frac{2\pi i}{(n-1)!}\frac{d^{n-1}}{dz^{n-1}}(1)$

$\Rightarrow I_2 = \frac{2\pi i}{(n-1)!}(0) = 0$

(c) Let f(z) = cos(z)

Then f(z) is every where analytic

⇒ f(z) is analytic at every point inside and on the given region $|z| = 1$.

∴ By a Cauchy's theorem, we have $\oint_C f(z)dz = 0$

(d) Let f(z) = sec(z)

Then $f(z) = \frac{1}{\cos(z)}$

⇒ The singular points of f(z) are given by cos(z) = 0

$\Rightarrow z = (2n+1)\frac{\pi}{2}, \quad n \in I$

$\Rightarrow z = \pm\frac{\pi}{2}, \pm\frac{3\pi}{2}, ---$ are singular points

But all the singular points lie outside the given region $|z| = 1$

By a Cauchy's Theorem we have

$\oint_C f(z)dz = 0$

Hence, options (a & b) are TRUE.

53. Consider a system where $x_1(t)$, $x_2(t)$, and $x_3(t)$ are three internal state signals and u(t) is the input signal. The differential equations governing the system are given by

$$\frac{d}{dt}\begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}u(t).$$

Which of the following statements is/are TRUE?

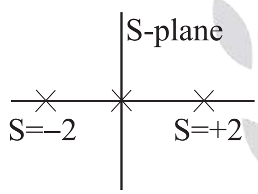
(a) The signals $x_1(t)$, $x_2(t)$, and $x_3(t)$ are bounded for all bounded inputs
(b) There exists a bounded input such that at least one of the signals $x_1(t)$, $x_2(t)$, and $x_3(t)$ is unbounded
(c) There exists a bounded input such that the signals $x_1(t)$, $x_2(t)$, and $x_3(t)$ are unbounded
(d) The signals $x_1(t)$, $x_2(t)$, and $x_3(t)$ are unbounded for all bounded inputs

53. Ans: (b)

Sol: Here given "A" matrix is in the diagonal canonical form [D.C.F] hence

$$T.F = \frac{k_1}{(s-2)} + \frac{k_2}{(s+2)} + \frac{k_3}{s}$$

Here poles $\Rightarrow s = -2, +2, 0$



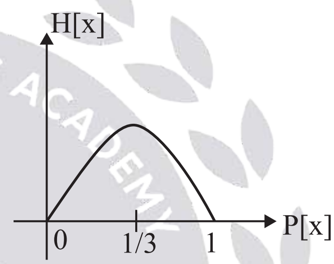
Here one pole is in the right half of s-plane so at least one of the signals $x_1(t)$, $x_2(t)$ and $x_3(t)$ are unbounded.

54. The random variable X takes values in $\{-1,0,1\}$ with probabilities $P(X = -1) = P(X = 1) = \alpha$ and $P(X = 0) = 1 - 2\alpha$, where $0 < \alpha < \frac{1}{2}$.
Let $g(\alpha)$ denote the entropy of X (in bits), parameterized by α.
Which of the following statements is/are TRUE?

(a) $g(0.4) > g(0.3)$ (b) $g(0.3) > g(0.4)$
(c) $g(0.3) > g(0.25)$ (d) $g(0.25) > g(0.3)$

54. Ans: (b; c)

Sol: X is having outcomes of random experiment.
Hence entropy H(x) will be maximum when are the events occur with equal probability.
H(x) is Max at $P[X = -1] = P[X = 0] = P[X = 1]$
$= \frac{1}{3} = 0.33$



(a) $g(0.4) > g(0.3) \rightarrow$ wrong
(b) $g(0.3) > g(0.4) \rightarrow$ correct
(c) $g(0.3) > g(0.25) \rightarrow$ correct
(d) $g(0.25) > g(0.3) \rightarrow$ wrong
only (b) and (c) are correct options.

55. Let f(t) be a periodic signal with fundamental period $T_0 > 0$. Consider the signal $y(t) = f(\alpha t)$, where $\alpha > 1$. The Fourier series expansions of f(t) and y(t) are given by

$$f(t) = \sum_{k=-\infty}^{\infty} c_k e^{j\frac{2\pi}{T_0}kt} \ \& \ y(t) = \sum_{k=-\infty}^{\infty} d_k e^{j\frac{2\pi}{T_0}\alpha kt}$$

Which of following statement is/are TRUE?
(a) $c_k = d_k$ for all k
(b) y(t) is periodic with a fundamental period αT_0
(c) $c_k = d_k/\alpha$ for all k
(d) y(t) is periodic with a fundamental period T_0/α

HEARTY CONGRATULATIONS TO OUR STUDENTS SELECTED IN TGPSC-AEE (2022)

Rank 1 (EE)

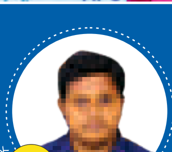
KAVYA NALLA

CLASSROOM COACHING

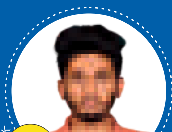
Selected in: Transport, R&B Dept., Govt. of TG.

RANK 1 CE
Venkat Reddy
MEGA MOCK TEST
Selected in Public Health, MA & UD Dept. Govt. of TG.

RANK 3 EE
Devarakonda Sathwik
CLASSROOM COACHING
Selected in Transport, R&B Dept., Govt. of TG.



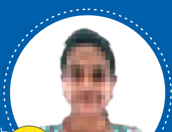
RANK 4 EE
Sangem Ravi Kumar
CLASSROOM COACHING
Selected in Transport, R&B Dept., Govt. of TG.



RANK 4 CE
Makam Jeevan Kumar
CLASSROOM COACHING
Selected in Public Health, MA & UD Dept., Govt. of TG.

RANK 6 CE
Balraj Madgan
MEGA MOCK TEST
Selected in Transport, R&B Dept., Govt. of TG.

RANK 7 EE
Challabotla Saikiran
CLASSROOM COACHING
Selected in Transport, R&B Dept., Govt. of TG.



RANK 7 ME
Vineetha Boddula
CLASSROOM COACHING
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RANK 7 CE
Rama Krishna
CLASSROOM COACHING
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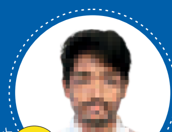
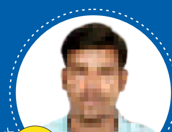
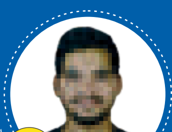


RANK 8 CE
Abhinav Karimilla
CLASSROOM COACHING
Selected in Transport, R&B Dept., Govt. of TG.

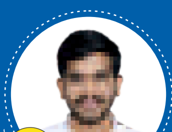


RANK 9 EE
Ganapathi G
CLASSROOM COACHING
Selected in Transport, R&B Dept., Govt. of TG.

RANK 9 CE
Pranay V
CLASSROOM COACHING
Selected in Public Health, MA & UD Dept., Govt. of TG.



RANK 11 EE
Sainath
CLASSROOM COACHING
Selected in Irrigation & CAD Dept., Govt. of TG.



RANK 11 CE
Bhugolla Surya Teja
CLASSROOM COACHING
Selected in Transport, R&B Dept., Govt. of TG.

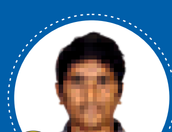
RANK 12 EE
Veligeti Umesh
CLASSROOM COACHING
Selected in Irrigation & CAD Dept., Govt. of TG.

RANK 12 CE
Puli Naveen Reddy
CLASSROOM COACHING
Selected in Transport, R&B Dept., Govt. of TG.

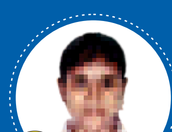
RANK 14 ME
Ravi Teja
CLASSROOM COACHING
Selected in Irrigation & CAD Dept., Govt. of TG.

RANK 15 ME
M Dheeraj Reddy
CLASSROOM COACHING
Selected in Irrigation & CAD Dept., Govt. of TG.

RANK 16 EE
Jangili Rajashekar
CLASSROOM COACHING
Selected in Irrigation & CAD Dept., Govt. of TG.



RANK 18 EE
Malka Kiran
CLASSROOM COACHING
Selected in Irrigation & CAD Dept., Govt. of TG.



RANK 19 EE
Sowmya
CLASSROOM COACHING
Selected in Irrigation & CAD Dept., Govt. of TG.

RANK 20 CE
Md. Azmatullah
MEGA MOCK TEST
Selected in Transport, R&B Dept., Govt. of TG.

AND MANY MORE..

500+ SELECTIONS CE : 434 | EE : 61 | ME : 20

55. Ans: (a; d)

Sol: $f(t) \xrightarrow[\text{coeff}]{\text{FS}} C_k$ with time period T_0

$$\underset{\alpha>1}{y(t) = f(\alpha t)} \xrightarrow[\text{Coeff}]{\text{F.S}} d_k$$

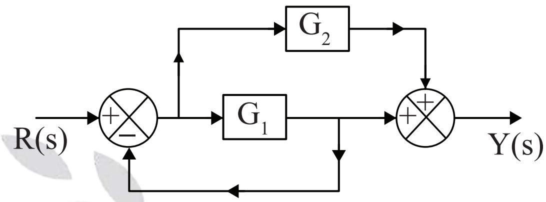
Time scaling $f(\alpha t) \rightarrow C_k$ with frequency changes from ω_0 to $\alpha\omega_0$

option (d) $f(\alpha t)$ has time period of $\frac{T_0}{\alpha}$ - - TRUE

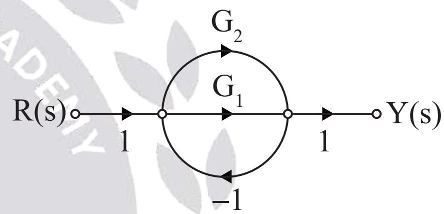
option (a) TRUE $C_k = d_k$ for all k

amplitudes of original & scaled periodic signals are same only the frequencies differs.

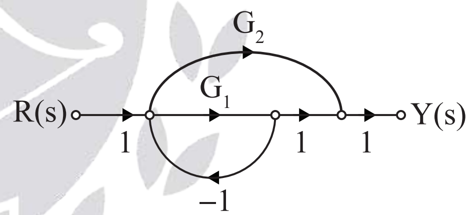
56. Consider a system represented by the block diagram shown below. Which of the following signal flow graphs represent(s) this system? Choose the correct option(s).



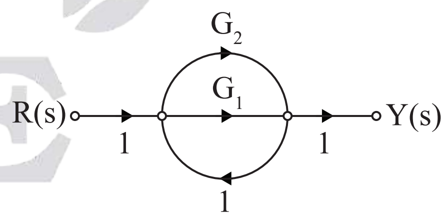
(a)



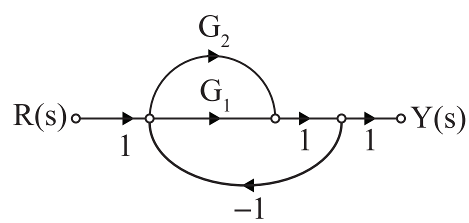
(b)



(c)



(d)



56. Ans: (b)

Sol: Using mason's gain formula, given block diagram

$$\text{Overall T.F} = \frac{Y(s)}{R(s)} = \frac{G_1 + G_2}{1 + G_1}$$

verify using options

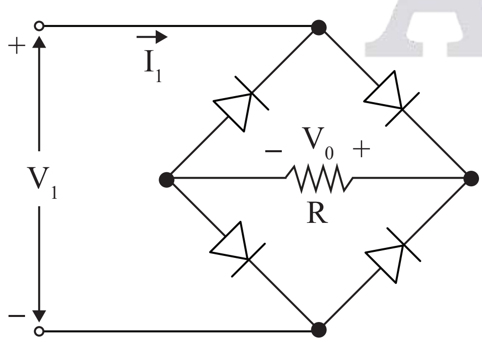
(a) $\frac{Y(s)}{R(s)} = \frac{G_1 + G_2}{1 + G_1 + G_2} \rightarrow$ wrong

(b) $\frac{Y(s)}{R(s)} = \frac{G_1 + G_2}{1 + G_1} \rightarrow$ correct

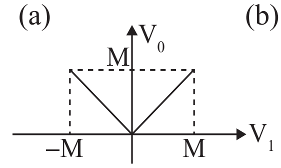
(c) $\frac{Y(s)}{R(s)} = \frac{G_1 + G_2}{1 - G_1 - G_2} \rightarrow$ wrong

(d) $\frac{Y(s)}{R(s)} = \frac{G_1 + G_2}{1 + G_1 + G_2} \rightarrow$ wrong

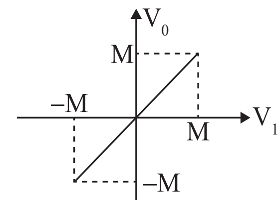
57. All the diodes in the circuit given below are ideal. Which of the following plots is/are correct when V_I (in Volts) is swept from –M to M ?



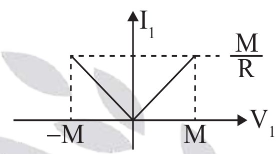
(a)



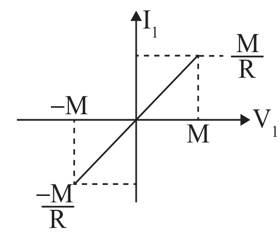
(b)



(c)



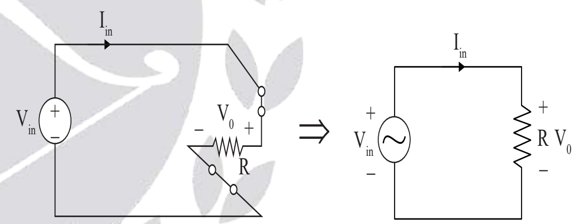
(d)



57. Ans: (a; d)

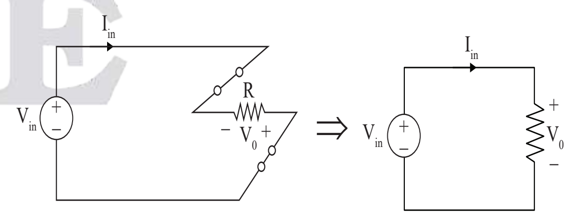
Sol: The circuit shown is a FWR

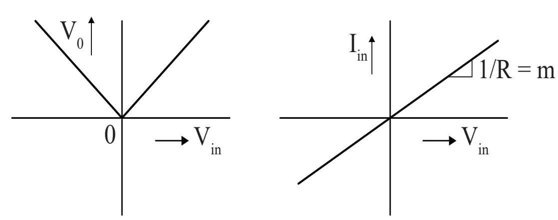
during positive cycle $V_0 = V_{in}$ $I_1 = \frac{V_{in}}{R}$



During negative cycle of $V_{in} \rightarrow V_0 = -V_{in}$

$I_{in} = \frac{V_{in}}{R}\left(y = mx, \text{ so here } m = \frac{1}{R}\right)$





58. Two fair dice (with faces labeled 1, 2, 3, 4, 5, and 6) are rolled. Let the random variable X denote the sum of the outcomes obtained.
The expectation of X is______ (rounded off to two decimal places).

58. Ans: 7.0(Range: 7.0 to 7.0)

Sol: $X = \{2, 3, 4, ---- 12\}$

x	2	3	4	5	6	7	8	9	10	11	12
P(x)	$\frac{1}{36}$	$\frac{2}{36}$	$\frac{3}{36}$	$\frac{4}{36}$	$\frac{5}{36}$	$\frac{6}{36}$	$\frac{5}{36}$	$\frac{4}{36}$	$\frac{3}{36}$	$\frac{2}{36}$	$\frac{1}{36}$

$$E(X) = \sum xP(x)$$
$$= \frac{1}{36}[2+6+12+20+30+42+40+36+30+22+12]$$
$$= \frac{252}{36} = 7$$

59. Consider the vectors $\mathbf{a} = \begin{bmatrix}1\\1\end{bmatrix}, \mathbf{b} = \begin{bmatrix}0\\3\sqrt{2}\end{bmatrix}$

For real-valued scalar variable x, the value of
$\min_x \|\mathbf{a}x - \mathbf{b}\|_2$
is ___________ (rounded off to two decimal places).
$\|\cdot\|_2$ denotes the Euclidean norm, i.e., for $\mathbf{y} = \begin{bmatrix}y_1\\y_2\end{bmatrix}$, $\|\mathbf{y}\|_2 = \sqrt{y_1^2 + y_2^2}$.

59. Ans: 3.0(Range: 3.0 to 3.0)

Sol: $\mathbf{a} = \begin{bmatrix}1\\1\end{bmatrix}, \mathbf{b} = \begin{bmatrix}0\\3\sqrt{2}\end{bmatrix}$

norm of $\|ax - b\|$ = Norm of $\begin{pmatrix}x\\x-3\sqrt{2}\end{pmatrix}$

$$= \sqrt{x^2 + (x-3\sqrt{2})^2}$$
$$= \sqrt{x^2 + x^2 - 6x\sqrt{2} + 18}$$
$$= \sqrt{2x^2 - 6x\sqrt{2} + 18}$$

Put $f(x) = 2x^2 - 6x\sqrt{2} + 18$
$f'(x) = 4x - 6\sqrt{2}$
$f''(x) = 4$
$f'(x) = 0 \Rightarrow 4x - 6\sqrt{2}$
$$\Rightarrow x = \frac{3\sqrt{2}}{2} \times \frac{\sqrt{2}}{\sqrt{2}} = \frac{3}{\sqrt{2}}$$
$$f''\left(\frac{3}{\sqrt{2}}\right) > 0$$
$x = \frac{3}{\sqrt{2}}$ is a point of minima

min value is $f\left(\frac{3}{2}\right) = \sqrt{2 \times \frac{9}{2} - 18 + 18} = 3$

60. X and Y are Bernoulli random variables taking values in $\{0, 1\}$. The joint probability mass function of the random variables is given by:
$P(X = 0, Y = 0) = 0.06$
$P(X = 0, Y = 1) = 0.14$
$P(X = 1, Y = 0) = 0.24$
$P(X = 1, Y = 1) = 0.56$
The mutual information I(X;Y) is __________ (rounded off to two decimal places).

60. Ans: 0.0(Range: 0.0 to 0.0)

Sol: $I[X:Y] = H[Y] - H\left[\frac{Y}{X}\right]$

$P[X, Y] \to$ joint pdf

X \ Y	0	1	
0	0.06	0.14	$\to P[X = 0] = 0.2$
1	0.24	0.56	$\to P[X = 1] = 0.8$
	$\downarrow$ $P[Y = 0] = 0.3$	$\downarrow$ $P[Y = 1] = 0.7$	

Hearty Congratulations to our students ESE - 2024

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Rohit Dhondge


AIR 1 E&T
Himanshu T

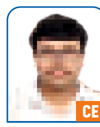

AIR 1 EE
Rajan Kumar


AIR 1 ME
Munish Kumar


AIR 2 CE
HARSHIT PANDEY


AIR 2 EE
SATYAM CHANDRAKANT


AIR 2 ME
RAJESH KASANIYA


AIR 3 CE
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AIR 3 EE
PRIYANSHU MUDGAL


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GOLLANGI SATEESH


AIR 4 CE
MADHAN KUMAR


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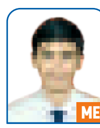
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AJINKYA DAGDU

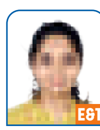

AIR 5 CE
AMAN PRATAP SINGH

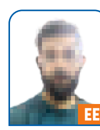

AIR 5 E&T
PARAG SAROHA


AIR 5 EE
MAYANK KUMAR S


AIR 5 ME
BANKURU NAVEEN


AIR 6 CE
SANCHIT GOEL


AIR 6 E&T
CHANDRIKA GADGIL


AIR 6 EE
RITVIK KOK


AIR 6 ME
CHANDAN JOSHI

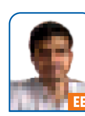

AIR 7 E&T
DEBARGHYA CH


AIR 7 EE
MANTHAN SHARMA


AIR 7 ME
DINESH KUMAR S


AIR 8 CE
ROHIT KUMAR


AIR 8 E&T
VIDHU SHREE


AIR 8 EE
MAYANK JAIMAN

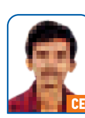

AIR 8 ME
SHAILENDRA SINGH


AIR 9 CE
ANKIT MEENA


AIR 9 E&T
T PIYUSH DAYANAND


AIR 9 EE
ANMOL SINGH


AIR 9 ME
KRISHNA KUMAR D


AIR 10 CE
RAJESH BADUGU


AIR 10 E&T
RAJVARDHAN SHARMA


AIR 10 ME
AKSHAY VIDHATE

TOTAL 36 SELECTIONS IN TOP 10

CE: 09 | ME: 10 | EE: 08 | E&T: 09

$$H[Y] = -[P(Y=0)\log_2 P(Y=0) + P(Y=1)\log_2 P(Y=1)]$$

$$H[Y] = -[0.3\log_2 P(0.3) + 0.7\log_2 P(0.7)]$$

$$H[Y] = -[0.3(-1.736) + 0.7(-0.5145)]$$

$$H[Y] = -[-0.520 - 0.3602)] = 0.881 \text{ (bits/symbol)}$$

$$P\left[\frac{Y}{X}\right] = \frac{P[XY]}{P[X]}$$

$P\left[\frac{Y}{X}\right]$ Conditional pdf

X \ Y	0	1
0	0.3	0.7
1	0.3	0.7

$$H\left[\frac{Y}{X}\right] = -[0.06\log_2(0.3) + 0.14\log_2(0.7) + 0.24\log_2(0.3) + 0.56\log_2(0.7)]$$

$$H\left[\frac{Y}{X}\right] = -[(0.3)(-1.7369) + (0.7)(-0.5145)]$$

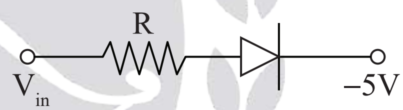
$$H\left[\frac{Y}{X}\right] = -[-0.52107 - 0.36015] = 0.88122$$

$$\therefore I[X:Y] = H[Y] - H\left[\frac{Y}{X}\right] = 0.881 - 0.88122 \simeq 0$$

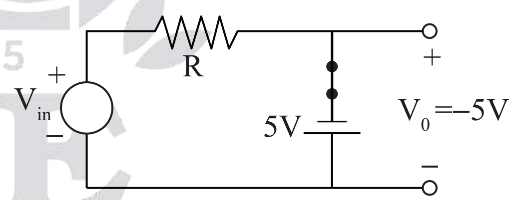
61. The diode in the circuit shown below is ideal. The input voltage (in Volts) is given by $V_I = 10\sin 100\pi t$, where time t is in seconds. The time duration (in ms, rounded off to two decimal places) for which the diode is forward biased during one period of the input is ___________.

61. Ans: 13.33 (Range: 13.32 to 13.34)

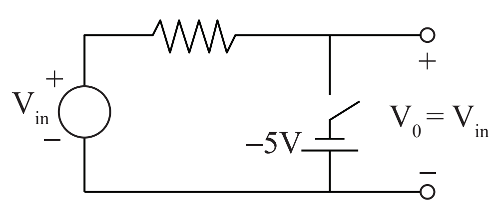
Sol:

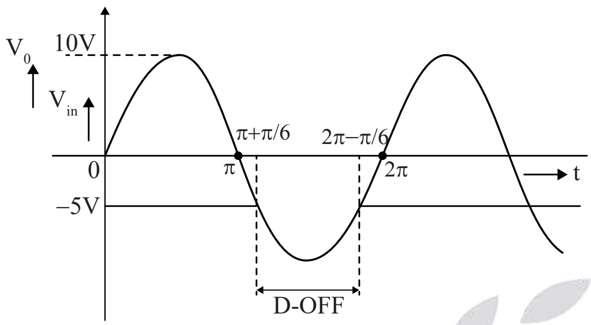


(1) $V_{in} > -5V$ (D-ON) and $V_0 = -5V$



(2) $V_{in} \le -5V$ (D-OFF) and $V_0 = V_{in}$





Given $V_{in} = V_m \sin\omega t = 10\sin 100\pi t$

$$\omega = \frac{2\pi}{T} = 100\pi \Rightarrow T = 0.02\,\text{sec}$$

Duration for diode OFF

$$= \left(2\pi - \frac{\pi}{6}\right) - \left(\pi + \frac{\pi}{6}\right) = \frac{2\pi}{3}$$

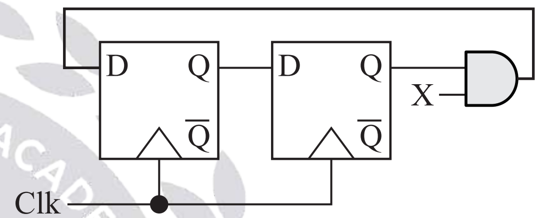
Duration for diode ON $= 2\pi - \dfrac{2\pi}{3} = \dfrac{4\pi}{3}$

Time for which the diode is ON

$$= \frac{4\pi/3}{2\pi} \times 0.02$$

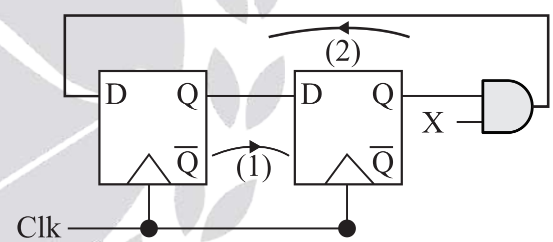
$$= \frac{2}{3} \times 0.02 = 13.3\text{ms}$$

62. In the circuit shown below, the AND gate has a propagation delay of 1 ns. The edge-triggered flip-flops have a set-up time of 2 ns, a hold-time of 0 ns, and a clock-to-Q delay of 2 ns.
The maximum clock frequency (in MHz, rounded off to the nearest integer) such that there are no setup violations is ________.



62. Ans: 200 (Range: 200 to 200)

Sol:



Path 1: $T_{min_1} = t_{ck\text{-}Q} + t_{su} = 2\text{ns} + 2\text{ns} = 4\text{ns}$

path 2: $T_{min_2} = t_{ck\text{-}Q} + t_{AND} + t_{su}$

$= 2\text{ns} + 1\text{ns} + 2\text{ns}$

$= 5\text{ns}$

The minimum clock period of entire circuit at which circuit works without fail is 5ns.

$T_{min} = 5\text{ns}$

$$f_{max} = \frac{1}{T_{min}} = \frac{1}{5\text{ns}} = 0.2\text{GHz}$$

$$= 200\text{MHz}$$

63. An ideal p-n junction germanium diode has a reverse saturation current of 10 μA at 300 K.
The voltage (in Volts, rounded off to two decimal places) to be applied across the junction to get a forward bias current of 100 mA at 300 K is _____.
(Consider the Boltzmann constant $k_B = 1.38\times10^{-23}$ J/K and the charge of an electron $e = 1.6\times10^{-19}$ C.

63. Ans: 0.24 (Range: 0.23 to 0.24)

Sol: Given ideal pn junction Ge diode.
$I_0 = 10\mu A$ at $T = 300^oK$
Need to find V_D to get $I_D = 100mA$ under forward bias

Since $I_D = I_0 \exp\left(\frac{V_D}{\eta V_T}\right) = 100m$

$$\Rightarrow V_D = \eta V_T \log_e\left|\frac{100m}{10\mu}\right|$$

$$= 1 \times 0.026 \times \log_e|10000|$$
$$= 0.24V$$

64. A 50 Ω lossless transmission line is terminated with a load Z_L of (50 – j75) Ω.
If the average incident power on the line is 10 mW, then the average power delivered to the load (in mW, rounded off to one decimal place) is ___________.

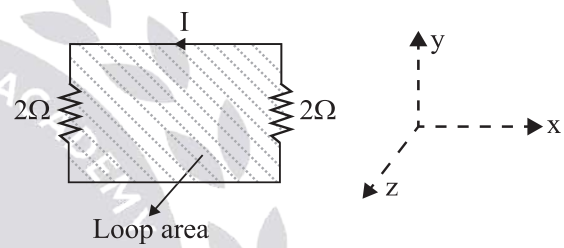
64. Ans: 6.4 (Range: 6.3 to 6.5)

Sol: $\Gamma_L = \frac{50-j75-50}{50-j75+50} = \frac{-j75}{100-j75} = \frac{-j3}{4-3j}$

$$|\Gamma_L| = \frac{3}{\sqrt{4^2+3^2}} = \frac{3}{5}$$

$$P_0 = 10m \times [1 - |\Gamma_L|^2]$$
$$= 10m \times \left[1 - \frac{9}{25}\right]$$
$$= 10m \times 0.64 = 6.4 \times 10^{-3}$$
$P_0 = 6.4mW$

65. Two resistors are connected in a circuit loop of area 5 m², as shown in the figure below. The circuit loop is placed on the x-y plane.
When a time-varying magnetic flux, with flux-density B(t) = 0.5t (in Tesla), is applied along the positive z-axis, the magnitude of current I (in Amperes, rounded off to two decimal places) in the loop is ________.



65. Ans: 0.625 (Range: 0.62 to 0.63)

Sol: $V = -\frac{d\psi}{dt} = -\frac{d}{dt}(BA)$

$$= -\frac{d}{dt}(0.5t \times 5) = -2.5V$$
$|V| = 2.5V$
$$I = \frac{V}{R} = \frac{2.5}{4} = 0.625A$$