No of Pages : 3 **Course Code : 15XW23**

Roll No:
(To be filled in by the candidate)

PSG COLLEGE OF TECHNOLOGY, COIMBATORE - 641 004

SEMESTER EXAMINATIONS, MAY 2018

MSc – SOFTWARE SYSTEMS Semester : 2

15XW23 DATA STRUCTURES AND ALGORITHMS

Time : 3 Hours **Maximum Marks : 100**

INSTRUCTIONS:

1. Answer **ALL** questions. Each question carries 20 Marks.
2. Subdivision (a) carries 3 marks each, subdivision (b) carries 7 marks each and subdivision (c) carries 10 marks each.
3. Course Outcome : Table

Qn.1	CO1	Qn.2	CO2	Qn.3	CO3	Qn.4	CO4	Qn.5	CO5

1. a) Does $3^n \in O(2^n)$? Give reasons for your answer.

   b) For each of the algorithms given below, mention the basic operation and analyse its time complexity

   (i) **ALGORITHM** (A,n) // A is an array of size n (3)

```
for i=1 to n
  for j=2i to n
    A[i]=A[j]+1
```

.

   (ii) **ALGORITHM** *Q(n)* (4)

```
//Input: A positive integer n
if n = 1 return 1
else return Q(n / 2) + 2 * n - 1
```

   c) i) Consider there are n disks and three pegs. The disks are of different sizes and can slide onto any of three pegs. Initially, all the disks are on the first peg in order of size, the largest on the bottom and the smallest on top. The goal is to move all the disks to the third peg, using the second one as an auxiliary, if necessary. To move the n^{th} disk, all other disks above it have to be moved to the auxiliary peg. Only one disk can be moved at a time, and it is forbidden to place a larger disk on top of a smaller one. Setup the recurrence relation for the above problem and derive its time complexity based on the basic operation.

(OR)

ii) What is the need for asymptotic notations? Explain the notations and its usage with examples. Analyse the best and worst case time complexity of sequential search.

2. a) Consider an array A[1:45, -4:34, 5:10] represented in row major order where each cell occupies two bytes of memory. Find the address of the element A[12,10,7] if the base address is 50. Also, find the total memory required to store the array.

b) Consider the sparse matrix S given below. Obtain the array and multilist representation of S. Write an algorithm to find the transpose of S using the array representation.

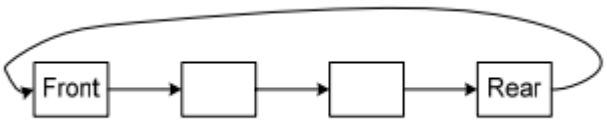
$$\begin{bmatrix} 0 & 3 & 0 & 0 & 0 \\ 1 & 4 & 0 & 0 & 0 \\ 2 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 7 & 8 \end{bmatrix}$$

c) Write procedures to perform PUSH and POP operations on a stack implemented as an array. Apply the procedures to convert an infix expression to a postfix expression. Trace the algorithm to find the postfix equivalent of a+b*c+d*e↑f where ↑ represents exponentiation. Assume normal operator precedence.

3. a) A priority queue Q is used to implement a stack S that stores characters. PUSH(C) is implemented as INSERT(Q, C, K) where K is an appropriate integer key chosen by the implementation. POP is implemented as DELETEMIN(Q). For a sequence of operations, in what order should the keys be inserted? Why?

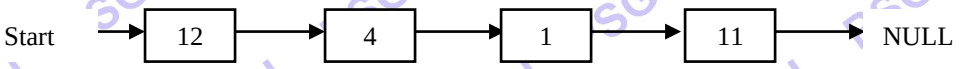
b) i) Is Linked list a linear or non-linear data structure? Justify your answer. (3)

ii) Consider a queue that is implemented using a circular linked list as shown below. The queue can be accessed only using a pointer ‘p’. To which node should ‘p’ point so that enqueue and dequeue operations are performed in constant time? Write a procedure to perform enqueue and dequeue operations on this queue. (4)



c) Consider a singly linked list S. Write procedures to reverse the links while the list is traversed. Once the last node is reached, the user must be able to traverse in the backward direction.

Initial List:



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Reversed List

While traversing in the reverse direction, Let P denote the node that is currently being examined and L is the node that lies to its immediate left. Write a procedure to move the node pointed by P, 'n' nodes to the left of L.

4. a) What is an expression tree? Construct an expression tree for the postfix expression ABC*FH^/+.

   b) i) Consider a binary tree with n nodes. Let n0, n1 and n2 denote the number of nodes with degree 0, 1 and 2 respectively. Obtain an expression for the number of nodes with degree 2 in terms of the number of leaf nodes. (3)

   ii) Construct a binary tree whose preorder and inorder sequences are A B M H E O C P G J D K L I N F and H M C O E B A G P K L D I N J F respectively, where A, B, C, D, E, ……. are the labels of the tree nodes. (4)

   c) What is the advantage of using Huffman encoding? Write an algorithm to encode a given text using Huffman's algorithm. Use the algorithm to encode the words DOG, DOLL, DOSE, DOME, DOOR, ROME and ROSE. Compute the total number of bits used to encode the words.

5. a) Construct a max heap for the following keys 15, 34, 45, 78, 7, 82, 33, 56, 90, 12, 99. Is the constructed heap a complete binary tree?

   b) Write an algorithm to perform quick sort and analyse the worst case complexity of the algorithm. Trace the algorithm on the following data: 22,45,1,67, 96, 97, 63, 85, 23**.**

   c) List the properties of a good hash function. How are collisions resolved using linear probing and chaining? Which of these techniques would be better? Why? Map the keys 23, 45, 67, 7, 89, 9, 90, 91, 24, 55, 82, 77, 50, 10, 19, 4, 20, 65, 28, 38, 12 and 5 to a hash table with 3 slots using the hash function H(X)=X mod 9. Use quadratic probing to resolve collision if there is any.

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