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**NPTEL** (<https://swayam.gov.in/explorer?ncCode=NPTEL>) » **Design and analysis of algorithms (course)**
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## Course outline

How does an NPTEL online course work?

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Introduction

Week 1 :  
Analysis of algorithms

Week 1 Quiz

Week 2 :  
Searching and sorting

Week 2 Quiz

Week 2  
Programming Assignment

Week 3 :  
Graphs

# Week 3 Programming Assignment: Road Trips and Museums

**Due on 2020-02-24, 23:59 IST**

- Select your language (C/C++/Java/Python3)
- Paste your code into the submission window.
- There are some public test cases and some (hidden) private test cases.
- "Compile and run" will evaluate your submission against the public test cases.
- "Submit" will evaluate your submission against the hidden private test cases. There are 10 private testcases in all, each with equal weightage. You will get feedback about which private test cases pass or fail, though you cannot see the actual test cases.
- Ignore warnings about "Presentation errors".

## Road Trips and Museums

*Indian National Olympiad in Informatics 2018*  
(<https://www.iarcs.org.in/inoi/2018/>)

Lavanya and Nikhil have **K** months of holidays ahead of them, and they want to go on exactly **K** road trips, one a month. They have a map of the various cities in the world with the roads that connect them. There are **N** cities, numbered from 1 to **N**. We say that you can reach city B from city A if there is a sequence of roads that starts from city A and ends at city B. Note that the roads are bidirectional. Hence, if you can reach city B from city A, you can also reach city A from city B.

Lavanya first decides which city to start from. In the first month, they will start from that city, and they will visit every city that they can reach by road from that

## Week 3 Quiz

## Week 3 Programming Assignment

### Week 3 Programming Assignment: Road Trips and Museums (/noc20\_cs27/progassignment?name=105)

## Week 4 : Weighted graphs

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## Week 5: Data Structures: Union-Find and Heaps

## Week 5 : Divide and Conquer

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particular city, even if it means that they have to pass through cities that they have already visited previously. Then, at the beginning of the second month, Nikhil picks a city that they haven't visited till then. In the second month, they first fly to that city and visit all the cities that they can reach from that city by road. Then, in the third month, Lavanya identifies a city, and they fly there and visit all cities reachable from there by road. Then in the fourth month it is Nikhil's turn to choose an unvisited city to start a road trip, and they alternate like this. Note that the city that they fly to (that is, the city from where they start each month's road trip) is also considered as being visited.

Each city has some museums, and when they visit a city for the first time, Lavanya makes them visit each of the museums there. Lavanya loves going to museums, but Nikhil hates them. Lavanya always makes her decisions so that they visit the maximum number of museums possible that month, while Nikhil picks cities so that the number of museums visited that month is minimized.

Given a map of the roads, the number of museums in each city, and the number **K**, find the total number of museums that they will end up visiting at the end of **K** months. Print -1 if they will have visited all the cities before the beginning of the **K<sup>th</sup>** month, and hence they will be left bored at home for some of the **K** months.

## Solution hint

Use BFS/DFS to identify the connected components of the underlying undirected graph. Sort the components based on how many museums they contain and make appropriate choices for Lavanya and Nikhil each month.

## Input format

- The first line of each testcase contains three integers: **N**, **M** and **K**, which represents the number of cities, number of roads and the number of months.
- The  $i^{\text{th}}$  of the next **M** lines contains two integers,  $u_i$  and  $v_i$ . This denotes that there is a direct road between city  $u_i$  and city  $v_i$ .
- The next line contains **N** integers, the  $i^{\text{th}}$  of which represents the number of museums in city  $i$ .

## Output format

If they can go on **K** road trips, output a single line containing a single integer which should be the total number of museums they visit in the **K** months. Output -1 if they can't go on **K** road trips.

## Constraints

- $1 \leq T \leq 3$
- $1 \leq N \leq 10^6$
- $0 \leq M \leq 10^6$
- $1 \leq K \leq 10^6$
- $1 \leq u_i, v_i \leq N$

- There is no road which goes from one city to itself. ie.  $u_i \neq v_i$ .
- There is at most one direct road between a pair of cities.
- $0 \leq \text{Number of museums in each city} \leq 1000$
- Sum of **N** over all testcases in a file will be  $\leq 1.5 * 10^6$

## Sample input 1

```
10 10 3
1 3
3 5
5 1
1 6
6 2
5 6
2 5
7 10
4 7
10 9
20 0 15 20 25 30 30 150 35 20
```

## Sample output 1

```
345
```

## Sample input 2

```
10 10 2
1 3
3 5
5 1
1 6
6 2
5 6
2 5
7 10
4 7
10 9
20 0 15 20 25 30 30 150 35 20
```

## Sample output 2

```
240
```

## Sample input 3

```

10 10 5
1 3
3 5
5 1
1 6
6 2
5 6
2 5
7 10
4 7
10 9
20 0 15 20 25 30 30 150 35 20

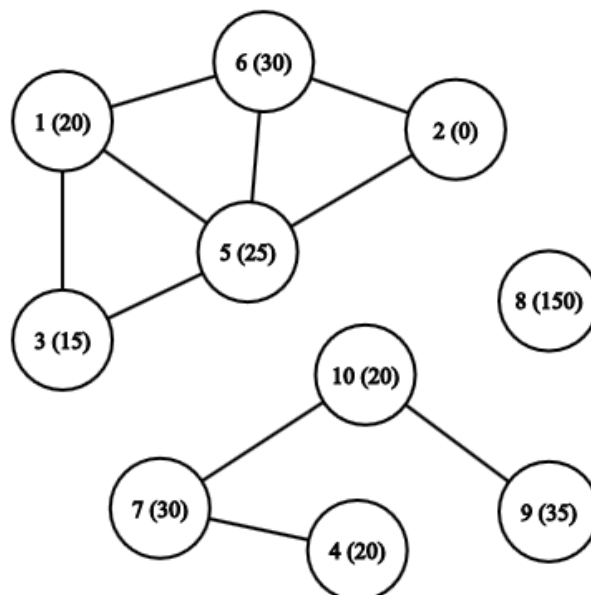
```

## Sample output 3

-1

## Explanation

Notice that in all the three testcases, everything is the same, except for the value of  $K$ . The following figure represents the road map in these testcases. Each node denotes a city, with a label of the form " $n (m)$ ", where  $n$  is the city number, between 1 and  $N$ , and  $m$  is the number of museums in this city. For example, the node with label "5 (25)" represents city 5, which has 25 museums.



**Testcase 1:** Lavanya will first choose to fly to city 8. In the first month, they visit only that city, but they visit 150 museums.

Then in the second month, Nikhil could choose to fly to city 3, and they visit the cities 1, 2, 3, 5 and 6, and visit  $20 + 0 + 15 + 25 + 30 = 90$  museums that month. Note that Nikhil could have instead chosen to fly to city 1 or 2 or 5 or 6, and they would all result in the same scenario.

In total, they have visited 345 museums in the three months (which is in fact all the museums), and that is the answer.

**Testcase 2:** It is same as the previous testcase, but now they have only 2 months. So they visit only  $150 + 90 = 240$  museums in total.

**Testcase 3:** It is same as the previous testcase, but now they have 5 months of holidays. But sadly, they finish visiting all the cities within the first three months itself, and hence the answer is -1.

C++ ▼

```

1 #include <iostream>
2 #include <cstdio>
3 #include <vector>
4 #include <algorithm>
5 #include <queue>
6 #include <climits>
7
8 #define DE(x) cout<<'>'<<#x<<':'<<x<<endl;
9
10 using namespace std;
11
12 class City
13 {
14 public:
15     long long int no=0;
16     long long int mus=0;
17     long long int visited=0;
18     vector<long long int> adj{};
19 };
20
21 long long int N, M, K;
22 vector<City> cities;
23 //vector<City> Tcities;
24
25 // void sortCities(vector<City> &Tcities, long long int low,

```

You may submit any number of times before the due date. The final submission will be considered for grading.

**This assignment has Public Test cases. Please click on "Compile & Run" button to see the status of Public test cases. Assignment will be evaluated only after submitting using Submit button below. If you only save as or compile and run the Program , your assignment will not be graded and you will not see your score after the deadline.**

Save as Draft

Compile & Run

Submit

Reset

| Sample Test Cases |        |
|-------------------|--------|
| Input             | Output |

|             |  |     |
|-------------|--|-----|
| Test Case 1 | <pre>10 10 3 1 3 3 5 5 1 1 6 6 2 5 6 2 5 7 10 4 7 10 9 20 0 15 20 25 30 30 150 35 20</pre> | 345 |
| Test Case 2 | <pre>10 10 2 1 3 3 5 5 1 1 6 6 2 5 6 2 5 7 10 4 7 10 9 20 0 15 20 25 30 30 150 35 20</pre> | 240 |
| Test Case 3 | <pre>10 10 5 1 3 3 5 5 1 1 6 6 2 5 6 2 5 7 10 4 7 10 9 20 0 15 20 25 30 30 150 35 20</pre> | -1  |