

Tasks 01-02 - Mathematical Foundations

Language, Sets, and Number Systems

Problem 1: Set Operations

Let $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ be the universal set.

Let $A = \{2, 3, 5, 7\}$ and $B = \{1, 2, 3, 4, 5\}$.

Find:

- a) $A \cup B$
- b) $A \cap B$
- c) $A \setminus B$
- d) $B \setminus A$

Problem 2: Properties of Operations

Determine if each statement is true or false. Provide a counterexample if false.

- a) Subtraction is associative: $(a - b) - c = a - (b - c)$
- b) Division is commutative: $\frac{a}{b} = \frac{b}{a}$
- c) Multiplication distributes over subtraction: $a(b - c) = ab - ac$
- d) Addition distributes over multiplication: $a + (b \times c) = (a + b) \times (a + c)$

Problem 3: Logical Statements

Consider: "If a product is on sale, then its price is reduced by at least 20%"

- a) Write this using logical notation (define your propositions)
- b) Is the converse necessarily true?

Problem 4: Business Application - Customer Analysis

A company surveys 200 customers about their service preferences:

- 120 use Service A
- 85 use Service B
- 60 use Service C
- 40 use both A and B
- 25 use both B and C
- 35 use both A and C
- 15 use all three services

Calculate:

- a) How many use exactly one service?
- b) How many use at least two services?

- c) How many use none of the services?

Problem 5: Interest Rate Calculation

A bank account grows from €5,000 to €5,500 in one year.

- a) What is the percentage increase?
- b) If this rate continues, what will be the balance after 3 years?
- c) Express the growth using set notation (hint: think of the set of all possible balances)

Problem 6: Number Classification and Conversions

For each of the following numbers, classify them by listing ALL applicable number systems (\mathbb{N} , \mathbb{Z} , \mathbb{Q} , \mathbb{R}) and show your work for conversions where needed:

- a) $0.\overline{27}$ (repeating decimal)
- b) $\sqrt{16}$
- c) $\frac{-15}{3}$
- d) 0.101001000100001... (non-repeating, non-terminating)