

DATA STRUCTURES AND ALGORITHMS DESIGN

SE ZG519/SS ZG519

EC-1: Assignment

Weightage: 20%

Marks: 40

Submission Dead Line: 04th May 2025 (Sunday) 12:00 Noon

Mode of Submission: Write down (preferably typed in a doc file) your answer in the space provided and submit a scan copy of your document.

Name:

ID:

A company wants to build a chain of restaurants on many street corners with the goal of maximizing their total profit. The street network is described as an undirected graph $G = (V, E)$, where the potential restaurant sites are the vertices of the graph. Each vertex u has a nonnegative integer value p_u indicating the potential profit of site u . Two restaurants cannot be built on adjacent vertices (to avoid self-competition). You are supposed to design an algorithm that outputs the chosen subset $U \subseteq V$ of sites that maximizes the total profit $\sum_{u \in U} p_u$.

(a) [Marks: 5] Suppose that the street network G is acyclic, i.e., a tree. Consider the following “greedy” restaurant-placement algorithm: Choose the highest-profit vertex u_0 in the tree (breaking ties according to some order on vertex names) and put it into U . Remove u_0 from further considerations, along with all of its neighbors in G . Repeat until no further vertices remain. Produce two example graphs, i.e., trees, where for one graph the algorithm produces maximum profit and for the other graph the algorithm does not produce the maximum profit. Consider having exactly five nodes in each of the graphs.

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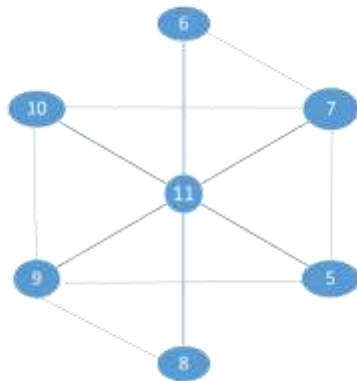
(b) [Marks: 10] Suppose that the street network G is acyclic. Give an efficient algorithm to determine a placement with maximum profit. Note: your algorithm should be written in plain English and in sequence of steps.

(c) [Marks: 5+5] Apply your algorithm designed in b) on the graphs in part a) and show the results. Your answer is expected in an appropriate graphical representation of the graph.

(d) [Marks: 5 points] Suppose that the street network G is acyclic. In the absence of a good market research, the company decides that all sites are equally good, and the goal is simply to design a restaurant placement with the largest number of locations. Give a simple greedy algorithm to solve the problem. Algorithm should be written in plain English and in sequence of steps.

(e) [Marks: 5] Now suppose that the graph is arbitrary, not necessarily acyclic. Give the fastest and correct algorithm you can for solving the problem. What is the time complexity of your algorithm?

(f) [Marks: 5] Apply algorithm in part e) to find the solution in the following graph. Draw only the final graph keeping the relative positions of the nodes unchanged.



*****End of Question Paper*****