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subject - Set theory

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Topic: set theory

family of sets. If all the element of set are sets themselve, then such a set is known as family of sets.

In generally 'class of sets', collection of sets, set of sets is also used in place of family of sets.

An Index family of sets: Let I be a fixed non-empty set with element i and let there be defined a set for every $i \in I$. Then the family of sets A_i where $i \in I$ is called an Indexed family of sets and the set I is called an Index set.

Usually the index set I is taken as the set of natural numbers N.

So that the family of sets $\{A_i : i \in I\}$ can be designated as $\{A_1, A_2, A_3, \cdots, A_n, \cdots\}$ and it is known as sequence of sets.

Note: For convenience, we shall use the words 'family of sets' in place of indexed family of sets.

An operation of set: The operations operating on sets or on a family of sets are the following

i) Union
ii) Intersection
iii) complementation.

We have read about them in the earlier class involving two or ~~the~~ three sets.

However, to start with, We shall define these operation and collect the results associated with them.

Union of two sets:

Let A and B be two sets. This union of the sets A and B is the set of all point x which belong to either A or B (or both), that is either $x \in A$ or $x \in B$.

The union of A and B is denoted by $A \cup B$.

Thus $A \cup B = \{x \mid x \in A \text{ or } x \in B\}$

Ex: Let $A = \{1, 2, 3, 5, 8\}$ and $B = \{2, 3, 4, 5\}$

Then $A \cup B = \{1, 2, 3, 4, 5, 8\}$

Ex. 2: $A = \{1, 2, 3, 4, 5\}$ and $B = \{2, 3, 4\}$

$A \cup B = \{1, 2, 3, 4, 5\}$

Union of more than two sets: Let S_1, S_2, S_3 by any three sets. Then the union of these three sets will be a set of all those element x which will be in at least one of sets S_1, S_2, S_3 and we write, as before the union as follows: $S_1 \cup S_2 \cup S_3$.

In symbols, $S_1 \cup S_2 \cup S_3 = \{x \mid x \in S_1, x \in S_2, x \in S_3\}$

Union of family of sets: Let $\{A_i : i \in I\}$ be a family of subsets of universal set Ω. Then the union of this family of sets are denoted by $\cup\{A_i : i \in I\}$ or $\bigcup_{i \in I} A_i$ and is defined by

$$\bigcup_i = \{x \mid x \in A_i \text{ for at least on } i \in I\}.$$

Ex- Let $A = \{1, 2, 3, 4, 5\}$ and $B = \{1, 3, 5, 7\}$ and $C = \{2, 4, 6\}$

$\Rightarrow A \cup B \cup C = \{1, 2, 3, 4, 5, 6, 7\}$.

Ex- Let $\Omega = [0, 1]$ (the closed interval) and Let $I = N = \{1, 2, 3, \cdots\}$ and for each $i \in N$.

Let $A_i = \left\{1, \frac{1}{2}, \frac{1}{3}, \cdots, \frac{1}{i}\right\}$

Then $\cup A_i = \left\{1, \frac{1}{2}, \frac{1}{3}, \cdots \frac{1}{i}, \frac{1}{i+1}, \cdots\right\}$