Practical Discrete Mathematics (CSE 1402)

MINOR ASSIGNMENT-1: MATHEMATICAL SET THEORY, RELATIONS, FUNCTIONS, VENN DIAGRAMS

1. At Delhi University, students enroll in different courses. Given two sets:
   Set A: Students enrolled in Mathematics = { ”Amit”, ”Bhavna”, ”Chirag”, ”Deepak”, ”Esha” }
   Set B: Students enrolled in Physics = { ”Chirag”, ”Deepak”, ”Farhan”, ”Geeta”, ”Harsh” }
   Write a Python program to:
   a) Find students enrolled in either Mathematics or Physics.
   b) Find students enrolled in both Mathematics and Physics .
   c) Find students enrolled in Mathematics but not in Physics .
   d) Find students enrolled in Physics but not in Mathematics.

2. A tech company maintains records of employees with expertise in Python and Java. The HR team wants to analyze skill distribution using in-built set functions. Given the following sets:
   Set A (Employees skilled in Python) = { ”Amit”, ”Bhavna”, ”Chirag”, ”Deepak”, ”Esha”, ”Farhan” }
   Set B (Employees skilled in Java) = { ”Chirag”, ”Deepak”, ”Farhan”, ”Gaurav”, ”Harsh” }
   Write a Python program to perform the following operations using in-built set functions:
   a) Find whether ”Deepak” is skilled in Python.
   b) Check if all Python-skilled employees are also skilled in Java.

3. Using the same data given in (Q2), find the following:
   a) Check if at least one employee has both skills
   b) Find employees skilled in either Python or Java, but not both.
   c) Make a copy of the Python-skilled employee set.
   d) Clear the Java-skilled employee set

4. ITER is conducting course registration for the new semester. Each student can enroll in any of the available subjects. Given a list of students and a list of subjects, generate all possible student-subject enrollment pairs.
   - Students: Asutosh, Ayushman, Mohit, Priya
   - Subjects: Mathematics, Physics, Computer Science, Economics

5. A board game uses two dice. Find all possible outcomes of rolling the dice.

6. In a social media app, friendships are symmetric: If A is a friend of B, then B must also be a friend of A. Define a Python function to verify if a given friendship relation is symmetric and complete the missing pairs if necessary. Given two relations are:
   - $R1$: {(”Anurag”, ”Nitish”), (”Priyabrata”, ”Koustav”), (”Prateek”, ”Asutosh”)}
   - $R2$: {(”Priya”, ”Nikita”), (”Nikita”, ”Priya”), (”Sancheeta”, ”Shreyashree”),(”Shreyashree”, ”Sancheeta”)}

7. At City Library, books are categorized based on genre and age group. The library wants to establish a relation that maps which genres are recommended for which age groups.
   - Genres (Set A) = { ”Fiction”, ”Non-Fiction”, ”Mystery”, ”Science”, ”Fantasy” }
   - AgeGroup (Set B) = { ”Children”, ”Teen”, ”Adult” }

The relation R follows these constraints:
i. Children can read Fiction and Fantasy.
ii. Teens can read all genres except Non-Fiction.
iii. Adults can read all genres.
Write a Python program to generate and print the valid (Genre, AgeGroup) pairs forming the relation R.

8. In a family tree, every person is related to themselves (reflexive relation). Given a parent-child relation, check if it includes reflexivity.

   - $people$ = {"Alice", "Bob", "Charlie"}
   - $parent\&child$ = {("Alice", "Bob"), ("Bob", "Charlie")}

9. A professor teaches exactly one subject. Given a set of professor-subject assignments, check if it forms a function.

   - $professor\&subject$ = {("Dr. Smith", "Math"), ("Dr. Johnson", "Physics"), ("Dr. Smith", "Physics")}

10. A flight network records direct flights between cities. If there is a flight from A to B and from B to C, then there should be a direct or indirect flight from A to C (transitive relation). Check if the relation is transitive.

    - $flights$ = {("New York", "London"), ("London", "Paris"), ("Paris", "Berlin"), ("New York", "Paris")}

11. In a company, an employee can have a supervisor. If A supervises B, then B cannot supervise A (anti-symmetric relation). Given a list of supervision relations, check if the relation is anti-symmetric.

    - $supervision$ = {("Alice", "Bob"), ("Alice", "Charlie"), ("Bob", "David")}

12. At XYZ University, students have the opportunity to join various clubs based on their interests. The university has three prominent clubs: the Coding Club, which has 120 members; the Robotics Club, with 95 members; and the AI Club, which consists of 80 students. However, some students are members of multiple clubs. Specifically, 30 students are part of both the Coding and Robotics Club, 25 students are in both the Robotics and AI Club, and 20 students are enrolled in both the Coding and AI Club. Additionally, there are 10 students who are members of all three clubs. The university administration wants to determine the total number of unique students participating in at least one of these clubs by applying the Inclusion-Exclusion Principle.

13. At Green Valley University, students actively participate in various extracurricular activities. The university has three major student communities: Music Club (M): 150 members Drama Club (D): 110 members,Dance Club (N): 90 members Some students are members of multiple clubs:

    - Students in both Music and Drama: 40
    - Students in both Drama and Dance: 35
    - Students in both Music and Dance: 25
    - Students in all three clubs: 15

    The university administration wants to find the total number of students who are registered for both the Music and Drama Club, regardless of whether they are also part of the Dance Club.

14. At Tech University, students can enroll in various advanced courses based on the prerequisite courses they have completed. The university wants to determine a relation between prerequisite courses and advanced courses based on specific eligibility criteria.

    - Prerequisite Courses (Set A) = { ”Math-101”, ”Physics-101”, ”CS-101”, ”Statistics-101” }
    - Advanced Courses (Set B) = { ”Machine Learning”, ”Quantum Computing”, ”Data Science”, ”Computer Vision”, ”AI Ethics” }

    The eligibility criteria are as follows:
    a) Machine Learning and Data Science require Math-101 or Statistics-101.
    b) Quantum Computing requires Math-101 and Physics-101.
    c) Computer Vision requires CS-101 and Math-101.
    d) AI Ethics is open to all students who have completed any one prerequisite.
    Write a Python program to generate the complete relation R, representing which prerequisite course allows enrollment in which advanced course.

15. A group of employees is classified based on whether they share the same birth month. If two employees have the same birth month, they are related. Consider the following relation,
    $birthmonth$ = {(”Neha”, ”Vikas”), (”Vikas”, ”Neha”), (”Vikas”, ”Raj”), (”Raj”, ”Vikas”), (”Neha”, ”Raj”)} Check whether the given relation is an equivalence relation or not.

16. A city classifies people as neighbors if they live in the same PIN code area. If two people live in the same PIN code, they are related.
    Write a Python program that checks if this relation is:
    a) Reflexive: Every person belongs to their own neighborhood.
    b) Symmetric: If A is related to B, then B is related to A.

17. Check whether the relation given in (Q16) is transitive or not.

18. A school conducted a survey to find out how many students play Cricket and Football. The survey results are:
    Students who play Cricket: 40
    Students who play Football: 35
    Students who play both Cricket and Football: 15
    Write a Python program to draw a Venn Diagram representing this data.

19. A school surveyed students’ subject preferences. The three subjects were Mathematics, Science, and English. The survey found: Students who like Mathematics: 30
    Students who like Science: 25
    Students who like English: 20
    Students who like both Mathematics and Science: 10
    Students who like both Science and English: 8
    Students who like both Mathematics and English: 7
    Students who like all three subjects: 5
    Write a Python program to draw a Venn Diagram representing this data.

20. A group of students were surveyed about their knowledge of Hindi and English. The survey found:
    Students who know Hindi: 50
    Students who know English: 40
    Students who know both Hindi and English: 20
    Write a Python program to draw a Venn Diagram representing this data.