No of Pages : 4 **Course Code : 15XW23**

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

PSG COLLEGE OF TECHNOLOGY, COIMBATORE - 641 004

SEMESTER EXAMINATIONS, APRIL 2019 (PHASE I)

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.

1. a) Does $3^n \in O(2^n)$? Give reasons for your answer.
   b) Solve the following recurrence relation giving a Θ bound: $T(n) = 2T(n/3) + 1$; $T(1) = 1$.
   c) 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.
2. a) Given the following sequence of letters and asterisks: EAS*Y*QUE***ST***IO*N***. Consider the stack data structure, supporting two operations push and pop. Suppose that for the above sequence, each letter (such as E) corresponds to a push of that letter onto the stack and each asterisk (*) corresponds a pop operation on the stack. Show the sequence of values returned by the pop operations.
   b) i) Convert the following postfix expression to an infix expression
   12 7 3 - / 2 1 5 + * + (3)
   ii) A programming language permits indexing of arrays with character subscripts. The programming language uses ordinal number of the characters are indices. The ordinal number for A is 1, B is 2, C is 3 and so on. For Example, in array A['B':'F'], the starting index is 2 and the ending index is 6. Consider two arrays TEMP[1:5, -1:2] and CODE['A':'Z', -1:2] are stored in the memory starting from address 500. Also, CODE succeeds TEMP in storage. Calculate the address of : (I) CODE['N,2] (II) CODE['N',-1] (4)

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c) Write an algorithm to convert an infix expression to a postfix expression. Trace the algorithm for the infix expression A+(B*C-(D/E^F)*G)*H . Evaluate the obtained postfix expression with A=1, B= -1, C=3, D=8, E=2, F=2, G= -5, H=4.

3. a) Can linked list be used to implement binary search? Give reasons.

b) i) Write a procedure to convert a linked stack in to a linked queue in such a way that the list is traversed only once. (3)

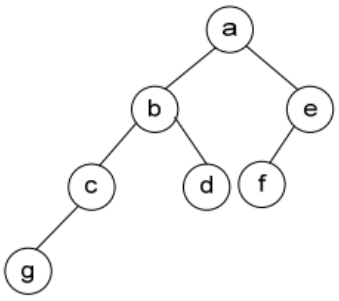
ii) Consider a singly linked list having n nodes. The data items d_1, d_2, …., d_n are stored in the n nodes. Let Y be a pointer to the j^{th} node ($1 \le j \le n$) in which d_j is stored. A new data item d has to be inserted before the node containing d_j. Give an algorithm to insert d into the list without traversing the entire list such that the final list is $d_1, d_2, .., d_{j-1}, d, d_j, …..d_n$ (4)

c) A circular linked list with n nodes is arranged in descending order. Write an algorithm to sort the list in ascending order. Modify the algorithm for a doubly linked list. Which of the algorithms would be an efficient one? Why?

4. a) The expression (a + (b - c)) * ((d - e) / (f + g - h) is depicted using an expression tree T. The pre order traversal sequence of the tree T is * + a – b c / - d e - + f g h and the post order traversal of T yields a b c - + d e – f g + h - / *. If all non-leaf nodes of T have two children, Identify T.

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) How are NULL pointers in a binary tree eliminated? Eliminate NULL pointers in the tree given below. (4)



c) i) 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.

(OR)

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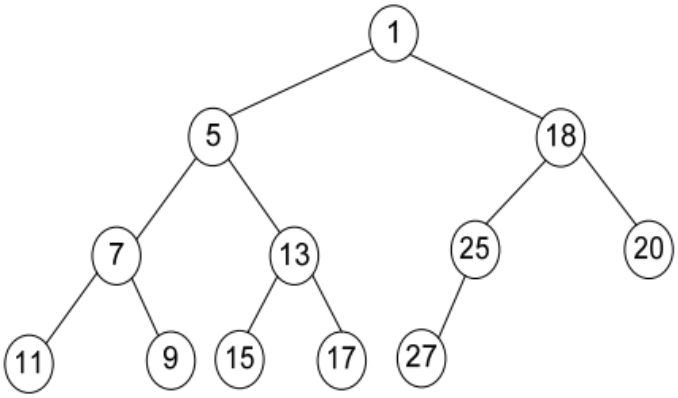
ii) Obtain an array and linked list representation of the binary tree given below. Which representation is efficient? Why? Write recursive procedures for tree traversals and traverse the tree given below using inorder, postorder and preorder traversals.



5. a) Construct a max heap for the following keys 15, 34, 45, 78, 7, 82, 36, 56, 90, 12, 99. Is the constructed heap a complete binary tree?

b) Write a procedure to sort a set of numbers using shell sort. Trace the algorithm on the list L= {7, 5, 5^2, 5^3, 5^4, 5^5, 5^6, 5^7, 5^9} for a sequence of increments {4,2,1}. The repeated occurrence of each element has been superscripted with their orders of occurrence**.**

c) What is the advantage of quadratic probing over linear probing? For the set of keys {17,9,34,56,11,4,71,86,55,10,39,49,52,82,31,13,22,35,44,20,60,28}, obtain a hash table following quadratic probing. Make use of the hash function H(X)=X mod 9 where X is the key. What are your observations?

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