Homework 2

Distributed Systems
Due date: 9 September, 2020, 10 PM

1 Set-1

***Problem* 1.1:** Estimate the value of e, the base of the natural logarithm, using definition that $e = 1 + \frac{2}{2!} + \frac{3}{3!} + \frac{4}{4!} + \ldots$. Your program should take as input the accuracy to be achieved.

***Problem* 1.2:** Use the numerical identity that the sum of the reciprocals of the squares of integers converges to $\frac{\pi^2}{6}$. Your program should take as input the accuracy to be achieved.

Input output format for the above two questions will be provided soon.

***Problem* 1.3:** Write a program to check if a number is prime. Read about the sieve of Eratosthenes and implement this strategy.

Input
An integer N.
Output
"1" if N is prime, otherwise "0" (both without quotes)
Constraints
$2 \leq N \leq 10^5$

Sample Test Case

Input	Output
5	1
8	0

2 Set-2

***Problem* 2.1:** Write a program to find the inverse of a square matrix using the row reduction method. You can assume that the input matrix is non-singular.

Input

First line contains an integer N, denoting the number of rows and columns of the matrix. Then, there are N lines, each of which contains N integers representing the matrix.

Output

N lines, where each line contains N floating point integers round off to two decimal places. This matrix should be the inverse of the given matrix

Constraints

$2 \leq N \leq 10^2$

$-100 \leq x \leq 100$ (x is any value in matrix)

Sample Test Case

Input	Output
2 2 2 3 4	2.00 -1.00 -1.50 1.00

***Problem* 2.2:** Write a program to find the solution to a set of linear equations using the Gauss elimination method.

Input

First line contains an integer N, denoting the number of variables in the linear equation (Let these variables are $x_1, x_2, ..., x_N$).

Then, there are N lines, each of which contains N integers. Each line represents one linear equation.

Let one linear equation is represented as $a_1x_1 + a_2x_2 + ... + a_Nx_N = y$.

i^{th} value of a line (linear equation) represents the value of a_i.

Then, there is one additional line containing N integers, each of which represents value of y for each linear equation.

Output

N floating point numbers rounded to 2 decimal places, representing the values of $x_1, x_2, ..., x_N$ in order. These values should satisfy the above equations.

Constraints

$2 \leq N \leq 10^2$

$-100 \leq a_i, y \leq 100$

Sample Test Case

Input	Output
2 1 3 1 4 3 4	0.00 1.00

Explanation

Above test case represents equations

$x + 3y = 3$

$x + 4y = 4$

$x = 0$ and $y = 1$ is the solution

***Problem* 2.3:** Write a program to multiply two square matrices. You should read about Cannon's algorithm and then write an MPI program for it.

Input
First line contains an integer N, denoting the dimensions of the both square matrix. Then, there are N lines, each of which contains N integers representing the first matrix. Then, another similar N lines representing the second matrix.
Output
N lines, where each line contains N integers. This matrix should be the multiplication of the given 2 matrices.
Constraints
$2 \leq N \leq 10^2$
$-100 \leq x \leq 100$ (x is value in any matrix)
Sample Test Case

Input	Output
2 1 2 5 7 1 0 0 1	1 2 5 7

3 Set-3

***Problem* 3.1:** Given an undirected graph G, find the number of triangles and the number of cycles of length four in the graph.

Input
First line contains two integers N & M, denoting the number vertices and edges of the graph. Then, there are M lines, each of which contains 2 integers u and v, which means there is an edge in graph joining vertices u and v..
Output
2 integers in a single line, denoting the number of triangles and 4-length cycles respectively.
Constraints
$1 \leq N \leq 10^2$
$1 \leq M \leq 500$
Sample Test Case

Input	Output
3 3 1 2 2 3 3 1	1 0

***Problem* 3.2:** Given an undirected graph G, find a proper vertex coloring of the graph using Delta(G) + 1 colors or fewer. Delta(G) is the maximum degree

of any vertex in G.

Input
First line contains two integers N & M, denoting the number vertices and edges of the graph. Then, there are M lines, each of which contains 2 integers u and v, which means there is an edge in graph joining vertices u and v..
Output
First line should contain a single integer x denoting the number of colors used. Second line should contain N integers $(c_1, c_2, ..., c_N)$, where c_i represents color of vertex i. $1 \leq c_i \leq x$
Constraints
$1 \leq N \leq 10^2$
$1 \leq M \leq 500$
Sample Test Case

Input	Output
3 3 1 2 2 3 3 1	3 1 2 3

***Problem* 3.3:** Given an undirected graph G, find a proper edge coloring of the graph using Delta(G) + 1 colors or fewer. Delta(G) is the maximum degree of any vertex in G.

Input
First line contains two integers N & M, denoting the number vertices and edges of the graph. Then, there are M lines, each of which contains 2 integers u and v, which means there is an edge in graph joining vertices u and v. i^{th} line here corresponds to edge i.
Output
First line should contain a single integer x denoting the number of colors used. Second line should contain M integers $(c_1, c_2, ..., c_N)$, where c_i represents color of the edge i. $1 \leq c_i \leq x$
Constraints
$1 \leq N \leq 10^2$
$1 \leq M \leq 500$
Sample Test Case

Input	Output
3 3 1 2 2 3 3 1	3 1 2 3

Points to Note

- There will be only one submission required for the group. So, we will assign the same points to both members of the group.
- Since your codes will be evaluated automatically, you have to follow the output format **strictly**.
- Any type of plagiarism will result in serious penalties.
- If we found any of the codes implementing the question in serial manner or using other algorithms than mentioned in the question, then it will result in serious penalties.
- Allowed language: C++.
- Submission format: rollNum1_rollNum2_hw2.zip. Inside the zip folder, the structure should be:
  rollNum1_rollNum2_hw2
  - set1_pNo.cpp
  - set2_pNo.cpp
  - set3_pNo.cpp

  Example - zip 20171001_20171002.zip contains three files set1_1.cpp, set2_1.cpp and set3_2.cpp. Not following the submission format will lead to penalties.