SET THEORY

Subject: Discrete Mathematics

Subject Code: BMAT-602B

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Definition

- A *set* is a collection of well-defined and distinct objects.
- The objects in a set are said to be *elements* or *members* of the set.
- Sets are usually denoted by capital letters $X,Y,Z,...$
- Elements of a set are usually denoted by lowercase letters $x,y,z,\ldots.$
- Examples of a set:
- The set of days of a week.
- The set of all states of India.

Some Standard Sets

- N represents the set of natural numbers = {1,2,3,4, …}
- I or Z^+ represents the set of positive integers = {1,2,3,4, …}
- Z represents the set of all integers, positive, negative and zero.
- Q represents the set of all rational numbers.
- R represents the set of all real numbers

Types of Sets

Empty Set: A set is said to be empty if it contains no elements.
Example: X = {} or X = ∅.
Singleton Set: A set is said to be singleton if it contains only one element.
Example: X = {10}.
Finite Set: A set is said to be finite if it has a finite number of elements.
Example: X = {1, 2, 3, 4, 5,6,7}.
Infinite Set: A set is said to be infinite if it has an infinite number of elements.
Example: Set of integers

Subset: A set X is a subset of Y if every element of X is in Y.

- Example: $X = \{1,2,3,4\}$, $Y = \{1,2,3,4,5\} \Rightarrow X \subseteq Y$.

Superset: Y is a superset of X.

- Example: $Y \supseteq X$.

Power Set: The power set of X is the set of all subsets of X.

- Example: $X = \{a,b\}$, $P(A) = \{\{\}, \{a\}, \{b\}, \{a,b\}\}$.

Disjoint Sets: Two sets are said to be disjoint if they have no common elements.

- Example: $X = \{1,2\}$, $Y = \{5,7\} \Rightarrow X \cap Y = \emptyset$.

Universal Set: A set that contains all objects under consideration.

- Example: If X = {1,2}, Y = {2,3}, then U = {1,2,3,4,...}.

Venn diagrams: The relations between sets can be illustrated by certain diagram is called Venn Diagram.

Operations on Sets

Union of two sets: If X and Y are two sets, then their union is the set containing all elements of X and Y. It is denoted by $X \cup Y$.

- Example: $A = \{a,b,c\}$, $B = \{e,f,g\} \Rightarrow A \cup B = \{a,b,c,e,f,g\}$.

Intersection of two sets: If X and Y are two sets, then their intersection is the set containing all common elements of X and Y. It is denoted by $X \cap Y$, is the set
Example: $A = \{1,2\}$, $B = \{2,3,4\} \Rightarrow A \cap B = \{2\}$.

Complement of a set: If X is a subset of a universal set U. Then the complement of a set X is the set of all those elements of U which do not belong to U. It is denoted by X’.

- Example: U = {1,2,3,4,5,6}, X = {1,2,3,4} ⇒ X' = {5,6}.
- Difference of two sets: The difference of two sets X and Y is the set of elements in X but not in Y. It is denoted by X – Y.
- Example: X = {1,2,3}, Y = {3,4,5} ⇒ X - Y = {1,2}.

Conclusion

Set operations play a crucial role in mathematics and have diverse applications in fields such as logic, probability, and database management.