National Institute of Technology, Hamirpur
Department of Computer Science and Engineering
Third Year-Fifth Semester (End Semester Examination)
CSD312-Design and Analysis of Algorithms

Time: 3hrs   **Max. Marks 60**

Give algorithm whenever possible.

For all problems, if you include any new algorithm in your solution, please also include a brief English description of what the algorithm does.

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1. (5 Marks) An element in an array X is called a leader if it is greater than all elements to the right of it in X. Device a linear time algorithm to find all the leaders in an array. Show that $X[9] = \{14, 20, 13, 15, 7, 8, 9, 4, 3\}$ has three leaders as $20, 15$ and 9.

2. (5 Marks) We want to merge nine given sorted files where the number of records in each file is given as $\{12, 34, 56, 73, 24, 11, 34, 56, 78\}$. Suppose you want to pairwise merge these files, then find a single merged file such that minimum number of record moves are performed. Mention number of moves required by your procedure.

3. (5 Marks) A vertex v is called sink of graph G if there is a path from every vertex in G to v. Write an efficient algorithm to check if a Directed Acyclic Graph (DAG) has a sink. (also give an example) (Hint: A DAG may have at most one sink).

4. (2+2+1 Marks) Create a complete undirected graph with vertex set $\{0, 1, 2, 3, 4\}$. Entry W_{ij} in the matrix W below is the weight of the edge $\{i, j\}$.

$$W = \begin{pmatrix} 0 & 1 & 8 & 1 & 4 \\ 1 & 0 & 12 & 4 & 9 \\ 8 & 12 & 0 & 7 & 3 \\ 1 & 4 & 7 & 0 & 2 \\ 4 & 9 & 3 & 2 & 0 \end{pmatrix}$$

   a) Find out that what is the minimum possible weight of a spanning tree T in this graph such that vertex 0 is a leaf node in the tree T? Explain the procedure in one or two lines.

   b) What is the minimum possible weight of a path P from vertex 1 to vertex 2 in this graph such that P contains at most 3 edges?

5. (7 marks) Can we have a graph in which a negative weighted cycle is not reachable from source S? If no, then why it is not possible and is that mean, Bellman – Ford algorithm will always detect negative weight cycle, if one exists. If yes, then can Bellman-Ford algorithm detect that cycle and what final value will be returned by the algorithm? Elaborate by considering an example.

6. (4+3 Marks) Depth-First Search can be used to do *in-order traversal* of a binary search tree. That is, given a binary search tree T containing n distinct elements $a_1 < a_2 < \ldots < a_n$, DFS can be used to return an array $[a_1, a_2, \ldots, a_n]$ containing these elements in sorted order. Give algorithm and an example for inOrderTraversal using DFS.

7. (8 Marks) Give a dynamic programming solution for the SUBSET-SUM problem. Explain why this solution does not put the subset sum problem in NP-hard?

8. (3+3+2 Marks) Write algorithm to insert element into a min-heap and draw the min-heap that results from insertion of following elements in order into an initially empty min-heap: 7, 6, 5, 4, 3, 2, 1. Show the result after the deletion of root of this heap.

9. (3+5+2 Marks) Give algorithm of quick sort and apply to sort the list E, X, A, M, P, L, E in alphabetic order. What value of q does PARTITION return when all elements in the array A[p......r] have the same value?