



**Islamic University of Technology**  
Department of Computer Science and Engineering

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## Lab 5: Shortest Path (Continued)

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**CSE 4404: Algorithms Lab**  
**Summer 2023-24**

# Task A. Abar Jigay!

Time Limit: 2 second | Memory Limit: 512 MB

Puran Dhaka is a legendary maze. Its roads twist like the plot of a badly written TV drama, and even GPS gives up trying to find a route there.

You were once a proud inhabitant of Puran Dhaka. In your prime, you knew all  $n$  important spots and the  $m$  chaotic roads connecting them. Whether someone asked how to get from the sweet shop in Chawkbazar to the secret rooftop adda near Lalbagh, you had the shortest route memorized.

But time passed. You moved away. The roads changed (or maybe your memory just got rusty). And now, your friends keep texting you with questions like: “Bro, what’s the fastest way from spot  $a$  to spot  $b$ ?”

You don’t want to admit that you’ve forgotten. So you secretly open your laptop, write some code, and pretend you’re still the undisputed master of Puran Dhaka navigation.

Your task is to answer  $q$  such questions about the shortest routes between pairs of spots.

## Input Format

The first line contains three integers  $n$ ,  $m$ , and  $q$  ( $1 \leq n \leq 500$ ,  $1 \leq m \leq n^2$ ,  $1 \leq q \leq 10^5$ ) — the number of spots, roads, and queries.

Then  $m$  lines follow, each containing three integers  $a$ ,  $b$ , and  $c$  ( $1 \leq a, b \leq n$ ,  $1 \leq c \leq 10^9$ ) — meaning there is a road of length  $c$  between spot  $a$  and spot  $b$ .

Finally,  $q$  lines follow, each containing two integers  $a$  and  $b$  ( $1 \leq a, b \leq n$ ) — a query asking for the length of the shortest route between spot  $a$  and spot  $b$ .

## Output Format

For each query, print the length of the shortest route between the two spots on its own line.

If there is no route, print -1.

## Examples

Sample Input	Sample Output
4 3 5	5
1 2 5	5
1 3 9	8
2 3 3	-1
1 2	3
2 1	
1 3	
1 4	
3 2	

# Task B. Dekisugi’s Childhood Dream

Time Limit: 2 second | Memory Limit: 512 MB

Hidetoshi Dekisugi was one of the brightest students in the country. He grew into a renowned astronaut and scientist. After a series of successful space missions, he is now working to fulfill a childhood dream. Ever since he saw Doraemon, he secretly wished to build a real-life time machine.

While progress has been slow, Dekisugi recently made a promising discovery — certain “wormholes” scattered across the galaxy. Each wormhole is a one-way portal that instantly transfers someone from one star system to another, but with a twist: it also shifts them forward or backward in time. The time difference can be positive or negative.

Dekisugi believes that if there exists a sequence of wormholes such that a traveler can return to the original star system and go back in time overall, this could form the core mechanism of a time machine.

You are given a map of these wormholes. Can you help Dekisugi determine whether such a time loop (a cycle with negative total time shift) exists?

## Input Format

The first line contains two integers  $n$  and  $m$  ( $1 \leq n \leq 2500$ ,  $1 \leq m \leq 5000$ ) — the number of star systems and the number of wormholes.

Each of the next  $m$  lines contains three integers  $a$ ,  $b$ , and  $c$  ( $1 \leq a, b \leq n$ ,  $-10^9 \leq c \leq 10^9$ ) — indicating that there is a one-way wormhole from star system  $a$  to star system  $b$  that shifts the traveler by  $c$  units of time.

## Output Format

Print YES if there exists any time loop (a cycle with total negative time shift). Otherwise, print NO.

## Examples

Sample Input	Sample Output
4 5 1 2 3 2 3 2 3 4 -1 4 2 -2 1 3 -5	YES

## Notes

In the sample input, the wormhole sequence  $2 \rightarrow 3 \rightarrow 4 \rightarrow 2$  forms a cycle with total time shift  $2+(-1)+(-2) = -1$ , which is negative. So the correct answer is YES.

## Marks Distribution

Task	Marks
Task A	50%
Task B	50%

## Practice Problems

Problem	Links
Signal Hill	DMOJ: <a href="https://dmoj.ca/problem/dmpg15s4">https://dmoj.ca/problem/dmpg15s4</a> Vjudge: <a href="https://vjudge.net/problem/DMOJ-dmpg15s4">https://vjudge.net/problem/DMOJ-dmpg15s4</a>
Roads in Berland	Codeforces: <a href="https://codeforces.com/contest/25/problem/C">https://codeforces.com/contest/25/problem/C</a> Vjudge: <a href="https://vjudge.net/problem/CodeForces-25C">https://vjudge.net/problem/CodeForces-25C</a>
High Score	CSES: <a href="https://cses.fi/problemset/task/1673">https://cses.fi/problemset/task/1673</a> Vjudge: <a href="https://vjudge.net/problem/CSES-1673">https://vjudge.net/problem/CSES-1673</a>
Cycle Finding	CSES: <a href="https://cses.fi/problemset/task/1197">https://cses.fi/problemset/task/1197</a> Vjudge: <a href="https://vjudge.net/problem/CSES-1197">https://vjudge.net/problem/CSES-1197</a>
Edge Deletion	AtCoder: <a href="https://atcoder.jp/contests/abc243/tasks/abc243_e">https://atcoder.jp/contests/abc243/tasks/abc243_e</a> Vjudge: <a href="https://vjudge.net/problem/AtCoder-abc243_e">https://vjudge.net/problem/AtCoder-abc243_e</a>
Flight Discount	CSES: <a href="https://cses.fi/problemset/task/1195">https://cses.fi/problemset/task/1195</a> Vjudge: <a href="https://vjudge.net/problem/CSES-1195">https://vjudge.net/problem/CSES-1195</a>
Greg and Graph	Codeforces: <a href="https://codeforces.com/problemset/problem/295/B">https://codeforces.com/problemset/problem/295/B</a> Vjudge: <a href="https://vjudge.net/problem/CodeForces-295B">https://vjudge.net/problem/CodeForces-295B</a>