





SESSION - 1

**General Aptitude (GA)**

Q.1 – Q.5 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: – 1/3).

Q.1	The ratio of boys to girls in a class is 7 to 3. Among the options below, an acceptable value for the total number of students in the class is:
(A)	21
(B)	37
(C)	50
(D)	73



<p>Q.2</p>	<p>A polygon is convex if, for every pair of points, P and Q belonging to the polygon, the line segment PQ lies completely inside or on the polygon.</p> <p>Which one of the following is <u>NOT</u> a convex polygon?</p>
<p>(A)</p>	
<p>(B)</p>	
<p>(C)</p>	
<p>(D)</p>	



Q.3	<p>Consider the following sentences:</p> <p>(i) Everybody in the class is prepared for the exam.</p> <p>(ii) Babu invited Danish to his home because he enjoys playing chess.</p> <p>Which of the following is the CORRECT observation about the above two sentences?</p>
(A)	(i) is grammatically correct and (ii) is unambiguous
(B)	(i) is grammatically incorrect and (ii) is unambiguous
(C)	(i) is grammatically correct and (ii) is ambiguous
(D)	(i) is grammatically incorrect and (ii) is ambiguous



<p>Q.4</p>	<p>A circular sheet of paper is folded along the lines in the directions shown. The paper, after being punched in the final folded state as shown and unfolded in the reverse order of folding, will look like _____.</p>
<p>(A)</p>	
<p>(B)</p>	
<p>(C)</p>	
<p>(D)</p>	



Computer Science and Information Technology (CS, Set-1)

<p>Q.5</p>	<p>_____ is to <i>surgery</i> as <i>writer</i> is to _____</p> <p>Which one of the following options maintains a similar logical relation in the above sentence?</p>
<p>(A)</p>	<p>Plan, outline</p>
<p>(B)</p>	<p>Hospital, library</p>
<p>(C)</p>	<p>Doctor, book</p>
<p>(D)</p>	<p>Medicine, grammar</p>



Q. 6 – Q. 10 Multiple Choice Question (MCQ), carry TWO marks each (for each wrong answer: – 2/3).

Q.6	We have 2 rectangular sheets of paper, M and N, of dimensions 6 cm x 1 cm each. Sheet M is rolled to form an open cylinder by bringing the short edges of the sheet together. Sheet N is cut into equal square patches and assembled to form the largest possible closed cube. Assuming the ends of the cylinder are closed, the ratio of the volume of the cylinder to that of the cube is _____
(A)	$\frac{\pi}{2}$
(B)	$\frac{3}{\pi}$
(C)	$\frac{9}{\pi}$
(D)	3π



Q.7	<table border="1"> <thead> <tr> <th>Items</th> <th>Cost (₹)</th> <th>Profit %</th> <th>Marked Price (₹)</th> </tr> </thead> <tbody> <tr> <td>P</td> <td>5,400</td> <td>---</td> <td>5,860</td> </tr> <tr> <td>Q</td> <td>---</td> <td>25</td> <td>10,000</td> </tr> </tbody> </table> <p>Details of prices of two items P and Q are presented in the above table. The ratio of cost of item P to cost of item Q is 3:4. Discount is calculated as the difference between the marked price and the selling price. The profit percentage is calculated as the ratio of the difference between selling price and cost, to the cost (Profit % = $\frac{\text{Selling price} - \text{Cost}}{\text{Cost}} \times 100$).</p> <p>The discount on item Q, as a percentage of its marked price, is _____</p>	Items	Cost (₹)	Profit %	Marked Price (₹)	P	5,400	---	5,860	Q	---	25	10,000
	Items	Cost (₹)	Profit %	Marked Price (₹)									
P	5,400	---	5,860										
Q	---	25	10,000										
(A)	25												
(B)	12.5												
(C)	10												
(D)	5												



Computer Science and Information Technology (CS, Set-1)

Q.8	<p>There are five bags each containing identical sets of ten distinct chocolates. One chocolate is picked from each bag.</p> <p>The probability that at least two chocolates are identical is _____</p>
(A)	0.3024
(B)	0.4235
(C)	0.6976
(D)	0.8125



Q.9	<p>Given below are two statements 1 and 2, and two conclusions I and II.</p> <p>Statement 1: All bacteria are microorganisms.</p> <p>Statement 2: All pathogens are microorganisms.</p> <p>Conclusion I: Some pathogens are bacteria.</p> <p>Conclusion II: All pathogens are not bacteria.</p> <p>Based on the above statements and conclusions, which one of the following options is logically CORRECT?</p>
(A)	Only conclusion I is correct
(B)	Only conclusion II is correct
(C)	Either conclusion I or II is correct.
(D)	Neither conclusion I nor II is correct.



Q.10	<p>Some people suggest anti-obesity measures (AOM) such as displaying calorie information in restaurant menus. Such measures sidestep addressing the core problems that cause obesity: poverty and income inequality.</p> <p>Which one of the following statements summarizes the passage?</p>
(A)	The proposed AOM addresses the core problems that cause obesity.
(B)	If obesity reduces, poverty will naturally reduce, since obesity causes poverty.
(C)	AOM are addressing the core problems and are likely to succeed.
(D)	AOM are addressing the problem superficially.



Computer Science and Information Technology (CS, Set-1)

Q.1 – Q.10 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: – 1/3).

Q.1	Suppose that L_1 is a regular language and L_2 is a context-free language. Which one of the following languages is NOT necessarily context-free?
(A)	$L_1 \cap L_2$
(B)	$L_1 \cdot L_2$
(C)	$L_1 - L_2$
(D)	$L_1 \cup L_2$

Q.2	Let P be an array containing n integers. Let t be the lowest upper bound on the number of comparisons of the array elements, required to find the minimum and maximum values in an arbitrary array of n elements. Which one of the following choices is correct?
(A)	$t > 2n - 2$
(B)	$t > 3 \left\lceil \frac{n}{2} \right\rceil$ and $t \leq 2n - 2$
(C)	$t > n$ and $t \leq 3 \left\lceil \frac{n}{2} \right\rceil$
(D)	$t > \lceil \log_2(n) \rceil$ and $t \leq n$



Q.3	<p>Consider the following three functions.</p> $f_1 = 10^n \quad f_2 = n^{\log n} \quad f_3 = n^{\sqrt{n}}$ <p>Which one of the following options arranges the functions in the increasing order of asymptotic growth rate?</p>
(A)	f_3, f_2, f_1
(B)	f_2, f_1, f_3
(C)	f_1, f_2, f_3
(D)	f_2, f_3, f_1

Q.4	<p>Consider the following statements.</p> <p>S_1 : The sequence of procedure calls corresponds to a preorder traversal of the activation tree.</p> <p>S_2 : The sequence of procedure returns corresponds to a postorder traversal of the activation tree.</p> <p>Which one of the following options is correct?</p>
(A)	S_1 is true and S_2 is false
(B)	S_1 is false and S_2 is true
(C)	S_1 is true and S_2 is true
(D)	S_1 is false and S_2 is false



Q.5	<p>Consider the following statements.</p> <p>S_1 : Every SLR(1) grammar is unambiguous but there are certain unambiguous grammars that are not SLR(1).</p> <p>S_2 : For any context-free grammar, there is a parser that takes at most $O(n^3)$ time to parse a string of length n.</p> <p>Which one of the following options is correct?</p>
(A)	S_1 is true and S_2 is false
(B)	S_1 is false and S_2 is true
(C)	S_1 is true and S_2 is true
(D)	S_1 is false and S_2 is false

Q.6	<p>Let the representation of a number in base 3 be 210. What is the hexadecimal representation of the number?</p>
(A)	15
(B)	21
(C)	D2
(D)	528



<p>Q.7</p>	<p>Let p and q be two propositions. Consider the following two formulae in propositional logic.</p> $S_1 : (\neg p \wedge (p \vee q)) \rightarrow q$ $S_2 : q \rightarrow (\neg p \wedge (p \vee q))$ <p>Which one of the following choices is correct?</p>
<p>(A)</p>	<p>Both S_1 and S_2 are tautologies.</p>
<p>(B)</p>	<p>S_1 is a tautology but S_2 is not a tautology.</p>
<p>(C)</p>	<p>S_1 is not a tautology but S_2 is a tautology.</p>
<p>(D)</p>	<p>Neither S_1 nor S_2 is a tautology.</p>

<p>Q.8</p>	<p>Consider the following two statements.</p> $S_1 : \text{Destination MAC address of an ARP reply is a broadcast address.}$ $S_2 : \text{Destination MAC address of an ARP request is a broadcast address.}$ <p>Which one of the following choices is correct?</p>
<p>(A)</p>	<p>Both S_1 and S_2 are true.</p>
<p>(B)</p>	<p>S_1 is true and S_2 is false.</p>
<p>(C)</p>	<p>S_1 is false and S_2 is true.</p>
<p>(D)</p>	<p>Both S_1 and S_2 are false.</p>



Q.9	<p>Consider the following array.</p> <table border="1" data-bbox="646 457 1089 493"> <tr> <td>23</td> <td>32</td> <td>45</td> <td>69</td> <td>72</td> <td>73</td> <td>89</td> <td>97</td> </tr> </table> <p>Which algorithm out of the following options uses the least number of comparisons (among the array elements) to sort the above array in ascending order?</p>	23	32	45	69	72	73	89	97
23	32	45	69	72	73	89	97		
(A)	Selection sort								
(B)	Mergesort								
(C)	Insertion sort								
(D)	Quicksort using the last element as pivot								

Q.10	<p>A binary search tree T contains n distinct elements. What is the time complexity of picking an element in T that is smaller than the maximum element in T?</p>
(A)	$\Theta(n \log n)$
(B)	$\Theta(n)$
(C)	$\Theta(\log n)$
(D)	$\Theta(1)$



Computer Science and Information Technology (CS, Set-1)

Q.11 – Q.15 Multiple Select Question (MSQ), carry ONE mark each (no negative marks).

Q.11	In the context of operating systems, which of the following statements is/are correct with respect to paging?
(A)	Paging helps solve the issue of external fragmentation.
(B)	Page size has no impact on internal fragmentation.
(C)	Paging incurs memory overheads.
(D)	Multi-level paging is necessary to support pages of different sizes.

Q.12	Let $\langle M \rangle$ denote an encoding of an automaton M . Suppose that $\Sigma = \{0, 1\}$. Which of the following languages is/are NOT recursive?
(A)	$L = \{\langle M \rangle \mid M \text{ is a DFA such that } L(M) = \emptyset\}$
(B)	$L = \{\langle M \rangle \mid M \text{ is a DFA such that } L(M) = \Sigma^*\}$
(C)	$L = \{\langle M \rangle \mid M \text{ is a PDA such that } L(M) = \emptyset\}$
(D)	$L = \{\langle M \rangle \mid M \text{ is a PDA such that } L(M) = \Sigma^*\}$



Q.13	Suppose a database system crashes again while recovering from a previous crash. Assume checkpointing is not done by the database either during the transactions or during recovery. Which of the following statements is/are correct?
(A)	The same undo and redo list will be used while recovering again.
(B)	The system cannot recover any further.
(C)	All the transactions that are already undone and redone will not be recovered again.
(D)	The database will become inconsistent.

Q.14	Which of the following standard C library functions will <i>always</i> invoke a system call when executed from a single-threaded process in a UNIX/Linux operating system?
(A)	<code>exit</code>
(B)	<code>malloc</code>
(C)	<code>sleep</code>
(D)	<code>strlen</code>



<p>Q.15</p>	<p>Consider a linear list based directory implementation in a file system. Each directory is a list of nodes, where each node contains the file name along with the file metadata, such as the list of pointers to the data blocks. Consider a given directory <code>foo</code>. Which of the following operations will necessarily require a full scan of <code>foo</code> for successful completion?</p>
<p>(A)</p>	<p>Creation of a new file in <code>foo</code></p>
<p>(B)</p>	<p>Deletion of an existing file from <code>foo</code></p>
<p>(C)</p>	<p>Renaming of an existing file in <code>foo</code></p>
<p>(D)</p>	<p>Opening of an existing file in <code>foo</code></p>





Computer Science and Information Technology (CS, Set-1)

Q.16 – Q.25 Numerical Answer Type (NAT), carry ONE mark each (no negative marks).

Q.16	In an undirected connected planar graph G , there are eight vertices and five faces. The number of edges in G is _____.
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Q.17	<p>Consider the following undirected graph with edge weights as shown:</p> <p>The number of minimum-weight spanning trees of the graph is _____.</p>
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Q.18	The lifetime of a component of a certain type is a random variable whose probability density function is exponentially distributed with parameter 2. For a randomly picked component of this type, the probability that its lifetime exceeds the expected lifetime (rounded to 2 decimal places) is _____.
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Q.19	<p>There are 6 jobs with distinct difficulty levels, and 3 computers with distinct processing speeds. Each job is assigned to a computer such that:</p> <ul style="list-style-type: none"> - The fastest computer gets the toughest job and the slowest computer gets the easiest job. - Every computer gets at least one job. <p>The number of ways in which this can be done is _____.</p>
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Computer Science and Information Technology (CS, Set-1)

Q.20	<p>Consider the following expression.</p> $\lim_{x \rightarrow -3} \frac{\sqrt{2x + 22} - 4}{x + 3}$ <p>The value of the above expression (rounded to 2 decimal places) is _____.</p>
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Q.21	<p>Consider the following sequence of operations on an empty stack.</p> <p style="text-align: center;"><code>push(54); push(52); pop(); push(55); push(62); s = pop();</code></p> <p>Consider the following sequence of operations on an empty queue.</p> <p style="text-align: center;"><code>enqueue(21); enqueue(24); dequeue(); enqueue(28); enqueue(32); q = dequeue();</code></p> <p>The value of <code>s + q</code> is _____.</p>
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Q.22	<p>Consider a computer system with a byte-addressable primary memory of size 2^{32} bytes. Assume the computer system has a direct-mapped cache of size 32 KB (1 KB = 2^{10} bytes), and each cache block is of size 64 bytes.</p> <p>The size of the tag field is _____ bits.</p>
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Q.23	<p>A relation $r(A, B)$ in a relational database has 1200 tuples. The attribute A has integer values ranging from 6 to 20, and the attribute B has integer values ranging from 1 to 20. Assume that the attributes A and B are independently distributed.</p> <p>The estimated number of tuples in the output of $\sigma_{(A>10) \vee (B=18)}(r)$ is _____.</p>
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Computer Science and Information Technology (CS, Set-1)

Q.24	<p>Consider the following representation of a number in IEEE 754 single-precision floating point format with a bias of 127.</p> $S : 1 \quad E : 10000001 \quad F : 11110000000000000000000$ <p>Here S, E and F denote the sign, exponent and fraction components of the floating point representation.</p> <p>The decimal value corresponding to the above representation (rounded to 2 decimal places) is _____.</p>
Q.25	<p>Three processes arrive at time zero with CPU bursts of 16, 20 and 10 milliseconds. If the scheduler has prior knowledge about the length of the CPU bursts, the minimum achievable average waiting time for these three processes in a non-preemptive scheduler (rounded to nearest integer) is _____ milliseconds.</p>



Computer Science and Information Technology (CS, Set-1)

Q.26 – Q.39 Multiple Choice Question (MCQ), carry TWO mark each (for each wrong answer: – 2/3).

Q.26	<p>Consider the following grammar (that admits a series of declarations, followed by expressions) and the associated syntax directed translation (SDT) actions, given as pseudo-code:</p> $P \rightarrow D^* E^*$ $D \rightarrow \text{int ID} \{\text{record that ID.lexeme is of type int}\}$ $D \rightarrow \text{bool ID} \{\text{record that ID.lexeme is of type bool}\}$ $E \rightarrow E_1 + E_2 \{\text{check that } E_1.\text{type} = E_2.\text{type} = \text{int}; \text{set } E.\text{type} := \text{int}\}$ $E \rightarrow !E_1 \{\text{check that } E_1.\text{type} = \text{bool}; \text{set } E.\text{type} := \text{bool}\}$ $E \rightarrow \text{ID} \{\text{set } E.\text{type} := \text{int}\}$ <p>With respect to the above grammar, which one of the following choices is correct?</p>
(A)	The actions can be used to correctly type-check any syntactically correct program.
(B)	The actions can be used to type-check syntactically correct integer variable declarations and integer expressions.
(C)	The actions can be used to type-check syntactically correct boolean variable declarations and boolean expressions.
(D)	The actions will lead to an infinite loop.



Computer Science and Information Technology (CS, Set-1)

<p>Q.27</p>	<p>The following relation records the age of 500 employees of a company, where <i>empNo</i> (indicating the employee number) is the key:</p> $empAge(\underline{empNo}, age)$ <p>Consider the following relational algebra expression:</p> $\Pi_{empNo}(empAge \bowtie_{(age > age1)} \rho_{empNo1, age1}(empAge))$ <p>What does the above expression generate?</p>
<p>(A)</p>	<p>Employee numbers of only those employees whose age is the maximum.</p>
<p>(B)</p>	<p>Employee numbers of only those employees whose age is more than the age of exactly one other employee.</p>
<p>(C)</p>	<p>Employee numbers of all employees whose age is not the minimum.</p>
<p>(D)</p>	<p>Employee numbers of all employees whose age is the minimum.</p>



Computer Science and Information Technology (CS, Set-1)

Q.28	<p>Consider a 3-bit counter, designed using T flip-flops, as shown below:</p> <p>Assuming the initial state of the counter given by PQR as 000, what are the next three states?</p>
(A)	011, 101, 000
(B)	001, 010, 111
(C)	011, 101, 111
(D)	001, 010, 000

Q.29	<p>Assume that a 12-bit Hamming codeword consisting of 8-bit data and 4 check bits is $d_8d_7d_6d_5c_8d_4d_3d_2c_4d_1c_2c_1$, where the data bits and the check bits are given in the following tables:</p> <table border="1" style="display: inline-table; margin-right: 20px;"> <thead> <tr> <th colspan="8">Data bits</th> </tr> <tr> <th>d_8</th> <th>d_7</th> <th>d_6</th> <th>d_5</th> <th>d_4</th> <th>d_3</th> <th>d_2</th> <th>d_1</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1</td> <td>0</td> <td>x</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> </tr> </tbody> </table> <table border="1" style="display: inline-table;"> <thead> <tr> <th colspan="4">Check bits</th> </tr> <tr> <th>c_8</th> <th>c_4</th> <th>c_2</th> <th>c_1</th> </tr> </thead> <tbody> <tr> <td>y</td> <td>0</td> <td>1</td> <td>0</td> </tr> </tbody> </table> <p>Which one of the following choices gives the correct values of x and y?</p>	Data bits								d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1	1	1	0	x	0	1	0	1	Check bits				c_8	c_4	c_2	c_1	y	0	1	0
Data bits																																					
d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1																														
1	1	0	x	0	1	0	1																														
Check bits																																					
c_8	c_4	c_2	c_1																																		
y	0	1	0																																		
(A)	x is 0 and y is 0.																																				
(B)	x is 0 and y is 1.																																				
(C)	x is 1 and y is 0.																																				
(D)	x is 1 and y is 1.																																				



Computer Science and Information Technology (CS, Set-1)

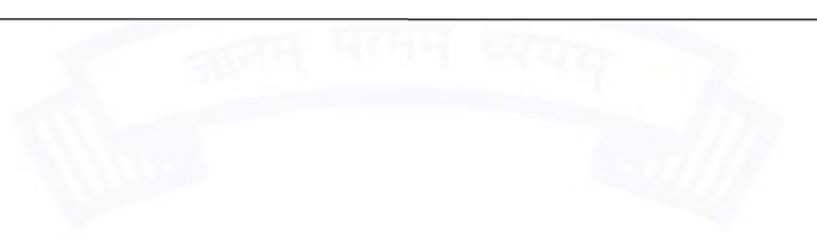
Q.30	<p>Consider the following recurrence relation.</p> $T(n) = \begin{cases} T(n/2) + T(2n/5) + 7n & \text{if } n > 0 \\ 1 & \text{if } n = 0 \end{cases}$ <p>Which one of the following options is correct?</p>
(A)	$T(n) = \Theta(n^{5/2})$
(B)	$T(n) = \Theta(n \log n)$
(C)	$T(n) = \Theta(n)$
(D)	$T(n) = \Theta((\log n)^{5/2})$





Computer Science and Information Technology (CS, Set-1)

<p>Q.31</p>	<p>Consider the following context-free grammar where the set of terminals is $\{a, b, c, d, f\}$.</p> $S \rightarrow daT \mid Rf$ $T \rightarrow aS \mid baT \mid \epsilon$ $R \rightarrow caTR \mid \epsilon$ <p>The following is a partially-filled LL(1) parsing table.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th><i>a</i></th> <th><i>b</i></th> <th><i>c</i></th> <th><i>d</i></th> <th><i>f</i></th> <th>\$</th> </tr> </thead> <tbody> <tr> <td>S</td> <td></td> <td></td> <td>①</td> <td>$S \rightarrow daT$</td> <td>②</td> <td></td> </tr> <tr> <td>T</td> <td>$T \rightarrow aS$</td> <td>$T \rightarrow baT$</td> <td>③</td> <td></td> <td>$T \rightarrow \epsilon$</td> <td>④</td> </tr> <tr> <td>R</td> <td></td> <td></td> <td>$R \rightarrow caTR$</td> <td></td> <td>$R \rightarrow \epsilon$</td> <td></td> </tr> </tbody> </table> <p>Which one of the following choices represents the correct combination for the numbered cells in the parsing table (“blank” denotes that the corresponding cell is empty)?</p>		<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>f</i>	\$	S			①	$S \rightarrow daT$	②		T	$T \rightarrow aS$	$T \rightarrow baT$	③		$T \rightarrow \epsilon$	④	R			$R \rightarrow caTR$		$R \rightarrow \epsilon$	
	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>f</i>	\$																							
S			①	$S \rightarrow daT$	②																								
T	$T \rightarrow aS$	$T \rightarrow baT$	③		$T \rightarrow \epsilon$	④																							
R			$R \rightarrow caTR$		$R \rightarrow \epsilon$																								
(A)	<p>① $S \rightarrow Rf$ ② $S \rightarrow Rf$ ③ $T \rightarrow \epsilon$ ④ $T \rightarrow \epsilon$</p>																												
(B)	<p>① blank ② $S \rightarrow Rf$ ③ $T \rightarrow \epsilon$ ④ $T \rightarrow \epsilon$</p>																												
(C)	<p>① $S \rightarrow Rf$ ② blank ③ blank ④ $T \rightarrow \epsilon$</p>																												
(D)	<p>① blank ② $S \rightarrow Rf$ ③ blank ④ blank</p>																												





Computer Science and Information Technology (CS, Set-1)

Q.32	<p>Let $r_i(z)$ and $w_i(z)$ denote read and write operations respectively on a data item z by a transaction T_i. Consider the following two schedules.</p> $S_1 : r_1(x) r_1(y) r_2(x) r_2(y) w_2(y) w_1(x)$ $S_2 : r_1(x) r_2(x) r_2(y) w_2(y) r_1(y) w_1(x)$ <p>Which one of the following options is correct?</p>
(A)	S_1 is conflict serializable, and S_2 is not conflict serializable.
(B)	S_1 is not conflict serializable, and S_2 is conflict serializable.
(C)	Both S_1 and S_2 are conflict serializable.
(D)	Neither S_1 nor S_2 is conflict serializable.

Q.33	<p>Consider the relation $R(P, Q, S, T, X, Y, Z, W)$ with the following functional dependencies.</p> $PQ \rightarrow X; P \rightarrow YX; Q \rightarrow Y; Y \rightarrow ZW$ <p>Consider the decomposition of the relation R into the constituent relations according to the following two decomposition schemes.</p> $D_1 : R = [(P, Q, S, T); (P, T, X); (Q, Y); (Y, Z, W)]$ $D_2 : R = [(P, Q, S); (T, X); (Q, Y); (Y, Z, W)]$ <p>Which one of the following options is correct?</p>
(A)	D_1 is a lossless decomposition, but D_2 is a lossy decomposition.
(B)	D_1 is a lossy decomposition, but D_2 is a lossless decomposition.
(C)	Both D_1 and D_2 are lossless decompositions.
(D)	Both D_1 and D_2 are lossy decompositions.



Computer Science and Information Technology (CS, Set-1)

Q.34	Let G be a group of order 6, and H be a subgroup of G such that $1 < H < 6$. Which one of the following options is correct?
(A)	Both G and H are always cyclic.
(B)	G may not be cyclic, but H is always cyclic.
(C)	G is always cyclic, but H may not be cyclic.
(D)	Both G and H may not be cyclic.

Q.35	<p>Consider the two statements.</p> <p>S_1 : There exist random variables X and Y such that</p> $\left(\mathbb{E} \left[(X - \mathbb{E}(X)) (Y - \mathbb{E}(Y)) \right] \right)^2 > \text{Var}[X] \text{Var}[Y]$ <p>S_2 : For all random variables X and Y,</p> $\text{Cov}[X, Y] = \mathbb{E} \left[X - \mathbb{E}[X] Y - \mathbb{E}[Y] \right]$ <p>Which one of the following choices is correct?</p>
(A)	Both S_1 and S_2 are true.
(B)	S_1 is true, but S_2 is false.
(C)	S_1 is false, but S_2 is true.
(D)	Both S_1 and S_2 are false.



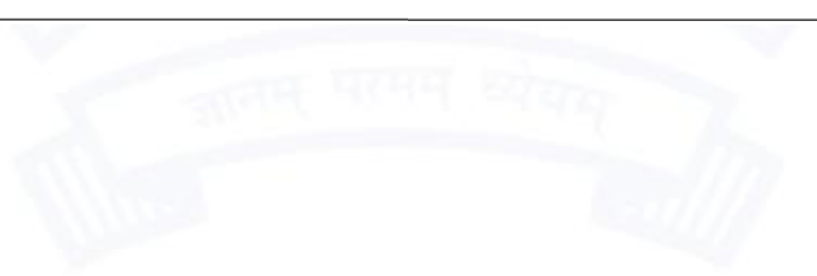
<p>Q.36</p>	<p>Let $G = (V, E)$ be an undirected unweighted connected graph. The <i>diameter</i> of G is defined as:</p> $\text{diam}(G) = \max_{u,v \in V} \{\text{the length of shortest path between } u \text{ and } v\}$ <p>Let M be the adjacency matrix of G. Define graph G_2 on the same set of vertices with adjacency matrix N, where</p> $N_{ij} = \begin{cases} 1 & \text{if } M_{ij} > 0 \text{ or } P_{ij} > 0, \text{ where } P = M^2 \\ 0 & \text{otherwise} \end{cases}$ <p>Which one of the following statements is true?</p>
<p>(A)</p>	<p>$\text{diam}(G_2) \leq \lceil \text{diam}(G)/2 \rceil$</p>
<p>(B)</p>	<p>$\lceil \text{diam}(G)/2 \rceil < \text{diam}(G_2) < \text{diam}(G)$</p>
<p>(C)</p>	<p>$\text{diam}(G_2) = \text{diam}(G)$</p>
<p>(D)</p>	<p>$\text{diam}(G) < \text{diam}(G_2) \leq 2 \text{ diam}(G)$</p>





Computer Science and Information Technology (CS, Set-1)

<p>Q.37</p>	<p>Consider the following ANSI C program.</p> <pre>#include <stdio.h> int main() { int i, j, count; count = 0; i = 0; for (j = -3; j <= 3; j++) { if ((j >= 0) && (i++)) count = count + j; } count = count + i; printf("%d", count); return 0; }</pre> <p>Which one of the following options is correct?</p>
<p>(A)</p>	<p>The program will not compile successfully.</p>
<p>(B)</p>	<p>The program will compile successfully and output 10 when executed.</p>
<p>(C)</p>	<p>The program will compile successfully and output 8 when executed.</p>
<p>(D)</p>	<p>The program will compile successfully and output 13 when executed.</p>





<p>Q.38</p>	<p>Consider the following language.</p> $L = \{w \in \{0,1\}^* \mid w \text{ ends with the substring } 011\}$ <p>Which one of the following deterministic finite automata accepts L?</p>
<p>(A)</p>	
<p>(B)</p>	
<p>(C)</p>	
<p>(D)</p>	



Computer Science and Information Technology (CS, Set-1)

<p>Q.39</p>	<p>For a Turing machine M, $\langle M \rangle$ denotes an encoding of M. Consider the following two languages.</p> $L_1 = \{ \langle M \rangle \mid M \text{ takes more than 2021 steps on all inputs} \}$ $L_2 = \{ \langle M \rangle \mid M \text{ takes more than 2021 steps on some input} \}$ <p>Which one of the following options is correct?</p>
<p>(A)</p>	<p>Both L_1 and L_2 are decidable.</p>
<p>(B)</p>	<p>L_1 is decidable and L_2 is undecidable.</p>
<p>(C)</p>	<p>L_1 is undecidable and L_2 is decidable.</p>
<p>(D)</p>	<p>Both L_1 and L_2 are undecidable.</p>





Computer Science and Information Technology (CS, Set-1)

Q.40 – Q.47 Multiple Select Question (MSQ), carry TWO mark each (no negative marks).

Q.40	<p>Define R_n to be the maximum amount earned by cutting a rod of length n meters into one or more pieces of integer length and selling them. For $i > 0$, let $p[i]$ denote the selling price of a rod whose length is i meters. Consider the array of prices:</p> $p[1] = 1, p[2] = 5, p[3] = 8, p[4] = 9, p[5] = 10, p[6] = 17, p[7] = 18$ <p>Which of the following statements is/are correct about R_7?</p>
(A)	$R_7 = 18$
(B)	$R_7 = 19$
(C)	R_7 is achieved by three different solutions.
(D)	R_7 cannot be achieved by a solution consisting of three pieces.

Q.41	<p>An <i>articulation point</i> in a connected graph is a vertex such that removing the vertex and its incident edges disconnects the graph into two or more connected components.</p> <p>Let T be a DFS tree obtained by doing DFS in a connected undirected graph G.</p> <p>Which of the following options is/are correct?</p>
(A)	Root of T can never be an articulation point in G .
(B)	Root of T is an articulation point in G if and only if it has 2 or more children.
(C)	A leaf of T can be an articulation point in G .
(D)	If u is an articulation point in G such that x is an ancestor of u in T and y is a descendent of u in T , then all paths from x to y in G must pass through u .



Computer Science and Information Technology (CS, Set-1)

Q.42	<p>Consider the following Boolean expression.</p> $F = (X + Y + Z)(\bar{X} + Y)(\bar{Y} + Z)$ <p>Which of the following Boolean expressions is/are equivalent to \bar{F} (complement of F)?</p>
(A)	$(\bar{X} + \bar{Y} + \bar{Z})(X + \bar{Y})(Y + \bar{Z})$
(B)	$X\bar{Y} + \bar{Z}$
(C)	$(X + \bar{Z})(\bar{Y} + \bar{Z})$
(D)	$X\bar{Y} + Y\bar{Z} + \bar{X}\bar{Y}\bar{Z}$

Q.43	<p>A relation R is said to be <i>circular</i> if aRb and bRc together imply cRa. Which of the following options is/are correct?</p>
(A)	If a relation S is reflexive and symmetric, then S is an equivalence relation.
(B)	If a relation S is circular and symmetric, then S is an equivalence relation.
(C)	If a relation S is reflexive and circular, then S is an equivalence relation.
(D)	If a relation S is transitive and circular, then S is an equivalence relation.



Computer Science and Information Technology (CS, Set-1)

Q.44	<p>A TCP server application is programmed to listen on port number P on host S. A TCP client is connected to the TCP server over the network.</p> <p>Consider that while the TCP connection was active, the server machine S crashed and rebooted. Assume that the client does not use the TCP keepalive timer.</p> <p>Which of the following behaviors is/are possible?</p>
(A)	If the client was waiting to receive a packet, it may wait indefinitely.
(B)	The TCP server application on S can listen on P after reboot.
(C)	If the client sends a packet after the server reboot, it will receive a RST segment.
(D)	If the client sends a packet after the server reboot, it will receive a FIN segment.

Q.45	<p>Consider two hosts P and Q connected through a router R. The maximum transfer unit (MTU) value of the link between P and R is 1500 bytes, and between R and Q is 820 bytes.</p> <p>A TCP segment of size 1400 bytes was transferred from P to Q through R, with IP identification value as 0x1234. Assume that the IP header size is 20 bytes. Further, the packet is allowed to be fragmented, i.e., Don't Fragment (DF) flag in the IP header is <i>not</i> set by P.</p> <p>Which of the following statements is/are correct?</p>
(A)	Two fragments are created at R and the IP datagram size carrying the second fragment is 620 bytes.
(B)	If the second fragment is lost, R will resend the fragment with the IP identification value 0x1234.
(C)	If the second fragment is lost, P is required to resend the whole TCP segment.
(D)	TCP destination port can be determined by analysing <i>only</i> the second fragment.



Computer Science and Information Technology (CS, Set-1)

Q.46	<p>Consider the following pseudocode, where S is a semaphore initialized to 5 in line#2 and counter is a shared variable initialized to 0 in line#1. Assume that the increment operation in line#7 is <i>not</i> atomic.</p> <pre>1. int counter = 0; 2. Semaphore S = init(5); 3. void parop(void) 4. { 5. wait(S); 6. wait(S); 7. counter++; 8. signal(S); 9. signal(S); 10.}</pre> <p>If five threads execute the function parop concurrently, which of the following program behavior(s) is/are possible?</p>
(A)	The value of counter is 5 after all the threads successfully complete the execution of parop.
(B)	The value of counter is 1 after all the threads successfully complete the execution of parop.
(C)	The value of counter is 0 after all the threads successfully complete the execution of parop.
(D)	There is a deadlock involving all the threads.



Computer Science and Information Technology (CS, Set-1)

<p>Q.47</p>	<p>Consider a <i>dynamic</i> hashing approach for 4-bit integer keys:</p> <ol style="list-style-type: none"> 1. There is a main hash table of size 4. 2. The 2 least significant bits of a key is used to index into the main hash table. 3. Initially, the main hash table entries are empty. 4. Thereafter, when more keys are hashed into it, to resolve collisions, the set of all keys corresponding to a main hash table entry is organized as a binary tree that grows on demand. 5. First, the 3rd least significant bit is used to divide the keys into left and right subtrees. 6. To resolve more collisions, each node of the binary tree is further sub-divided into left and right subtrees based on the 4th least significant bit. 7. A split is done only if it is needed, i.e., only when there is a collision. <p>Consider the following state of the hash table.</p> <div style="text-align: center;"> </div> <p>Which of the following sequences of key insertions can cause the above state of the hash table (assume the keys are in decimal notation)?</p>
(A)	5, 9, 4, 13, 10, 7
(B)	9, 5, 10, 6, 7, 1
(C)	10, 9, 6, 7, 5, 13
(D)	9, 5, 13, 6, 10, 14



Computer Science and Information Technology (CS, Set-1)

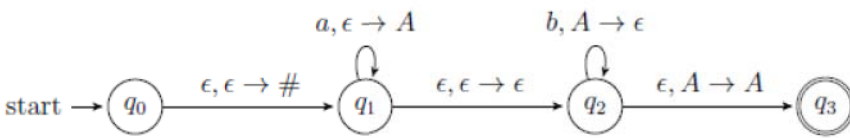
Q.48 – Q.55 Numerical Answer Type (NAT), carry TWO mark each (no negative marks).

Q.48	<p>Consider the following ANSI C function:</p> <pre>int SimpleFunction(int Y[], int n, int x) { int total = Y[0], loopIndex; for (loopIndex = 1; loopIndex <= n - 1; loopIndex++) total = x * total + Y[loopIndex]; return total; }</pre> <p>Let Z be an array of 10 elements with $Z[i]=1$, for all i such that $0 \leq i \leq 9$. The value returned by <code>SimpleFunction(Z, 10, 2)</code> is _____.</p>
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Q.49	<p>Consider the sliding window flow-control protocol operating between a sender and a receiver over a full-duplex error-free link. Assume the following:</p> <ul style="list-style-type: none"> • The time taken for processing the data frame by the receiver is negligible. • The time taken for processing the acknowledgement frame by the sender is negligible. • The sender has infinite number of frames available for transmission. • The size of the data frame is 2,000 bits and the size of the acknowledgement frame is 10 bits. • The link data rate in each direction is 1 Mbps ($= 10^6$ bits per second). • One way propagation delay of the link is 100 milliseconds. <p>The minimum value of the sender's window size in terms of the number of frames, (rounded to the nearest integer) needed to achieve a link utilization of 50% is _____.</p>
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Q.50	<p>Consider the following C code segment:</p> <pre>a = b + c; e = a + 1; d = b + c; f = d + 1; g = e + f;</pre> <p>In a compiler, this code segment is represented internally as a directed acyclic graph (DAG). The number of nodes in the DAG is _____.</p>
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Q.51	<p>In a pushdown automaton $P = (Q, \Sigma, \Gamma, \delta, q_0, F)$, a transition of the form,</p> $\textcircled{p} \xrightarrow{a, X \rightarrow Y} \textcircled{q}$ <p>where $p, q \in Q$, $a \in \Sigma \cup \{\epsilon\}$, and $X, Y \in \Gamma \cup \{\epsilon\}$, represents</p> $(q, Y) \in \delta(p, a, X).$ <p>Consider the following pushdown automaton over the input alphabet $\Sigma = \{a, b\}$ and stack alphabet $\Gamma = \{\#, A\}$.</p>  <p>The number of strings of length 100 accepted by the above pushdown automaton is _____.</p>
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Q.52	<p>Consider the following matrix.</p> $\begin{pmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 1 \\ 1 & 1 & 1 & 0 \end{pmatrix}$ <p>The largest eigenvalue of the above matrix is _____.</p>
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Q.53	<p>A five-stage pipeline has stage delays of 150, 120, 150, 160 and 140 nanoseconds. The registers that are used between the pipeline stages have a delay of 5 nanoseconds each.</p> <p>The total time to execute 100 independent instructions on this pipeline, assuming there are no pipeline stalls, is _____ nanoseconds.</p>
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Computer Science and Information Technology (CS, Set-1)

Q.54

A sender (S) transmits a signal, which can be one of the two kinds: H and L with probabilities 0.1 and 0.9 respectively, to a receiver (R).

In the graph below, the weight of edge (u, v) is the probability of receiving v when u is transmitted, where $u, v \in \{H, L\}$. For example, the probability that the received signal is L given the transmitted signal was H , is 0.7.

If the received signal is H , the probability that the transmitted signal was H (rounded to 2 decimal places) is _____.

Q.55

Consider the following instruction sequence where registers R1, R2 and R3 are general purpose and MEMORY[X] denotes the content at the memory location X.

Instruction	Semantics	Instruction Size (bytes)
MOV R1, (5000)	$R1 \leftarrow \text{MEMORY}[5000]$	4
MOV R2, (R3)	$R2 \leftarrow \text{MEMORY}[R3]$	4
ADD R2, R1	$R2 \leftarrow R1 + R2$	2
MOV (R3), R2	$\text{MEMORY}[R3] \leftarrow R2$	4
INC R3	$R3 \leftarrow R3 + 1$	2
DEC R1	$R1 \leftarrow R1 - 1$	2
BNZ 1004	Branch if not zero to the given absolute address	2
HALT	Stop	1

Assume that the content of the memory location 5000 is 10, and the content of the register R3 is 3000. The content of each of the memory locations from 3000 to 3010 is 50. The instruction sequence starts from the memory location 1000. All the numbers are in decimal format. Assume that the memory is byte addressable.

After the execution of the program, the content of memory location 3010 is _____.

END OF QUESTION PAPER

GATE 2021 Answer Key for Computer Science and Information Technology (CS - 1)

Graduate Aptitude Test in Engineering (GATE 2021)

Subject/Paper: Computer Science and Information Technology (CS - 1)

Q. No.	Session	Question Type MCQ/MSQ/NAT	Section Name	Answer Key/Range	Marks	Negative Marks
1	5	MCQ	GA	C	1	1/3
2	5	MCQ	GA	A	1	1/3
3	5	MCQ	GA	C	1	1/3
4	5	MCQ	GA	A	1	1/3
5	5	MCQ	GA	C	1	1/3
6	5	MCQ	GA	C	2	2/3
7	5	MCQ	GA	C	2	2/3
8	5	MCQ	GA	C	2	2/3
9	5	MCQ	GA	C O R D	2	2/3
10	5	MCQ	GA	D	2	2/3
1	5	MCQ	CS	C	1	1/3
2	5	MCQ	CS	C	1	1/3
3	5	MCQ	CS	D	1	1/3
4	5	MCQ	CS	C	1	1/3
5	5	MCQ	CS	C	1	1/3
6	5	MCQ	CS	A	1	1/3
7	5	MCQ	CS	B	1	1/3
8	5	MCQ	CS	C	1	1/3
9	5	MCQ	CS	C	1	1/3
10	5	MCQ	CS	D	1	1/3
11	5	MSQ	CS	A; C	1	0

GATE 2021 Answer Key for Computer Science and Information Technology (CS - 1)

Q. No.	Session	Question Type MCQ/MSQ/NAT	Section Name	Answer Key/Range	Marks	Negative Marks
12	5	MSQ	CS	D	1	0
13	5	MSQ	CS	A	1	0
14	5	MSQ	CS	A; C	1	0
15	5	MSQ	CS	A; C	1	0
16	5	NAT	CS	11 to 11	1	0
17	5	NAT	CS	3 to 3	1	0
18	5	NAT	CS	0.35 to 0.39	1	0
19	5	NAT	CS	65 to 65	1	0
20	5	NAT	CS	0.25 to 0.25	1	0
21	5	NAT	CS	86 to 86	1	0
22	5	NAT	CS	17 to 17	1	0
23	5	NAT	CS	819 to 820 OR 205 to 205	1	0
24	5	NAT	CS	-7.75 to -7.75	1	0
25	5	NAT	CS	12 to 12	1	0
26	5	MCQ	CS	B	2	2/3
27	5	MCQ	CS	C	2	2/3
28	5	MCQ	CS	A	2	2/3
29	5	MCQ	CS	A	2	2/3
30	5	MCQ	CS	C	2	2/3
31	5	MCQ	CS	A	2	2/3
32	5	MCQ	CS	B	2	2/3
33	5	MCQ	CS	A	2	2/3
34	5	MCQ	CS	B	2	2/3

GATE 2021 Answer Key for Computer Science and Information Technology (CS - 1)

Q. No.	Session	Question Type MCQ/MSQ/NAT	Section Name	Answer Key/Range	Marks	Negative Marks
35	5	MCQ	CS	D	2	2/3
36	5	MCQ	CS	A	2	2/3
37	5	MCQ	CS	B	2	2/3
38	5	MCQ	CS	D	2	2/3
39	5	MCQ	CS	A	2	2/3
40	5	MSQ	CS	A; C	2	0
41	5	MSQ	CS	B	2	0
42	5	MSQ	CS	B; C; D	2	0
43	5	MSQ	CS	C	2	0
44	5	MSQ	CS	A; B; C	2	0
45	5	MSQ	CS	A; C	2	0
46	5	MSQ	CS	A; B; D	2	0
47	5	MSQ	CS	C	2	0
48	5	NAT	CS	1023 to 1023	2	0
49	5	NAT	CS	50 to 52	2	0
50	5	NAT	CS	6 to 6	2	0
51	5	NAT	CS	50 to 50	2	0
52	5	NAT	CS	3 to 3	2	0
53	5	NAT	CS	17160 to 17160	2	0
54	5	NAT	CS	0.04 to 0.04	2	0
55	5	NAT	CS	50 to 50	2	0

SESSION - 2

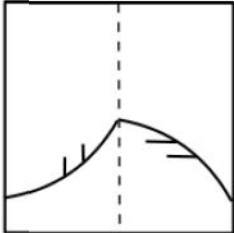
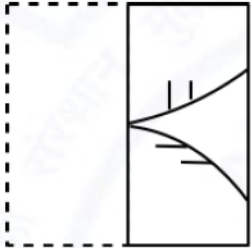
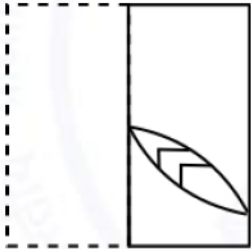
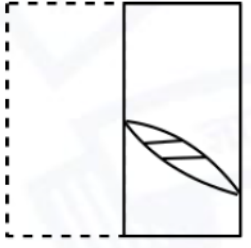
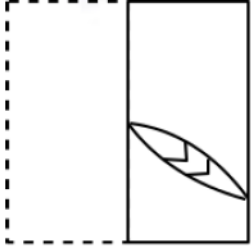


General Aptitude (GA)

Q.1 – Q.5 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: – 1/3).

Q.1	Gauri said that she can play the keyboard _____ her sister.
(A)	as well as
(B)	as better as
(C)	as nicest as
(D)	as worse as



<p>Q.2</p>	<div style="text-align: center;">  </div> <p>A transparent square sheet shown above is folded along the dotted line. The folded sheet will look like _____.</p>
<p>(A)</p>	
<p>(B)</p>	
<p>(C)</p>	
<p>(D)</p>	



Computer Science and Information Technology (CS, Set-2)

Q.3	If θ is the angle, in degrees, between the longest diagonal of the cube and any one of the edges of the cube, then, $\cos \theta =$
(A)	$\frac{1}{2}$
(B)	$\frac{1}{\sqrt{3}}$
(C)	$\frac{1}{\sqrt{2}}$
(D)	$\frac{\sqrt{3}}{2}$

Q.4	If $\left(x - \frac{1}{2}\right)^2 - \left(x - \frac{3}{2}\right)^2 = x + 2$, then the value of x is:
(A)	2
(B)	4
(C)	6
(D)	8



Q.5	Pen : Write :: Knife : _____ Which one of the following options maintains a similar logical relation in the above?
(A)	Vegetables
(B)	Sharp
(C)	Cut
(D)	Blunt

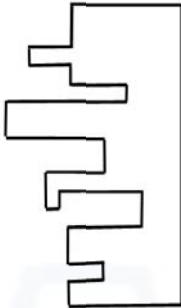

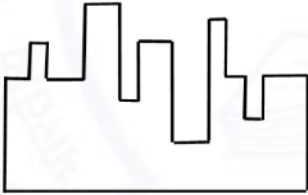
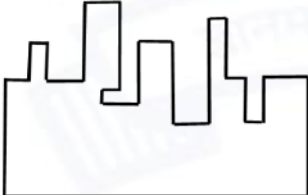
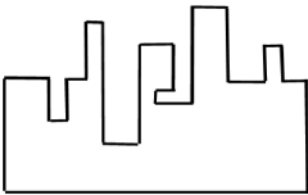


Computer Science and Information Technology (CS, Set-2)

Q. 6 – Q. 10 Multiple Choice Question (MCQ), carry TWO marks each (for each wrong answer: – 2/3).

<p>Q.6</p>	<p>Listening to music during exercise improves exercise performance and reduces discomfort. Scientists researched whether listening to music while studying can help students learn better and the results were inconclusive. Students who needed external stimulation for studying fared worse while students who did not need any external stimulation benefited from music.</p> <p>Which one of the following statements is the CORRECT inference of the above passage?</p>
<p>(A)</p>	<p>Listening to music has no effect on learning and a positive effect on physical exercise.</p>
<p>(B)</p>	<p>Listening to music has a clear positive effect both on physical exercise and on learning.</p>
<p>(C)</p>	<p>Listening to music has a clear positive effect on physical exercise. Music has a positive effect on learning only in some students.</p>
<p>(D)</p>	<p>Listening to music has a clear positive effect on learning in all students. Music has a positive effect only in some students who exercise.</p>



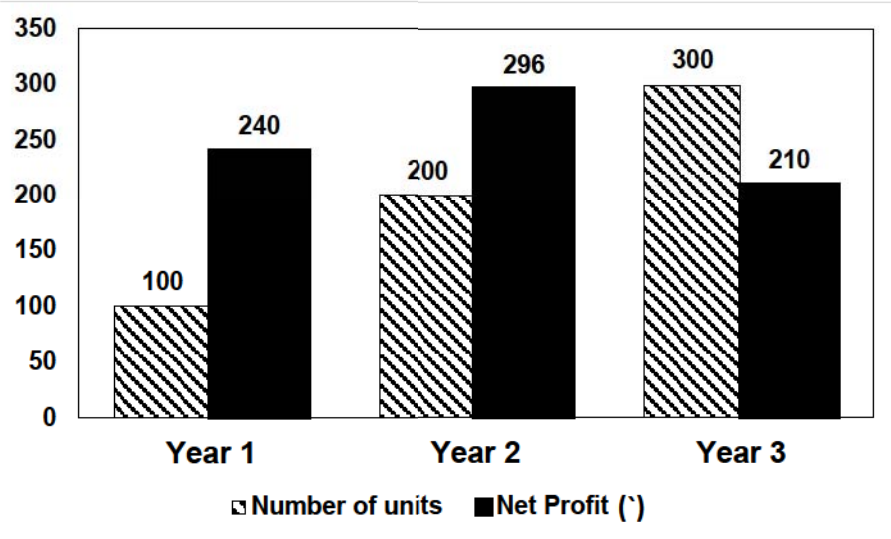
<p>Q.7</p>	<div style="text-align: center;">  </div> <p>A jigsaw puzzle has 2 pieces. One of the pieces is shown above. Which one of the given options for the missing piece when assembled will form a rectangle? The piece can be moved, rotated or flipped to assemble with the above piece.</p>
<p>(A)</p>	
<p>(B)</p>	
<p>(C)</p>	
<p>(D)</p>	



Q.8	<p>The number of students in three classes is in the ratio 3:13:6. If 18 students are added to each class, the ratio changes to 15:35:21.</p> <p>The total number of students in all the three classes in the beginning was:</p>
(A)	22
(B)	66
(C)	88
(D)	110



Q.9



The number of units of a product sold in three different years and the respective net profits are presented in the figure above. The cost/unit in Year 3 was ₹1, which was half the cost/unit in Year 2. The cost/unit in Year 3 was one-third of the cost/unit in Year 1. Taxes were paid on the selling price at 10%, 13% and 15% respectively for the three years. Net profit is calculated as the difference between the selling price and the sum of cost and taxes paid in that year.

The ratio of the selling price in Year 2 to the selling price in Year 3 is _____.

A)	4:3
(B)	1:1
(C)	3:4
(D)	1:2



Computer Science and Information Technology (CS, Set-2)

<p>Q.10</p>	<p>Six students P, Q, R, S, T and U, with distinct heights, compare their heights and make the following observations.</p> <p>Observation I: S is taller than R.</p> <p>Observation II: Q is the shortest of all.</p> <p>Observation III: U is taller than only one student.</p> <p>Observation IV: T is taller than S but is not the tallest.</p> <p>The number of students that are taller than R is the same as the number of students shorter than _____.</p>
<p>(A) T</p>	
<p>(B) R</p>	
<p>(C) S</p>	
<p>(D) P</p>	



Computer Science and Information Technology (CS, Set-2)

Q.1 – Q.10 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: – 1/3).

Q.1	<p>Let G be a connected undirected weighted graph. Consider the following two statements.</p> <p>S_1 : There exists a minimum weight edge in G which is present in every minimum spanning tree of G.</p> <p>S_2 : If every edge in G has distinct weight, then G has a unique minimum spanning tree.</p> <p>Which one of the following options is correct?</p>
(A)	Both S_1 and S_2 are true.
(B)	S_1 is true and S_2 is false.
(C)	S_1 is false and S_2 is true.
(D)	Both S_1 and S_2 are false.

Q.2	<p>Let H be a binary min-heap consisting of n elements implemented as an array. What is the worst case time complexity of an optimal algorithm to find the maximum element in H?</p>
(A)	$\Theta(1)$
(B)	$\Theta(\log n)$
(C)	$\Theta(n)$
(D)	$\Theta(n \log n)$



Computer Science and Information Technology (CS, Set-2)

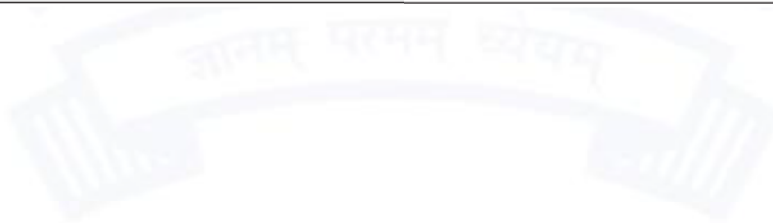
<p>Q.3</p>	<p>Consider the following ANSI C program:</p> <pre>int main() { Integer x; return 0; }</pre> <p>Which one of the following phases in a seven-phase C compiler will throw an error?</p>
<p>(A)</p>	<p>Lexical analyzer</p>
<p>(B)</p>	<p>Syntax analyzer</p>
<p>(C)</p>	<p>Semantic analyzer</p>
<p>(D)</p>	<p>Machine dependent optimizer</p>

<p>Q.4</p>	<p>The format of the single-precision floating-point representation of a real number as per the IEEE 754 standard is as follows:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 2px;">sign</td> <td style="padding: 2px;">exponent</td> <td style="padding: 2px;">mantissa</td> </tr> </table> <p>Which one of the following choices is correct with respect to the <i>smallest</i> normalized positive number represented using the standard?</p>	sign	exponent	mantissa
sign	exponent	mantissa		
<p>(A)</p>	<p>exponent = 00000000 and mantissa = 000000000000000000000000</p>			
<p>(B)</p>	<p>exponent = 00000000 and mantissa = 000000000000000000000001</p>			
<p>(C)</p>	<p>exponent = 00000001 and mantissa = 000000000000000000000000</p>			
<p>(D)</p>	<p>exponent = 00000001 and mantissa = 000000000000000000000001</p>			



Computer Science and Information Technology (CS, Set-2)

Q.5	<p>Which one of the following circuits implements the Boolean function given below?</p> $f(x, y, z) = m_0 + m_1 + m_3 + m_4 + m_5 + m_6, \text{ where } m_i \text{ is the } i^{\text{th}} \text{ minterm.}$
(A)	
(B)	
(C)	
(D)	





Computer Science and Information Technology (CS, Set-2)

Q.6	<p>Consider the following statements S1 and S2 about the relational data model:</p> <p>S1: A relation scheme can have at most one foreign key. S2: A foreign key in a relation scheme R cannot be used to refer to tuples of R.</p> <p>Which one of the following choices is correct?</p>
(A)	Both S1 and S2 are true.
(B)	S1 is true and S2 is false.
(C)	S1 is false and S2 is true.
(D)	Both S1 and S2 are false.

Q.7	<p>Consider the three-way handshake mechanism followed during TCP connection establishment between hosts P and Q. Let X and Y be two random 32-bit starting sequence numbers chosen by P and Q respectively. Suppose P sends a TCP connection request message to Q with a TCP segment having SYN bit = 1, SEQ number = X, and ACK bit = 0. Suppose Q accepts the connection request. Which one of the following choices represents the information present in the TCP segment header that is sent by Q to P?</p>
(A)	SYN bit = 1, SEQ number = X+1, ACK bit = 0, ACK number = Y, FIN bit = 0
(B)	SYN bit = 0, SEQ number = X+1, ACK bit = 0, ACK number = Y, FIN bit = 1
(C)	SYN bit = 1, SEQ number = Y, ACK bit = 1, ACK number = X+1, FIN bit = 0
(D)	SYN bit = 1, SEQ number = Y, ACK bit = 1, ACK number = X, FIN bit = 0



Computer Science and Information Technology (CS, Set-2)

Q.8	What is the worst-case number of arithmetic operations performed by recursive binary search on a sorted array of size n ?
(A)	$\Theta(\sqrt{n})$
(B)	$\Theta(\log_2(n))$
(C)	$\Theta(n^2)$
(D)	$\Theta(n)$

Q.9	Let $L \subseteq \{0, 1\}^*$ be an arbitrary regular language accepted by a minimal DFA with k states. Which one of the following languages must necessarily be accepted by a minimal DFA with k states?
(A)	$L - \{01\}$
(B)	$L \cup \{01\}$
(C)	$\{0, 1\}^* - L$
(D)	$L \cdot L$



Q.10	<p>Consider the following ANSI C program.</p> <pre>#include <stdio.h> int main(){ int arr[4][5]; int i, j; for (i=0; i<4; i++){ for (j=0; j<5; j++){ arr[i][j] = 10*i + j; } } printf("%d", *(arr[1] + 9)); return 0; }</pre> <p>What is the output of the above program?</p>
(A)	14
(B)	20
(C)	24
(D)	30



Computer Science and Information Technology (CS, Set-2)

Q.11 – Q.15 Multiple Select Question (MSQ), carry ONE mark each (no negative marks).

Q.11	<p>Consider the following sets, where $n \geq 2$:</p> <p>S_1: Set of all $n \times n$ matrices with entries from the set $\{a, b, c\}$ S_2: Set of all functions from the set $\{0, 1, 2, \dots, n^2 - 1\}$ to the set $\{0, 1, 2\}$</p> <p>Which of the following choice(s) is/are correct?</p>
(A)	There does not exist a bijection from S_1 to S_2 .
(B)	There exists a surjection from S_1 to S_2 .
(C)	There exists a bijection from S_1 to S_2 .
(D)	There does not exist an injection from S_1 to S_2 .

Q.12	<p>Let L_1 be a regular language and L_2 be a context-free language. Which of the following languages is/are context-free?</p>
(A)	$L_1 \cap \overline{L_2}$
(B)	$\overline{L_1 \cup L_2}$
(C)	$L_1 \cup (L_2 \cup \overline{L_2})$
(D)	$(L_1 \cap L_2) \cup (\overline{L_1} \cap L_2)$



Computer Science and Information Technology (CS, Set-2)

Q.13	In the context of compilers, which of the following is/are NOT an intermediate representation of the source program?
(A)	Three address code
(B)	Abstract Syntax Tree (AST)
(C)	Control Flow Graph (CFG)
(D)	Symbol table

Q.14	Which of the following statement(s) is/are correct in the context of CPU scheduling?
(A)	Turnaround time includes waiting time.
(B)	The goal is to only maximize CPU utilization and minimize throughput.
(C)	Round-robin policy can be used even when the CPU time required by each of the processes is not known apriori.
(D)	Implementing preemptive scheduling needs hardware support.



Computer Science and Information Technology (CS, Set-2)

Q.15	Choose the correct choice(s) regarding the following propositional logic assertion S : $S : ((P \wedge Q) \rightarrow R) \rightarrow ((P \wedge Q) \rightarrow (Q \rightarrow R))$
(A)	S is neither a tautology nor a contradiction.
(B)	S is a tautology.
(C)	S is a contradiction.
(D)	The antecedent of S is logically equivalent to the consequent of S .





Computer Science and Information Technology (CS, Set-2)

Q.16 – Q.25 Numerical Answer Type (NAT), carry ONE mark each (no negative marks).

Q.16	<p>Consider a complete binary tree with 7 nodes. Let A denote the set of first 3 elements obtained by performing Breadth-First Search (BFS) starting from the root. Let B denote the set of first 3 elements obtained by performing Depth-First Search (DFS) starting from the root.</p> <p>The value of $A - B$ is _____.</p>
------	---

Q.17	<p>Consider the following deterministic finite automaton (DFA).</p> <div style="text-align: center;"> <pre> graph LR start((start)) -- 0 --> S1(()) start -- 1 --> S2(()) S1 -- 0 --> S3(()) S1 -- 1 --> S4(()) S2 -- 0 --> S3 S2 -- 1 --> S4 S3 -- 0 --> S4 S3 -- 1 --> S4 S4 -- 0 --> S4 S4 -- 1 --> S4 style start fill:none,stroke:none style S4 stroke-width:2px </pre> </div> <p>The number of strings of length 8 accepted by the above automaton is _____.</p>
------	--

Q.18	<p>If x and y are two decimal digits and $(0.1101)_2 = (0.8xy5)_{10}$, the decimal value of $x + y$ is _____.</p>
------	---

Q.19	<p>Consider a set-associative cache of size 2KB ($1\text{KB} = 2^{10}$ bytes) with cache block size of 64 bytes. Assume that the cache is byte-addressable and a 32-bit address is used for accessing the cache. If the width of the tag field is 22 bits, the associativity of the cache is _____.</p>
------	--



Computer Science and Information Technology (CS, Set-2)

Q.20	Consider a computer system with DMA support. The DMA module is transferring one 8-bit character in one CPU cycle from a device to memory through <i>cycle stealing</i> at regular intervals. Consider a 2 MHz processor. If 0.5% processor cycles are used for DMA, the data transfer rate of the device is _____ bits per second.
------	--

Q.21	A data file consisting of 1,50,000 student-records is stored on a hard disk with block size of 4096 bytes. The data file is sorted on the primary key RollNo. The size of a record pointer for this disk is 7 bytes. Each student-record has a candidate key attribute called ANum of size 12 bytes. Suppose an index file with records consisting of two fields, ANum value and the record pointer to the corresponding student record, is built and stored on the same disk. Assume that the records of data file and index file are not split across disk blocks. The number of blocks in the index file is _____.
------	---

Q.22	For a given biased coin, the probability that the outcome of a toss is a head is 0.4. This coin is tossed 1,000 times. Let X denote the random variable whose value is the number of times that head appeared in these 1,000 tosses. The standard deviation of X (rounded to 2 decimal places) is _____.
------	--

Q.23	<p>Consider the following ANSI C function:</p> <pre>int SomeFunction(int x, int y) { if ((x == 1) (y == 1)) return 1; if (x == y) return x; if (x > y) return SomeFunction(x - y, y); if (y > x) return SomeFunction(x, y - x); }</pre> <p>The value returned by SomeFunction(15, 255) is _____.</p>
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**Computer Science and Information Technology (CS, Set-2)**

Q.24	Suppose that P is a 4×5 matrix such that every solution of the equation $Px = 0$ is a scalar multiple of $[2 \ 5 \ 4 \ 3 \ 1]^T$. The rank of P is _____.
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Q.25	Suppose that $f: \mathbb{R} \rightarrow \mathbb{R}$ is a continuous function on the interval $[-3, 3]$ and a differentiable function in the interval $(-3, 3)$ such that for every x in the interval, $f'(x) \leq 2$. If $f(-3) = 7$, then $f(3)$ is at most _____.
------	---





Computer Science and Information Technology (CS, Set-2)

Q.26 – Q.39 Multiple Choice Question (MCQ), carry TWO mark each (for each wrong answer: – 2/3).

Q.26	<p>Consider the string <code>abbccddeee</code>. Each letter in the string must be assigned a binary code satisfying the following properties:</p> <ol style="list-style-type: none"> 1. For any two letters, the code assigned to one letter must not be a prefix of the code assigned to the other letter. 2. For any two letters of the same frequency, the letter which occurs earlier in the dictionary order is assigned a code whose length is at most the length of the code assigned to the other letter. <p>Among the set of all binary code assignments which satisfy the above two properties, what is the minimum length of the encoded string?</p>
(A)	21
(B)	23
(C)	25
(D)	30



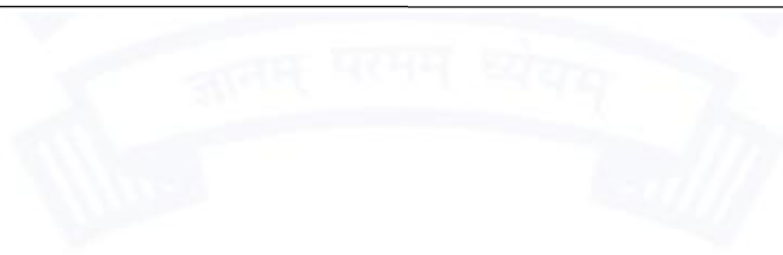
Computer Science and Information Technology (CS, Set-2)

Q.27	<p>Assume a two-level inclusive cache hierarchy, L1 and L2, where L2 is the larger of the two. Consider the following statements.</p> <p>S_1 : Read misses in a write through L1 cache do not result in writebacks of dirty lines to the L2.</p> <p>S_2 : Write allocate policy <i>must</i> be used in conjunction with write through caches and no-write allocate policy is used with writeback caches.</p> <p>Which of the following statements is correct?</p>
(A)	S_1 is true and S_2 is false
(B)	S_1 is false and S_2 is true
(C)	S_1 is true and S_2 is true
(D)	S_1 is false and S_2 is false



Computer Science and Information Technology (CS, Set-2)

<p>Q.28</p>	<p>Suppose we want to design a synchronous circuit that processes a string of 0's and 1's. Given a string, it produces another string by replacing the first 1 in any subsequence of consecutive 1's by a 0. Consider the following example.</p> <p style="text-align: center;">Input sequence: 00100011000011100 Output sequence: 00000001000001100</p> <p>A <i>Mealy Machine</i> is a state machine where both the next state and the output are functions of the present state and the current input. The above mentioned circuit can be designed as a two-state Mealy machine. The states in the Mealy machine can be represented using Boolean values 0 and 1. We denote the current state, the next state, the next incoming bit, and the output bit of the Mealy machine by the variables s, t, b and y respectively. Assume the initial state of the Mealy machine is 0. What are the Boolean expressions corresponding to t and y in terms of s and b?</p>
<p>(A)</p>	<p>$t = s + b$ $y = sb$</p>
<p>(B)</p>	<p>$t = b$ $y = sb$</p>
<p>(C)</p>	<p>$t = b$ $y = s\bar{b}$</p>
<p>(D)</p>	<p>$t = s + b$ $y = s\bar{b}$</p>





Computer Science and Information Technology (CS, Set-2)

<p>Q.29</p>	<p>In an examination, a student can choose the order in which two questions (QuesA and QuesB) must be attempted.</p> <ul style="list-style-type: none"> - If the first question is answered wrong, the student gets zero marks. - If the first question is answered correctly and the second question is not answered correctly, the student gets the marks only for the first question. - If both the questions are answered correctly, the student gets the sum of the marks of the two questions. <p>The following table shows the probability of correctly answering a question and the marks of the question respectively.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>question</th> <th>probability of answering correctly</th> <th>marks</th> </tr> </thead> <tbody> <tr> <td>QuesA</td> <td>0.8</td> <td>10</td> </tr> <tr> <td>QuesB</td> <td>0.5</td> <td>20</td> </tr> </tbody> </table> <p>Assuming that the student always wants to maximize her expected marks in the examination, in which order should she attempt the questions and what is the expected marks for that order (assume that the questions are independent)?</p>	question	probability of answering correctly	marks	QuesA	0.8	10	QuesB	0.5	20
question	probability of answering correctly	marks								
QuesA	0.8	10								
QuesB	0.5	20								
<p>(A)</p>	<p>First QuesA and then QuesB. Expected marks 14.</p>									
<p>(B)</p>	<p>First QuesB and then QuesA. Expected marks 14.</p>									
<p>(C)</p>	<p>First QuesB and then QuesA. Expected marks 22.</p>									
<p>(D)</p>	<p>First QuesA and then QuesB. Expected marks 16.</p>									



Computer Science and Information Technology (CS, Set-2)

<p>Q.30</p>	<p>Consider the following ANSI C code segment:</p> <pre> z = x + 3 + y->f1 + y->f2; for (i = 0; i < 200; i = i + 2){ if (z > i) { p = p + x + 3; q = q + y->f1; } else { p = p + y->f2; q = q + x + 3; } } </pre> <p>Assume that the variable <code>y</code> points to a <code>struct</code> (allocated on the heap) containing two fields <code>f1</code> and <code>f2</code>, and the local variables <code>x</code>, <code>y</code>, <code>z</code>, <code>p</code>, <code>q</code>, and <code>i</code> are allotted registers. Common sub-expression elimination (CSE) optimization is applied on the code. The number of addition and dereference operations (of the form <code>y->f1</code> or <code>y->f2</code>) in the optimized code, respectively, are:</p>
<p>(A)</p>	<p>403 and 102</p>
<p>(B)</p>	<p>203 and 2</p>
<p>(C)</p>	<p>303 and 102</p>
<p>(D)</p>	<p>303 and 2</p>



Computer Science and Information Technology (CS, Set-2)

<p>Q.31</p>	<p>The relation scheme given below is used to store information about the employees of a company, where empId is the key and deptId indicates the department to which the employee is assigned. Each employee is assigned to exactly one department.</p> <p style="text-align: center;">emp(empId, name, gender, salary, deptId)</p> <p>Consider the following SQL query:</p> <pre>select deptId, count(*) from emp where gender = "female" and salary > (select avg(salary) from emp) group by deptId;</pre> <p>The above query gives, for each department in the company, the number of female employees whose salary is greater than the average salary of</p>
<p>(A)</p>	<p>employees in the department.</p>
<p>(B)</p>	<p>employees in the company.</p>
<p>(C)</p>	<p>female employees in the department.</p>
<p>(D)</p>	<p>female employees in the company.</p>



Computer Science and Information Technology (CS, Set-2)

<p>Q.32</p>	<p>Let S be the following schedule of operations of three transactions T_1, T_2 and T_3 in a relational database system:</p> $R_2(Y), R_1(X), R_3(Z), R_1(Y), W_1(X), R_2(Z), W_2(Y), R_3(X), W_3(Z)$ <p>Consider the statements P and Q below:</p> <p>P: S is conflict-serializable. Q: If T_3 commits before T_1 finishes, then S is recoverable.</p> <p>Which one of the following choices is correct?</p>
<p>(A)</p>	<p>Both P and Q are true.</p>
<p>(B)</p>	<p>P is true and Q is false.</p>
<p>(C)</p>	<p>P is false and Q is true.</p>
<p>(D)</p>	<p>Both P and Q are false.</p>

<p>Q.33</p>	<p>A bag has r red balls and b black balls. All balls are identical except for their colours. In a trial, a ball is randomly drawn from the bag, its colour is noted and the ball is placed back into the bag along with another ball of the same colour. Note that the number of balls in the bag will increase by one, after the trial. A sequence of four such trials is conducted. Which one of the following choices gives the probability of drawing a red ball in the fourth trial?</p>
<p>(A)</p>	$\frac{r}{r+b}$
<p>(B)</p>	$\frac{r}{r+b+3}$
<p>(C)</p>	$\frac{r+3}{r+b+3}$
<p>(D)</p>	$\left(\frac{r}{r+b}\right) \left(\frac{r+1}{r+b+1}\right) \left(\frac{r+2}{r+b+2}\right) \left(\frac{r+3}{r+b+3}\right)$



Computer Science and Information Technology (CS, Set-2)

Q.34	Consider the cyclic redundancy check (CRC) based error detecting scheme having the generator polynomial $X^3 + X + 1$. Suppose the message $m_4m_3m_2m_1m_0 = 11000$ is to be transmitted. Check bits $c_2c_1c_0$ are appended at the end of the message by the transmitter using the above CRC scheme. The transmitted bit string is denoted by $m_4m_3m_2m_1m_0c_2c_1c_0$. The value of the checkbit sequence $c_2c_1c_0$ is
(A)	101
(B)	110
(C)	100
(D)	111





<p>Q.35</p>	<p>Consider the following ANSI C program:</p> <pre>#include <stdio.h> #include <stdlib.h> struct Node{ int value; struct Node *next;}; int main(){ struct Node *boxE, *head, *boxN; int index = 0; boxE = head = (struct Node *) malloc(sizeof(struct Node)); head->value = index; for (index = 1; index <= 3; index++){ boxN = (struct Node *) malloc(sizeof(struct Node)); boxE->next = boxN; boxN->value = index; boxE = boxN; } for (index = 0; index <= 3; index++) { printf("Value at index %d is %d\n", index, head->value); head = head->next; printf("Value at index %d is %d\n", index+1, head->value); } }</pre> <p>Which one of the statements below is correct about the program?</p>
<p>(A)</p>	<p>Upon execution, the program creates a linked-list of five nodes.</p>
<p>(B)</p>	<p>Upon execution, the program goes into an infinite loop.</p>
<p>(C)</p>	<p>It has a missing return which will be reported as an error by the compiler.</p>
<p>(D)</p>	<p>It dereferences an uninitialized pointer that may result in a run-time error.</p>



Computer Science and Information Technology (CS, Set-2)

Q.36	<p>Consider the following two statements about regular languages: S_1: Every infinite regular language contains an undecidable language as a subset. S_2: Every finite language is regular. Which one of the following choices is correct?</p>
(A)	Only S_1 is true.
(B)	Only S_2 is true.
(C)	Both S_1 and S_2 are true.
(D)	Neither S_1 nor S_2 is true.

Q.37	<p>For two n-dimensional real vectors P and Q, the operation $s(P, Q)$ is defined as follows:</p> $s(P, Q) = \sum_{i=1}^n (P[i] \cdot Q[i])$ <p>Let \mathcal{L} be a set of 10-dimensional non-zero real vectors such that for every pair of distinct vectors $P, Q \in \mathcal{L}$, $s(P, Q) = 0$. What is the maximum cardinality possible for the set \mathcal{L}?</p>
(A)	9
(B)	10
(C)	11
(D)	100



Computer Science and Information Technology (CS, Set-2)

Q.38	<p>For a statement S in a program, in the context of liveness analysis, the following sets are defined:</p> <p>$USE(S)$: the set of variables used in S $IN(S)$: the set of variables that are live at the entry of S $OUT(S)$: the set of variables that are live at the exit of S</p> <p>Consider a basic block that consists of two statements, S_1 followed by S_2. Which one of the following statements is correct?</p>
(A)	$OUT(S_1) = IN(S_2)$
(B)	$OUT(S_1) = IN(S_1) \cup USE(S_1)$
(C)	$OUT(S_1) = IN(S_2) \cup OUT(S_2)$
(D)	$OUT(S_1) = USE(S_1) \cup IN(S_2)$

Q.39	<p>For constants $a \geq 1$ and $b > 1$, consider the following recurrence defined on the non-negative integers:</p> $T(n) = a \cdot T\left(\frac{n}{b}\right) + f(n)$ <p>Which one of the following options is correct about the recurrence $T(n)$?</p>
(A)	If $f(n)$ is $n \log_2(n)$, then $T(n)$ is $\Theta(n \log_2(n))$.
(B)	If $f(n)$ is $\frac{n}{\log_2(n)}$, then $T(n)$ is $\Theta(\log_2(n))$.
(C)	If $f(n)$ is $O(n^{\log_b(a)-\epsilon})$ for some $\epsilon > 0$, then $T(n)$ is $\Theta(n^{\log_b(a)})$.
(D)	If $f(n)$ is $\Theta(n^{\log_b(a)})$, then $T(n)$ is $\Theta(n^{\log_b(a)})$.



Computer Science and Information Technology (CS, Set-2)

Q.40 – Q.47 Multiple Select Question (MSQ), carry TWO mark each (no negative marks).

Q.40	<p>Suppose the following functional dependencies hold on a relation U with attributes P, Q, R, S, and T:</p> $P \rightarrow QR$ $RS \rightarrow T$ <p>Which of the following functional dependencies can be inferred from the above functional dependencies?</p>
(A)	$PS \rightarrow T$
(B)	$R \rightarrow T$
(C)	$P \rightarrow R$
(D)	$PS \rightarrow Q$

Q.41	<p>For a string w, we define w^R to be the reverse of w. For example, if $w = 01101$ then $w^R = 10110$. Which of the following languages is/are context-free?</p>
(A)	$\{wxw^R x^R \mid w, x \in \{0, 1\}^*\}$
(B)	$\{ww^R xx^R \mid w, x \in \{0, 1\}^*\}$
(C)	$\{wxw^R \mid w, x \in \{0, 1\}^*\}$
(D)	$\{wxx^R w^R \mid w, x \in \{0, 1\}^*\}$



Computer Science and Information Technology (CS, Set-2)

<p>Q.42</p>	<p>Consider the following multi-threaded code segment (in a mix of C and pseudo-code), invoked by two processes P1 and P2, and each of the processes spawns two threads T1 and T2:</p> <pre> int x = 0; // global Lock L1; // global main() { create a thread to execute foo(); // Thread T1 create a thread to execute foo(); // Thread T2 wait for the two threads to finish execution; print (x);} foo() { int y = 0; Acquire L1; x = x + 1; y = y + 1; Release L1; print (y);} </pre> <p>Which of the following statement(s) is/are correct?</p>
<p>(A)</p>	<p>Both P1 and P2 will print the value of x as 2.</p>
<p>(B)</p>	<p>At least one of P1 and P2 will print the value of x as 4.</p>
<p>(C)</p>	<p>At least one of the threads will print the value of y as 2.</p>
<p>(D)</p>	<p>Both T1 and T2, in both the processes, will print the value of y as 1.</p>



Computer Science and Information Technology (CS, Set-2)

<p>Q.43</p>	<p>Consider a computer system with multiple shared resource types, with one instance per resource type. Each instance can be owned by only one process at a time. Owning and freeing of resources are done by holding a global lock (L). The following scheme is used to own a resource instance :</p> <pre> function OWNRESOURCE(Resource R) Acquire lock L // a global lock if R is available then Acquire R Release lock L else if R is owned by another process P then Terminate P, after releasing all resources owned by P Acquire R Restart P Release lock L end if end if end function </pre> <p>Which of the following choice(s) about the above scheme is/are correct?</p>
<p>(A)</p>	<p>The scheme ensures that deadlocks will not occur.</p>
<p>(B)</p>	<p>The scheme may lead to live-lock.</p>
<p>(C)</p>	<p>The scheme may lead to starvation.</p>
<p>(D)</p>	<p>The scheme violates the mutual exclusion property.</p>



Computer Science and Information Technology (CS, Set-2)

Q.44	If the numerical value of a 2-byte unsigned integer on a little endian computer is 255 more than that on a big endian computer, which of the following choices represent(s) the unsigned integer on a little endian computer?
(A)	0x6665
(B)	0x0001
(C)	0x4243
(D)	0x0100





<p>Q.45</p>	<p>Consider a computer network using the distance vector routing algorithm in its network layer. The partial topology of the network is as shown below.</p> <div style="text-align: center;"> </div> <p>The objective is to find the shortest-cost path from the router R to routers P and Q. Assume that R does not initially know the shortest routes to P and Q. Assume that R has three neighbouring routers denoted as X, Y, and Z. During one iteration, R measures its distance to its neighbours X, Y, and Z as 3, 2, and 5, respectively. Router R gets routing vectors from its neighbours that indicate that the distance to router P from routers X, Y, and Z are 7, 6, and 5, respectively. The routing vector also indicates that the distance to router Q from routers X, Y, and Z are 4, 6, and 8, respectively. Which of the following statement(s) is/are correct with respect to the new routing table of R, after update during this iteration?</p>
<p>(A)</p>	<p>The distance from R to P will be stored as 10.</p>
<p>(B)</p>	<p>The distance from R to Q will be stored as 7.</p>
<p>(C)</p>	<p>The next hop router for a packet from R to P is Y.</p>
<p>(D)</p>	<p>The next hop router for a packet from R to Q is Z.</p>



<p>Q.46</p>	<p>Consider the following directed graph:</p> <p>Which of the following is/are correct about the graph?</p>
<p>(A)</p>	<p>The graph does not have a topological order.</p>
<p>(B)</p>	<p>A depth-first traversal starting at vertex S classifies three directed edges as back edges.</p>
<p>(C)</p>	<p>The graph does not have a strongly connected component.</p>
<p>(D)</p>	<p>For each pair of vertices u and v, there is a directed path from u to v.</p>



Computer Science and Information Technology (CS, Set-2)

Q.47	Which of the following regular expressions represent(s) the set of all binary numbers that are divisible by three? Assume that the string ϵ is divisible by three.
(A)	$(0 + 1(01^*0)^*1)^*$
(B)	$(0 + 11 + 10(1 + 00)^*01)^*$
(C)	$(0^*(1(01^*0)^*1)^*)^*$
(D)	$(0 + 11 + 11(1 + 00)^*00)^*$





Computer Science and Information Technology (CS, Set-2)

Q.48 – Q.55 Numerical Answer Type (NAT), carry TWO mark each (no negative marks).

Q.48	<p>Consider a three-level page table to translate a 39-bit virtual address to a physical address as shown below.</p> <div style="text-align: center; margin: 10px 0;"> <p><----- 39-bit virtual address -----></p> <table border="1" style="margin: auto; border-collapse: collapse;"> <tr> <td style="padding: 5px;"> </td> <td style="padding: 5px;">Level 1</td> <td style="padding: 5px;"> </td> <td style="padding: 5px;">Level 2</td> <td style="padding: 5px;"> </td> <td style="padding: 5px;">Level 3</td> <td style="padding: 5px;"> </td> <td style="padding: 5px;">Page</td> <td style="padding: 5px;"> </td> </tr> <tr> <td style="padding: 5px;"> </td> <td style="padding: 5px;">offset</td> <td style="padding: 5px;"> </td> <td style="padding: 5px;">offset</td> <td style="padding: 5px;"> </td> <td style="padding: 5px;">offset</td> <td style="padding: 5px;"> </td> <td style="padding: 5px;">offset</td> <td style="padding: 5px;"> </td> </tr> <tr> <td style="padding: 5px;"> </td> <td colspan="2" style="padding: 5px;">-----</td> <td colspan="2" style="padding: 5px;">-----</td> <td colspan="2" style="padding: 5px;">-----</td> <td colspan="2" style="padding: 5px;">-----</td> <td style="padding: 5px;"> </td> </tr> <tr> <td style="padding: 5px;"> </td> <td style="padding: 5px;">9 bits</td> <td style="padding: 5px;"> </td> <td style="padding: 5px;">9 bits</td> <td style="padding: 5px;"> </td> <td style="padding: 5px;">9 bits</td> <td style="padding: 5px;"> </td> <td style="padding: 5px;">12 bits</td> <td style="padding: 5px;"> </td> </tr> </table> </div> <p>The page size is 4KB (1KB = 2^{10} bytes) and page table entry size at every level is 8 bytes. A process P is currently using 2GB (1GB = 2^{30} bytes) virtual memory which is mapped to 2GB of physical memory. The minimum amount of memory required for the page table of P across all levels is _____ KB.</p>		Level 1		Level 2		Level 3		Page			offset		offset		offset		offset			-----		-----		-----		-----				9 bits		9 bits		9 bits		12 bits	
	Level 1		Level 2		Level 3		Page																															
	offset		offset		offset		offset																															
	-----		-----		-----		-----																															
	9 bits		9 bits		9 bits		12 bits																															

Q.49	<p>Consider the following ANSI C program.</p> <pre>#include <stdio.h> int foo(int x, int y, int q) { if ((x <= 0) && (y <= 0)) return q; if (x <= 0) return foo(x, y-q, q); if (y <= 0) return foo(x-q, y, q); return foo(x, y-q, q) + foo(x-q, y, q); } int main() { int r = foo(15,15,10); printf("%d", r); return 0; }</pre> <p>The output of the program upon execution is _____</p>
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Computer Science and Information Technology (CS, Set-2)

Q.50	Let S be a set consisting of 10 elements. The number of tuples of the form (A, B) such that A and B are subsets of S , and $A \subseteq B$ is _____.
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Q.51	<p>Consider the following augmented grammar with $\{\#, @, <, >, a, b, c\}$ as the set of terminals.</p> $S' \rightarrow S$ $S \rightarrow S \# c S$ $S \rightarrow S S$ $S \rightarrow S @$ $S \rightarrow < S >$ $S \rightarrow a$ $S \rightarrow b$ $S \rightarrow c$ <p>Let $I_0 = \text{CLOSURE}(\{S' \rightarrow \bullet S\})$. The number of items in the set $\text{GOTO}(\text{GOTO}(I_0, <), <)$ is _____.</p>
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Q.52	<p>Consider a Boolean function $f(w, x, y, z)$ such that</p> $f(w, 0, 0, z) = 1$ $f(1, x, 1, z) = x + z$ $f(w, 1, y, z) = wz + y$ <p>The number of literals in the minimal sum-of-products expression of f is _____.</p>
------	--



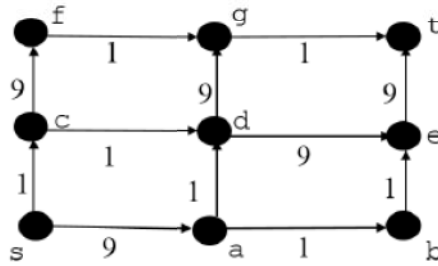
Computer Science and Information Technology (CS, Set-2)

Q.53	<p>Consider a pipelined processor with 5 stages, Instruction Fetch (IF), Instruction Decode (ID), Execute (EX), Memory Access (MEM), and Write Back (WB). Each stage of the pipeline, except the EX stage, takes one cycle. Assume that the ID stage merely decodes the instruction and the register read is performed in the EX stage. The EX stage takes one cycle for ADD instruction and two cycles for MUL instruction. Ignore pipeline register latencies.</p> <p>Consider the following sequence of 8 instructions:</p> $\text{ADD, MUL, ADD, MUL, ADD, MUL, ADD, MUL}$ <p>Assume that every MUL instruction is data-dependent on the ADD instruction just before it and every ADD instruction (except the first ADD) is data-dependent on the MUL instruction just before it. The <i>Speedup</i> is defined as follows:</p> $\text{Speedup} = \frac{\text{Execution time without operand forwarding}}{\text{Execution time with operand forwarding}}$ <p>The <i>Speedup</i> achieved in executing the given instruction sequence on the pipelined processor (rounded to 2 decimal places) is _____.</p>
Q.54	<p>Consider a network using the pure ALOHA medium access control protocol, where each frame is of length 1,000 bits. The channel transmission rate is 1 Mbps (= 10^6 bits per second). The aggregate number of transmissions across all the nodes (including new frame transmissions and retransmitted frames due to collisions) is modelled as a Poisson process with a rate of 1,000 frames per second. Throughput is defined as the average number of frames successfully transmitted per second. The throughput of the network (rounded to the nearest integer) is _____.</p>



Q.55

In a directed acyclic graph with a source vertex s , the *quality-score* of a directed path is defined to be the product of the weights of the edges on the path. Further, for a vertex v other than s , the quality-score of v is defined to be the maximum among the quality-scores of all the paths from s to v . The quality-score of s is assumed to be 1.



The sum of the quality-scores of all the vertices in the graph shown above is _____.

END OF QUESTION PAPER

GATE 2021 Answer Key for Computer Science and Information Technology (CS - 2)
Graduate Aptitude Test in Engineering (GATE 2021)

Subject/Paper: Computer Science and Information Technology (CS - 2)

Q. No.	Session	Question Type MCQ/MSQ/NAT	Section Name	Answer Key/Range	Marks	Negative Marks
1	6	MCQ	GA	A	1	1/3
2	6	MCQ	GA	B	1	1/3
3	6	MCQ	GA	B	1	1/3
4	6	MCQ	GA	B	1	1/3
5	6	MCQ	GA	C	1	1/3
6	6	MCQ	GA	C	2	2/3
7	6	MCQ	GA	A	2	2/3
8	6	MCQ	GA	C	2	2/3
9	6	MCQ	GA	A	2	2/3
10	6	MCQ	GA	C	2	2/3
1	6	MCQ	CS	C	1	1/3
2	6	MCQ	CS	C	1	1/3
3	6	MCQ	CS	C	1	1/3
4	6	MCQ	CS	C	1	1/3
5	6	MCQ	CS	A	1	1/3
6	6	MCQ	CS	D	1	1/3
7	6	MCQ	CS	C	1	1/3
8	6	MCQ	CS	B	1	1/3
9	6	MCQ	CS	C	1	1/3
10	6	MCQ	CS	C	1	1/3
11	6	MSQ	CS	B; C	1	0

GATE 2021 Answer Key for Computer Science and Information Technology (CS - 2)

Q. No.	Session	Question Type MCQ/MSQ/NAT	Section Name	Answer Key/Range	Marks	Negative Marks
12	6	MSQ	CS	B; C; D	1	0
13	6	MSQ	CS	D	1	0
14	6	MSQ	CS	A; C; D	1	0
15	6	MSQ	CS	B; D	1	0
16	6	NAT	CS	1 to 1	1	0
17	6	NAT	CS	256 to 256	1	0
18	6	NAT	CS	3 to 3	1	0
19	6	NAT	CS	2 to 2	1	0
20	6	NAT	CS	80000 to 80000	1	0
21	6	NAT	CS	698 to 698	1	0
22	6	NAT	CS	15.00 to 16.00	1	0
23	6	NAT	CS	15 to 15	1	0
24	6	NAT	CS	4 to 4	1	0
25	6	NAT	CS	19 to 19	1	0
26	6	MCQ	CS	B	2	2/3
27	6	MCQ	CS	A	2	2/3
28	6	MCQ	CS	B	2	2/3
29	6	MCQ	CS	D	2	2/3
30	6	MCQ	CS	D	2	2/3
31	6	MCQ	CS	B	2	2/3
32	6	MCQ	CS	B	2	2/3
33	6	MCQ	CS	A	2	2/3
34	6	MCQ	CS	C	2	2/3

GATE 2021 Answer Key for Computer Science and Information Technology (CS - 2)

Q. No.	Session	Question Type MCQ/MSQ/NAT	Section Name	Answer Key/Range	Marks	Negative Marks
35	6	MCQ	CS	D	2	2/3
36	6	MCQ	CS	C	2	2/3
37	6	MCQ	CS	B	2	2/3
38	6	MCQ	CS	A	2	2/3
39	6	MCQ	CS	C	2	2/3
40	6	MSQ	CS	A; C; D	2	0
41	6	MSQ	CS	B; C; D	2	0
42	6	MSQ	CS	A; D	2	0
43	6	MSQ	CS	A; B; C	2	0
44	6	MSQ	CS	A; D	2	0
45	6	MSQ	CS	B; C	2	0
46	6	MSQ	CS	A; B	2	0
47	6	MSQ	CS	A; B; C	2	0
48	6	NAT	CS	4108 to 4108	2	0
49	6	NAT	CS	60 to 60	2	0
50	6	NAT	CS	59049 to 59049	2	0
51	6	NAT	CS	8 to 8	2	0
52	6	NAT	CS	6 to 6	2	0
53	6	NAT	CS	1.87 to 1.88	2	0
54	6	NAT	CS	130 to 140	2	0
55	6	NAT	CS	929 to 929	2	0