Symbiosis Institute of Technology, Pune

Department of Computer Science and Engineering

Academic Year 2025-26

Design and Analysis of Algorithms– Lab

Batch 2023-27 - Sem V

Lab Assignment No:- 1	
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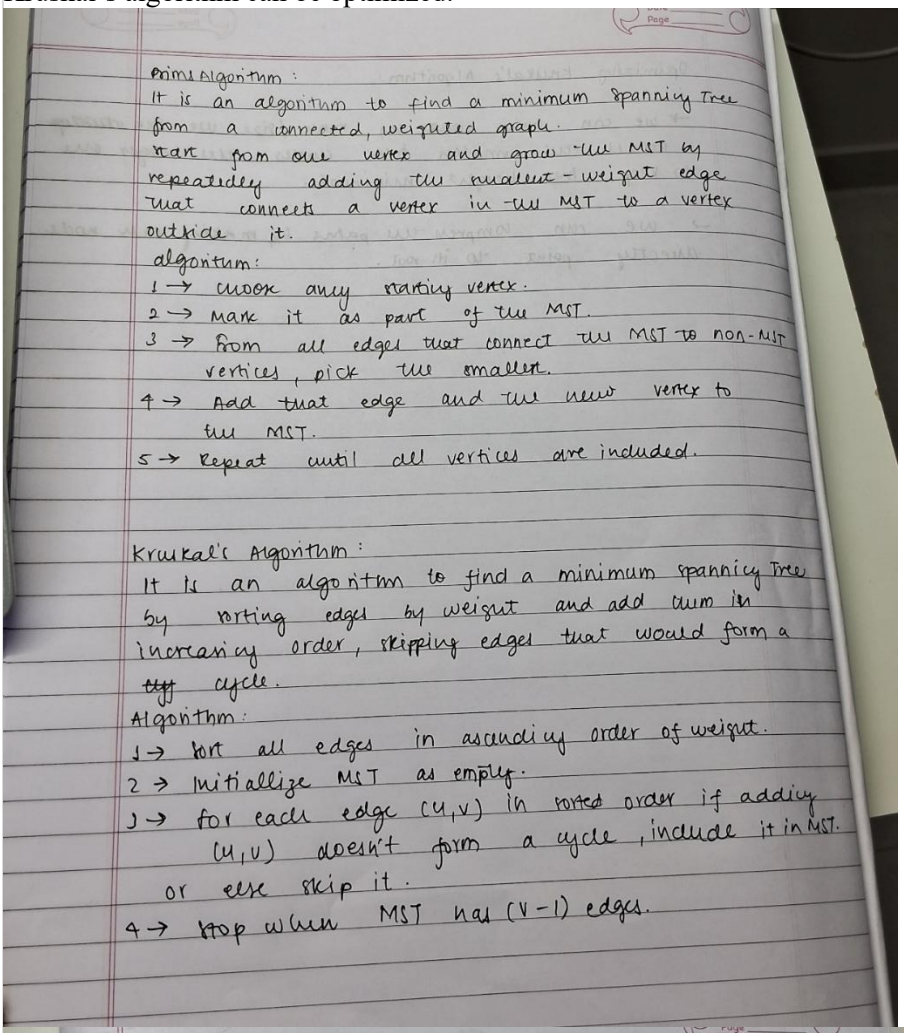
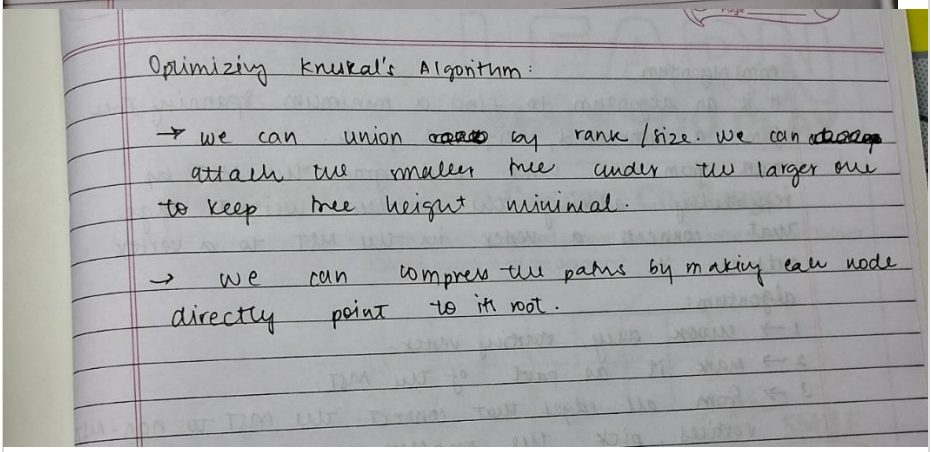
Batch	CSE
Class	A3
Academic Year & Semester	2023-27 , TY, 5th Sem
Date of Submission	11 Aug 2025
Title of Assignment:	Create implementations for the Kruskal's & Prim's Algorithm for finding the Minimum Cost Spanning Tree for a given graph. You may input the graph from the file and use an adjacency matrix. **Scenario:** A university campus **is planning to connect all its departments with** network cables **to enable high-speed internet access. The goal is to** minimize the total cost **of laying down the cables while ensuring every department is connected.** **Your Task:** Design a program that: • Reads a graph (departments as vertices and cost of laying cables as edge weights) from a file • Implements **Prim's Algorithm** to find the **Minimum Cost Spanning Tree (MCST)**. • Tracks the number of **edge comparisons**. • Displays each stage of node inclusion and cumulative cost.

Theory: (Handwritten)	Explain Prim's and Kruskal's algorithms in detail. Discuss in detail how Kruskal's algorithm can be optimized.  

Source code (Implementation Screenshot)	import java.io.*;
	import java.util.*;
	
	public class Main {
	Scanner scan = new Scanner(System.in);
	public static void main(String[] args) {
	
	//read the matrix:
	try {

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                        File file = new File("clg_network_cost.txt");
                        Scanner scan = new Scanner(file);
                        int v = scan.nextInt();
                        int[][] graph = new int[v][v];

                        for(int i=0; i<v; i++) {
                                for(int j=0; j<v; j++) {
                                        graph[i][j] = scan.nextInt();
                                }
                        }
                        scan.close();


                        System.out.println("Prim's Algorithm Output : ");
                        prims(graph, v);

                        System.out.println("\nKruskal's Algorithm Output :
");
                        kruskal(graph, v);
                } catch (FileNotFoundException e) {
                        System.out.println("Graph file not found!");
                }

        }

        //prims algorithm
        public static void prims(int[][] graph, int v) {
                int[] key = new int[v];
                boolean[] mstSet = new boolean[v];
                int[] parent = new int[v];

                //initailize
                Arrays.fill(key, Integer.MAX_VALUE);
                key[0] = 0;
                parent[0] = -1;
                int cumCost = 0;
                int edgeCompares = 0;

                for(int count = 0; count<v-1; count ++) {
                        int u = minkey(key, mstSet, v);
                        mstSet[u] = true;

                        if (parent[u] != -1) {
                                cumCost += graph[u][parent[u]];
                                System.out.println("Edge: (" + parent[u] + " -
" + u +
                                                ") | Cost: " + graph[u][parent[u]]
+
                                                " | Cumulative Cost: " +
cumCost);
                        }

                        for(int i=0; i<v; i++) {
                                edgeCompares++;
                                if(graph[u][i] != 0 && !mstSet[i] &&
```

```
graph[u][i]<key[i]) {
                                        parent[i] = u;
                                        key[i] = graph[u][i];
                                }
                        }
                }

                System.out.println("Total Cost of MST: " + cumCost);
                System.out.println("Total Edge Comparisons: " +
edgeCompares);

        }

        public static int minkey(int[] key, boolean[] mstSet, int n) {
                int min = Integer.MAX_VALUE;
                int minIndex = -1;
                for(int v=0; v<n; v++) {
                        if(!mstSet[v] && key[v]<min) {
                                min = key[v];
                                minIndex = v;
                        }
                }
                return minIndex;
        }

        //kruskal-----------
        static class Edge implements Comparable<Edge> {
                int src, dest, weight;
                public int compareTo(Edge other) {
                        return this.weight - other.weight;
                }
        }

        static class Subset {
                int parent, rank;
        }

        static void kruskal(int[][] graph, int v) {
                List<Edge> edges = new ArrayList<>();
                int edgeCompares = 0;
                int cumCost = 0;

                for (int i = 0; i < v; i++) {
                        for (int j = i + 1; j < v; j++) {
                                if (graph[i][j] != 0) {
                                        Edge e = new Edge();
                                        e.src = i;
                                        e.dest = j;
                                        e.weight = graph[i][j];
                                        edges.add(e);
                                }
                        }
                }

                Collections.sort(edges);
```

```
		Subset[] subsets = new Subset[v];

		for (int i = 0; i < v; i++) {
			subsets[i] = new Subset();
			subsets[i].parent = i;
			subsets[i].rank = 0;
		}

		int e = 0;
		int i = 0;
		while (e < v-1 && i < edges.size()) {
			Edge nextEdge = edges.get(i++);
			edgeCompares++;

			int x = find(subsets, nextEdge.src);
			int y = find(subsets, nextEdge.dest);

			if (x != y) {
				e++;
				cumCost += nextEdge.weight;
				System.out.println("Included Edge: (" +
nextEdge.src + " - " + nextEdge.dest +
					") | Cost: " + nextEdge.weight +
					" | Cumulative Cost: " +
cumCost);
				union(subsets, x, y);
			}
		}

		System.out.println("Total Cost of MST: " + cumCost);
		System.out.println("Total Edge Comparisons: " +
edgeCompares);
	}

	static int find(Subset[] subsets, int i) {
		if (subsets[i].parent != i)
			subsets[i].parent = find(subsets, subsets[i].parent);
		return subsets[i].parent;
	}

	static void union(Subset[] subsets, int x, int y) {
		int xroot = find(subsets, x);
		int yroot = find(subsets, y);

		if (subsets[xroot].rank < subsets[yroot].rank)
			subsets[xroot].parent = yroot;
		else if (subsets[xroot].rank > subsets[yroot].rank)
			subsets[yroot].parent = xroot;
		else {
			subsets[yroot].parent = xroot;
			subsets[xroot].rank++;
		}
	}
}
```

Output Screenshots

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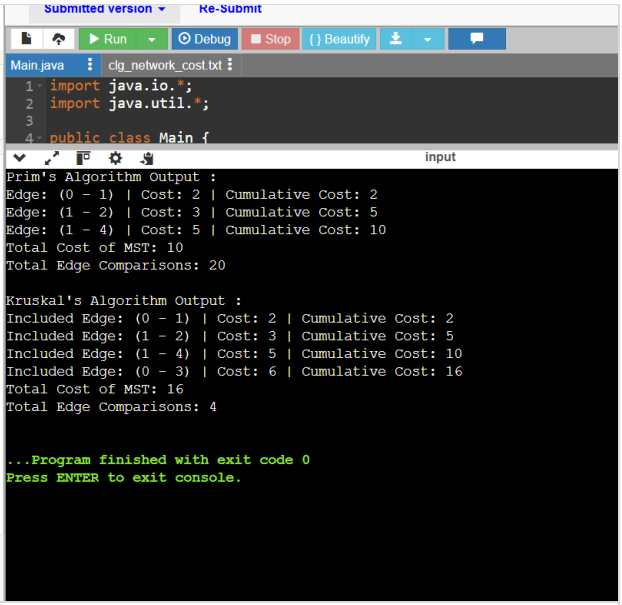
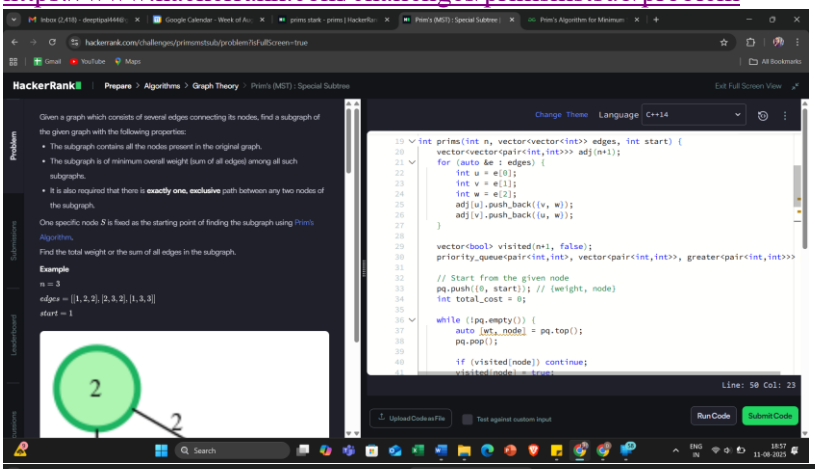
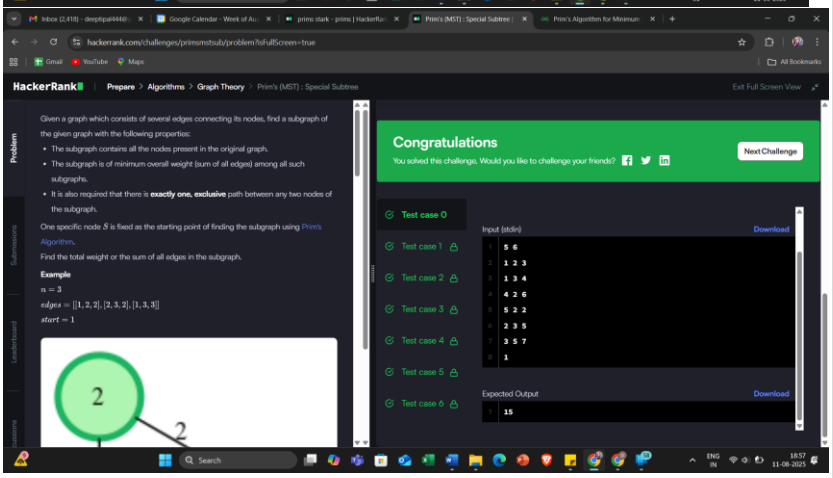


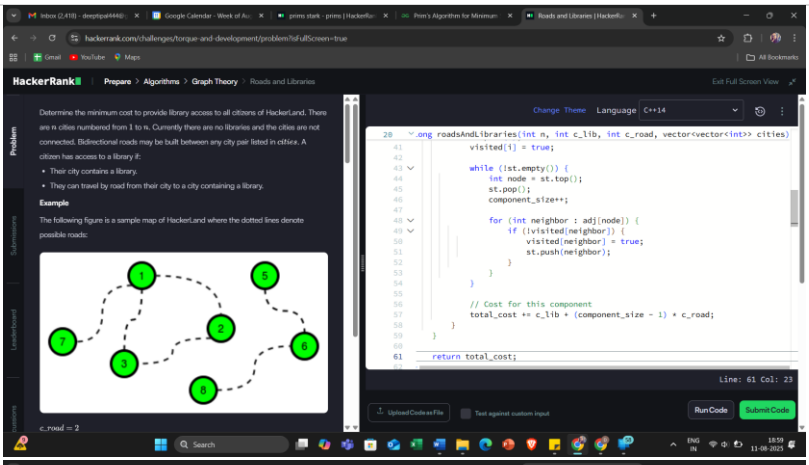
Problems Solved from Hacker Rank (Minimum 4)

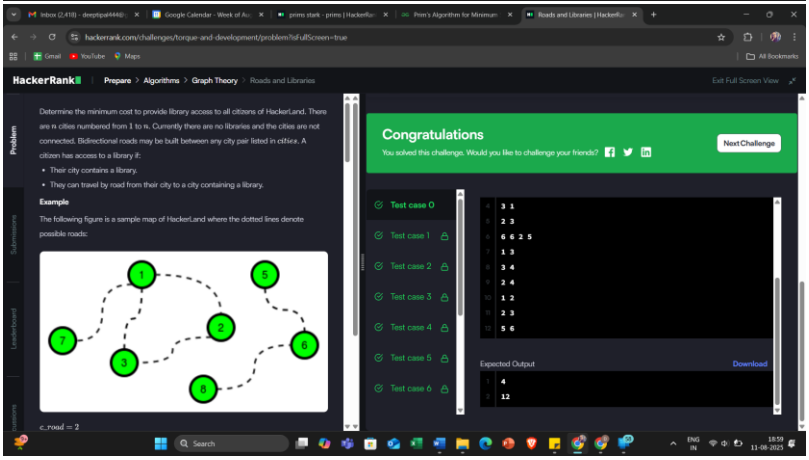
1. https://www.hackerrank.com/challenges/primsmstsub/problem



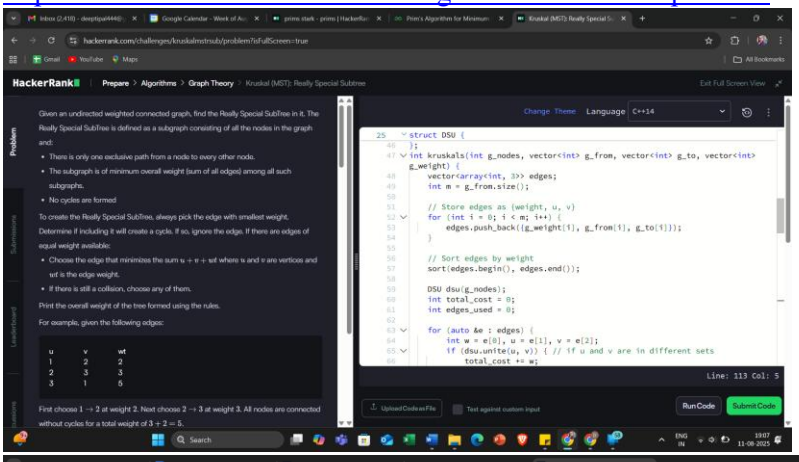


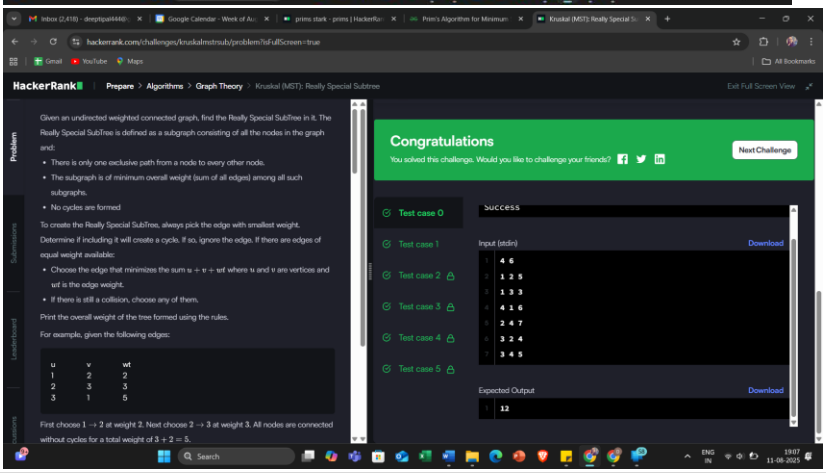
2. https://www.hackerrank.com/challenges/torque-and-development/problem





3. https://www.hackerrank.com/challenges/kruskalmstrsub/problem





	4. https://www.hackerrank.com/contests/vit-bhopal/challenges/prims-algorithm-2 - **locked**