Islamic University of Technology
Department of Computer Science and Engineering

Lab 4: Single Source Shortest Path in Graphs

CSE 4404: Algorithms Lab
Summer 2023-24

Task A. Shortest Signal Path

Time Limit: 1 second | *Memory Limit: 512 MB*

A research facility has established a network of n outposts, connected by m one-way signal links. Each link transmits signals in one direction and has a certain delay associated with it.

Outpost 1, known as *Command Center*, initiates all signal transmissions. Your task is to compute the shortest signal delay from the Command Center to each of the other outposts in the network.

It is guaranteed that every outpost is reachable from the Command Center.

Input Format

The first line contains two integers n and m ($1 \le n \le 10^5,\ 1 \le m \le 2 \cdot 10^5$) — the number of outposts and signal links.

The next m lines each contain three integers a, b, and c ($1 \le a, b \le n,\ 1 \le c \le 10^9$) — meaning there is a one-way signal link from outpost a to outpost b with a delay of c units.

Output Format

Print n space-separated integers: the minimum signal delay from the Command Center (outpost 1) to each outpost $1, 2, \ldots, n$.

Examples

Sample Input	Sample Output
3 4 1 2 6 1 3 2 3 2 3 1 3 4	0 5 2

Task B. Bicycles

Time Limit: 4 seconds | *Memory Limit: 512 MB*

Rifat and his friends are going to a festival in another city. All of them have bicycles — except Rifat. The festival is held in city n, and all of them live in city 1. The region has n cities connected by m two-way roads, forming an undirected graph.

Each city has exactly one bicycle for sale. The bicycle in city i takes s_i time to travel one unit of distance.

Rifat can buy any bicycle from any city, and he can buy multiple bicycles along the way. Once he owns a bicycle, he can use it to travel along any road, and the time taken to traverse a road of length w with a bicycle from city j is $w \cdot s_j$.

Rifat cannot travel without a bicycle. Since he wants to reach the festival as quickly as possible, he asks you to help determine the shortest time it would take him to travel from city 1 to city n.

It is guaranteed that it is possible to reach any city from city 1.

Input Format

The first line contains a single integer t ($1 \le t \le 100$) — the number of test cases.

Each test case begins with a line containing two integers n and m ($2 \le n \le 1000,\ n-1 \le m \le 1000$) — the number of cities and roads.

The next m lines each contain three integers u_i, v_i, and w_i ($1 \le u_i, v_i \le n,\ u_i \ne v_i,\ 1 \le w_i \le 10^5$) — describing a two-way road between cities u_i and v_i with length w_i. Multiple roads may exist between the same pair of cities.

The final line of each test case contains n integers $s_1, s_2, \ldots, s_n$ ($1 \le s_i \le 1000$) — the time required per unit distance for the bicycle in each city.

Output Format

For each test case, print a single integer — the minimum amount of time Rifat needs to reach city n from city 1.

Examples

Sample Input	Sample Output

3 5 5 1 2 2 3 2 1 2 4 5 2 5 7 4 5 1 5 2 1 3 3 5 10 1 2 5 1 3 5 1 4 4 1 5 8 2 3 6 2 4 3 2 5 2 3 4 1 3 5 8 4 5 2 7 2 8 4 1 7 10 3 2 8 2 1 4 2 5 7 2 6 4 7 1 2 4 3 5 6 4 2 6 7 1 6 7 4 4 5 9 7 6 5 4 3 2 1	19 36 14

Marks Distribution

Task	**Marks**
Task A	90%
Task B	10%

Practice Problems

Problem	**Links**
Shortest Path	Library Checker: https://judge.yosupo.jp/problem/shortest_path Vjudge: https://vjudge.net/problem/Yosupo-shortest_path
Dijkstra?	Codeforces: https://codeforces.com/problemset/problem/20/C Vjudge: https://vjudge.net/problem/CodeForces-20C
Jzzhu and Cities	Codeforces: https://codeforces.com/problemset/problem/449/B Vjudge: https://vjudge.net/problem/CodeForces-449B
Graph and Graph	Codeforces: https://codeforces.com/contest/2059/problem/D Vjudge: https://vjudge.net/problem/CodeForces-2059D