

Master of Computer Applications (MCA)

MCAC-103: Data Structures

Unique Paper Code: 223401103

Semester: I

April 2023

Year of admission: 2022

Yogendra Sir

Time: 3 Hours

Max. Marks: 70

Instructions for the Students:

Attempt all questions. Parts of a question should be answered together.

- 1 a. Arrange the following functions in the increasing order of their rate of growth: 2

$$n^{\lg n}, \quad \sqrt{n}, \quad n \log n, \quad n, \quad \frac{100}{n}, \quad n^{\sqrt{n}}$$

- b. What are stable sorting algorithms? Which of the following is/are not a stable sorting algorithm? 2

Bubble sort, Quick sort, Selection sort and Heap sort.

- c. What does the following piece of code do? 2

```
public void func(Tree root)
{
    func(root.left());
    func(root.right());
    System.out.println(root.data());
}
```

- d. Which of the following is an efficient data structure for searching words in dictionaries?
- e. Which sorting algorithms is best if list is almost sorted? Why?
- f. What is the maximum height of any AVL-tree with 7 nodes? Assume that the height of a tree with a single node is 0.
- g. What are the worst- and Best-case time complexities of a binary search tree?

- h. Consider (QA) be Quick sort algorithm to sort integers in non-decreasing order using last element as pivot. C1 and C2 be the number of comparisons made by QA for the given inputs {12, 8, 6, 7, 8, 10} and {4, 4, 4, 4, 4, 4} respectively. What will be the values of C1 and C2? 3
- 2 a. Consider the algorithm for max heapify using priority queue implementation. 4
- Fill the missing details (marked by ?) correctly (as discussed in class).
- ```

MAX-HEAPIFY (A, i)
  l = Left(i)
  r = Right(i)
  if (l ≤ A.heapSize and A[l] > A[i])
    largest = l
  else largest = ... ? ...
  if (r ≤ A.heapSize and A[r] > A[largest])
    largest = r
  if (largest ≠ i)
    exchange A[i] with A[largest]
    MAX-HEAPIFY(A, largest)

```
- 
- Note: Assume that the size of array is  $n$  and starting index of array is from 0.
- b. What are the advantages and disadvantages of tries? Construct a ~~suffix~~ tree T for a string (as discussed in class) 4
- "David", Dravid, "Maria", Marriage, and "Mario".
- 3 a. Given a stack of integers, how do you check whether each successive pair of members in the stack is consecutive or not. The pair can be increasing or decreasing, and if the stack has an odd number of elements, the elements at the top is left out of pair. For example, if stack of elements are [4,5,-2,-3,11,10], then the output should be true because each of the pairs (4,5), (-2,-3), (11,10) and (5,6) consists of the consecutive members. 4
- b. Consider the following array declaration A [-10.....10, -15.....15]. 4
- Suppose that the elements are stored in i) Row Major Order (RMO) and ii) Column Major Order (CMO). Give the formula and calculate the address of the element

$A[0][0]$  where assume that the base address of the array is 100 and every element requires 10 bytes of storage.

- 4 a. Explain the concept of Linear probing, Quadratic probing and chaining methods of hashing. Consider a Hash function  $f(x) = x \% 17$ , Store the following values in a hash table 58, 48, 79, 46, 54, 32, 24, 19, 18, 35, 15, 84, 16, 12. Assume that the size of hash table is 16. 4

- b. Analysing the time complexity for the given algorithms (written in Pseudo-code) by counting the number of steps. 4

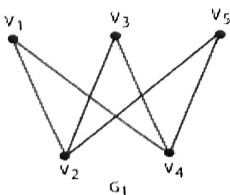
```

A(n)
{
    n = 22k
    for (i = 1; i ≤ n; i++)
    {
        j = 2
        while (j ≤ n)
        {
            j = j2
            Print("DUCS");
        }
    }
}

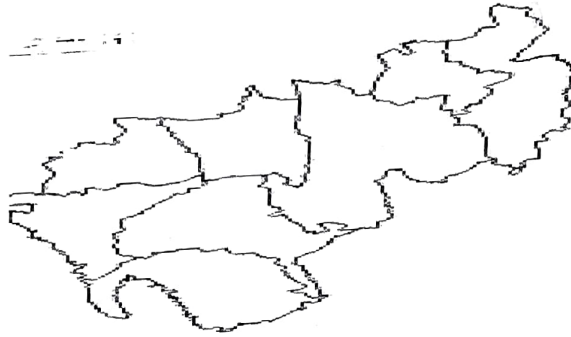
```

- 5 a. Write a program to implement stack by using linked list, where you will specify push and pop operation. Also include condition to check full or empty. 4

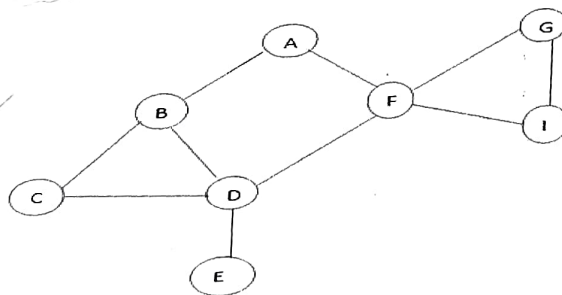
- b. State the condition for Euler path (EP), Euler circuit (EC), Hamiltonian path (HP) and Hamiltonian circuit (HC). Determine whether the graph  $G_1$  has EP, EC, and HP. 4



- 6 a. Write an algorithm to find both smallest and largest elements in a set of  $n$  entries. 5  
Try to find a method that does at most roughly  $1.5 \cdot n$  comparisons of elements.
- b. Consider the following district map of Tripura state. Is it four colourable? If yes, 5  
assign the colour to each region else give the chromatic number and its colouring.



- 7 a. Consider a variation of binary search algorithm; The instructor wants to search a 4  
number in a sorted array of size  $n$  by dividing it into two parts of size  $2n/3$  and  $n/3$ .  
Write down the recurrence for the running time for the best- and worst-case  
scenario.
- b. Run the Depth first search (DFS) algorithm and Breadth first search (BFS) 6  
algorithms on the network given in the figure starting from vertex  $s=A$ . Also  
assume that both the BFS and DFS algorithms will choose the left-most node first.



- Determine if the graph is bipartite. If yes, give the two partitions else justify your answer.
- Find the tree edges, cross edges and back edges using DFS.
- Explain how DFS can be used to find a cycle in the graph
- Given a pair of vertices  $s$  and  $t$ , explain how BFS can be used to find a shortest path between  $s$ - $t$  in graph.