

Mathematical Logic – Complete Chapter Notes (MHT-CET Maths)

1. Statement (Proposition)

- A statement is a sentence that is either TRUE or FALSE but not both.
- Examples: '2 + 3 = 5' (True), '7 is an even number' (False).
- Statements are usually denoted by p, q, r etc.

2. Types of Statements

- Simple Statement: Contains no logical connectives.
- Compound Statement: Formed by combining two or more statements using logical connectives.

3. Logical Connectives

- Negation (NOT): Symbol $\neg p$ – opposite truth value of p.
- Conjunction (AND): $p \wedge q$ – true only when both are true.
- Disjunction (OR): $p \vee q$ – true if at least one is true.
- Implication (IF...THEN): $p \rightarrow q$.
- Biconditional (IF AND ONLY IF): $p \leftrightarrow q$.

4. Truth Table

- A truth table shows all possible truth values of logical statements.
- It is used to analyze compound statements.

5. Negation

- If p is true then $\neg p$ is false.
- If p is false then $\neg p$ is true.

6. Tautology

- A statement that is always true regardless of truth values of variables.

7. Contradiction

- A statement that is always false.

8. Contingency

- A statement that is neither always true nor always false.

9. Logical Equivalence

- Two statements are logically equivalent if they have identical truth tables.

10. Important Logical Laws

- Idempotent Law: $p \vee p = p$, $p \wedge p = p$
- Commutative Law: $p \vee q = q \vee p$, $p \wedge q = q \wedge p$
- Associative Law: $(p \vee q) \vee r = p \vee (q \vee r)$
- De Morgan's Law: $\neg(p \wedge q) = \neg p \vee \neg q$
- De Morgan's Law: $\neg(p \vee q) = \neg p \wedge \neg q$

11. Converse, Inverse, Contrapositive

- For statement $p \rightarrow q$
- Converse: $q \rightarrow p$
- Inverse: $\neg p \rightarrow \neg q$
- Contrapositive: $\neg q \rightarrow \neg p$

12. Important CET Tips

- Understand truth tables carefully.
- Learn logical equivalence and De Morgan's laws.
- Practice implication questions.

Example Truth Table for Conjunction ($p \wedge q$)

p	q	$p \wedge q$
T	T	T
T	F	F
F	T	F
F	F	F