General Aptitude (GA)

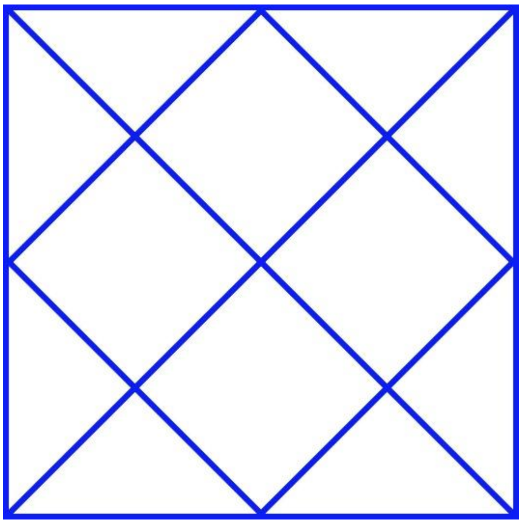
Q.1 – Q.5 Carry ONE mark Each

Q.1	"I cannot support this proposal. My ________ will not permit it."
(A)	conscious
(B)	consensus
(C)	conscience
(D)	consent

Q.2	Courts : ________ : : Parliament : Legislature (By word meaning)
(A)	Judiciary
(B)	Executive
(C)	Governmental
(D)	Legal

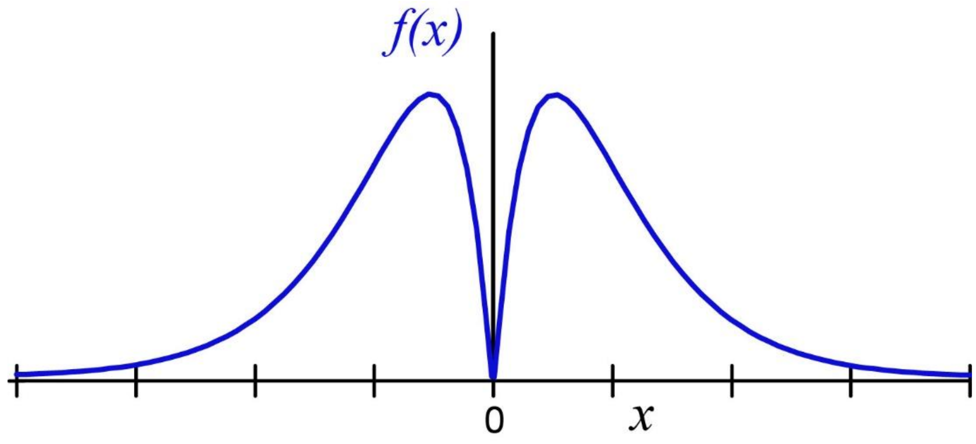
Q.3	What is the smallest number with distinct digits whose digits add up to 45?
(A)	123555789
(B)	123457869
(C)	123456789
(D)	99999

Q.4	In a class of 100 students, (i) there are 30 students who neither like romantic movies nor comedy movies, (ii) the number of students who like romantic movies is twice the number of students who like comedy movies, and (iii) the number of students who like both romantic movies and comedy movies is 20. How many students in the class like romantic movies?
(A)	40
(B)	20
(C)	60
(D)	30

Q.5	How many rectangles are present in the given figure?
	
(A)	8
(B)	9
(C)	10
(D)	12

Q.6 – Q.10 Carry TWO marks Each

Q.6	Forestland is a planet inhabited by different kinds of creatures. Among other creatures, it is populated by animals all of whom are ferocious. There are also creatures that have claws, and some that do not. All creatures that have claws are ferocious. Based only on the information provided above, which one of the following options can be logically inferred with *certainty*?
(A)	All creatures with claws are animals.
(B)	Some creatures with claws are non-ferocious.
(C)	Some non-ferocious creatures have claws.
(D)	Some ferocious creatures are creatures with claws.

Q.7	Which one of the following options represents the given graph?
	
(A)	$f(x) = x^2 2^{-\|x\|}$
(B)	$f(x) = x\, 2^{-\|x\|}$
(C)	$f(x) = \|x\| 2^{-x}$
(D)	$f(x) = x\, 2^{-x}$

Q.8	Which one of the following options can be inferred from the given passage alone? When I was a kid, I was partial to stories about other worlds and interplanetary travel. I used to imagine that I could just gaze off into space and be whisked to another planet. [Excerpt from *The Truth about Stories* by T. King]
(A)	It is a child's description of what he or she likes.
(B)	It is an adult's memory of what he or she liked as a child.
(C)	The child in the passage read stories about interplanetary travel only in parts.
(D)	It teaches us that stories are good for children.

Q.9	Out of 1000 individuals in a town, 100 unidentified individuals are covid positive. Due to lack of adequate covid-testing kits, the health authorities of the town devised a strategy to identify these covid-positive individuals. The strategy is to: (i) Collect saliva samples from all 1000 individuals and randomly group them into sets of 5. (ii) Mix the samples within each set and test the mixed sample for covid. (iii) If the test done in (ii) gives a negative result, then declare all the 5 individuals to be covid negative. (iv) If the test done in (ii) gives a positive result, then all the 5 individuals are separately tested for covid. Given this strategy, no more than _______ testing kits will be required to identify all the 100 covid positive individuals irrespective of how they are grouped.
(A)	700
(B)	600
(C)	800
(D)	1000

Q.10	A 100 cm $\times$ 32 cm rectangular sheet is folded 5 times. Each time the sheet is folded, the long edge aligns with its opposite side. Eventually, the folded sheet is a rectangle of dimensions 100 cm $\times$ 1 cm. The total number of creases visible when the sheet is unfolded is ________.
(A)	32
(B)	5
(C)	31
(D)	63

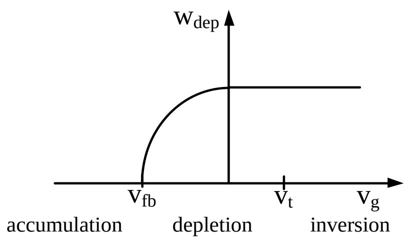
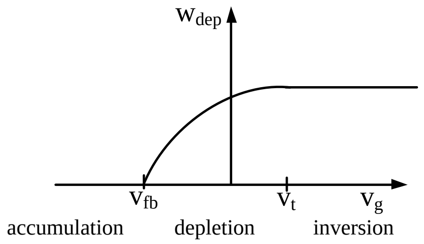
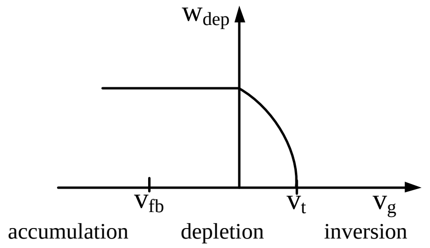
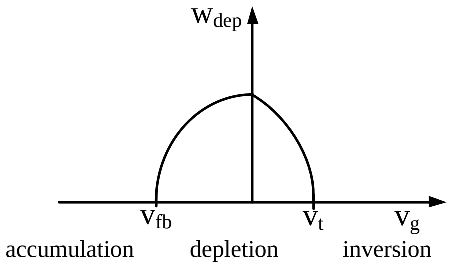
Q.11 – Q.35 Carry ONE mark Each

Q.11	Let $\boldsymbol{v_1} = \begin{bmatrix}1\\2\\0\end{bmatrix}$ and $\boldsymbol{v_2} = \begin{bmatrix}2\\1\\3\end{bmatrix}$ be two vectors. The value of the coefficient α in the expression $\boldsymbol{v_1} = \alpha\boldsymbol{v_2} + \boldsymbol{e}$, which minimizes the length of the error vector $\boldsymbol{e}$, is
(A)	$\frac{7}{2}$
(B)	$\frac{-2}{7}$
(C)	$\frac{2}{7}$
(D)	$\frac{-7}{2}$
Q.12	The rate of increase, of a scalar field $f(x, y, z) = xyz$, in the direction $\boldsymbol{v} = (2,1,2)$ at a point $(0,2,1)$ is
(A)	$\frac{2}{3}$
(B)	$\frac{4}{3}$
(C)	2
(D)	4

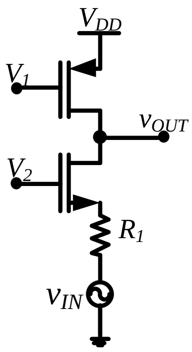
Q.13	Let $w^4 = 16j$. Which of the following cannot be a value of w?
(A)	$2e^{\frac{j2\pi}{8}}$
(B)	$2e^{\frac{j\pi}{8}}$
(C)	$2e^{\frac{j5\pi}{8}}$
(D)	$2e^{\frac{j9\pi}{8}}$
Q.14	The value of the contour integral, $\oint_C \left(\frac{z+2}{z^2+2z+2}\right) dz$, where the contour C is $\left\{z: \left\|z + 1 - \frac{3}{2}j\right\| = 1\right\}$, taken in the counter clockwise direction, is
(A)	$-\pi(1 + j)$
(B)	$\pi(1 + j)$
(C)	$\pi(1 - j)$
(D)	$-\pi(1 - j)$

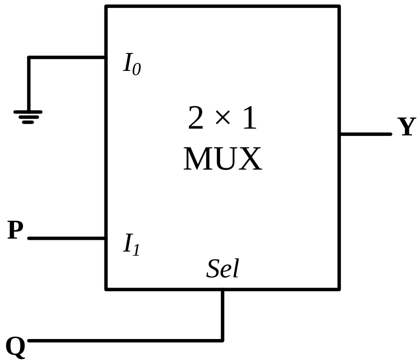
Q.15	Let the sets of eigenvalues and eigenvectors of a matrix B be $\{\lambda_k \mid 1 \leq k \leq n\}$ and $\{\boldsymbol{v}_k \mid 1 \leq k \leq n\}$, respectively. For any invertible matrix P, the sets of eigenvalues and eigenvectors of the matrix A, where $B = P^{-1}AP$, respectively, are
(A)	$\{\lambda_k \det(A) \mid 1 \leq k \leq n\}$ and $\{P\boldsymbol{v}_k \mid 1 \leq k \leq n\}$
(B)	$\{\lambda_k \mid 1 \leq k \leq n\}$ and $\{\boldsymbol{v}_k \mid 1 \leq k \leq n\}$
(C)	$\{\lambda_k \mid 1 \leq k \leq n\}$ and $\{P\boldsymbol{v}_k \mid 1 \leq k \leq n\}$
(D)	$\{\lambda_k \mid 1 \leq k \leq n\}$ and $\{P^{-1}\boldsymbol{v}_k \mid 1 \leq k \leq n\}$
Q.16	In a semiconductor, if the Fermi energy level lies in the conduction band, then the semiconductor is known as
(A)	degenerate n-type.
(B)	degenerate p-type.
(C)	non-degenerate n-type.
(D)	non-degenerate p-type.

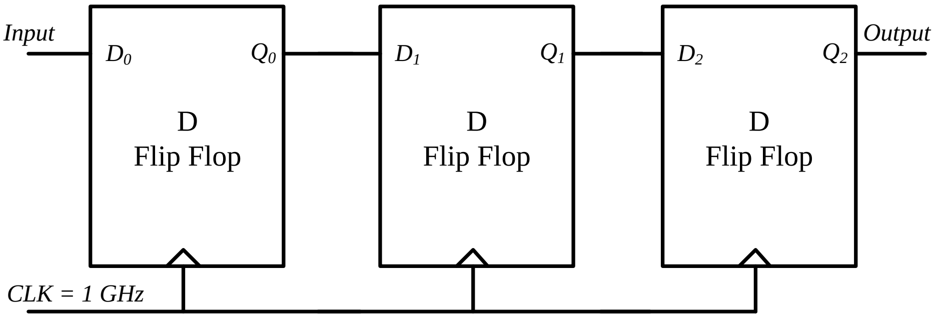
Q.17	For an intrinsic semiconductor at temperature $T = 0\ K$, which of the following statement is true?
(A)	All energy states in the valence band are filled with electrons and all energy states in the conduction band are empty of electrons.
(B)	All energy states in the valence band are empty of electrons and all energy states in the conduction band are filled with electrons.
(C)	All energy states in the valence and conduction band are filled with holes.
(D)	All energy states in the valence and conduction band are filled with electrons.
Q.18	A series RLC circuit has a quality factor Q of 1000 at a center frequency of 10^6 rad/s. The possible values of R, L and C are
(A)	$R = 1\ \Omega, L = 1\ \mu H$ and $C = 1\ \mu F$
(B)	$R = 0.1\ \Omega, L = 1\ \mu H$ and $C = 1\ \mu F$
(C)	$R = 0.01\ \Omega, L = 1\ \mu H$ and $C = 1\ \mu F$
(D)	$R = 0.001\ \Omega, L = 1\ \mu H$ and $C = 1\ \mu F$

Q.19	For a MOS capacitor, V_{fb} and V_t are the flat-band voltage and the threshold voltage, respectively. The variation of the depletion width (W_{dep}) for varying gate voltage (V_g) is best represented by
(A)	
(B)	
(C)	
(D)	

Q.20	Consider a narrow band signal, propagating in a lossless dielectric medium ($\varepsilon_r = 4, \mu_r = 1$), with phase velocity v_p and group velocity v_g. Which of the following statement is true? (c is the velocity of light in vacuum.)
(A)	$v_p > c, v_g > c$
(B)	$v_p < c, v_g > c$
(C)	$v_p > c, v_g < c$
(D)	$v_p < c, v_g < c$

Q.21	In the circuit shown below, V_1 and V_2 are bias voltages. Based on input and output impedances, the circuit behaves as a
	
(A)	voltage controlled voltage source.
(B)	voltage controlled current source.
(C)	current controlled voltage source.
(D)	current controlled current source.
Q.22	A cascade of common-source amplifiers in a unity gain feedback configuration oscillates when
(A)	the closed loop gain is less than 1 and the phase shift is less than 180°.
(B)	the closed loop gain is greater than 1 and the phase shift is less than 180°.
(C)	the closed loop gain is less than 1 and the phase shift is greater than 180°.
(D)	the closed loop gain is greater than 1 and the phase shift is greater than 180°.

Q.23	In the circuit shown below, P and Q are the inputs. The logical function realized by the circuit shown below is
	
(A)	$Y = PQ$
(B)	$Y = P + Q$
(C)	$Y = \overline{PQ}$
(D)	$Y = \overline{P + Q}$

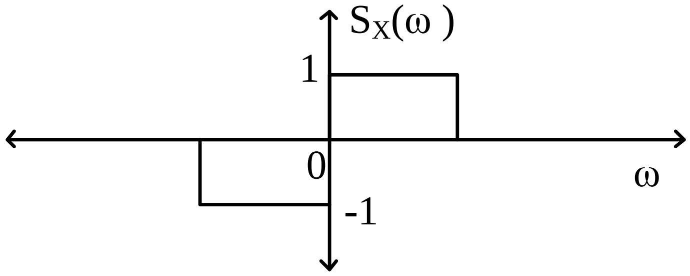
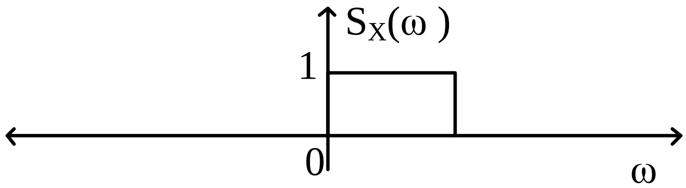
Q.24	The synchronous sequential circuit shown below works at a clock frequency of 1 GHz. The throughput, in Mbits/s, and the latency, in ns, respectively, are
	
(A)	1000, 3
(B)	333.33, 1
(C)	2000, 3
(D)	333.33, 3

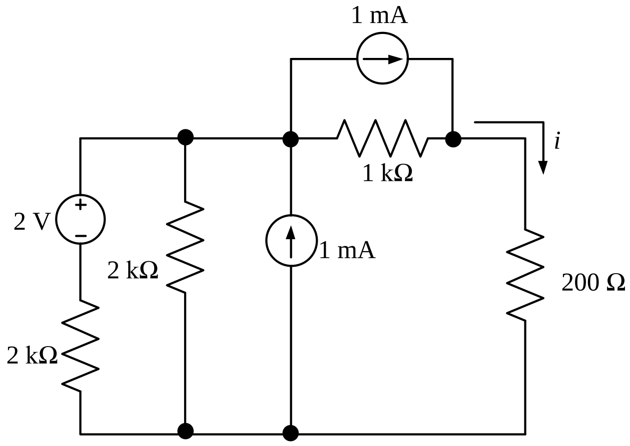
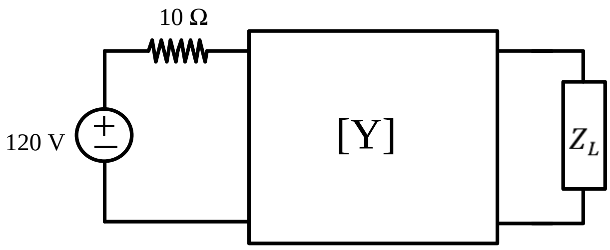
Q.25	The open loop transfer function of a unity negative feedback system is $G(s) = \frac{k}{s(1+sT_1)(1+sT_2)}$, where k, T_1 and T_2 are positive constants. The phase cross-over frequency, in rad/s, is
(A)	$\frac{1}{\sqrt{T_1 T_2}}$
(B)	$\frac{1}{T_1 T_2}$
(C)	$\frac{1}{T_1\sqrt{T_2}}$
(D)	$\frac{1}{T_2\sqrt{T_1}}$
Q.26	Consider a system with input $x(t)$ and output $y(t) = x(e^t)$. The system is
(A)	Causal and time invariant.
(B)	Non-causal and time varying.
(C)	Causal and time varying.
(D)	Non-causal and time invariant.

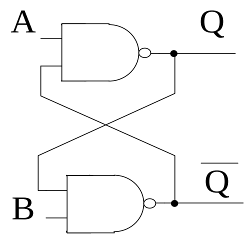
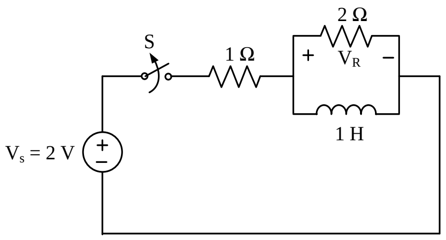
Q.27	Let $m(t)$ be a strictly band-limited signal with bandwidth B and energy E. Assuming $\omega_0 = 10B$, the energy in the signal $m(t)\cos\omega_0 t$ is
(A)	$\frac{E}{4}$
(B)	$\frac{E}{2}$
(C)	E
(D)	$2E$
Q.28	The Fourier transform $X(\omega)$ of $x(t) = e^{-t^2}$ is
	Note: $\int_{-\infty}^{\infty} e^{-y^2} dy = \sqrt{\pi}$
(A)	$\sqrt{\pi}\, e^{\frac{\omega^2}{2}}$
(B)	$\frac{e^{-\frac{\omega^2}{4}}}{2\sqrt{\pi}}$
(C)	$\sqrt{\pi}\, e^{-\frac{\omega^2}{4}}$
(D)	$\sqrt{\pi}\, e^{-\frac{\omega^2}{2}}$

Q.29	In the table shown below, match the signal type with its spectral characteristics.
(A)	$(i) \rightarrow (a), (ii) \rightarrow (b), (iii) \rightarrow (c), (iv) \rightarrow (d)$
(B)	$(i) \rightarrow (a), (ii) \rightarrow (c), (iii) \rightarrow (b), (iv) \rightarrow (d)$
(C)	$(i) \rightarrow (d), (ii) \rightarrow (b), (iii) \rightarrow (c), (iv) \rightarrow (a)$
(D)	$(i) \rightarrow (a), (ii) \rightarrow (c), (iii) \rightarrow (d), (iv) \rightarrow (b)$

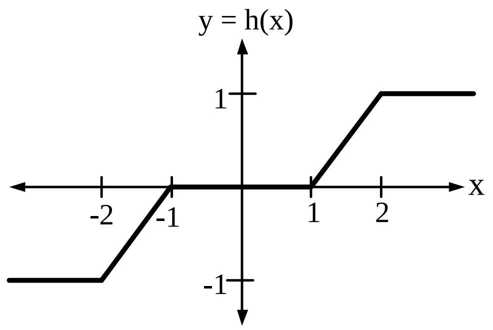
Signal type	Spectral characteristics
(i) Continuous, aperiodic	(a) Continuous, aperiodic
(ii) Continuous, periodic	(b) Continuous, periodic
(iii) Discrete, aperiodic	(c) Discrete, aperiodic
(iv) Discrete, periodic	(d) Discrete, periodic

Q.30	For a real signal, which of the following is/are valid power spectral density/densities?
(A)	$S_X(\omega) = \dfrac{2}{9+\omega^2}$
(B)	$S_X(\omega) = e^{-\omega^2}\cos^2\omega$
(C)	
(D)	
Q.31	The signal-to-noise ratio (SNR) of an ADC with a full-scale sinusoidal input is given to be 61.96 dB. The resolution of the ADC is ________ bits (*rounded off to the nearest integer*).

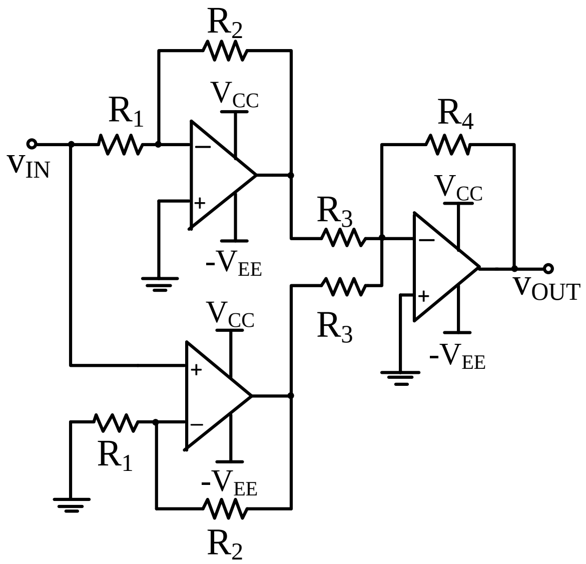
Q.32	In the circuit shown below, the current i flowing through 200 Ω resistor is _______ mA (*rounded off to two decimal places*). 
Q.33	For the two port network shown below, the [Y]-parameters is given as $$[Y] = \frac{1}{100}\begin{bmatrix} 2 & -1 \\ -1 & 4/3 \end{bmatrix} S$$ The value of load impedance Z_L, in Ω, for maximum power transfer will be ________ (*rounded off to the nearest integer*).
	

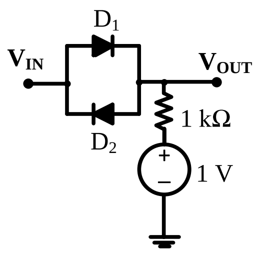
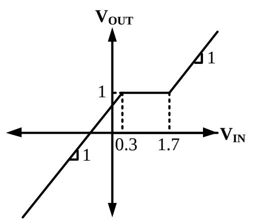
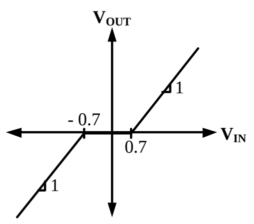
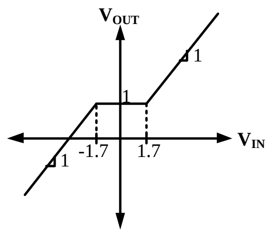
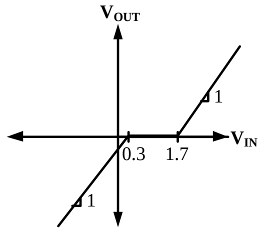
Q.34	For the circuit shown below, the propagation delay of each NAND gate is 1 ns. The critical path delay, in ns, is ________ (*rounded off to the nearest integer*).
	
Q.35	In the circuit shown below, switch S was closed for a long time. If the switch is opened at $t = 0$, the maximum magnitude of the voltage V_R, in volts, is ________ (*rounded off to the nearest integer*). 

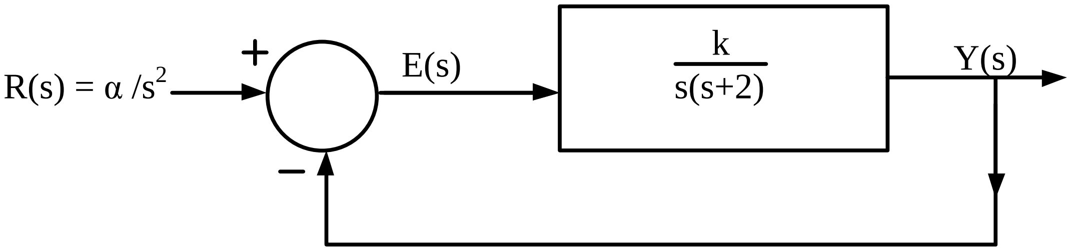
Q.36 – Q.65 Carry TWO marks Each

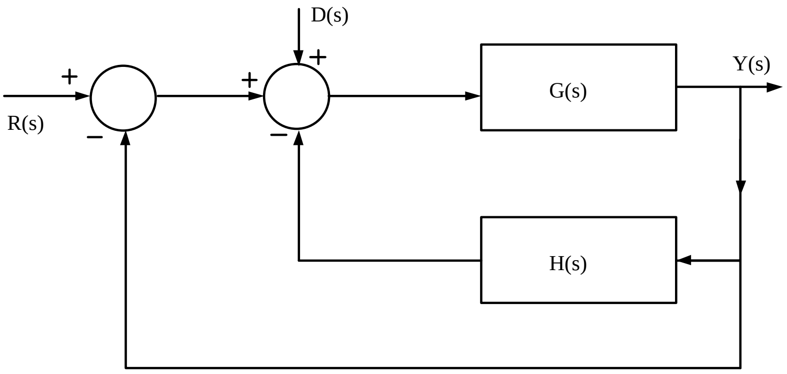
Q.36	A random variable X, distributed normally as $N(0,1)$, undergoes the transformation $\mathrm{Y} = \mathrm{h}(\mathrm{X})$, given in the figure. The form of the probability density function of Y is (In the options given below, a, b, c are non-zero constants and $g(y)$ is piece-wise continuous function)
	
(A)	$a\delta(y-1) + b\delta(y+1) + g(y)$
(B)	$a\delta(y+1) + b\delta(y) + c\delta(y-1) + g(y)$
(C)	$a\delta(y+2) + b\delta(y) + c\delta(y-2) + g(y)$
(D)	$a\delta(y+2) + b\delta(y-2) + g(y)$

Q.37	The value of the line integral $\int_P^Q (z^2\,dx + 3y^2\,dy + 2xz\,dz)$ along the straight line joining the points P (1,1,2) and Q (2,3,1) is
(A)	20
(B)	24
(C)	29
(D)	-5
Q.38	Let $\boldsymbol{x}$ be an $n \times 1$ real column vector with length $l = \sqrt{\boldsymbol{x}^T\boldsymbol{x}}$. The trace of the matrix $P = \boldsymbol{x}\boldsymbol{x}^T$ is
(A)	l^2
(B)	$\frac{l^2}{4}$
(C)	l
(D)	$\frac{l^2}{2}$

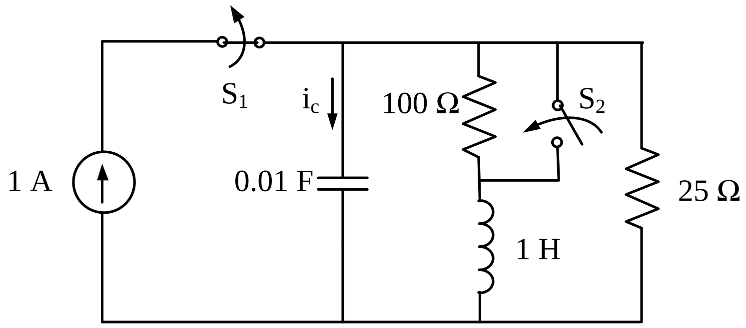
Q.39	The $\frac{V_{OUT}}{V_{IN}}$ of the circuit shown below is
	
(A)	$-\frac{R_4}{R_3}$
(B)	$\frac{R_4}{R_3}$
(C)	$1+\frac{R_4}{R_3}$
(D)	$1-\frac{R_4}{R_3}$

Q.40	In the circuit shown below, D_1 and D_2 are silicon diodes with cut-in voltage of 0.7 V. V_{IN} and V_{OUT} are input and output voltages in volts. The transfer characteristic is
	
(A)	
(B)	
(C)	
(D)	

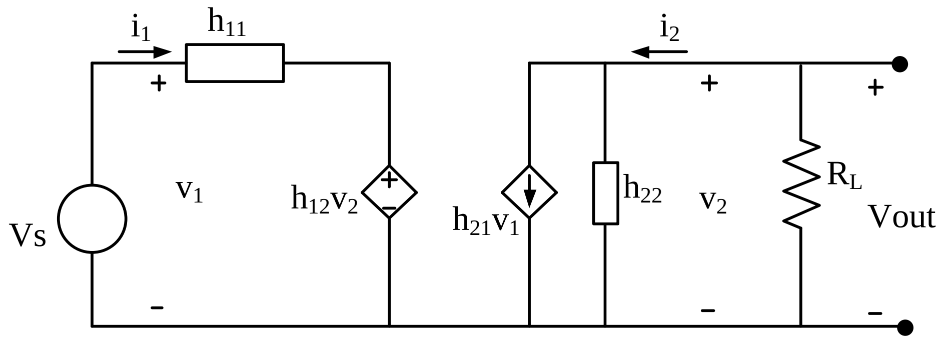
Q.41	A closed loop system is shown in the figure where $k > 0$ and $\alpha > 0$. The steady state error due to a ramp input $(R(s) = \alpha/s^2)$ is given by
	
(A)	$\frac{2\alpha}{k}$
(B)	$\frac{\alpha}{k}$
(C)	$\frac{\alpha}{2k}$
(D)	$\frac{\alpha}{4k}$

Q.42	In the following block diagram, R(s) and D(s) are two inputs. The output Y(s) is expressed as $Y(s) = G_1(s)R(s) + G_2(s)D(s)$. $G_1(s)$ and $G_2(s)$ are given by
	
(A)	$G_1(s) = \dfrac{G(s)}{1 + G(s) + G(s)H(s)}$ and $G_2(s) = \dfrac{G(s)}{1 + G(s) + G(s)H(s)}$
(B)	$G_1(s) = \dfrac{G(s)}{1 + G(s) + H(s)}$ and $G_2(s) = \dfrac{G(s)}{1 + G(s) + H(s)}$
(C)	$G_1(s) = \dfrac{G(s)}{1 + G(s) + H(s)}$ and $G_2(s) = \dfrac{G(s)}{1 + G(s) + G(s)H(s)}$
(D)	$G_1(s) = \dfrac{G(s)}{1 + G(s) + G(s)H(s)}$ and $G_2(s) = \dfrac{G(s)}{1 + G(s) + H(s)}$

Q.43	The state equation of a second order system is $\dot{\boldsymbol{x}}(t) = \mathrm{A}\boldsymbol{x}(t), \quad \boldsymbol{x}(0)$ is the initial condition. Suppose λ_1 and λ_2 are two distinct eigenvalues of A and $\boldsymbol{v}_1$ and $\boldsymbol{v}_2$ are the corresponding eigenvectors. For constants α_1 and α_2, the solution, $\boldsymbol{x}(t)$, of the state equation is
(A)	$\sum_{i=1}^{2} \alpha_i e^{\lambda_i t} \boldsymbol{v}_i$
(B)	$\sum_{i=1}^{2} \alpha_i e^{2\lambda_i t} \boldsymbol{v}_i$
(C)	$\sum_{i=1}^{2} \alpha_i e^{3\lambda_i t} \boldsymbol{v}_i$
(D)	$\sum_{i=1}^{2} \alpha_i e^{4\lambda_i t} \boldsymbol{v}_i$

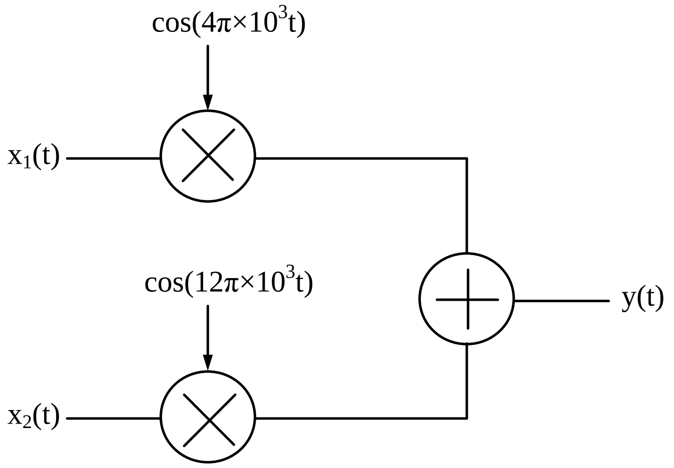
Q.44	The switch S_1 was closed and S_2 was open for a long time. At $t = 0$, switch S_1 is opened and S_2 is closed, simultaneously. The value of $i_c(0^+)$, in amperes, is
	
(A)	1
(B)	-1
(C)	0.2
(D)	0.8

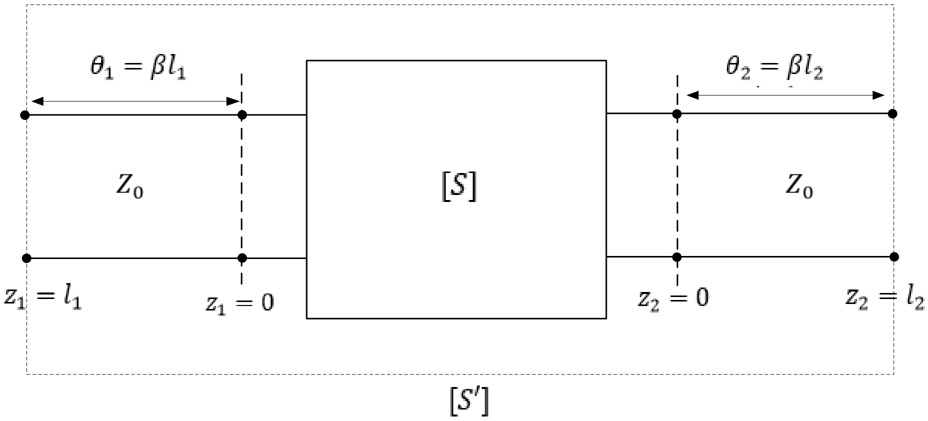
Q.45	Let a frequency modulated (FM) signal $x(t) = A\cos(\omega_c t + k_f \int_{-\infty}^{t} m(\lambda)d\lambda)$, where $m(t)$ is a message signal of bandwidth W. It is passed through a non-linear system with output $y(t) = 2x(t) + 5(x(t))^2$. Let B_T denote the FM bandwidth. The minimum value of ω_c required to recover $x(t)$ from $y(t)$ is
(A)	$B_T + W$
(B)	$\frac{3}{2}B_T$
(C)	$2B_T + W$
(D)	$\frac{5}{2}B_T$

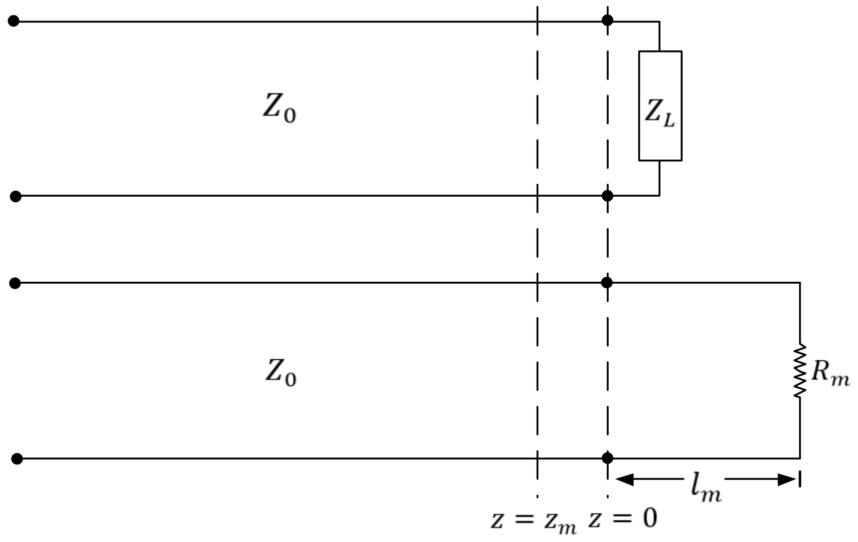
Q.46	The h-parameters of a two port network are shown below. The condition for the maximum small signal voltage gain $\frac{V_{out}}{V_s}$ is 
(A)	$h_{11} = 0, h_{12} = 0, h_{21} =$ very high and $h_{22} = 0$
(B)	$h_{11} =$ very high, $h_{12} = 0, h_{21} =$ very high and $h_{22} = 0$
(C)	$h_{11} = 0, h_{12} =$ very high, $h_{21} =$ very high and $h_{22} = 0$
(D)	$h_{11} = 0, h_{12} = 0, h_{21} =$ very high and $h_{22} =$ very high

Q.47	Consider a discrete-time periodic signal with period $N = 5$. Let the discrete-time Fourier series (DTFS) representation be $x[n] = \sum_{k=0}^{4} a_k e^{\frac{jk2\pi n}{5}}$, where $a_0 = 1, a_1 = 3j, a_2 = 2j, a_3 = -2j$ and $a_4 = -3j$. The value of the sum $\sum_{n=0}^{4} x[n] \sin \frac{4\pi n}{5}$ is
(A)	-10
(B)	10
(C)	-2
(D)	2
Q.48	Let an input $x[n]$ having discrete time Fourier transform $X(e^{j\Omega}) = 1 - e^{-j\Omega} + 2e^{-3j\Omega}$ be passed through an LTI system. The frequency response of the LTI system is $H(e^{j\Omega}) = 1 - \frac{1}{2}e^{-j2\Omega}$. The output $y[n]$ of the system is
(A)	$\delta[n] + \delta[n-1] - \frac{1}{2}\delta[n-2] - \frac{5}{2}\delta[n-3] + \delta[n-5]$
(B)	$\delta[n] - \delta[n-1] - \frac{1}{2}\delta[n-2] - \frac{5}{2}\delta[n-3] + \delta[n-5]$
(C)	$\delta[n] - \delta[n-1] - \frac{1}{2}\delta[n-2] + \frac{5}{2}\delta[n-3] - \delta[n-5]$
(D)	$\delta[n] + \delta[n-1] + \frac{1}{2}\delta[n-2] + \frac{5}{2}\delta[n-3] + \delta[n-5]$

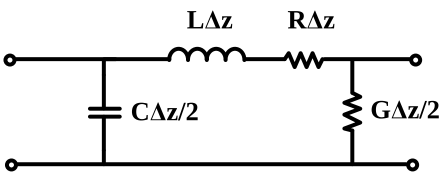
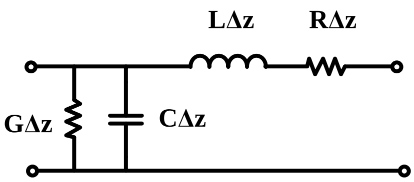
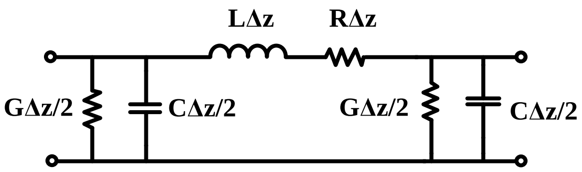
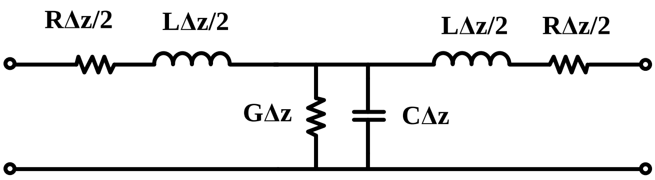
Q.49	Let $x(t) = 10\cos(10.5Wt)$ be passed through an LTI system having impulse response $h(t) = \pi\left(\frac{\sin Wt}{\pi t}\right)^2 \cos 10Wt$. The output of the system is
(A)	$\left(\frac{15W}{4}\right)\cos(10.5Wt)$
(B)	$\left(\frac{15W}{2}\right)\cos(10.5Wt)$
(C)	$\left(\frac{15W}{8}\right)\cos(10.5Wt)$
(D)	$(15W)\cos(10.5Wt)$

Q.50	Let $x_1(t)$ and $x_2(t)$ be two band-limited signals having bandwidth $B = 4\pi \times 10^3$ rad/s each. In the figure below, the Nyquist sampling frequency, in rad/s, required to sample $y(t)$, is
	
(A)	$20\pi \times 10^3$
(B)	$40\pi \times 10^3$
(C)	$8\pi \times 10^3$
(D)	$32\pi \times 10^3$

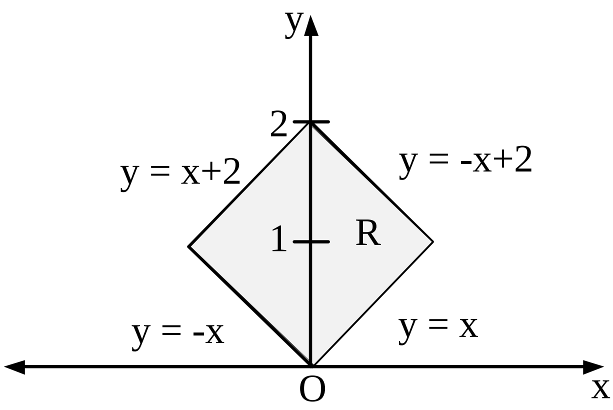
Q.51	The S-parameters of a two port network is given as $$[S] = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$$ with reference to Z_0. Two lossless transmission line sections of electrical lengths $\theta_1 = \beta l_1$ and $\theta_2 = \beta l_2$ are added to the input and output ports for measurement purposes, respectively. The S-parameters $[S']$ of the resultant two port network is
	
(A)	$\begin{bmatrix} S_{11}e^{-j2\theta_1} & S_{12}e^{-j(\theta_1+\theta_2)} \\ S_{21}e^{-j(\theta_1+\theta_2)} & S_{22}e^{-j2\theta_2} \end{bmatrix}$
(B)	$\begin{bmatrix} S_{11}e^{j2\theta_1} & S_{12}e^{-j(\theta_1+\theta_2)} \\ S_{21}e^{-j(\theta_1+\theta_2)} & S_{22}e^{j2\theta_2} \end{bmatrix}$
(C)	$\begin{bmatrix} S_{11}e^{j2\theta_1} & S_{12}e^{j(\theta_1+\theta_2)} \\ S_{21}e^{j(\theta_1+\theta_2)} & S_{22}e^{j2\theta_2} \end{bmatrix}$
(D)	$\begin{bmatrix} S_{11}e^{-j2\theta_1} & S_{12}e^{j(\theta_1+\theta_2)} \\ S_{21}e^{j(\theta_1+\theta_2)} & S_{22}e^{-j2\theta_2} \end{bmatrix}$

Q.52	The standing wave ratio on a 50 Ω lossless transmission line terminated in an unknown load impedance is found to be 2.0. The distance between successive voltage minima is 30 cm and the first minimum is located at 10 cm from the load. Z_L can be replaced by an equivalent length l_m and terminating resistance R_m of the same line. The value of R_m and l_m, respectively, are
	
(A)	R_m=100 Ω, l_m= 20 cm
(B)	R_m= 25 Ω, l_m= 20 cm
(C)	R_m=100 Ω, l_m= 5 cm
(D)	R_m= 25 Ω, l_m= 5 cm

Q.53	The electric field of a plane electromagnetic wave is $\boldsymbol{E} = \boldsymbol{a}_x C_{1x} \cos(\omega t - \beta z) + \boldsymbol{a}_y C_{1y} \cos(\omega t - \beta z + \theta)$ V/m. Which of the following combination(s) will give rise to a left handed elliptically polarized (LHEP) wave?
(A)	$C_{1x} = 1, C_{1y} = 1, \theta = \pi/4$
(B)	$C_{1x} = 2, C_{1y} = 1, \theta = \pi/2$
(C)	$C_{1x} = 1, C_{1y} = 2, \theta = 3\pi/2$
(D)	$C_{1x} = 2, C_{1y} = 1, \theta = 3\pi/4$

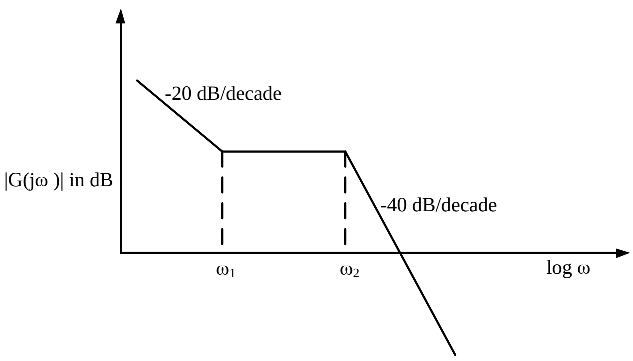
Q.54	The following circuit(s) representing a lumped element equivalent of an infinitesimal section of a transmission line is/are
(A)	
(B)	
(C)	
(D)	

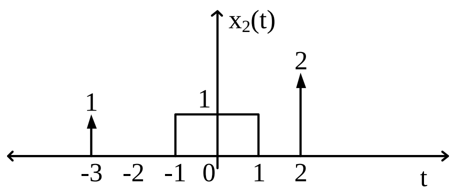
Q.55 The value of the integral $\iint_R xy\,dx\,dy$ over the region R, given in the figure, is ________ (*rounded off to the nearest integer*).



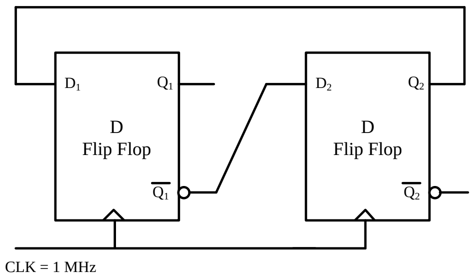
Q.56 In an extrinsic semiconductor, the hole concentration is given to be $1.5n_i$ where n_i is the intrinsic carrier concentration of $1 \times 10^{10}\ cm^{-3}$. The ratio of electron to hole mobility for equal hole and electron drift current is given as ___________ (*rounded off to two decimal places*).

Q.57 The asymptotic magnitude Bode plot of a minimum phase system is shown in the figure. The transfer function of the system is $(s) = \frac{k(s+z)^a}{s^b(s+p)^c}$, where k, z, p, a, b and c are positive constants. The value of $(a + b + c)$ is ___________(*rounded off to the nearest integer*).

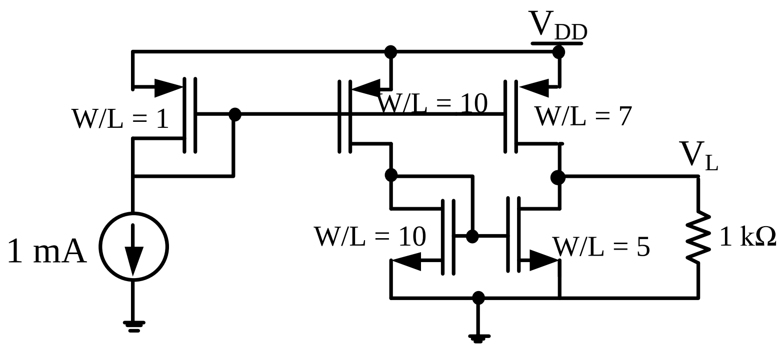


Q.58	Let $x_1(t) = u(t + 1.5) - u(t - 1.5)$ and $x_2(t)$ is shown in the figure below. For $y(t) = x_1(t) * x_2(t)$, the $\int_{-\infty}^{\infty} y(t)dt$ is ______________________(*rounded off to the nearest integer*).
	
Q.59	Let $X(t)$ be a white Gaussian noise with power spectral density $\frac{1}{2}$ W/Hz. If $X(t)$ is input to an LTI system with impulse response $e^{-t}u(t)$. The average power of the system output is ___________ W (*rounded off to two decimal places*).
Q.60	A transparent dielectric coating is applied to glass ($\varepsilon_r = 4, \mu_r = 1$) to eliminate the reflection of red light ($\lambda_0 = 0.75$ μm). The minimum thickness of the dielectric coating, in μm, that can be used is _________ (*rounded off to two decimal places*).
Q.61	In a semiconductor device, the Fermi-energy level is 0.35 eV above the valence band energy. The effective density of states in the valence band at $T = 300$ K is $1 \times 10^{19} cm^{-3}$. The thermal equilibrium hole concentration in silicon at 400 K is ____________ $\times\ 10^{13} cm^{-3}$ (*rounded off to two decimal places*). Given kT at 300 K is 0.026 eV.
Q.62	A sample and hold circuit is implemented using a resistive switch and a capacitor with a time constant of 1 μs. The time for the sampling switch to stay closed to charge a capacitor adequately to a full scale voltage of 1 V with 12-bit accuracy is _______ μs (*rounded off to two decimal places*).

Q.63 In a given sequential circuit, initial states are $Q_1 = 1$ and $Q_2 = 0$. For a clock frequency of 1 MHz, the frequency of signal Q_2 in kHz, is ____________ (*rounded off to the nearest integer*).



Q.64 In the circuit below, the voltage V_L is _____________ V (*rounded off to two decimal places*).



Q.65 The frequency of occurrence of 8 symbols (a-h) is shown in the table below. A symbol is chosen and it is determined by asking a series of "yes/no" questions which are assumed to be truthfully answered. The average number of questions when asked in the most efficient sequence, to determine the chosen symbol, is ________ (*rounded off to two decimal places*).

Symbols	a	b	c	d	e	f	g	h
Frequency of occurrence	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{128}$	$\frac{1}{128}$

END OF QUESTION PAPER

GATE 2023 Electronics and Communication Engineering (EC)

Q. No.	Session	Question Type (QT) MCQ/MSQ/NAT	Subject Name (SN)	Key/Range (KY)	Mark (MK)
1	4	MCQ	GA	C	1
2	4	MCQ	GA	A	1
3	4	MCQ	GA	C	1
4	4	MCQ	GA	C	1
5	4	MCQ	GA	C	1
6	4	MCQ	GA	D	2
7	4	MCQ	GA	A	2
8	4	MCQ	GA	B	2
9	4	MCQ	GA	A	2
10	4	MCQ	GA	C	2
11	4	MCQ	EC	C	1
12	4	MCQ	EC	B	1
13	4	MCQ	EC	A	1
14	4	MCQ	EC	B	1
15	4	MCQ	EC	C	1
16	4	MCQ	EC	A	1
17	4	MCQ	EC	A	1
18	4	MCQ	EC	D	1
19	4	MCQ	EC	B	1
20	4	MCQ	EC	D	1
21	4	MCQ	EC	D	1
22	4	MCQ	EC	MTA	1
23	4	MCQ	EC	A	1
24	4	MCQ	EC	A	1
25	4	MCQ	EC	A	1
26	4	MCQ	EC	B	1
27	4	MCQ	EC	B	1
28	4	MCQ	EC	C	1
29	4	MCQ	EC	B	1
30	4	MSQ	EC	A,B	1
31	4	NAT	EC	10 to 10	1
32	4	NAT	EC	1.30 to 1.40	1
33	4	NAT	EC	80 to 80	1
34	4	NAT	EC	02 to 02	1
35	4	NAT	EC	04 to 04	1
36	4	MCQ	EC	B	2
37	4	MCQ	EC	B	2
38	4	MCQ	EC	A	2
39	4	MCQ	EC	A	2
40	4	MCQ	EC	A	2
41	4	MCQ	EC	A	2
42	4	MCQ	EC	A	2
43	4	MCQ	EC	A	2
44	4	MCQ	EC	B	2
45	4	MCQ	EC	B	2

46	4	MCQ	EC	MTA	2
47	4	MCQ	EC	A	2
48	4	MCQ	EC	C	2
49	4	MCQ	EC	A	2
50	4	MCQ	EC	D	2
51	4	MCQ	EC	A	2
52	4	MSQ	EC	B,C	2
53	4	MSQ	EC	A,B,D	2
54	4	MSQ	EC	B,C,D	2
55	4	NAT	EC	0 to 0	2
56	4	NAT	EC	2.20 to 2.30	2
57	4	NAT	EC	4 to 4	2
58	4	NAT	EC	15 to 15	2
59	4	NAT	EC	0.24 to 0.26	2
60	4	NAT	EC	0.12 to 0.14	2
61	4	NAT	EC	60.00 to 70.00	2
62	4	NAT	EC	8.30 to 8.34	2
63	4	NAT	EC	250 to 250 OR 500 to 500	2
64	4	NAT	EC	2.00 to 2.00	2
65	4	NAT	EC	1.97 to 1.99	2

MTA = Marks to ALL