B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING
SECOND YEAR SECOND SEMESTER EXAM - 2019

Data Structures And Algorithms **Time: 3 hours** **Full Marks: 100**

1. Give brief answers to the following questions: **10x2**
   a) Write a pseudocode for inserting an element into the front of a list.
   b) Differentiate between a queue and a priority queue.
   c) Prove or disprove: $3n^2 + 4n^2\ logn + 5n + 2 = O(n^3 \log n)$.
   d) Given: $T(n) = T\left(\frac{3n}{4}\right) + 1$. Find the tight asymptotic bound for $T(n)$.
   e) Show the bounds for number of nodes of an almost complete binary tree of depth *d*.
   f) Prove or disprove: Number of edges in K_n is less than the number of edges in $K_{n,n}$.
   g) Find the complexity of the Merge Sort algorithm.
   h) What is meant by hash collision?
   i) Explain whether dynamic programming is the most suitable approach to solve the Fractional Knapsack problem.
   j) State the shortest path problem in a weighted directed graph.

2. a) Define a stack. **1**
   b) Clearly explain how you can use a stack for reversing a string. Show linked implementation of the two basic operations you will need for achieving the above task. **2+3+3**
   c) Explain how a stack can be used to solve the Towers of Hanoi problem. Trace the recursive solution for the above problem with 4 discs. **2+5**

3. a) Define a height balanced binary search tree. **2**
   b) Show that the binary search tree constructed with nodes as 8, 6, 10, 4, 7, 9, 11, 3, 5, 2 is not height-balanced. You should first show the step-by-step construction of the tree taking the first data as the root. **5**
   c) Apply appropriate AVL rotation on the tree in (b). Verify that the rotation indeed achieves the desired result. **6**
   d) Prove or disprove: A complete graph is always connected. **3**

4. a) Define Θ-notation with proper explanation. **3**
   b) Using the definition in (a), prove that $n^2 - \frac{3n}{2} = \Theta(n^2)$. **5**
   c) Find the solution to the recurrence relation $T(n) = 2T(\sqrt{n}) + 1$ using the substitution method. **8**

OR

a) Prove that for any two functions $f(n)$ and $g(n)$, $f(n) = \Theta(g(n))$ if and only if $f(n) = O(g(n))$ and $f(n) = \Omega(g(n))$. **4**

b) Find the solution to the recurrence relation $T(n) = 4T\left(\frac{n}{2}\right) + n$ using the recursion tree approach. **8**

c) Verify your solution in (b) using any alternative approach. **4**

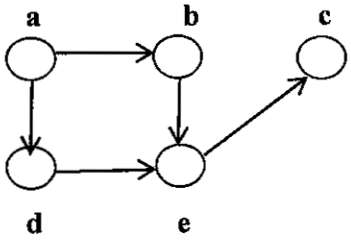
5. a) Write a recursive procedure for the Quick Sort algorithm including a separate code for the partition process. **6**

b) Apply the algorithm in (a) to sort the dataset 25, 57, 48, 37, 12, 92, 86 in the ascending order. Analyze the time-complexity of your solution. **5+2**

c) Compare the number of operations necessary to check whether the *key* = 86 is present in the given dataset using two different search techniques. **3**

6. a) Shortest Common Supersequence (SCS) of strings X[1,...,m] and Y[1,...,n] is the shortest string Z[1,...,p] such that both X and Y are subsequences of Z. For example, if X = "AB" and Y = "BC", then Z = SCS(X,Y) = "ABC" and length of Z is 3. Find a dynamic programming based solution to the SCS problem. Apply your solution to find the length of a SCS of strings "ABCDGH" and "AEDFHR". **10**

b) Apply depth-first search on the following directed graph with starting node as **'a'**. Show the nested parenthesis structure based on timestamps. **6**



OR

a) Compare and contrast dynamic programming and greedy algorithms. **3**

b) Explain the greedy choice behind construction of a Huffman tree. Apply a greedy procedure for building a Huffman tree with 6 symbols a, b, c, d, e, f having respective frequencies (in thousands) as 30, 10, 20, 15, 13, 12. **2+5**

c) Grow a breadth-first tree in the following graph with root node as **'b'**. Analyze the complexity of your solution. **6**