Design and Analysis of Algorithm Lab (PCC CS494)

Laboratory Instructor's Manual

Last Revised

June, 2021

Dept. of CSE
Techno Main, Salt Lake

GENERAL INSTRUCTIONS FOR STUDENTS

1. Do not enter the Laboratory without prior permission.
2. Switch off your mobile phones during Lab class and maintain silence.
3. Save your files only on the specific destination folders as instructed.
4. Do not play games, watch movies, chat or listen to music during the class.
5. Do not change desktop setting, screen saver or any other system settings.
6. Do not use any external storage device without prior permission.
7. Do not install any software without prior permission.
8. Do not browse any restricted, illegal or spam sites.

GENERAL ADDRESS FOR LABORATORY TEACHERS

1. Submission of documented lab reports related to completed lab assignments should be done during the following lab session.
2. The promptness of submission should be encouraged by way of marking and evaluation patterns as reflected in the lab rubric which eventually will benefit the students**.**

Program Outcomes (POs)

PO1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis:** Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural and engineering sciences.

PO3. **Design/Development of solutions:** Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety and the cultural societal and environmental considerations.

PO4. **Conduct investigations of complex problems:** Use research based knowledge including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage:** Create, select and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.

PO8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work:** Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10. **Communications:** Communicate effectively with the engineering community and with the society at large. Be able to comprehend and write effective reports documentation. Make effective presentations and give and receive clear instructions.

PO11. **Project management and finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

PO12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Ability to develop the solutions for scientific, analytical and research-oriented problems in the area of Computer Science and Engineering.

PSO2: Ability to apply suitable programming skills integrated with professional competence to develop applications catering to the industrial and societal needs in the field of Computer Science and Engineering and its allied areas.

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COURSE NAME: Design and Analysis of Algorithm Lab	**SEMESTER: 4th**
COURSE CODE: PCC CS494	**COURSE CREDIT: 2**
COURSE TYPE: LAB	**CONTACT HOURS: 4P**

SYLLABUS

Laboratory Experiments:	
Divide and Conquer:	
1	Implement Binary Search using Divide and Conquer approach Implement Merge Sort using Divide and Conquer approach
2	Implement Quick Sort using Divide and Conquer approach Find Maximum and Minimum element from a array of integer using Divide and Conquer approach
3	Find the minimum number of scalar multiplication needed for chain of matrix
4	Implement all pair of Shortest path for a graph (Floyed- Warshall Algorithm) Implement Traveling Salesman Problem
5	Implement Single Source shortest Path for a graph (Dijkstra , Bellman Ford Algorithm
Brunch and Bound:	
6	Implement 15 Puzzle Problem
Backtracking:	
7	Implement 8 Queen problem
8	Graph Coloring Problem Hamiltonian Problem
Greedy method:	
9	Knapsack Problem Job sequencing with deadlines
10	Minimum Cost Spanning Tree by Prim's Algorithm Minimum Cost Spanning Tree by Kruskal's Algorithm
Graph Traversal Algorithm:	
11	Implement Breadth First Search (BFS) Implement Depth First Search (DFS)

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Course Outcomes (CO)

CO-1: Understand how the choice of data structures and the basic techniques for algorithm design like recursion, divide-and-conquer, dynamic programming etc. impact the performance of the programs.

CO-2: Apply classical sorting, searching, optimization, graph algorithms etc. to solve real world problems.

CO-3: Implement an algorithm for a given problem in common engineering design situations in any programming language by choosing the appropriate data structure and design strategy.

CO-4: Solve computational/real world problems relevant to cultural/ social/ health/ safety and allied issues by applying an appropriate algorithmic design paradigm, working effectively either as an individual or as a team.

CO-5: Compose well-drafted documents/ transcripts to present the design and solutions conclusively.

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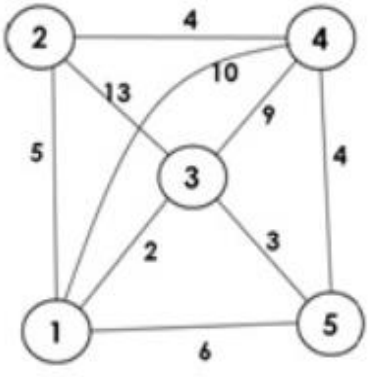
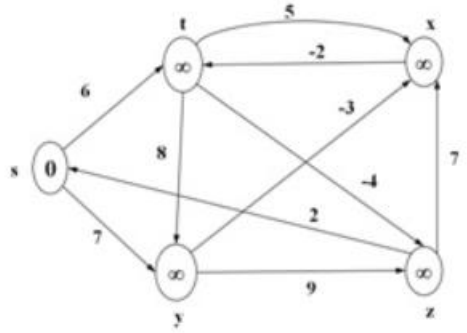
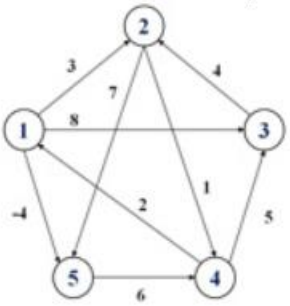
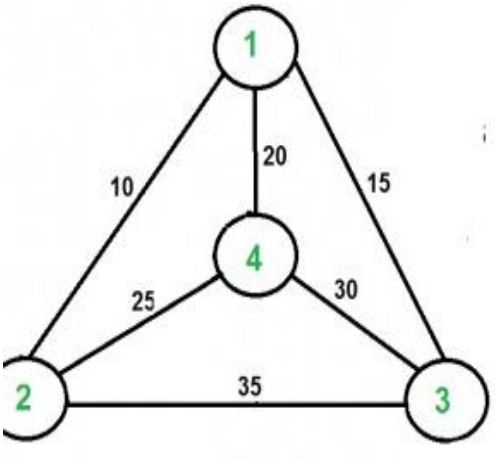
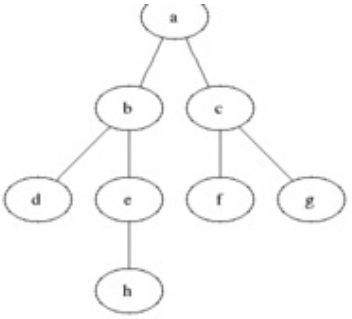
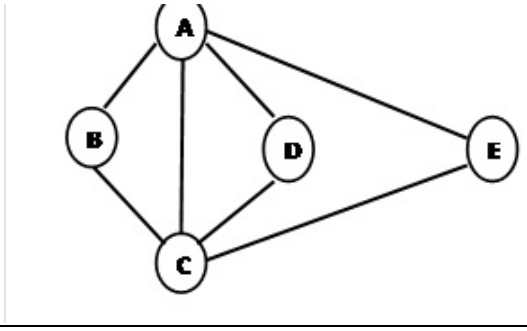
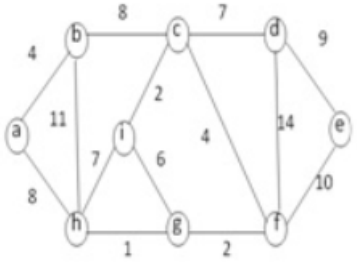
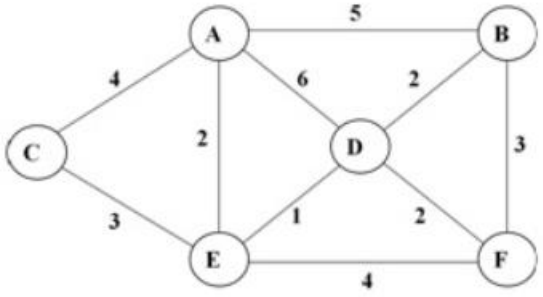
List of Experiments

Assignment No.	List of Experiments	Week No.
Assignment 1	I) Implement Binary Search using Divide and Conquer approach. II) Implement Merge Sort, Quick Sort and Heap Sort using Divide and Conquer approach.	**Week 1**
Assignment 2	I) Find Maximum and Minimum element from a array of integer using Divide and Conquer approach as well as dynamic programming approach. II) WAP to multiply two 4x4 matrices using Strassen's Matrix Multiplication. $A = \begin{bmatrix} 4 & 2 & 0 & 1 \\ 8 & 1 & 2 & 5 \\ 3 & 2 & 1 & 4 \\ 5 & 2 & 6 & 7 \end{bmatrix}$ $B = \begin{bmatrix} 2 & 1 & 3 & 2 \\ 5 & 4 & 2 & 3 \\ 1 & 4 & 0 & 2 \\ 3 & 2 & 4 & 1 \end{bmatrix}$	**Week 2**
Assignment 3	I) Write a program to find the binomial coefficient using Dynamic programming method. II) Find the minimum number of scalar multiplications needed for a chain of matrices whose sequences are <5, 10, 3, 12, 5, 50, 6> using the dynamic programming technique.	**Week 3**
Assignment 4	I) WAP using the single-source-shortest-path problem to find out the shortest path from the source vertex '1', using the Dijkstra's algorithm, using the dynamic programming technique. 	**Week 4**

Assignment No.	List of Experiments	Week No.
	II) WAP using the single-source-shortest-path problem to find out the shortest path from the source vertex 's' using the Bellman-Ford's algorithm, using the dynamic programming technique.  	
Assignment 5	I) WAP to find out the all-pair-shortest-path for the given graph using the Floyd-Warshall's algorithm by the dynamic programming technique.  	**Week 5**
	II) WAP using dynamic programming to find the optimal route for the given graph using TSP and taking vertex '1' as source.  	

Assignment No.	List of Experiments	Week No.
Assignment 6	I) WAP to implement BFS on the given graph starting at 'a'.  	**Week 6**
	II) WAP to implement DFS on the given graph starting at 'A'.  	
Assignment 7	I) WAP using greedy method to find the MST for the given graph using the Prim's Algorithm.  	**Week 7**
	II) WAP using greedy method to find the MST for the given graph using the Kruskal's  Algorithm.	
Assignment 8	I) Consider the following knapsack problem where n = 3, W = 20 Kgs, (v1, v2, v3) = (25, 24, 15), and (w1, w2, w3) = (18, 15, 10). WAP to find the optimal solution by	**Week 8**

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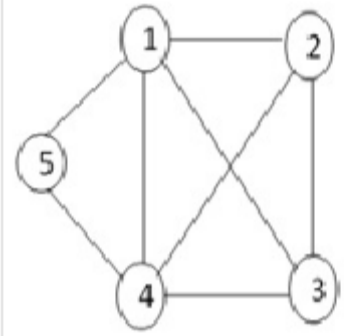
	fractional knapsack (greedy method) as well as 0 / 1 knapsack (Dynamic programming method).	
	II) Given a set of '10' jobs with their s_i and f_i, find the optimal sequence of mutually compatible jobs using the greedy method: A = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}, s_i = {3, 4, 5, 6, 7, 8, 9, 10, 11, 12} and f_i = {5, 7, 8, 10, 11, 12, 13, 14, 15, 16}.	
Assignment 9	Write a procedure using B & B technique to solve the 15-puzzle problem. (Take an initial state of your choice that will converge in the goal state.)	**Week 9**
Assignment 10	I) WAP to implement the 4-Queen's problem using the method of backtracking.	**Week 10**
	II) WAP using backtracking to find the chromatic number for the given graph, using the graph-coloring problem. 	
Assignment 11	The Maximum Sub-array Sum problem is to find the sub-array (A sub-array of the array A [0…N-1] is A[i…j] where $0 \le i \le j < N$) for which the sum of its elements is maximum. For example, given an array {12, -13, -5, 25, -20, 30, 10}, the maximum sub-array sum is 45 for sub-array {25, -20, 30, 10}. The naive solution to this problem is to calculate the sum of all sub-arrays starting with every element and returning the maximum of all. WAP to find the maximum sub-array given below: (1) Divide the given array in two halves. (2) Return the maximum of the following: i. Maximum sub-array sum in the left half (Make a recursive call). ii. Maximum sub-array sum in the right half (Make a recursive call).	**Week 11**
Assignment 12	I) Find the only 10 digit number where the digit at the ith position (i = 0, 1, 2, 3 etc.) from left specifies the number of occurrences of digit "i" in the given number.	**Week 12**
	II) Find the numbers from 1 to N that contains exactly k non-zero digits	

Assignment No.	List of Experiments	Week No.
	Given two integers **N** and **K**. The task is to find the number of integers between **1** and **N** (inclusive) that contains exactly **K** non-zero digits when written in base ten. Example: ***Input:*** *N = 100, K = 1* ***Output:*** *19* ***Explanation:*** *The digits with exactly 1 non zero digits between 1 and 100 are:* *1, 2, 3, 4, 5, 6, 7, 8, 9,* *10, 20, 30, 40, 50, 60, 70, 80, 90, 100* ***Input:*** *N = 25, K = 2* ***Output:*** *14* ***Explanation:*** *The digits with exactly 2 non zero digits between 1 and 25 are:* *11, 12, 13, 14, 15, 16, 17,* *18, 19, 21, 22, 23, 24, 25*	
	III) The following is a description of the instance of this famous puzzle involving 2 eggs and a building with 100 floors. Suppose that we wish to know which stories in a 100-story building are safe to drop eggs from, and which will cause the eggs to break on landing. What strategy should be used to drop eggs such that total number of drops in worst case is minimized and we find the required floor from where the egg is dropped such that it does not break? Identify the appropriate algorithm and design a solution to this problem.	**Week 12**

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Rubrics for Lab

Criteria / Score	Excellent (10-8)	Good (7-6)	Average (5-4)	Poor (3-1)	CO Mapping	PO/PSO Mapping
Lab Participation (Following Procedure +Lab Techniques+ Subject Knowledge + Contribution)	Student demonstrates an accurate understanding of the lab assignments. The student can correctly answer questions and if required, can explain concepts to fellow classmates. Student is eager to develop new ideas and assists when needed.	Student arrives on time to lab, but may be underprepared. Answers to questions are basic and superficial suggesting that concepts are not fully grasped. Able to follow the instruction and somehow manage to execute the program.	Student's unpreparedness makes it impossible to fully participate. If able to participate, student has difficulty explaining key lab concepts.	There was no attempt to make prior arrangements to make up the lab. Attendance is not regular. Not able to run the program even after getting help from the peers.	CO1/CO2 /CO3/ CO 4	PO1/ PO2/ PO3, PSO1/ PSO2
Interaction with Group (Team work)	Very good participation with a good leadership quality; is respectful of others and their point of view; makes sure that everyone gets a turn; conscious of time	Good participation; appears interested; enthusiastic but talks over teammates; try to help group complete tasks; somewhat conscious of time	Minimal participation ; shows little interest; doesn't pay attention to other group members; may argue to get point across; helps group only when asked; little emphasis on time	No participation; sits on the sidelines with no interaction; disinterested; no stake in time management	CO4	PO9

Criteria / Score	Excellent (10-8)	Good (7-	Average (5-4)	Poor (3-1)	CO Mapping	PO/PSO Mapping
Execution and Debugging (Modern tool usage)	Follow the logical ideas; can develop suitable program from specific algorithm; debug the program with proficiency; Able to check the reliability	Can develop suitable program specific algorithm with the help of the instructor; program proficiency; Able to the	Can develop suitable program from specific algorithm with the help of the instructor; debug the program with the help of technical assistant; Not able to check the reliability.	Not be able to develop suitable program from specific algorithm; need assistance to debug the program. Not able to check the reliability	CO1/CO2 /CO3/ CO 4	PO5/ PSO2
Lab Report	Student demonstrates an accurate understanding of the lab concepts. Questions are answered completely and correctly. Output of each program is neat, creative and includes complete titles. Errors, if any are minimal	Student has a basic knowledge of content, but may lack some understandin g of some concepts. Questions are answered fairly well and/or output could have been done more neatly, accurately or with more complete information	Student has problems with both the output and the answers. Student appears to have not fully grasped the lab content and the code possess multiple errors	Student turns in lab report late or the report is so incomplete and/or so inaccurate that it is unacceptable.	CO5	PO10/ PSO1