Quiz 4: ECS 342/442/642 Competitive Programming

2 pm to 2:55 pm on 21^{st} Feb, 2025

Instructions

- Please show your code to the invigilator and make sure he makes a note of it.
- Suppose your enrollment number is `20001`.
  - Open Linux and create folder `quiz-04-20001`.
  - The folder should contain files `quiz-41-20001.cpp`, `quiz-42-20001.cpp`, and `quiz-43-20001.cpp` corresponding to the following three questions.
  - Zip the folder and upload it at http://172.28.153.65:5000
- Your output should use the following line of code.

```
int main()
{
   int final_output; // or other relevant declaration
   cout << ``20001\t'' << ``Donald Knuth\t'' << final_output << endl;
   //Replace '20001' by your roll number and 'Donald Knuth' by your name.
 }
```

Questions

1. (10 pts) **Building Teams**

   There are n pupils in Uolevi's class, and m friendships between them. Your task is to divide the pupils into two teams in such a way that no two pupils in a team are friends. You can freely choose the sizes of the teams.

   Input: The first input line has two integers n and m: the number of pupils and friendships. The pupils are numbered $1, 2, \ldots, n$. Then, there are m lines describing the friendships. Each line has two integers a and b: pupils a and b are friends. Every friendship is between two different pupils. You can assume that there is at most one friendship between any two pupils.

   Output: Print 1 if such teams are possible, otherwise print 0.

2. (10 pts) **Investigation**

   You are going to travel from Syrjälä to Lehmälä by plane. You would like to find answers to the following questions: (i) what is the minimum price of such a route? (ii) how many minimum-price routes are there? (modulo $10^9 + 7$) (iii) what is the minimum number of flights in a minimum-price route?

   Input: The first input line contains two integers n and m: the number of cities and the number of flights. The cities are numbered $1, 2, \ldots, n$. City 1 is Syrjälä, and city n is Lehmälä. After this, there are m lines describing the flights. Each line has three integers a, b, and c: there is a flight from city a to city b with price c. All flights are one-way flights. You may assume that there is a route from Syrjälä to Lehmälä.

   Output: Print sum of three integers according to the problem statement.

3. (10 pts) **Road Construction** There are n cities and initially no roads between them. However, every day a new road will be constructed, and there will be a total of m roads. A component is a group of cities where there is a route between any two cities using the roads. After each day, your task is to find the size of the largest component.

   Input: The first input line has two integers n and m: the number of cities and roads. The cities are numbered $1, 2, \ldots, n$. Then, there are m lines describing the new roads. Each line has two integers a and b: a new road is constructed between cities a and b. You may assume that every road will be constructed between two different cities.

   Output: Let c_i be the size of largest component after i^{th} day. Print $\sum_{i \in [m]} c_i$.