
Mth 140 Sets and Set Operations Study Guide

1 Basic Set Concepts

Definition: Set

A set is a collection of distinct objects, called elements or members of the set. Sets are typically denoted with capital letters.

1.1 Set Notation

- Elements are listed within curly braces: $A = \{1, 2, 3\}$
- $x \in A$ means "x is an element of set A"
- $x \notin A$ means "x is not an element of set A"
- $|A|$ represents the cardinality (size) of set A

Example: Basic Set Notation

Let $A = \{1, 2, 3, 4\}$

- $2 \in A$ (true)
- $5 \notin A$ (true)
- $|A| = 4$

1.2 Special Sets

- Empty Set: $\emptyset$ or $\{\}$ (a set with no elements)
- Universal Set: U (all possible elements)
- Natural Numbers: $\mathbb{N} = \{1, 2, 3, \dots\}$ (positive integers)
- Whole Numbers: $\mathbb{W} = \{0, 1, 2, 3, \dots\}$ (natural numbers including zero)
- Integers: $\mathbb{Z} = \{\dots, -2, -1, 0, 1, 2, \dots\}$ (positive and negative whole numbers)
- Rational Numbers: $\mathbb{Q} = \{\frac{p}{q} \mid p, q \in \mathbb{Z}, q \neq 0\}$ (numbers that can be written as a ratio of integers)
- Irrational Numbers: Numbers that cannot be written as a ratio of integers (e.g., π , $\sqrt{2}$)
- Real Numbers: $\mathbb{R}$ (all rational and irrational numbers)

Example: Number Sets

Examples of numbers in different sets:

- $5 \in \mathbb{N}, \mathbb{W}, \mathbb{Z}, \mathbb{Q}, \mathbb{R}$
- $0 \in \mathbb{W}, \mathbb{Z}, \mathbb{Q}, \mathbb{R}$
- $-3 \in \mathbb{Z}, \mathbb{Q}, \mathbb{R}$
- $\frac{3}{4} \in \mathbb{Q}, \mathbb{R}$
- $\pi \in \mathbb{R}$ (but not in $\mathbb{Q}$)

2 Set Operations

2.1 Basic Operations

Definition: Union

The union of sets A and B , denoted $A \cup B$, is the set of all elements that belong to A OR B or both.

Definition: Intersection

The intersection of sets A and B , denoted $A \cap B$, is the set of all elements that belong to both A AND B .

Definition: Complement

The complement of set A , denoted A' or A^c , is the set of all elements in the universal set that are not in A .

Example: Set Operations

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

- $A \cup B = \{1, 2, 3, 4\}$
- $A \cap B = \{2, 3\}$
- If $U = \{1, 2, 3, 4, 5\}$, then $A' = \{4, 5\}$

2.2 Set Differences

- Difference: $A - B = \{x \mid x \in A \text{ and } x \notin B\}$

3 Set Relations

3.1 Subset Relations

- Subset: $A \subseteq B$ means every element of A is also in B

4 Venn Diagrams

Definition: Venn Diagram

A visual representation of sets and their relationships using circles or other closed shapes. Each circle represents a set, and overlapping regions show elements common to multiple sets.

4.1 Basic Venn Diagram Representations

- Single circle: One set
- Two overlapping circles: Two sets with possible intersection
- Three overlapping circles: Three sets with possible intersections
- Rectangle surrounding the circles: Universal set U

4.2 Reading Venn Diagrams

- Inside a circle: Elements in that set
- Overlap of circles: Elements in both sets (intersection)
- Outside circles but inside rectangle: Elements in U but not in any set
- Shaded regions: Areas of interest or specific operations

4.3 Common Set Operations Using Venn Diagrams

Operation	Shaded Region
$A \cap B$	Overlap of circles A and B
$A \cup B$	All regions in either circle A or B
A'	Outside circle A but inside U
$A - B$	Region in A but not in B