2022

COMPUTER APPLICATION

Paper : MCA-T11

(Design and Analysis of Algorithms)

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer **question no. 1** and **any two** from the rest.

1. (a) Derive tight asymptotic complexities for the following algorithms.

Algorithm COUNT 1

Input: $n = 2^k$, for some positive integer k.

Output: *count* = number of times Step 4 is executed.

1. *count* ← 0
2. **while** $n \geq 1$
3.   **for** j ← 1 **to** n
4.   *count* ← *count* + 1
5.   **end for**
6. n ← n/2
7. **end while**
8. **return** *count*

Algorithm COUNT 2

Input: A positive integer n.

Output: *count* = number of times Step 5 is executed.

1. *count* ← 0
2.   **for** i ← 1 **to** n
3. m ← *floor(n/i)*
4.   **for** j ← 1 **to** m
5.   *count* ← *count* + 1
6.   **end for**
7.   **end for**
8. **return** *count*

Please Turn Over

Algorithm COUNT 3

Input: $n = (2^2)^k$, for some positive integer k.

Output: Number of times Step 6 is executed.

1. $count \leftarrow 0$
2. **for** $i \leftarrow 1$ **to** n
3. $j \leftarrow 2$
4.   **while** $j \leq n$
5. $j \leftarrow j^2$
6. $count \leftarrow count + 1$
7.   **end while**
8. **end for**
9. **return** $count$

(b) Show that the number of element comparisons to MERGE two sorted arrays of sizes n_1 and n_2 respectively where $n_1 \leq n_2$ into one sorted array of size $n = n_1 + n_2$ is between n_1 and $(n-1)$. Also show that if the two array sizes are floor (n/2) and ceil (n/2) then the number of comparisons needed is between floor (n/2) and (n-1).

(c) What is amortized analysis? Explain by citing appropriate examples.

(d) Explain the different techniques by which graphs are represented in computer memory.

(5+5+5)+5+5+5

2. (a) Choose an appropriate data structure for representation of disjoint sets. Write efficient FIND and UNION methods over the chosen data structure. Derive their time complexities.

(b) Write and explain the ordered sequential search algorithm. Derive the time complexity of the method.
10+10

3. Write and explain two graph traversal techniques. Derive the time and space complexities of the traversal methods considering the data structures used.
10+10

4. Explain the divide and conquer algorithm design technique. Write and explain the Quick Sort algorithm. Derive the worst case, average case and best case time and space complexities of the above method.
3+7+10

5. (a) Define and explain the significance of Big-Oh (O), Big-Theta (Θ) and Big Omega (Ω) asymptotic notations in connection to the time complexity analysis of algorithms.
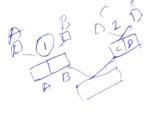
(b) Show that:

(i) If $y(n) \in O(z(n))$ and $x(n) \in O(y(n))$ then $x(n) \in O(z(n))$

(ii) $(2n^2 2^n + n \log n) \in \Theta (n^2 2^n)$

(iii) $(33n^3 + 4n^2) \in \Omega (n^3)$

(iv) $n! \in O(n^n)$ Hint: use $n! \approx \sqrt{(2\lceil n)(n/e)^n}$.

(c) Draw the binary decision tree for binary search with n=14 where n is the total number of elements in the table to be searched.
(2+2+2)+(2+2+2+2)+6

2022

COMPUTER APPLICATION

Paper : MCA-T12

(Mathematical Foundations)

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Answer **question no. 1** and **any five** from **question nos. 2-7**.

1. Answer the following questions (1 mark for correct option and 1 mark for justification) : 2×10

(a) The order of the differential equation : $\left(\dfrac{dy}{dx} + y\right)^{\frac{3}{2}} = x$ is

   (i) 1

   (ii) 2

   (iii) 3

   (iv) 4.

(b) The general solution of the differential equation : $\dfrac{dy}{dx} = 5x^2 + 2$ is

   (i) $10x^3 + 12x - 3y^2 = c$

   (ii) $10x^3 + x - 3y^2 = c$

   (iii) $10x^3 + 12x - y^2 = c$

   (iv) $x^3 + 12x - 3y^2 = c$.

(c) The probability of getting two tails when two coins are tossed is

   (i) 1/6

   (ii) 1/2

   (iii) 1/3

   (iv) 1/4.

(d) A man is known to speak truth 3 out of 4 times. He throws a die and reports that it is six. Find the probability that it is actually a six.

   (i) 1/8

   (ii) 5/8

   (iii) 2/7

   (iv) 3/8.

(e) For any square matrix A, AA^T is a

   (i) unit matrix

   (ii) symmetric matrix

   (iii) skew-symmetric matrix

   (iv) diagonal matrix.

(f) For two invertible matrices A and B of suitable orders, the value of $(AB)^{-1}$ is

     (i) $(BA)^{-1}$ (ii) $B^{-1}A^{-1}$

     (iii) $A^{-1}B^{-1}$ (iv) None of these.

(g) The number of solution of the following equations : $y - z = 1$, $-x + 2z = -2$, $x - 2y = 3$ is

     (i) zero   (ii) one

     (iii) two   (iv) infinite.

(h) If $A^2 - A + I = 0$, then $A^{-1} =$

     (i) A^{-2} (ii) $A + I$

     (iii) $I - A$ (iv) $A - I$.

(i) If A and B are square matrices of order 3 such that $\det(A) = -1$, $\det(B) = 3$, then $\det(3AB) =$

     (i) -9 (ii) -81

     (iii) -27 (iv) 81.

(j) V be a vector space over field F, then

     (i) $a\alpha = b\alpha$, implies $a = b$, $\alpha \neq 0$ for all a, $b \in F$

     (ii) $a\alpha = a\beta$, implies $\alpha = \beta$, $a \neq 0$ for all α, $\beta \in V$

     (iii) both (i) and (ii)

     (iv) none of these.

2. (a) Prove that the set M of all real matrices of order $m \times n$ forms real vector space over a field R of all real numbers with respect to matrix addition and scalar multiplication.

(b) Find rank of the matrix $\begin{pmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{pmatrix}$.   7+3

3. In a vector space V over field F, show that :

     (a) $0.\alpha = \theta$, for all $\alpha \in V$; (b) $c.\theta = 0$, for all $c \in F$; (c) $c.\alpha = \theta$ implies either $c = 0$, or $\alpha = 0$.   3+3+4

4. (a) Prove without expanding that $\det \begin{vmatrix} 1 & x & x^2 - yz \\ 1 & y & y^2 - xz \\ 1 & z & z^2 - yx \end{vmatrix}$ vanishes.

(b) Verify Cayley Hamilton theorem for the matrix $\begin{bmatrix} 1 & 4 \\ 2 & 3 \end{bmatrix}$.   5+5

5. (a) Find eigenvalues and eigenvectors of the matrix $\begin{pmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{pmatrix}$.

(b) Solve the following equations by Cramer's rule : $3x + y + 2z = 3,\ 2x - 3y - z = -3,\ x + 2y + z = 4.$

6+4

6. Solve the differential equations :

(a) $y(\log y)dx + (x - \log y)dy = 0$

(b) $(xy^3 + y)dx + 2(x^2y^2 + x + y^4)dy = 0.$

5+5

7. (a) Solve : $\dfrac{dy}{dx} = \dfrac{x^3 + y^3}{xy^2}$.

(b) State and prove Bayes' Theorem.

5+5

_____

2022

COMPUTER APPLICATION

Paper : MCA-T13

(Advanced Database Management Systems)

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Answer *any five* questions.

1. (a) Consider the following Relation :

   r(R) = {A, B, C, D, E, F, G, H, I}

   The set of Functional dependency is given below :

   F = {A → B, C → D,E,F → G, B → GH, AF → C, E → I}

   Determine the current normal form of the given relation. Decompose it upto 3NF.

   (b) Give an example where a relation is in 3NF but not in BCNF.

   (c) Give an example where a relation is in 3NF as well as in BCNF.

   (d) What do you understand by attribute preservation? Explain.   6+2+2+4

2. (a) Write an algorithm to find out the F^+ for a given relation r, whose functional dependency is F.
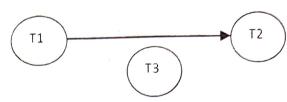
   (b) Consider the following relational schema

   r1(A, B, C, D, E, F, G)

   The following functional dependency is hold in the relation

   A -> B; B -> C; C -> D,E; F -> G

   Maintaining the functional dependency the relation r1 is broken as follows

   r2(A, B); r3(B, C); r4(C, D, E); r5(F, G)

   Verify whether this decomposition is lossless or not.

   (c) With example explain (i) full functional dependency, (ii) partial functional dependency.

                                                                    5+5+(2+2)

3. (a) What are the possible serial schedule for the given precedence graph?

(b) Check whether the following schedule is serializable or not.

T1	T2	T3
		Read(Y)
		Read(Z)
Read(X)		
Write(X)		
		Write(Y)
		Write(Z)
	Read(Z)	
Read(Y)		
Write(Y)		
	Write(Y)	
	Read(X)	
	Write(X)	

(c) Write the algorithm of Read_lock(X) and Unlock(X) for exclusive lock.   2+5+(3

4. (a) The following schedule is written in log:

   $< T_0,$ Start $>$

   $< T_0,$ X, 1002 $>$

   $< T_0,$ Y, 801 $>$

   $< T_0,$ Commit $>$

   $< T_1,$ Start $>$

   $< T_1,$ X, 687 $>$

   $< T_1,$ Y, 300 $>$

   What actions will be taken for recovery if (i) Deferred Database Modification and (ii) Immed
   Database Modification applied?

(b) Give an example of a schedule which is view equivalent but not conflict equivalent.

(c) What is the recovery policy in Strict Schedule?

(d) Explain Dirty-Read problem.   5+4

5. (a) A fact table Logistics is organized in the form of star schema. The associated dimension tables are Time, Product, City and Vehicle Company. Assume the attributes as required for each of the dimension table. Measures are Amount (in INR) and No_of_Vehicles. Represent the star schema.

(b) Now generate the lattice of cuboids corresponding to the fact table of Question 5. (a)   7+7

6. (a) Prove that the number of cuboid patterns produced by Drill-down from a particular cuboid in the current level i is i.

(b) Why is holistic type of measure not preferred over other types of measures in data warehouse?

(c) How is the concept of data mart over the time extended to data warehouse?

(d) A data warehouse comprises of dimensions M, N, O, P, Q and R. Out of these O and Q does not maintain any concept hierarchy. M and P have 2 concept hierarchy and N has 3 concept hierarchy. Compute the total number of cuboids to represent this in the form of lattice of cuboids.

4+2+3+5

7. (a) Explain semi-join with example.

(b) How is derived horizontal fragmentation obtained by using semi-join? Explain with an example.

(c) Consider a database EMP(ENO, SAL, DEPTNO, LOC, JOB)

It is fragmented into 2 databases EMP1 and EMP2 based on the values of LOC. IF LOC = 'KOLKATA' then the data is stored into EMP1 and for LOC = 'MUMBAI' data is stored into EMP2. EMP1 is stored in Site-1 and Site-2 and EMP2 is stored in Site-3 and Site-4. An employee having ENO= 'E01' located in MUMBAI is shifted to KOLKATA. Write the query to execute this for Local Mapping Transparency.

(d) What do you understand by 'graceful degradation' of distributed database?   3+3+6+2

2022

COMPUTER APPLICATION

Paper : MCA-T14

(Theory of Computation and Compiler Design)

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Group - A

(Theory of Computation)

Answer *question no.*1 and *any two* questions from the rest.

1. Define grammar. Discuss Chomsky's classification of grammar. 7

2. Design a D.F.A. which accepts string in which every 00 is followed immediately by 1.
   For example – 001, 0010, 0010011001 in the language but 0001 and 000100 are not. 14

3. Convert the following context-free grammar in (a) to Chomsky Normal Form (CNF) and in (b) to Greibach Normal Form : 7+7

   (a) S->AB | aB, A->aab | $\in$, B->bbA

   (b) S->ABb | a, A->aaA | B, B->bAb.

4. (a) Remove unit Production from the following grammar :

   S->Aa | B, B->A | bb, A->a | bc | B.

   (b) Remove NULL production from the following grammar :

   S->ABaC, A->BC, B->b | $\in$, C-> D | $\in$, D-> $\in$.

   (c) Use pumping lemma to show that the following language is not regular :

   L = {a^n | n is a perfect square}

   5+5+4

Please Turn Over

Group - B

(Compiler Design)

Answer *question no.* **5** and *any two* questions from the rest.

5. With the help of an example, explain the different representation of three address code. Generate 3 address code for the Boolean expression — if A<B OR C<D AND P<S.   3+4

6. Design a LALR Parser for the following Grammar :   14

     S -> CC

     C -> cC

     C -> d

7. What is Operator Grammar? Design Operator Precedence Parser for the following grammar :   4+10

     S -> A

     A -> T | A+T | A–T

     T->F | T*F |T/F

     F -> P | P ! F

     P -> i | n | (A)

8. What is LL(1) Grammar? Design a Predictive Parser for the following grammar :   4+10

     E -> TE'

     E' -> +TE' | $\in$

     T -> F T'

     T' -> *FT' | $\in$

     F -> (E) | id

2022

COMPUTER APPLICATION

Paper : MCA-T15

(Advanced Computer Architecture)

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Answer *any five* questions.

1. (a) Discuss the importance of Amdahl's law. Explain how Amdahl's law can be used for estimating the speedup due to parallel execution.

   (b) Assume 2% of the runtime of a program is not parallelizable. This program runs on 48 cores of an Intel Xeon Phi. Under the assumption that the program runs at the same speed on all of those cores, and there are no additional overheads, what is the parallel speedup?

   (c) Explain the parameter 'MTTF' in regard to computing hardware. State how it is estimated.

   $(2+3)+5+(2+2)$

2. (a) Discuss the various categories of instructions as supported by MIPS ISA explaining the generic formats for each of the different categories.

   (b) Write the MIPS Assembly code for the following operation: A[10]= K + A[10]; where K is a constant.

   (c) Discuss the memory word access in MIPS 32.

   $10+2+2$

3. (a) Discuss with proper illustrations the operations performed in the various stages of the instruction cycle of a single-cycle MIPS processor implementation.

   (b) Explain the 'beq' instruction of MIPS 32.

   $12+2$

4. (a) Explain the situation of stalling in the pipeline. Mention the possible cases of stalling in the case of structural hazards.

   (b) State the various compiler optimization techniques that can be applied for handling Data Hazards.

   (c) Explain the 'Operand Forwarding' method for handling Data Hazards.

   $(2+3)+5+4$

5. (a) Discuss on the memory hierarchy of a computer system.

   (b) Consider a direct mapped cache of size 32 KB with a block size of 32 bytes. The CPU generates 32-bit addresses. Find the number of bits required for cache indexing.

(c) A computer system uses 16-bit memory addresses. It has a 2K-byte cache organized in a direct-mapped manner with 64 bytes per cache block. Assume that the size of each memory word is 1 byte. When a program is executed, the processor reads data sequentially from the following word addresses: 128, 144, 2176. All the above addresses are shown in decimal values. Assume that the cache is initially empty. For each of the above addresses, indicate whether the cache access will result in a hit or a miss. 3+5+6

6. (a) Discuss the key features of (i) UMA and (ii) NUMA architectures.

(b) Discuss the key features of SIMD architectures. (4+4)+6

7. Write short notes on : 7+7

(a) Snoopy Cache Protocol

(b) Single Stage and Multi-Stage Crossbar Switch.

———————

2022

COMPUTER APPLICATION

Paper : MCA-M11

(Soft Skills)

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Do as directed :

(a) Write antonyms of the following (*any five*) :   1×5

　　(i) Ascend

　　(ii) Disappear

　　(iii) Hatred

　　(iv) Temporary

　　(v) Encourage

　　(vi) Insane.

(b) Choose the correct alternatives for the following :   1×5

　　(i) Empathy leads to:

　　　　1. Insight

　　　　2. Perception

　　　　3. Understanding

　　　　4. All of these.

　　(ii) Listening is:

　　　　1. Conscious

　　　　2. Involuntary

　　　　3. Passive

　　　　4. Casual.

　　(iii) Job application is synonymous to:

　　　　1. Cover letter

　　　　2. Sales letter

　　　　3. Bio-data

　　　　4. Order letter.

    (iv) Syntax refers to:

        1. Bad communication

        2. Intention of the speaker

        3. Construction of a sentence

        4. Meanings associated with words.

    (v) The adjective form of the word **'merchant'** is :

        1. Merchandise

        2. Mercantile

        3. Mercurous

        4. Merciful.

. Answer any *three* of the following :   5×3

(a) Mention the constituent parts of a Technical / Manuscript report in their correct order.

(b) What are the three types of formats in which business reports may be generated? What exactly is the difference between a 'memo' and a 'memo report'?

(c) Transform the following sentences as directed:

    (i) Iron is more useful than any other metal. *(Begin: No other metal...)*

    (ii) Were we sent into the world simply to make money? *(End:...make money.)*

    (iii) Besides robbing the poor child, he also murdered her. *(Begin: Not only...)*

    (iv) It is very cold today. *(End:...today!)*

    (v) As soon as the sales began, we bought our Diwali presents. *(Begin: Hardly had...)*

(d) Indicate the error in the following sentences. Write 'No error' if the sentences are grammatically correct:

    (i) He jumped in the lake.

    (ii) The bag's leather was black in colour.

    (iii) The PM and his Cabinet are arriving in Kolkata tonight.

    (iv) The reason I am supporting Ms. Ayengar is that her extensive background in foreign affairs have made her uniquely qualified for the post.

    (v) Rajiv is going to get a MBA degree this year.

(e) Write short notes on the following :

    (i) Grapevine Communication

    (ii) Barriers of Communication.

. Answer *any three* of the following :   15×3

(a) As a senior manager, write a letter report to the Managing Director of your company on the advantages of having an in-house Placement Training Cell.

(b) Write an essay of 500 words on *one* of the following topics:

   (i) Ambition and ethics

   (ii) Sustainable Development — the need of the hour.

(c) Define Verbal and Non-Verbal Communication. In this context, discuss the different components of KOPPACT. 10

(d) Explain the difference between a group discussion and a debate. Enumerate the skills and sub-skills required to be an effective participant in a group discussion.

(e) Define and explain SWOT. How do you use SWOT analysis in your career-planning?