

**DATA STRUCTURES & ALGORITHM
(CSEN 3106)**

Time Allotted : 3 hrs**Full Marks : 70***Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

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

**Group - A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Stack is also called
 (a) First In First Out (b) Last In Last Out
 (c) First In Last Out (d) all of the above.
- (ii) A data structure where elements can be added or removed at either end but not in the middle is called
 (a) stack (b) queue (c) dequeue (d) linked List.
- (iii) A linear list in which last node points to the first node is
 (a) singly linked list (b) doubly linked list
 (c) circular queue (d) circular linked list.
- (iv) A hash function f defined as $f(\text{key}) = \text{key} \bmod 7$, with linear probing, is used to insert the keys 37, 38, 72, 48, 98, 11, 56 into a table indexed from 0 to 6. What will be the location of key 11?
 (a) 3 (b) 4 (c) 5 (d) 6.
- (v) What is the best case time complexity of merge sort?
 (a) $O(n)$ (b) $O(n \log n)$ (c) $O(n^2)$ (d) $O(\log n)$.
- (vi) Which of the following searching techniques does not require the data to be in sorted form?
 (a) Binary search (b) Interpolation search
 (c) Linear search (d) all of the above.
- (vii) How many swaps are required to sort the given array using bubble sort - { 2, 5, 1, 3, 4 }?
 (a) 5 (b) 6 (c) 7 (d) 4.

- (viii) In a modified Towers of Hanoi problem, you have to move 5 disks from peg 1 to peg 3. To do that first you need to move 4 disks from peg 1 to peg 2. How many legitimate moves will it take to move 4 disks from peg 1 to peg 2?
 (a) 31 (b) 16 (c) 32 (d) 15.
- (ix) A complete binary tree of level 5 has how many nodes?
 (a) 15 (b) 25 (c) 63 (d) 30.
- (x) The minimum number of edges required to create a cyclic graph of n vertices is
 (a) $2n$ (b) $n - 1$ (c) $n + 1$ (d) n .

Group - B

2. (a) Examine the code snippet below where n is some positive integer.

```
for (i=0; i<n; i++)
{ for (j=0; j<i; j++)
  printf("\n Hello! \n");
}
```

 Deduce how many times Hello will be printed when $n = 6$. Show your work.
4 + 4 + (3 + 1) = 12
- (b) Consider an array of 40×4 called Score to store the numerical grades of 40 students in four different subjects. Suppose base address of Score is 1000 and $w = 2$ bytes. What will be the address of Score [25, 3], i.e., the score of 3rd subject of 25th student in row-major order? What will be the address of the same in column-major order?
- (c) Prove that running time $T(n) = n^3 + 20n + 1$ is $O(n^3)$. What do you understand by $O(1)$?
2 + 5 + (2 + 3) = 12
3. (a) Draws the linked representation of the polynomial : $9x^3 - 7x^2 + 9$.
- (b) Write an algorithm to delete an element from a doubly linked list. The position of the element will be supplied by the user.
- (c) Explain with diagram, how you add a node in linked queue. Write the corresponding algorithm for the operation.

Group - C

4. (a) Suppose STACK is an array of size 6 and initially STACK is empty, i.e., TOP = 0. A, B and ITEM are integer variables, and STACK operates on LIFO principle. Find the output of the following:
 Set A: = 2 and B : = 5;
 PUSH (STACK, A);

```

PUSH (STACK, 4);
PUSH (STACK, B+2);
PUSH (STACK, 9);
PUSH (STACK, A + B);
Repeat while (TOP is not equal to zero)
{ POP (STACK, ITEM)
  PRINT: ITEM;
}[ End of loop]
Return;

```

- (b) Convert the following infix expression into postfix expression using stack:
 $A + (B * C - (D / E ^ F) * G) * F$
 Draw stack and show what happens with proper explanations.
- (c) Write a short note on circular queue.

$$4 + 5 + 3 = 12$$

5. (a) Let N be an integer and suppose H(N) is recursively defined by

$$H(N) = \begin{cases} 3*N & \text{if } N > 5 \\ 2*H(N-5) + 7 & \text{otherwise} \end{cases}$$

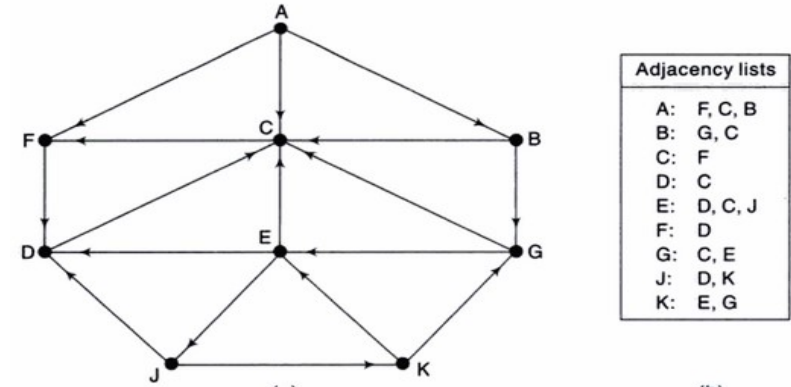
 Find the values of H(2), H(8) and H(24).
- (b) Write a C function, in recursive method which implements binary search algorithm.
- (c) Write recursive function for computing Fibonacci series and GCD.

$$(1 + 2 + 2) + 3 + (2 + 2) = 12$$

Group - D

6. (a) A binary tree T has 12 nodes. The inorder and preorder traversals of T yield the following sequences of nodes:
 Inorder : Q B K C F A G P E D H R
 Preorder: G B Q A C K F P D E R H
 Draw the tree. State briefly the logic used to construct the tree.
- (b) Construct an expression tree for the expression $E = a + b / c - d * e + f$
- (c) Write the algorithm for postorder traversal of a binary tree.
7. (a) What are adjacency matrix and adjacency list? Explain with example.
- (b) Consider the graph in the figure below. Suppose the graph represents the daily flights between cities of some airline, and suppose we want to fly from city A to city J with the minimum number of stops. Find out

the minimum path from A to J using BFS traversal. Show every step with explanation.



$$4 + 8 = 12$$

Group - E

8. (a) Suppose a company with 88 employees assigns a unique 4-digit employee no. to each employee which is used as primary key in the company emp-file. T is the hash table and L is the set of memory addresses in T. L consists of two-digit addresses: 00, 01, 02,, 99.
- (i) Apply the division method to the following employee numbers: 3205, 7148, 2345. What will be the corresponding hash addresses?
- (ii) If you apply folding method then what will be the corresponding hash addresses?
- (b) What is double hashing? When do we need it?
- (c) (i) In insertion sort algorithm, how many times will the outer for loop iterate when $n = 100$?
- (ii) In insertion sort, at some point you are trying to insert k^{th} element where $0 < k < n$. Assume also you started with a file which was sorted in reverse order. What will be the exact number of key comparisons?
9. (a) Given an array of six elements: 15, 19, 10, 7, 17, 16, sort it in ascending order using heap sort. Show every step by drawing diagrams with brief explanation.
- (b) Show step by step (using diagram), how the following list of unsorted numbers will be sorted using merge sort: 26, 33, 35, 29, 19, 12, 22.

$$(3 + 2) + 3 + (1 + 3) = 12$$

$$7 + 5 = 12$$