

- Definition and notation
- Types of sets: finite, infinite, empty, universal
- Operations: union, intersection, difference, complement
- Venn diagrams for visual understanding

Relations

- Definition and properties
- Types: reflexive, symmetric, transitive, antisymmetric
- Equivalence relations and partitions

Functions

- Concepts of domain, codomain, and range
- Types: one-to-one, onto, bijections
- Composition of functions

Sample Problem:

Given sets $A = \{1, 2, 3\}$ and $B = \{x, y\}$, find all functions from A to B.

- Mathematical Logic and Propositional Calculus

Propositions and Logical Connectives

- AND, OR, NOT, IMPLIES, BICONDITIONAL
- Truth tables for logical operations

Predicates and Quantifiers

- Universal (?) and existential (?) quantifiers
- Statements involving quantifiers

Logical Equivalence and Inference

- Laws of Boolean algebra
- Methods of proof: direct, contrapositive, contradiction

Example:

Prove that $(p \rightarrow q) \rightarrow p$ is a tautology using truth tables.

- Combinatorics

Permutations and Combinations

- Counting arrangements and selections
- Formulae for permutations ($n!$) and combinations (nCr)

Pigeonhole Principle

- Basic principle for proof by contradiction

Inclusion-Exclusion Principle

- Calculating the size of unions of sets

Sample Problem:

How many 3-letter passwords can be formed from the alphabet if repetition is allowed?

- Graph Theory

Basic Concepts

- Graphs, vertices, edges
- Types: directed, undirected, weighted, bipartite

Special Graphs

