CSI35 programming projects

Instructions for the projects:
- The program can be written in Python, C++ or Java, using only standard libraries.
- The program must be well commented.
- The due date is the date of our Final Exam
- Send the source files only (do not send .exe files, in case of C++)
- Instructions on how to run the program must be supplied
- The format of the input must be explained

Project 1
Write a program that will find a finite sum $\sum_{i=k}^{n} (expression\ on\ i)$

Input examples:

Input:
from file or from a keyboard

Output:
file or display

Math notation	Program's input
$\sum_{i=-3}^{20} (3i^2+5i+(-1)^i+2^i)$	sum -3 20 (3*i**2+5*i+(-1)**i + 2**i) or sum -3 20 (3*pow(i,2)+5*i+pow(-1,i) + pow(2,i))
$\sum_{i=1}^{25} \left(10-\dfrac{i}{3^i}\right)$	sum 1 25 (10 – i / (3**i)) or sum 1 25 (10 – i / pow(3,i))

Project 2
Write a program that given two sets finds their intersection ($\cap$), union ($\cup$), difference (-), and symmetric difference ($\oplus$). In this program you are supposed to define a class Set with all the necessary methods/functions, including the ones listed above. Do not use the built-in Set class.

Input: two sets, from file or from a keyboard
Output: file or display clearly stating what is being displayed.

Example of an input: (from keyboard)
Enter the elements of the set A, separated by space: a b d g h j
Enter the elements of the set B, separated by space: a 3 g h

Example of the output:
Union   A U B = {3,a,b,d,g,h,j}
Intersection of   A and B = {a,g,h}
Difference   A – B = {b,d,j}
Symmetric difference A + B = {3,b,d,j}

Project 3
Given a relation *R* on a finite subset of positive integers *S*, as a set of pairs, check if it is an equivalence relation.

Input: a set S and a collection of pairs separated by a space or a comma that represent the relation R, in a file or from a keyboard
Output: a verdict

Example of input (from keyboard):
State the set S: 1,2,3,4,5
State the relation R as pairs: (1,1),(1,2),(1,3),(2,1),(2,2),(2,5),(3,3),(4,4),(5,5)

Example of an output (display):
Relation R on set S:
1) Reflexive? Yes
2) Symmetric? No
3) Transitive? Not checked
The relation R on set S is not an equivalence relation.

Project 4

Given a relation *R* on a finite subset of positive integers *S*, as a set of pairs, check if it is antisymmetric, asymmetric, and/or irreflexive.

Input: a set S and a collection of pairs separated by a space or a comma that represent the relation R, in a file or from a keyboard
Output: a verdict for each of the properties.

Example of input (from keyboard):
State the set S: 1,2,3,4,5
State the relation R as pairs: (1,1),(1,2),(1,3),(2,1),(2,2),(2,5),(3,3),(4,4),(5,5)

Example of an output (display):
Relation R on set S:
1) irreflexive? No
2) antisymmetric? No
3) asymmetric? No

Project 5

Given a relation *R* on a finite subset of positive integers *S*, as a set of pairs, find R^{-1} and $\overline{R}$.

Input: a set S and a collection of pairs separated by a space or a comma that represent the relation R, in a file or from a keyboard
Output: R^{-1} and $\overline{R}$

Example of input (from keyboard):
State the set S: 1,2,3
State the relation R as pairs: (1,1),(1,2),(2,1),(2,2),(2,3),(3,3)

Example of an output (display):
Relation R on set S: (1,1),(1,2),(2,1),(2,2),(2,3),(3,3)
Relation R^{-1} on set S: (1,1),(1,2),(2,1),(2,2),(3,2),(3,3)
Relation $\overline{R}$ on set S: (1,3),(3,1), (3,2)

Project 6

Given a relation *R* on a finite subset of positive integers *S*, as a set of pairs, find its matrix representation and check whether it is reflexive, symmetric, and/or antisymmetric.

Input: a set S and a collection of pairs separated by a space or a comma that represent the relation R, in a file or from a keyboard
Output: matrix representation and verdicts

Example of input (from keyboard):
State the set S: 1,2,3
State the relation R as pairs: (1,1),(1,2),(2,1),(2,2),(2,3),(3,3)
Example of an output (display):
Relation R on set S: (1,1),(1,2),(2,1),(2,2),(2,3),(3,3)

Matrix representation:
1 1 0
1 1 1
0 0 1

Reflexive? Yes
Symmetric? No
Antisymmetric? No

Project 7
Given two relations *R* and *S* by their matrix representations, find their intersection, union, difference and symmetric difference.

Input: two matrices, representing relations *R* and *S* correspondingly.
From a file
Output: intersection, union, difference and symmetric difference (file or display)

Example of an input (from file):
File r.txt: *File s.txt:*
1 0 1   0 1 1
1 1 1   0 1 0
0 0 1   0 1 1

Example of an output (display):
R intersection S, matrix representation:
0 0 1
0 1 0
0 0 1

R union S, matrix representation:
1 1 1
1 1 1
0 1 1

…

Project 8
Given a relation *R* on a finite subset of positive integers *S*, as a set of pairs, check if it is a partial order(ing).

Input: a set S and a collection of pairs separated by a space or a comma that represent the relation R, in a file or from a keyboard
Output: a verdict

Example of input (from keyboard):
State the set S: 1,2,3
State the relation R as pairs: (1,1),(2,1),(2,2),(2,3),(3,1),(3,3)

Example of an output (display):
Relation R on set S:
1) Reflexive? Yes
2) Antisymmetric? Yes
3) Transitive? Yes
The relation R on set S is a partial order.

Project 9
Given the set of vertices and vertex pairs associated to the edges of an undirected graph, find the degree of each vertex, and state whether the graph has Euler path, Euler circuit, or neither.

Example of an input (from keyboard):
Set of vertices: a,b,c,d
Edges: (a,b), (a,c), (a,d), (b,c), (b,d), (c,d),

Example of an output (display):
deg(a) = ...
deg(b) = ...
deg(c) = ...
deg(d) = ...
The graph doesn't have an Euler circuit because ….
The graph doesn't have an Euler path because …

Project 10
Given the set of vertices and vertex pairs associated to the edges of a directed graph, find the in-degree and out-degree of each vertex, and state whether the graph has Euler circuit, Euler path, or not.

Example of an input (from keyboard):
Set of vertices: a,b,c
Edges: (a,b), (a,c), (b,a),(b,c)

Example of an output (display):
deg-(a) = …   , deg+(a) = ...
deg-(b) = …   , deg+(b) = ...
deg-(c) = …   , deg+(c) = ...
The graph doesn't have an Euler circuit because ….
The graph doesn't have an Euler circuit because ….

Project 11
Given the set of vertices and vertex pairs associated to the edges of a directed graph, find the in-degree and out-degree of each vertex, and state whether the graph has Euler circuit or not.

Example of an input (from keyboard):
Set of vertices: a,b,c
Edges: (a,b), (a,c), (b,a),(b,c)

Example of an output (display):
deg-(a) = …   , deg+(a) = ...
deg-(b) = …   , deg+(b) = ...
deg-(c) = …   , deg+(c) = ...
The graph doesn't have an Euler path because …

Project 12
Given the adjacency matrix of an undirected graph and an ordered set of vertices, find the degree of each vertex, and state whether the graph has Euler path, Euler circuit, or neither.

Example of an input (from file):
a,b,c,d

0 1 1 1
1 0 1 1
1 1 0 1
1 1 1 0

Example of an output (display):
deg(a) = ...
deg(b) = ...
deg(c) = ...
deg(d) = …
The graph doesn't have an Euler circuit because ….
The graph doesn't have an Euler path because …

Project 13
Given the adjacency matrix of a directed graph, and an ordered set of vertices, find the in-degree and out-degree of each vertex, and state whether the graph has Euler circuit or not.

Example of an input (from file):
a,b,c

0 1 1
1 0 1
0 0 0

Example of an output (display):
deg-(a) = …   , deg+(a) = ...
deg-(b) = …   , deg+(b) = ...
deg-(c) = …   , deg+(c) = ...
The graph doesn't have an Euler path because …

Project 14
Given the set of vertices and vertex pairs associated to the edges of an undirected graph (multiple edges are listed multiple times), construct the incidence matrix for the graph and ..

Example of an input (from file):
a,b,c
(a,b),(a,b),(a,c),(b,c),(b,c)

Example of an output (display):
Associations: (a,b): edge 1 ; (a,b): edge 2 ;   (a,c): edge 3 ; (b,c): edge 4 ; (b,c): edge 5

	edge 1	edge 2	edge 3	edge 4	edge 5
a	1	1	1	0	0
b	1	1	0	1	1
c	0	0	1	1	1