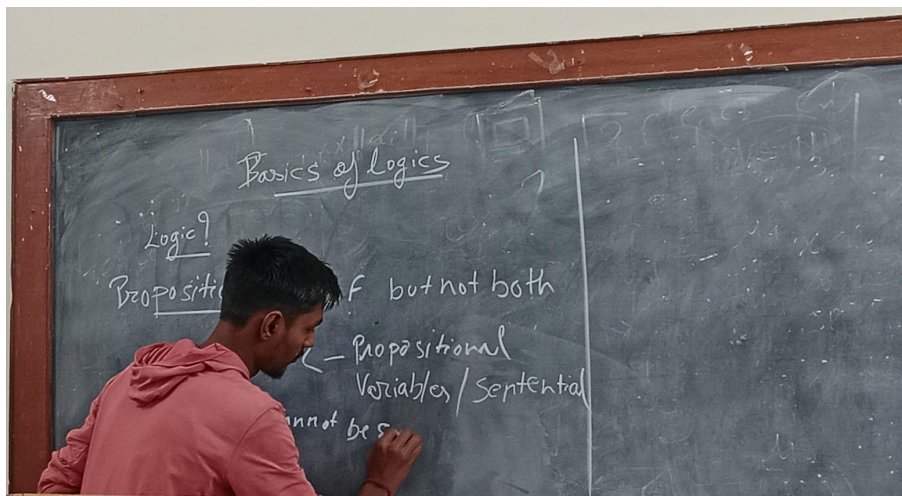# The Basics of Logics

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Krishnakant while Lecture

# Logics

## Definition 1. Logic

Logic is the systematic study of reasoning. It helps us determine an argument's validity or invalidity. Basically, it provides rules for evaluating truth.

## Importance

1. Foundational to Mathematics, Computer Science, and Philosophy.

2. Used in Programming, Legal Arguments, and Decision-making.

## Definition 2. Propositions:

A statement that can either be true or false, but not both.
Examples:

- "Earth is round." (True)

- "5 is greater than 10." (False)

## Definition 3. Non-propositions:

Statements that cannot be classified as true or false.
Examples:

- "What is your name?" (Question)

- "Please close the door!" (Command)

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**Key point to pick up:** Logic deals with propositions and their relationships, not commands or questions.

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## Logical Connectives

These are the operations that combine propositions to form compound statements.

- **AND ($\wedge$): Conjunction**
  True if both propositions are true.
  Example: $P = $ True, $Q = $ True, $P \wedge Q = $ True

  **Truth Table Example:**

  | $P$ | $Q$ | $P \wedge Q$ |
  |---|---|---|
  | $T$ | $T$ | $T$ |
  | $T$ | $F$ | $F$ |
  | $F$ | $T$ | $F$ |
  | $F$ | $F$ | $F$ |

- **OR ($\vee$): Disjunction**
  True if at least one proposition is true.

  **Truth Table Example:**

  | $P$ | $Q$ | $P \wedge Q$ |
  |---|---|---|
  | $T$ | $T$ | $T$ |
  | $T$ | $F$ | $T$ |
  | $F$ | $T$ | $T$ |
  | $F$ | $F$ | $F$ |

- **NOT (¬): Negation**
  Reverses the truth value of a proposition.

  **Truth Table Example:**

  | $P$ | $P\neg Q$ |
  |-----|-----------|
  | $F$ | $T$ |
  | $T$ | $F$ |

- **IMPLIES ( $\implies$ ): Implication**
  True unless a true statement implies a false one.

  **Truth Table Example:**

  | $P$ | $Q$ | $P \wedge Q$ |
  |-----|-----|--------------|
  | $T$ | $T$ | $T$ |
  | $T$ | $F$ | $F$ |
  | $F$ | $T$ | $T$ |
  | $F$ | $F$ | $T$ |

- **IFF ( $\iff$ ): Biconditional**
  True if both propositions have the same truth value.

  **Truth Table Example:**

  | $P$ | $Q$ | $P \wedge Q$ |
  |-----|-----|--------------|
  | $T$ | $T$ | $T$ |
  | $T$ | $F$ | $F$ |
  | $F$ | $T$ | $F$ |
  | $F$ | $F$ | $T$ |

# Types of Logics

**propositional Logic:**

Deals with simple propositions and their connectives.

**Predicate Logic**

- **Universal Quantifiers ($\forall$):** "For all"

- **Existential Quantifiers ($\exists$):** "There exists"

# Conditional Statements

The conditional statement $P \implies Q$:
**Let $P$ and $Q$ be propositions.**

- $P \implies Q$ is false when $P$ is true and $Q$ is false, and true otherwise.

- $P$ is called the hypothesis (or antecedent/premise).

- $Q$ is the conclusion (or consequence).

Conditional statements are also called **implications**.
**IFF and IMPLIES** are conditional statements.

# Interactive Segment

## Question 1.

A person meets three people: one always tells the truth, one always lies, and one alternates between truth and lies. The person asks: who is the liar? What logical method can be used to identify the liar?

## Question 2.

**Make the Truth Table for :**

$$(P \wedge Q) \implies \neg R$$