

Total number of printed pages-4

1 (Sem-4) COM 3

2025

## COMPUTER SCIENCE

Paper : COM0400304

*(Mathematical Foundation of  
Computer Science)*

Full Marks : 60

Time : 2½ hours

**The figures in the margin indicate  
full marks for the questions.**

1. Answer the following questions as directed in the bracket : 1×8=8
  - (i) Is this true? (Choose the correct option proposition/predicate)
  - (ii)  $5 + 1 = 6$  (Negate the statement)
  - (iii)  $\phi = \{\{\phi\}\}$  (State True **or** False)
  - (iv) A relation which is symmetric and reflexive but not transitive.  
(Give one example)

(v) The relation  $\{(x, y) : x, y \in N, x < y\}$  is a function. (State True **or** False)

(vi) A graph in which all vertices are of equal degree is a \_\_\_\_\_ graph.  
(Fill in the blank)

(vii) If  $A$  and  $B$  are two disjoint sets then  $|A + B| = |A| + |B|$ .  
(Write the rule name)

(viii) \_\_\_\_\_ are sets where an element can occur as a member more than once.  
(Fill in the blank)

2. Assign a truth value to each of the following statements and justify it : **(any six)**

$2 \times 6 = 12$

(i)  $5 < 5 \vee 5 < 6$

(ii)  $5 \times 4 = 21 \vee 9 + 7 = 17$

(iii)  $6 + 4 = 10 \vee 0 > 2$

(iv) Ram is a name.

(v) Four is even.

(vi) What a hit!

(vii) Answer this question.

(viii)  $5 \in \{1, 6, 7\}$

(ix)  $5 + 6 = 12$

(x) May God bless you.

3. Answer the following questions : **(any four)**

$$5 \times 4 = 20$$

(i) Obtain the DNF of :

$$p \vee (\sim p \Rightarrow (q \vee (q \Rightarrow \sim r)))$$

(ii) Show that  $s$  is a valid conclusion from the premises  $p \Rightarrow q$ ,  $p \Rightarrow r$ ,  $\sim(q \wedge r)$  and  $s \vee p$ .

(iii) Use induction to show that

$$n! \geq 2^{n-1} \text{ for } n \geq 1$$

(iv) Let  $K(x)$  :  $x$  is student,  $M(x)$  :  $x$  is clever,  $N(x)$  :  $x$  is successful. Express the following using quantifiers :

(a) There exists a student.

(b) Some students are clever.

(c) Some students are not successful.

(v) Prove that

$$A \times (B \cap C) = (A \times B) \cap (A \times C)$$

(vi) If  $R$  be a relation in the set of integers  $Z$  defined by

$$R = \{ (x, y) : x \in Z, y \in Z, x - y \text{ is divisible by } 3 \}$$

Describe the distinct equivalence classes of  $R$ .

(vii) Let  $A = \{1, 2\}$  and  $B = \{a, b, c\}$ , find all functions  $g : B \rightarrow A$  and for each such functions, determine whether it is one-one, onto, both or neither.

(viii) Give an example of a graph which is Hamiltonian but not Eulerian and vice-versa.

4. Answer the following questions : **(any two)**  
 $10 \times 2 = 20$

(i) Define Relation. Describe its all types with example. What is an equivalence class ?

(ii) Discuss Poset and Lattice. Give example.

(iii) Explain BFS and DFS algorithms.

(iv) What do you understand by growth of a function ? Discuss. What is the difference between concave and convex function ?

(v) Write the Pigeonhole principle. Explain with proper example.

Total number of printed pages-7

1 (Sem-4) COM 4

2025

**COMPUTER SCIENCE**

Paper : COM0400404

**(Operating System)**

Full Marks : 45

Time : Two hours

***The figures in the margin indicate full marks for the questions.***

1. Choose the correct answer : (Each Question carries 1 mark) 1×5=5

(i) Operating system is an example of

(A) Application software

(B) System software

(C) Utility software

(D) None of the above

(ii) Which of the following is not a typical scheduling criteria used to assess a CPU scheduling algorithm?

- (A) Turn around time
- (B) Waiting time
- (C) Response time
- (D) Split time

(iii) For a semaphore  $S$ , which of the following statements constitutes Signal operation?

- (A)  $S--$
- (B)  $S++$
- (C)  $S = S * S$
- (D) None of the above

(iv) Which of the following is not a necessary condition for deadlock?

- (A) Hold and wait
- (B) No preemption
- (C) No generalization
- (D) Mutual exclusion

(v) In paging, logical address is composed of

- (A) Frame number and offset
- (B) Page number and offset
- (C) Page number and frame number
- (D) Base address and frame number

2. Answer **any five** of the following questions :  
(Each Question carries **2** marks)

2×5=10

(i) How multiprogramming operating system is better than a uni-programming operating system?

(ii) What is virtualization?

(iii) How open source software is different from proprietary software?

(iv) What is context switching?

(v) What is long term scheduler?

(vi) What is safe state in handling deadlock?

(vii) How deadlock avoidance scheme is different from deadlock detection scheme?

(viii) What is memory management unit?

(ix) What is thrashing?

(x) Differentiate between Least Recently Used (LRU) and Optimal page replacement algorithms.

3. Answer **any four** of the following questions :  
(Each Question carries **5** marks)

5×4=20

(i) What are different models of cloud computing? Explain briefly each of the models.

(ii) What are different states of a process? Briefly explain each of the states with a transition diagram.

(iii) What are different multi threading models used in an operating system? Explain these models briefly.

(iv) What is semaphore? Explain briefly. What are the atomic operations we can perform on a semaphore? Explain each of the operations.

(v) Explain the Dining Philosophers' problem. Briefly explain how we can solve this problem using any synchronization tool offered by an operating system.

(vi) Briefly explain about different components of Resource Allocation Graph. What is the role of Resource Allocation Graph in handling deadlock?

(vii) Explain Banker's algorithm.

(viii) Explain how simple paging scheme works.

(iv) What are the four necessary conditions for deadlock? How these conditions are addressed in deadlock prevention scheme? Explain.

4. Answer **any one** of the following questions: (Each Question carries 10 marks) 10×1=10

(i) Define operating system with examples. What are the major functions of an operating system? Explain.

(ii) What is CPU scheduling algorithm? Define turn around time and waiting time in CPU scheduling. Compute average turn around time, average waiting time and average response time for following five processes using Shortest Job First scheduling algorithm.

Process	Arrival time	Burst time
P0	0	4
P1	0	5
P2	2	3
P3	2	4
P4	5	2

(iii) What are race condition and critical section problem? Explain how Peterson's algorithm works to address critical section problem.

Total number of printed pages=7

1 (Sem-4) COM 1

2025

## COMPUTER SCIENCE

Paper : COM0400104

( *Data Structure* )

Full Marks : 45

Time : Two hours

**The figures in the margin indicate full marks for the questions.**

1. Choose the correct option for the following questions : 1×5=5

(a) Which of the following sorting algorithm is not comparison based ?

(i) Counting sort

(ii) Selection sort

(iii) Merge sort

(iv) Bubble sort

(b) Which one of the following is the fastest searching technique?

- (i) Linear Search
- (ii) Binary Search
- (iii) Hashing
- (iv) Random Search

(c) Total number of comparisons performed by the *Insertion sort* algorithm on a sorted array of size  $n$  is

- (i)  $n$
- (ii)  $2n$
- (iii)  $n - 1$
- (iv)  $n(n - 1)/2$

(d) Which of the following statements is incorrect?

- (i)  $n^2 + 2n = O(n^2)$
- (ii)  $4n = \theta(n)$
- (iii)  $n^2 + 2n + 10 = O(n^3)$
- (iv)  $n^2 + 2n = O(n)$

(e) In a Max Heap, which property must always be true?

- (i) Every parent node is smaller than its children
- (ii) The root is the smallest element
- (iii) Every parent node is greater than or equal to its children
- (iv) All leaf nodes are at the same level

2. Answer the following questions : **(any five)**  
2×5=10

- (a) What is a data structure?
- (b) Differentiate between *linear* and *non-linear* data structures.
- (c) State *two* disadvantages of an array.
- (d) State *two* advantages of Linked List data structure over array data structure.
- (e) What is Big-O notation?
- (f) What is a pointer?

- (g) What are derived data types?
- (h) State the best case and worst case time complexities of merge sort algorithm.
- (i) Differentiate between row-major ordering and column-major ordering address calculation methods.
- (j) Show that  $3n + 4 = O(n^2)$

3. Answer **any four** of the following questions :  
5×4=20

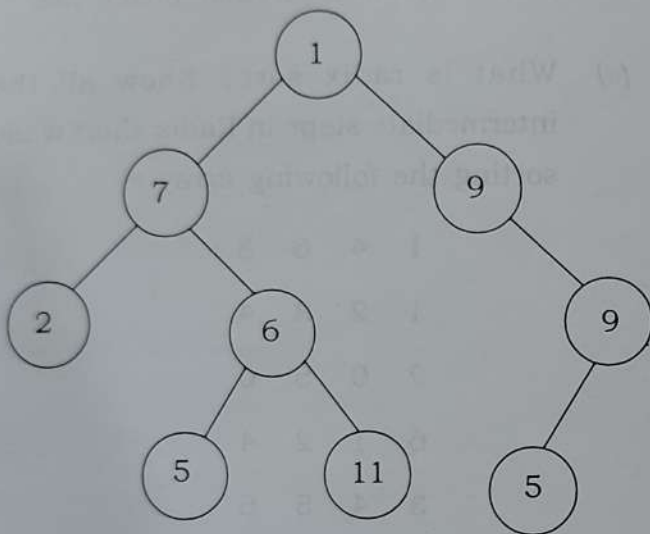
- (a) Write an algorithm/program for *insertion sort* algorithm.
- (b) What is binary searching? How it is different from linear searching? Find the number of comparisons done by 'binary search' while searching for the element 10 in the following array :  
2 6 10 12 15 20 22
- (c) What is stack? Explain various operations performed in a stack data structure.

- (d) What is a single linked list? Write an algorithm/program to insert a new node at the end of a circular linked list.
- (e) What is radix sort? Show all the intermediate steps in Radix sort while sorting the following array :

1	4	6	8
1	2	3	4
2	0	5	0
6	1	2	4
3	4	5	6
2	1	6	4

- (f) What is the *collision problem* in hashing? Discuss any collision resolution technique.
- (g) What is circular queue? Write an algorithm/program to delete an element from a circular queue.

(h) What is binary tree? Write in-order, pre-order and post order traversals for the following binary tree :



4. Answer the following questions : **(any one)**  
10×1=10

(a) Define the terms with respect to a tree data structure : *leaf node, height of a tree, depth of a tree, internal nodes and level of a tree.* 2×5=10

(b) What is sorting? State the needs of a sorting algorithm. Explain the working principle of bubble sort algorithm with a suitable example. 2+2+6=10

(c) Define *infix, prefix* and *postfix* notations. State the demerits of an infix expression. Convert the following infix expression to postfix expression using stack. (show each step of processing of the stack)

$$(a + b) - d / (f - g) * f \quad 2+2+6=10$$

(d) Write short notes on : **(any two)**  
5×2=10

(i) Time complexity and Space complexity

(ii) Data types

(iii) Structure and Union

(iv) Circular Linked List

Total number of printed pages-7

1 (Sem-4) COM 2

2025

**COMPUTER SCIENCE**

Paper : COM0400204

**( Database Management System )**

Full Marks : 45

Time : Two hours

***The figures in the margin indicate full marks for the questions.***

1. Answer the following questions :  $1 \times 5 = 5$

(a) What is DBMS ?

(i) DBMS is a collection of queries.

(ii) DBMS is a high-level language.

(iii) DBMS is a programming language.

(iv) DBMS stores, modifies and retrieves data.

(b) What does an RDBMS consist of?

- (i) Collection of records
- (ii) Collection of keys
- (iii) Collection of tables
- (iv) Collection of fields

(c) Which command is used to remove a relation from an SQL?

- (i) Drop table
- (ii) Delete
- (iii) Purge
- (iv) Remove

(d) Which data structure is used in Hierarchical model records?

- (i) Graph
- (ii) Tree
- (iii) Linked list
- (iv) Stacks

(e) Which normalization form is based on the transitive dependency?

- (i) 1NF
- (ii) 2NF
- (iii) 3NF
- (iv) BCNF

2. Answer the following questions : **(any five)**

2×5=10

- (a) Define data and database.
- (b) Define primary key and candidate key.
- (c) What do you mean by functional dependency?
- (d) Define Multiuser database system.
- (e) How can you say that a table is in 2nd normal form?
- (f) What is the basic difference between partial and full functional dependency?
- (g) What do you mean by transaction in DBMS?

(h) Write *two* advantages of DBMS.

(i) Write the syntax of 'Alter table' command in SQL.

(j) Differentiate between strong and weak entity.

3. Answer the following questions : **(any four)**  
5×4=20

(a) Differentiate between Traditional file approach and database approach.

(b) Briefly explain the three-tier architecture of DBMS with proper diagram.

(c) Given the following relation and functional dependencies :

$$R(A, B, C, D)$$
$$AB \rightarrow CD$$
$$D \rightarrow A.$$

Find the candidate key.

(d) Given the following relation and functional dependencies :

$$R(A, B, C, D, E)$$
$$AB \rightarrow CD$$
$$D \rightarrow A$$
$$BC \rightarrow DE.$$

Identify the normal form of the above relation and justify your answer.

(e) Briefly explain the ACID properties of transaction.

(f) Briefly explain the transaction states with proper diagram.

(g) Given the following table :

Employee (E\_id, E\_name, E\_address, E\_DoJ, E\_Salary)

Write the SQL statements for the following questions :

(i) Get the details of all employees.

1

(ii) Get the name of employees whose name start or end with 'R'.

1

(iii) Find the maximum salary from all the employees.

1

(iv) Get the address of employees who are joining before "01-01-2020".

1

(v) Increase the salary by 10,000 of all employees.

1

(h) Briefly explain the Client/Server database system.

4. Answer the following questions : **(any one)**

10×1=10

(a) Draw an E-R diagram of a company database in which the following properties should be included :

(i) all type of attributes

(ii) all type of entities

(iii) all type of relationships

(iv) types of participation

(v) minimum four entities

(b) Explain the lost update problem with a suitable example.

(c) Briefly explain object-based data model and physical data model.

(d) Write five responsibilities of DBA. Differentiate between left outer join and right outer join with an example.

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