B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING
SECOND YEAR SECOND SEMESTER EXAM - 2018

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

1. Give brief answers to the following questions: **10x2**
   a) Realize product of two complex numbers with abstract data type representation.
   b) What is meant by FIFO principle? Name a data structure which follows that principle.
   c) Prove or disprove: $3n^2 + 4n\,logn + 6n + 7 = O(n \log n)$.
   d) Given: $T(n) = 4T\left(\frac{n}{2}\right) + n^2$. Find the asymptotic bound for $T(n)$.
   e) Define a Splay tree.
   f) Prove or disprove: The graph K_5 is non-planar.
   g) Explain why Quicksort is not suitable for sorting an almost sorted data set.
   h) Show that the sequential search runs in linear time in the worst-case.
   i) Analyze whether dynamic programming is necessary to solve the Tower of Hanoi problem.
   j) Mention one application each of the depth-first search and the breadth-first search algorithms.

2. a) Define a linear linked list. **2**
   b) Model traffic control at a turning point using an appropriate data structure. Use linked implementation to represent two primitive operations for this data structure. **2+3+3**
   c) With an appropriate data structure, evaluate the following arithmetic expression P written in postfix notation: 12, 7, 3, -, /, 2, 1, 5, +, *, +. Show your steps. **6**

3. a) Define a strictly binary tree. Prove that a strictly binary tree with n leaves has $(2n - 1)$ nodes. **2+3**
   b) Define an almost complete binary tree. Construct a tree which is not strictly binary but is almost complete binary. Justify your construction. **2+3**
   c) Define a complete graph. Draw two complete graphs of order 4. Find the number of vertices and edges in the above graphs. **2+2+2**

4. a) Explain the meaning of O-notation. **3**
   b) Prove that if $f(n) = O(g(n))$ and $g(n) = O(h(n))$, then $f(n) = O(h(n))$. What is this property called? **3+1**
   c) What is a recurrence? Find the solution to the recurrence $T(n) = 2T\left(\frac{n}{2}\right) + 17$ using the substitution method. **1+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 $f(n) = \Omega(g(n))$. **5**

b) Find the solution to the recurrence $T(n) = 2T\left(\frac{n}{2}\right) + n^2$ using the substitution method. **8**

c) Find the solution to the recurrence in b) using the master method. **3**

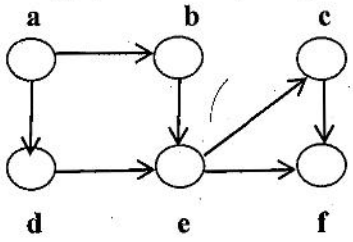
5. a) Apply bubble sort to sort the dataset 25, 57, 48, 37, 12, 92, 86 in the ascending order. Analyze the time-complexity of your solution. **4+2**

b) Show how you can use a tree to achieve the task in a). Analyze the time-complexity of your solution. **3+2**

c) Apply an efficient search algorithm to check whether the *key* = 92 exists in the sorted dataset. Analyze the time-complexity of your solution. **3+2**

6. a) Explain the Integer Knapsack problem. Provide an efficient solution to this problem with necessary mathematical details. Justify your solution strategy. **1+5+2**

b) Write a procedure for depth-first search. Apply this procedure on the following directed graph with starting node as '**a**'. Show your steps. **3+5**



OR

a) What is an optimal prefix code? Write a procedure to build a tree for representing optimal prefix codes. Apply this procedure for 6 symbols a, b, c, d, e, f having respective frequencies (in thousands) as 30, 10, 20, 15, 13, 12. **1+3+4**

b) Write a procedure for breadth-first search. Grow a breadth-first tree in the following graph with root node as '**c**'. **3+5**