# Problem B.

| | |
|---|---|
| Input file: | `standard input` |
| Output file: | `standard output` |
| Time limit: | 3 seconds |
| Memory limit: | 1024 megabytes |

You are given multiple pairs of equations representing straight lines in a 2D plane. Each equation is of the form $ax + by + c = 0$. Your task is to determine if the two equations in each pair represent the same line.

Two lines $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ are considered the same if there exists a non-zero constant $k$ such that:

- $a_1 = k \cdot a_2$
- $b_1 = k \cdot b_2$
- $c_1 = k \cdot c_2$

## Input

The first line of the input contains an integer $T$ ($1 \leq T \leq 10^5$), the number of test cases.

Each of the next $T$ lines contains six integers $a_1, b_1, c_1, a_2, b_2, c_2$ ($-10^{18} \leq a_1, b_1, c_1, a_2, b_2, c_2 \leq 10^{18}$), representing two equations of the form $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$.

## Output

For each test case, output `YES` if the two lines are the same, otherwise output `NO`.

## Example

| standard input | standard output |
|---|---|
| 3<br>1 2 3 2 4 6<br>1 -1 2 -2 2 -4<br>1 1 1 1 1 2 | YES<br>YES<br>NO |

## Note

In the first test case, the second line is exactly twice the first line, so they are the same.

In the second test case, the second line is exactly -2 times the first line, so they are the same.

In the third test case, the lines are clearly not the same as their coefficients do not satisfy the condition.

# Problem C.

SCCAlgo

| | |
|---|---|
| Input file: | `standard input` |
| Output file: | `standard output` |
| Time limit: | 2 seconds |
| Memory limit: | 1024 megabytes |

You are given a connected undirected graph with $n$ vertices and $m$ edges. Your task is to identify all the articulation points and bridges in the graph.

An **articulation point** (or cut vertex) is a vertex which, when removed (along with all the edges incident to it), increases the number of connected components of the graph.

A **bridge** (or cut edge) is an edge which, when removed, increases the number of connected components of the graph.

You need to find:

1. The number of articulation points and their IDs (sorted in ascending order, 0-based).
2. The number of bridges and their IDs (sorted in ascending order, 0-based as given in the input).

## Input

The first line contains two integers $n$ and $m$ ($1 \le n \le 10^5, 0 \le m \le 10^5$) — the number of vertices and edges in the graph respectively.

Each of the next $m$ lines contains two integers $u$ and $v$ ($0 \le u, v < n$), describing an edge between vertex $u$ and vertex $v$. It is guaranteed that the graph is connected.

## Output

The first line should contain a single integer $a$ — the number of articulation points.

The second line should contain $a$ integers — the IDs of the articulation points sorted in ascending order.

The third line should contain a single integer $b$ — the number of bridges.

The fourth line should contain $b$ integers — the IDs of the bridges 0-based by the order they appeared in the input.

## Example

| standard input | standard output |
|---|---|
| 10 11<br>8 0<br>3 1<br>9 8<br>5 0<br>3 8<br>2 6<br>0 3<br>6 7<br>8 4<br>7 4<br>2 9 | 3<br>0 3 8<br>2<br>1 3 |

max-flow

# Problem F.

| | |
|---|---|
| Input file: | `standard input` |
| Output file: | `standard output` |
| Time limit: | 5 seconds |
| Memory limit: | 1024 megabytes |

Given a network with $n$ cities and $m$ one-way roads, each road connects city $u$ to city $v$ and has a maximum capacity $c$. Boss need to transport goods from city 1 to city $n$. The roads have a capacity limit, so moving more than $c$ units of goods on a road will cause it to fail.

Your task is to determine the maximum number of goods that can be safely transported from city 1 to city $n$.

## Input

The first line will contain $T$ $(1 \leq T \leq 100)$ the number of test cases.

Each test case will start with two space-separated integers $n$, and $m$

Then $m$ lines follow, each line contains three space-separated integers $u$, $v$ and $c$ $(1 \leq u, v \leq n)$ $(1 \leq c \leq 10)$ which means there is directed road from city $u$ to city $v$ with capacity of $c$.

## Output

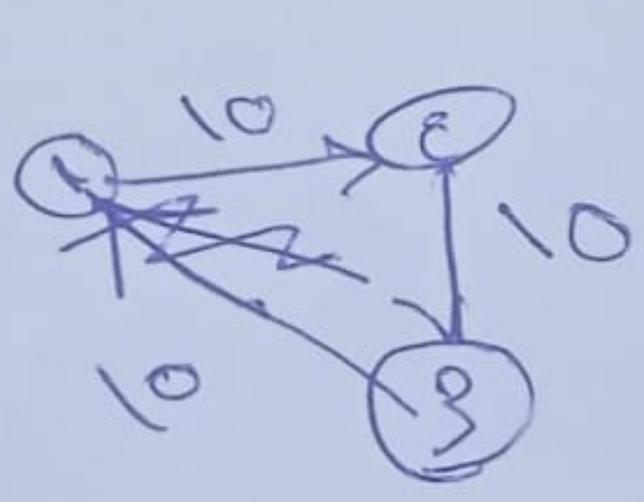
For each test case, print a single integer the maximum number of pieces can be moved from city 1 to city $n$.

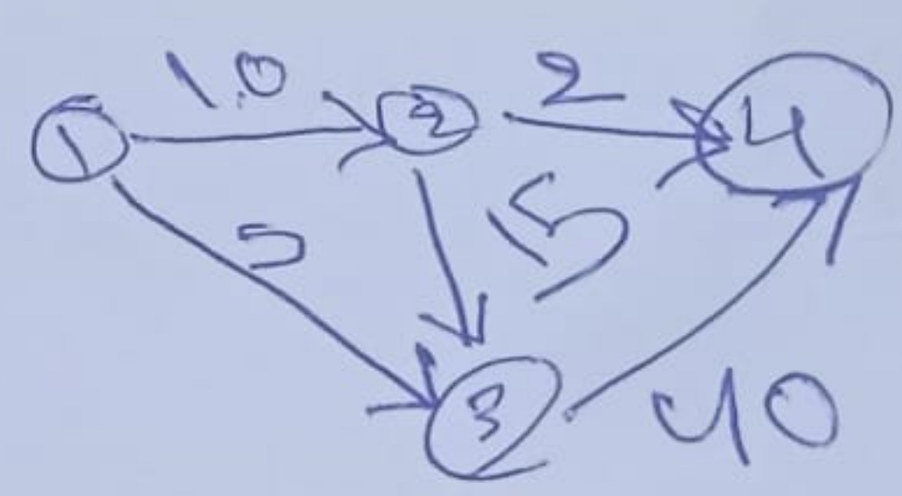
## Scoring

Sub task #1 (100 points): $(1 \leq n, m \leq 100)$

## Example

| standard input | standard output |
|---|---|
| 3<br>3 3<br>1 2 10<br>2 3 10<br>1 3 10<br>4 5<br>1 2 10<br>2 3 15<br>1 3 5<br>2 4 2<br>3 4 40<br>4 1<br>1 2 10 | 20<br>15<br>0 |




MST?

2021/06/14

CS496 Selected Topics in Computer Science-2 FinalExam Spring 2024
Cairo University, June, 2 ,2024

# Problem A.

ICPC

| | |
|---|---|
| Input file: | `standard input` |
| Output file: | `standard output` |
| Time limit: | 2 seconds |
| Memory limit: | 1024 megabytes |

You are given a string $S$ and a pattern $P$. Your task is to count the number of occurrences of $P$ in $S$.

## Input

The first line contains the text string $S$.

The second line contains the pattern string $P$.

Both strings contain lowercase Latin characters only.

## Output

Print the number of occurrences of $P$ in $S$.

## Scoring

Subtask 1 (10 points): $(1 \leq |S|, |P| \leq 100)$.

Subtask 2 (20 points): $(1 \leq |S|, |P| \leq 5 \cdot 10^3)$.

Subtask 3 (70 points): $(1 \leq |S|, |P| \leq 10^6)$.

Where $||$ is the string length.

Each subtask depends on its previous subtasks.

## Examples

| standard input | standard output |
|---|---|
| abaabab<br>aba | 2 |
| aurauraura<br>aura | 3 |
| axaaxbaaaabaa<br>aa | 5 |

# Problem D.

Ternary Search
Euclidean

| | |
|---|---|
| Input file: | standard input |
| Output file: | standard output |
| Time limit: | 1 second |
| Memory limit: | 1024 megabytes |

Mnesy and Fegla are best friends living in a city represented by a coordinate system. Given their locations and a railway line, they want to meet on the railway line at a point such that their total travel distance is minimized.

## Input

The input consists of four lines:

- The first line contains two integers $x_1$ and $y_1$ ($-10^9 \leq x_1, y_1 \leq 10^9$), the coordinates of Mnesy's location.
- The second line contains two integers $x_2$ and $y_2$ ($-10^9 \leq x_2, y_2 \leq 10^9$), the coordinates of Fegla's location.
- The third line contains two integers $a_1$ and $b_1$ ($-10^9 \leq a_1, b_1 \leq 10^9$), the coordinates of the first point on the railway line.
- The fourth line contains two integers $a_2$ and $b_2$ ($-10^9 \leq a_2, b_2 \leq 10^9$), the coordinates of the second point on the railway line.

## Output

Output a single floating-point number, the minimized total distance Mnesy and Fegla have to travel to meet on the railway line. The answer should be accurate up to six decimal places.

## Example

| standard input | standard output |
|---|---|
| 1 2<br>3 4<br>0 0<br>4 4 | 3.162278 |

## Note

- Ensure that both initial points $(x_1, y_1)$ and $(x_2, y_2)$ are on the same side of the railway line.
- The points defining the railway line $(a_1, b_1)$ and $(a_2, b_2)$ are distinct and the line they define is valid.
- Mnesy's and Fegla's initial positions are not on the railway line.

# Problem E.

| | |
|---|---|
| Input file: | `standard input` |
| Output file: | `standard output` |
| Time limit: | 2 seconds |
| Memory limit: | 1024 megabytes |

Given a graph consists of $n$ nodes and $m$ bidirectional edges, find a route that traverses each edge **exactly** $x$ **times**, starting and ending at any vertex, or determine if such a route does not exist.

## Input

The first line contains a single integer $t$ ($1 \leq t \leq 55$) denoting the number of test cases.

The first line of each test case contains three space-separated integers $n$, $m$ and $x$ ($1 \leq n \leq 500$) ($1 \leq m \leq 5000$)

The next $m$ lines of each test case, each contains two space-separated integers $u$ and $v$ ($1 \leq u, v \leq n$) which means there is an undirected edge from node $u$ to node $v$.

## Output

For each test case, if there is no route print $-1$ otherwise print a single line containing the sequence of the route, if there are multiple solutions print any of them.

## Scoring

Sub task #1 (60 points): ($x = 1$)

Sub task #2 (40 points): ($1 \leq x \leq 5$)

## Example

| standard input | standard output |
|---|---|
| 3<br>6 7 1<br>2 5<br>1 6<br>1 2<br>1 2<br>2 3<br>3 4<br>5 6<br>4 4 1<br>1 2<br>1 3<br>1 3<br>3 4<br>4 4 1<br>1 2<br>2 3<br>1 3<br>3 4 | 1 2 1 6 5 2 3 4<br>-1<br>3 1 2 3 4 |