

# Engineering Mathematics IV

Nikesh Kumar

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# 1 Set Theory

A Set is a collection of well defined objects which is denoted by a capital letter and its elements are described by small letters or numbers.

## Types of Sets

- Universal Set ( $\xi$  or  $U$ )
- Null Set ( $\phi$ )
- Subset ( $\subset$ )
- Superset ( $\supset$ )
- Complement of a set ( $A^c$  or  $\bar{A}$ )
- Equal Sets ( $=$ )

## Operations on Sets

- Union ( $\cup$ )
- Intersection ( $\cap$ )
- De Morgans
- Laws - Associative, Distributive

### 1.1 Random Experiments, Events and more

If the repetition of an experiment under identical condition results in different possible outcomes, then such an experiment is called Random Experiment or Stochastic Experiment.

**Sample Space (S)** is a set of all possible outcomes of a random experiment.

**Event (E)** is a subset of Sample Space S

Example Tossing of coin:  $S = \{H, T\}$

## Types of Events

- Mutually Exclusive
- Equally Likely

## 1.2 Probability

Let **A** be an event of **S**. If **A** occurs  $m$  different ways out of a total of  $n$ , then probability of **A** is denoted by

$$P(A) = \frac{\text{Favorable Cases}}{\text{Total Outcomes}} = \frac{m}{n}$$

### 1.2.1 Kalmogorav's Axioms

Let **E** be an experiment with sample space **S**. Let **A** be an event of **S**, then:

- $0 \leq P(A) \leq 1$
- $P(S) = 1$
- Given A & B are mutually exclusive then,  $P(A \cup B) = P(A) + P(B)$
- If  $A_1, A_2, A_3 \dots A_n$  are mutually exclusive then,  $P(\cup_{i=1}^n A_i) = \sum_{i=1}^n P(A_i)$

**Theorem 1.1.** *If A is an event of S then,*

i  $P(\phi) = 0$

ii  $P(A) + P(\bar{A}) = 1$

*Proof.* i) Let  $A \cup \phi = \phi$

$$A \cap \phi = \phi \tag{1a}$$

$$P(A \cap \phi) = P(\phi)$$

$$A \cup \phi = \phi \tag{1b}$$

$$P(A \cup \phi) = P(\phi)$$

Using axiom from 1.2.1 & equation.(1b) we get,

$$P(A) + P(\phi) = P(A)$$

$$P(\phi) = 0$$

ii) Let  $S = A \cup \bar{A}$

$$P(S) = P(A \cup \bar{A})$$

[Mutually Exclusive]

$$1 = P(A) + P(\bar{A})$$

$$P(A) + P(\bar{A}) = 1$$

□

To be continued