# 2007 CS: Computer Science and Engineering

Duration : Three Hours Maximum Marks :150

#### Read the following instructions carefully.

- This question paper contains 85 objective type questions. Q.1 to Q.20 carry one mark each and Q.21 to Q.85 carry two marks each.
- 2. Attempt all the questions.
- 3. Questions must be answered on Objective Response Sheet (ORS) by darkening the appropriate bubble (marked A, B, C, D) using HB pencil against the question number on the left hand side of the ORS. Each question has only one correct answer. In case you wish to change an answer, erase the old answer completely.
- 4. Wrong answers will carry NEGATIVE marks. In Q.1 to Q.20, 0.25 mark will be deducted for each wrong answer. In Q.21 to Q.76, Q.78, Q.80, Q.82 and in Q.84, 0.5 mark will be deducted for each wrong answer. However, there is no negative marking in Q.77, Q.79, Q.81, Q.83 and in Q.85. More than one answer bubbled against a question will be taken as an incorrect response. Unattempted questions will not carry any marks.
- Write your registration number, your name and name of the examination centre at the specified locations on the right half of the ORS.
- Using HB pencil, darken the appropriate bubble under each digit of your regist:ation number and the letters corresponding to your paper code.
- 7. Calculator is allowed in the examination hall.
- 8. Charts, graph sheets or tables are NOT allowed in the examination hall.
- Rough work can be done on the question paper itself. Additionally blank pages are given at the end of the question paper for rough work.
- This question paper contains 24 printed pages including pages for rough work. Please check all pages and report, if there is any discrepancy.

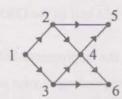
## Q. 1 - Q. 20 carry one mark each.

- 0.1 Consider the following two statements about the function f(x) = |x|:
  - P. f(x) is continuous for all real values of x
  - Q. f(x) is differentiable for all real values of x

Which of the following is TRUE?

- (A) P is true and O is false.
- (B) P is false and Q is true.
- (C) Both P and Q are true.
- (D) Both P and Q are false.
- Q.2 Let S be a set of n elements. The number of ordered pairs in the largest and the smallest equivalence relations on S are
  - (A) n and n
- (B)  $n^2$  and n (C)  $n^2$  and 0
- (D) n and 1
- Q.3 What is the maximum number of different Boolean functions involving n Boolean variables?
  - $(A) n^2$
- (B) 2"

- 0.4 Let G be the non-planar graph with the minimum possible number of edges. Then G has
  - (A) 9 edges and 5 vertices
  - (B) 9 edges and 6 vertices
  - (C) 10 edges and 5 vertices
  - (D) 10 edges and 6 vertices
- Q.5 Consider the DAG with  $V = \{1,2,3,4,5,6\}$ , shown below.



Which of the following is NOT a topological ordering?

(A) 123456

(B) 132456

(C) 132465

- (D) 324165
- Q.6 Which of the following problems is undecidable?
  - (A) Membership problem for CFGs.
  - (B) Ambiguity problem for CFGs.
  - (C) Finiteness problem for FSAs.
  - (D) Equivalence problem for FSAs.

Q.7	Which of the following is TRUE?	
	<ul> <li>(A) Every subset of a regular set is regular.</li> <li>(B) Every finite subset of a non-regular set</li> <li>(C) The union of two non-regular sets is no</li> <li>(D) Infinite union of finite sets is regular.</li> </ul>	is regular.
Q.8	How many 3-to-8 line decoders with an ena line decoder without using any other logic a	able input are needed to construct a 6-to-64 gates?
	(A) 7 (B) 8	(C) 9 (D) 10
Q.9	Consider the following Boolean function of $f(w,x,y,z) = \sum (1,3,4,6,9,11,12,14)$ The function is  (A) independent of one variable. (B) independent of two variables.	
	<ul><li>(C) independent of three variables.</li><li>(D) dependent on all the variables.</li></ul>	
Q.10	Consider a 4-way set associative cache con words. The CPU generates a 20-bit address of bits in the TAG, LINE and WORD field.	s of a word in main memory. The number
	(A) 9, 6, 5 (B) 7, 7, 6	(C) 7, 5, 8 (D) 9, 5, 6
Q.11	Consider a disk pack with 16 surfaces, 128 track. 512 bytes of data are stored in a bit s the disk pack and the number of bits require are respectively:	serial manner in a sector. The capacity of
	(A) 256 Mbyte, 19 bits (C) 512 Mbyte, 20 bits	(B) 256 Mbyte, 28 bits (D) 64 Gbyte, 28 bits
Q.12	The height of a binary tree is the maximum. The maximum number of nodes in a binary	
	(A) $2^h - 1$ (B) $2^{h-1} - 1$	(C) $2^{h+1}-1$ (D) $2^{h+1}$
Q.13	The maximum number of binary trees that is:	can be formed with three unlabeled nodes
	(A) 1 (B) 5	(C) 4 (D) 3
Q.14	Which of the following sorting algorithms	s has the lowest worst-case complexity?
	(A) Merge sort (C) Quick sort	(B) Bubble sort (D) Selection sort

Q.15	Consider the following segment of C-co int j, n;	de:	
	<pre>j = 1; while (j &lt;= n)</pre>		
	j = j*2;		
	The number of comparisons made in the	execution of the loop	o for any $n > 0$ is:
	(A) $\lceil \log_2 n \rceil + 1$ (B) $n$	(C) $\lceil \log_2 n \rceil$	(D) $\lfloor \log_2 n \rfloor + 1$
Q.16	Group 1 contains some CPU scheduling applications. Match entries in Group 1 to		p 2 contains some
	Group 1	Group 2	
	P. Gang Scheduling	1. Guaranteed Sci	heduling
	Q. Rate Monotonic Scheduling	2. Real-time Sche	
	R. Fair Share Scheduling	3. Thread Schedul	
	(A) P-3; Q-2; R-1	(B) P-1; Q-2; R-3	
	(C) P-2; Q-3; R-1	(D) P-1; Q-3; R-2	
Q.17	Consider the following statements about Which one of the following statements is		d kernel level threads.
	<ul> <li>(A) Context switch time is longer for ke</li> <li>(B) User level threads do not need any h</li> <li>(C) Related kernel level threads can be a processor system.</li> <li>(D) Blocking one kernel level thread blocking</li> </ul>	nardware support. scheduled on differen	t processors in a multi-
Q.18	Which one of the following is a top-dov	vn parser?	
	(A) Recursive descent parser.		
	(B) Operator precedence parser.		
	(C) An LR(k) parser.		
	(D) An LALR(k) parser.		
Q.19	In Ethernet when Manchester encoding	is used, the bit rate is	or light of the
	(A) Half the baud rate.		
	(B) Twice the baud rate.		
	(C) Same as the baud rate.		
	(D) None of the above.		
Q.20	Which one of the following uses UDP a	as the transport protoc	ol?

(C) DNS

(D) SMTP

(B) Telnet

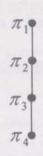
(A) HTTP

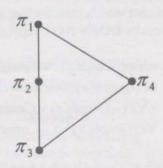
# Q. 21 to Q. 75 carry two marks each.

Q.21	.21 How many different non-isomorphic Abelian groups of order 4 are there?							
	(A) 2	(B) 3	(C) 4	(D) 5				
Q.22	Let $Graph(x)$ be a predicate which denotes that $x$ is a graph. Let $Connected(x)$ be a predicate which denotes that $x$ is connected. Which of the following first order logic sentences <b>DOES NOT</b> represent the statement: "Not every graph is connected"?							
	(A) $\neg \forall x (Graph)$	$h(x) \Rightarrow Connected(x)$	))					
	(B) $\exists x (Graph(x) \land \neg Connected(x))$							
	(C) $\neg \forall x (\neg Gra$	$ph(x) \lor Connected(x)$	))					
	(D) $\forall x (Graph($	(D) $\forall x (Graph(x) \Rightarrow \neg Connected(x))$						
Q.23	Which of the fo	llowing graphs has ar	Eulerian circuit?					
		ar graph where $k$ is a						
		graph on 90 vertices.						
	(D) None of the	ment of a cycle on 25 above.	vertices.					
Q.24	of 1,2,3,,20.		lity that 2 appears at a	from the 20! permutation n earlier position than any				
	(A) 1							
	(A) 2							
	(A) $\frac{1}{2}$ (B) $\frac{1}{10}$							
	(C) $\frac{9!}{20!}$							
	(D) None of the	e above.						
Q.25	Let A be a $4\times4$ matrix with eigenvalues $-5, -2, 1, 4$ . Which of the following is an							
	eigenvalue of	$\begin{bmatrix} A & I \\ I & A \end{bmatrix}$ , where $I$ is th	e 4×4 identity matri	x?				
	(A) -5	(B) -7	(C) 2	(D) 1				

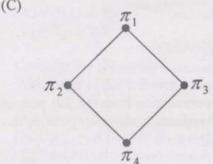
Q.26 · Consider the set  $S = \{a, b, c, d\}$ . Consider the following 4 partitions  $\pi_1, \pi_2, \pi_3, \pi_4$  on S:  $\pi_1 = \{\overline{abcd}\}, \pi_2 = \{\overline{ab}, \overline{cd}\}, \pi_3 = \{\overline{abc}, \overline{d}\}, \pi_4 = \{\overline{a}, \overline{b}, \overline{c}, \overline{d}\}$ . Let  $\prec$  be the partial order on the set of partitions  $S' = \{\pi_1, \pi_2, \pi_3, \pi_4\}$  defined as follows:  $\pi_i \prec \pi_j$  if and only if  $\pi_i$  refines  $\pi_j$ . The poset digram for  $(S', \prec)$  is



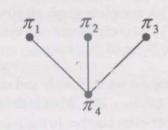




(C)



(D)



- Consider the set of (column) vectors defined by  $X = \{x \in \mathbb{R}^3 \mid x_1 + x_2 + x_3 = 0 \}$ , where Q.27  $x^{T} = [x_1, x_2, x_3]^{T}$  }. Which of the following is **TRUE**?
  - (A)  $\{[1,-1,0]^T,[1,0,-1]^T\}$  is a basis for the subspace X.
  - (B)  $\{[1,-1,0]^T,[1,0,-1]^T\}$  is a linearly independent set, but it does not span X and therefore is not a basis of X.
  - (C) X is not a subspace of  $R^3$ .
  - (D) None of the above.
- Q.28 Consider the series  $x_{n+1} = \frac{x_n}{2} + \frac{9}{8x_n}$ ,  $x_0 = 0.5$  obtained from the Newton-Raphson method. The series converges to
  - (A) 1.5
- (B)  $\sqrt{2}$
- (C) 1.6
- (D) 1.4
- Q.29 A minimum state deterministic finite automaton accepting the language  $L = \{w | w \in \{0,1\}^*, \text{ number of 0s and 1s in } w \text{ are divisible by 3 and 5, respectively} \}$  has
  - (A) 15 states
- (B) 11 states
- (C) 10 states
- (D) 9 states

- Q.30 The language  $L = \{0'21' | i \ge 0\}$  over the alphabet  $\{0, 1, 2\}$  is (A) not recursive. (B) is recursive and is a deterministic CFL. (C) is a regular language. (D) is not a deterministic CFL but a CFL. Which of the following languages is regular? (A)  $\left\{ww^{R} \middle| w \in \left\{0,1\right\}^{+}\right\}$ (B)  $\left\{ ww^R x \middle| x, w \in \{0,1\}^+ \right\}$ (C)  $\left\{ wxw^{R} \middle| x, w \in \{0,1\}^{+} \right\}$ (D)  $\left\{ xww^{R} \mid x, w \in \{0,1\}^{+} \right\}$ Q.32 Let  $f(w, x, y, z) = \sum_{x \in \mathbb{Z}} (0,4,5,7,8,9,13,15)$ . Which of the following expressions are **NOT** equivalent to f? (P) x'y'z'+w'xy'+wy'z+xz(Q) w' v' z' + wx' v' + xz(R) w' y' z' + wx' y' + xyz + xy' z(S) x'y'z'+wx'y'+w'y(A) P only (B) O and S (C) R and S (D) S only 0.33 Define the connective \* for the Boolean variables X and Y as: X \* Y = XY + X'Y'. Let Z = X \* Y. Consider the following expressions P, Q and R. P: X = Y \* ZQ: Y = X \* Z R: X \* Y \* Z = 1Which of the following is TRUE? (A) Only P and Q are valid. (B) Only Q and R are valid. (C) Only P and R are valid. (D) All P, Q, R are valid.
- Q.34 Suppose only one multiplexer and one inverter are allowed to be used to implement any Boolean function of n variables. What is the minimum size of the multiplexer needed?
  - (A) 2<sup>n</sup> line to 1 line

(B)  $2^{n+1}$  line to 1 line (D)  $2^{n-2}$  line to 1 line

(C)  $2^{n-1}$  line to 1 line

Q.35 In a look-ahead carry generator, the carry generate function G<sub>i</sub> and the carry propagate function P<sub>i</sub> for inputs A<sub>i</sub> and B<sub>i</sub> are given by:

$$P_i = A_i \oplus B_i$$
 and  $G_i = A_i B_i$ 

The expressions for the sum bit S<sub>i</sub> and the carry bit C<sub>i+1</sub> of the look-ahead carry adder are given by:

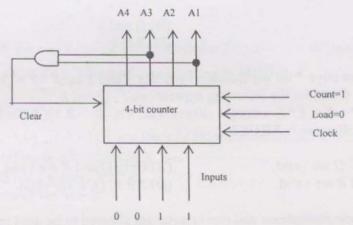
$$S_i = P_i \oplus C_i$$
 and  $C_{i+1} = G_i + P_i C_i$ , where  $C_0$  is the input carry.

Consider a two-level logic implementation of the look-ahead carry generator. Assume that all  $P_i$  and  $G_i$  are available for the carry generator circuit and that the AND and OR gates can have any number of inputs. The number of AND gates and OR gates needed to implement the look-ahead carry generator for a 4-bit adder with  $S_3$ ,  $S_2$ ,  $S_1$ ,  $S_0$  and  $C_4$  as its outputs are respectively:

- (A) 6, 3
- (B) 10, 4
- (C) 6, 4
- (D) 10,5
- Q.36 The control signal functions of a 4-bit binary counter are given below (where X is "don't care"):

Clear	Clock	Load	Count	Function
1	X	X	X	Clear to 0
0	X	0	0	No change
0	1	1	X	Load input
0	1	0	1	Count next

The counter is connected as follows:



Assume that the counter and gate delays are negligible. If the counter starts at 0, then it cycles through the following sequence:

- (A) 0, 3, 4
- (C) 0, 1, 2, 3, 4

- (B) 0, 3, 4, 5
- (D) 0, 1, 2, 3, 4, 5

Q.37 Consider a pipelined processor with the following four stages:

IF: Instruction Fetch

ID: Instruction Decode and Operand Fetch

EX: Execute WB: Write Back

The IF, ID and WB stages take one clock cycle each to complete the operation. The number of clock cycles for the EX stage depends on the instruction. The ADD and SUB instructions need 1 clock cycle and the MUL instruction needs 3 clock cycles in the EX stage. Operand forwarding is used in the pipelined processor. What is the number of clock cycles taken to complete the following sequence of instructions?

ADD R2, R1, R0 R2  $\leftarrow$  R1 + R0 MUL R4, R3, R2 R4  $\leftarrow$  R3 \* R2 SUB R6, R5, R4 R6  $\leftarrow$  R5 - R4

(A) 7

(B) 8

(C) 10

(D) 14

Q.38 The following postfix expression with single digit operands is evaluated using a stack:

823 ^ / 23 \* + 51 \* -

Note that ^ is the exponentiation operator. The top two elements of the stack after the first \* is evaluated are:

(A) 6,1

(B) 5,7

(C) 3,2

(D) 1,5

Q.39 The inorder and preorder traversal of a binary tree are

d b e a f c g and a b d e c f g, respectively.

The postorder traversal of the binary tree is

(A) debfgca

(B) edbgfca

(C) edbfgca

(D) defgbca

Q.40 Consider a hash table of size seven, with starting index zero, and a hash function  $(3x+4) \mod 7$ . Assuming the hash table is initially empty, which of the following is the contents of the table when the sequence 1,3,8,10 is inserted into the table using closed hashing? Note that – denotes an empty location in the table.

(A) 8, -, -, -, -, -, 10

(B) 1,8,10,-,-,3

(C) 1, -, -, -, -, 3

(D) 1,10,8,-,-,-,3

dren. Let I te n-ary					
How many recursive calls are made by this function?					
$(\sqrt{n})$					
$\log_2 \log_2 n$					
t					

Q.46 Consider the following C program segment where CellNode represents a node in a binary tree:

The value returned by GetValue when a pointer to the root of a binary tree is passed as its argument is:

- (A) the number of nodes in the tree.
- (B) the number of internal nodes in the tree.
- (C) the number of leaf nodes in the tree.
- (D) the height of the tree.
- Q.47 Consider the process of inserting an element into a *Max Heap*, where the *Max Heap* is represented by an *array*. Suppose we perform a binary search on the path from the new leaf to the root to find the position for the newly inserted element, the number of *comparisons* performed is:
  - (A)  $\Theta(\log_2 n)$
  - (B)  $\Theta(\log, \log, n)$
  - (C)  $\Theta(n)$
  - (D)  $\Theta(n\log_2 n)$
- Q.48 Which of the following is TRUE about formulae in Conjunctive Normal Form?
  - (A) For any formula, there is a truth assignment for which at least half the clauses evaluate to true.
  - (B) For any formula, there is a truth assignment for which all the clauses evaluate to true.
  - (C) There is a formula such that for each truth assignment, at most one-fourth of the clauses evaluate to true.
  - (D) None of the above.

- Q.49 Let w be the minimum weight among all edge weights in an undirected connected graph. Let e be a specific edge of weight w. Which of the following is FALSE?
  - (A) There is a minimum spanning tree containing e.
  - (B) If e is not in a minimum spanning tree T, then in the cycle formed by adding e to T, all edges have the same weight.
  - (C) Every minimum spanning tree has an edge of weight w.
  - (D) e is present in every minimum spanning tree.
- Q.50 An array of *n* numbers is given, where *n* is an even number. The maximum as well as the minimum of these *n* numbers needs to be determined. Which of the following is **TRUE** about the number of comparisons needed?
  - (A) At least 2n-c comparisons, for some constant c, are needed.
  - (B) At most 1.5n 2 comparisons are needed.
  - (C) At least  $n \log_2 n$  comparisons are needed.
  - (D) None of the above.
- Q.51 Consider the following C code segment:

Let T(n) denote the number of times the *for* loop is executed by the program on input n. Which of the following is **TRUE**?

(A) 
$$T(n) = O(\sqrt{n})$$
 and  $T(n) = \Omega(\sqrt{n})$ 

(B) 
$$T(n) = O(\sqrt{n})$$
 and  $T(n) = \Omega(1)$ 

(C) 
$$T(n) = O(n)$$
 and  $T(n) = \Omega(\sqrt{n})$ 

- (D) None of the above.
- Q.52 Consider the grammar with non-terminals  $N = \{S, C, S_1\}$ , terminals  $T = \{a, b, i, t, e\}$ , with S as the start symbol, and the following set of rules:

$$S \to iCtSS_1 \mid a$$

$$S_1 \to eS \mid \varepsilon$$

$$C \to b$$

The grammar is NOT LL(1) because:

- (A) it is left recursive.
- (B) it is right recursive.
- (C) it is ambiguous.
- (D) it is not context-free.

		lar grammar is L lar set has a LR(				
	Which of the f	ollowing is TRU	JE?			
	(A) Both P and (C) P is false a			B) P is true an D) Both P and		
Q.54	OP $R_j, R_i$ OP $m, R_i$ MOV $m, R_i$ MOV $R_i, m$ The computer following basi $t_1 =$ $t_2 =$ $t_3 =$ $t_4 =$ Assume that a	In a simplified computer the instructions are:  OP R <sub>j</sub> ,R <sub>i</sub> - Performs R <sub>j</sub> OP R <sub>i</sub> and stores the result in register R <sub>i</sub> .  OP m,R <sub>i</sub> - Performs val OP R <sub>i</sub> and stores the result in R <sub>i</sub> . val denotes the content of memory location m.  MOV m,R <sub>i</sub> - Moves the content of memory location m to register R <sub>i</sub> .  MOV R <sub>i</sub> ,m - Moves the content of register R <sub>i</sub> to memory location m.  The computer has only two registers, and OP is either ADD or SUB. Consider the following basic block:  t <sub>1</sub> = a + b  t <sub>2</sub> = c + d  t <sub>3</sub> = e - t <sub>2</sub> t <sub>4</sub> = t <sub>1</sub> - t <sub>3</sub> Assume that all operands are initially in memory. The final value of the computation should be in memory. What is the minimum number of MOV instructions in the code				
		this basic block?				
	(A) 2			(B) 3		
	(C) 5			(D) 6		
Q.55	An operating system uses Shortest Remaining Time first (SRT) process scheduling algorithm. Consider the arrival times and execution times for the following processes:					
		Process	Execution	Arrival		
			time	time		
		P1	20	0		
		P2	25	15		
		P3	10	30		
		P4	15	45		
	What is the total waiting time for process P2?					
	(A) 5	(B) 15		(C) 40	(D) 55	

Q.53 Consider the following two statements:

- Q.56 A virtual memory system uses First In First Out (FIFO) page replacement policy and allocates a fixed number of frames to a process. Consider the following statements:
  - P: Increasing the number of page frames allocated to a process sometimes increases the page fault rate.
  - Q: Some programs do not exhibit locality of reference.

Which one of the following is TRUE?

- (A) Both P and Q are true, and Q is the reason for P.
- (B) Both P and Q are true, but Q is not the reason for P.
- (C) P is false, but Q is true.
- (D) Both P and Q are false.
- Q.57 A single processor system has three resource types X, Y, and Z, which are shared by three processes. There are 5 units of each resource type. Consider the following scenario, where the column alloc denotes the number of units of each resource type allocated to each process, and the column request denotes the number of units of each resource type requested by a process in order to complete execution. Which of these processes will finish LAST?

	alloc	request
	XYZ	XYZ
P0	121	103
P1	201	012
P2	221	120

- (A) P0
- (B) P1
- (C) P2
- (D) None of the above, since the system is in a deadlock.
- Q.58 Two processes, P1 and P2, need to access a critical section of code. Consider the following synchronization construct used by the processes:

```
/* P1 */
while (true) {
  wants1 = true;
  while (wants2==true);
  /* Critical
    Section */
  wants1=false;
}
/* Remainder section */
```

```
/* P2 */
while (true) {
   wants2 = true;
   while (wants1==true);
   /* Critical
       Section */
   wants2=false;
}
/* Remainder section */
```

Here, wants1 and wants2 are shared variables, which are initialized to false. Which one of the following statements is TRUE about the above construct?

- (A) It does not ensure mutual exclusion.
- (B) It does not ensure bounded waiting.
- (C) It requires that processes enter the critical section in strict alternation.
- (D) It does not prevent deadlocks, but ensures mutual exclusion.

Q.59 Information about a collection of students is given by the relation studInfo(studId, name, sex). The relation enroll(studId, courseId) gives which student has enrolled for (or taken) what course(s). Assume that every course is taken by at least one male and at least one female student. What does the following relational algebra expression represent?

 $\Pi_{courseld} ((\Pi_{studld}(\sigma_{sex = "female"}(studInfo)) \times \Pi_{courseld}(enroll)) - enroll)$ 

- (A) Courses in which all the female students are enrolled.
- (B) Courses in which a proper subset of female students are enrolled.
- (C) Courses in which only male students are enrolled.
- (D) None of the above.
- Q.60 Consider the relation employee(name, sex, supervisorName) with name as the key. supervisorName gives the name of the supervisor of the employee under consideration. What does the following Tuple Relational Calculus query produce?

{e.name | employee(e)  $\land$   $(\forall x)[ \neg employee(x) \lor x.supervisorName <math>\neq$  e.name  $\lor x.sex = "male"] }$ 

- (A) Names of employees with a male supervisor.
- (B) Names of employees with no immediate male subordinates.
- (C) Names of employees with no immediate female subordinates.
- (D) Names of employees with a female supervisor.
- Q.61 Consider the table employee(empld, name, department, salary) and the two queries Q<sub>1</sub>, Q<sub>2</sub> below. Assuming that department 5 has more than one employee, and we want to find the employees who get higher salary than anyone in the department 5, which one of the statements is TRUE for any arbitrary employee table?
  - Q<sub>1</sub>: Select e.empId

From employee e

Where not exists

(Select \* From employee s Where s.department = "5" and s.salary >= e.salary)

Q2: Select e.empId

From employee e

Where e.salary > Any

(Select distinct salary From employee's Where s.department = "5")

- (A) Q<sub>1</sub> is the correct query.
- (B) Q<sub>2</sub> is the correct query.
- (C) Both Q<sub>1</sub> and Q<sub>2</sub> produce the same answer.
- (D) Neither Q<sub>1</sub> nor Q<sub>2</sub> is the correct query.
- Q.62 Which one of the following statements is FALSE?
  - (A) Any relation with two attributes is in BCNF.
  - (B) A relation in which every key has only one attribute is in 2NF.
  - (C) A prime attribute can be transitively dependent on a key in a 3NF relation.
  - (D) A prime attribute can be transitively dependent on a key in a BCNF relation.

Q.63	pointer) pairs i	leaf node in a B <sup>+</sup> -tree it can hold. Given that he value field is 9 byte the leaf node?	the block size is 1	K bytes, data red	cord pointer is
	(A) 63	(B) 64	(C) 67	(D) 6	8
Q.64			involving two transfers, $r_2(X)$ ; $r_2(Y)$ ; $w_2(Y)$ ; $v_2(Y)$ ; $v_1(Y)$ ; $v_2(Y)$ ; $v_1(Y)$	7); w <sub>1</sub> (X)	h one of the
	(B) S <sub>1</sub> is confl (C) S <sub>1</sub> is not co	id S <sub>2</sub> are conflict serial ict serializable and S <sub>2</sub> is onflict serializable and id S <sub>2</sub> are not conflict serial	s not conflict seria S <sub>2</sub> is conflict seria		
Q.65	probability p is	ntions in a slotted LAN n each time slot. What given time slot?		*	
	(A) $np(1-p)^n$	(B) $(1-p)^{n-1}$	(C) $p(1-p)$	$(D)^{n-1}$ , $(D)$ 1	$-(1-p)^{n-1}$
Q.66		network the transmiss. The 1-bit delay in th			gation speed is
	(A) 500 metre (B) 200 metres (C) 20 metres (D) 50 metres	s of cable. of cable.			
Q.67		f a class B host is to be aximum number of sub			
	(B) 64 subnets (C) 62 subnets	s and 262142 hosts. s and 262142 hosts. s and 1022 hosts. s and 1024 hosts.			
Q.68		11001001 is to be trans errors. The message t			$x^3 + 1$ to
	(A) 11001001	000 (B) 110010010	011 (C) 11001	010 (D)	110010010011

The distance between two stations M and N is L kilometres. All frames are K bits 0.69 long. The propagation delay per kilometre is t seconds. Let R bits/second be the channel capacity. Assuming that processing delay is negligible, the minimum number of bits for the sequence number field in a frame for maximum utilization, when the sliding window protocol is used, is:

(A) 
$$\left[\log_2 \frac{2LtR + 2K}{K}\right]$$
  
(B)  $\left[\log_2 \frac{2LtR}{K}\right]$   
(C)  $\left[\log_2 \frac{2LtR + K}{K}\right]$   
(D)  $\left[\log_2 \frac{2LtR + K}{2K}\right]$ 

(B) 
$$\left[\log_2 \frac{2LtR}{K}\right]$$

(C) 
$$\left[\log_2 \frac{2LtR + K}{K}\right]$$

(D) 
$$\left[\log_2 \frac{2LtR + K}{2K}\right]$$

Q.70 Match the following:

P. SMTP

Q. BGP

R. TCP

S. PPP

- 1. Application layer
- 2. Transport layer
- 3. Data link layer
- 4. Network layer
- 5. Physical layer

- (A) P-2, Q-1, R-3, S-5
- (B) P-1, Q-4, R-2, S-3
- (C) P-1, Q-4, R-2, S-5
- (D) P-2, Q-4, R-1, S-3

#### **Common Data Questions**

#### Common Data for Questions 71,72,73:

Consider the following program segment. Here R1, R2 and R3 are the general purpose registers.

	Instruction		Operation	Instruction size (no. of words)	
	MOV	R1, (3000)	R1 ← M[3000]	2	
LOOP:	MOV	R2, (R3)	$R2 \leftarrow M[R3]$	1	
	ADD	R2, R1	R2 ← R1 + R2	1	
	MOV	(R3), R2	$M[R3] \leftarrow R2$	1	
	INC	R3	$R3 \leftarrow R3 + 1$	1	
	DEC	R1	$R1 \leftarrow R1 - 1$	1	
	BNZ HALT	LOOP	Branch on not zero Stop	2	

Assume that the content of memory location 3000 is 10 and the content of the register R3 is 2000. The content of each of the memory locations from 2000 to 2010 is 100. The program is loaded from the memory location 1000. All the numbers are in decimal.

Q.71 Assume that the memory is word addressable. The number of memory references for accessing the data in executing the program completely is

(A) 10 (B) 11 (C) 20 (D) 21

Q.72 Assume that the memory is word addressable. After the execution of this program, the content of memory location 2010 is

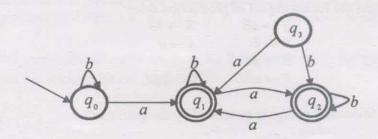
(A) 100 (B) 101 (C) 102 (D) 110

Q.73 Assume that the memory is byte addressable and the word size is 32 bits. If an interrupt occurs during the execution of the instruction "INC R3", what return address will be pushed on to the stack?

(A) 1005 (B) 1020 (C) 1024 (D) 1040

### Common Data for Questions 74, 75:

Consider the following Finite State Automaton:



- The language accepted by this automaton is given by the regular expression Q.74
  - (A) b'ab'ab'ab'
- (B)  $(a+b)^*$  (C)  $b^*a(a+b)^*$  (D)  $b^*ab^*ab^*$
- Q.75 The minimum state automaton equivalent to the above FSA has the following number of states
  - (A) 1

Linked Answer Questions: Q.76 to Q.85 carry two marks each.

#### Statement for Linked Answer Questions 76 & 77:

Suppose the letters a,b,c,d,e,f have probabilities  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{8}$ ,  $\frac{1}{16}$ ,  $\frac{1}{32}$ , respectively.

- Which of the following is the Huffman code for the letters a,b,c,d,e,f? Q.76
  - (A) 0,10,110,1110,11110,11111
  - (B) 11,10,011,010,001,000
  - (C) 11,10,01,001,0001,0000
  - (D) 110,100,010,000,001,111
- Q.77 What is the average length of the correct answer to Q.76?
- (B) 2.1875

### Statement for Linked Answer Questions 78 & 79:

Consid	der the CFG with {	S, A, B as the non-ter	minal alphabet, $\{a,b\}$	as the terminal alphab	et,
S as th	e start symbol and	the following set of p			
			$S \rightarrow bA$		
		$B \rightarrow b$	$A \rightarrow a$		
		$B \rightarrow bS$			
		$B \rightarrow aBB$	$A \rightarrow bAA$		
Q.78	Which of the foll	owing strings is gene	rated by the grammar?		
	(A) aaaabb	(B) aabbbb	(C) aabbab	(D) abbbba	
Q.79	For the correct ar	nswer string to Q.78,	how many derivation t	rees are there?	
	(A) 1	(B) 2	(C) 3	(D) 4	
Stater	nent for Linked A	answer Questions 80	& 81:		
mappe two-d 1100F	ed data cache consi imensional array of I. Assume that the	sting of 32 lines of 64 f bytes is stored in the data cache is initially	bytes each is used in main memory starting	from memory locationarray is accessed twice	n
Q.80	How many data	cache misses will occ	ur in total?		
	(A) 48	(B) 50	(C) 56	(D) 59	
Q.81		lowing lines of the da	ata cache will be replace?	ed by new blocks in	
	(A) line 4 to line	11	(B) line 4 to line	12	
	(C) line 0 to line		(D) line 0 to line		
State	ment for Linked	Answer Questions 82	& 83:		
availa	able in the memory ences (reference str	initially. The processing): 1, 2, 1, 3, 7, 4, 5 replacement policy is	s makes the following, 6, 3, 1	e pages of the process sequence of page faults occur for the abo	
	(A) 7	(B) 8	(C) 9	(D) 10	
Q.83	optimal page re	placement. For the ab		actical approximation ow many more page fa	
	(A) 0	(B) 1	(C) 2	(D) 3	

#### Statement for Linked Answer Questions 84 & 85:

Suppose that a robot is placed on the Cartesian plane. At each step it is allowed to move either one unit up or one unit right, i.e., if it is at (i, j) then it can move to either (i+1, j) or (i, j+1).

- Q.84 How many distinct paths are there for the robot to reach the point (10,10) starting from the initial position (0,0)?
  - (A)  $\begin{pmatrix} 20 \\ 10 \end{pmatrix}$
  - (B)  $2^{20}$
  - (C) 210
  - (D)None of the above
- Q.85 Suppose that the robot is not allowed to traverse the line segment from (4,4) to (5,4). With this constraint, how many distinct paths are there for the robot to reach (10,10) starting from (0,0)?
  - $(A) 2^9$
  - (B) 219
  - $(C)\binom{8}{4} \times \binom{11}{5}$
  - $(D)^{\binom{20}{10}} \binom{8}{4} \times \binom{11}{5}$

**END OF THE QUESTION PAPER**