Definitions, Laws, and Axioms

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This document contains the official list of definitions, laws, and axioms that students are permitted to reference and use for CS 2050 assignments and examinations.

1 Definitions

1. **Negation ($\neg$):** the negation of p is the statement "not p."
2. **Conjunction ($\wedge$):** the conjunction of p and q is the statement "p and q." For the statement to be true, both p and q must be true.
3. **Disjunction ($\vee$):** the disjunction of p and q is the statement "p or q." For the statement to be true, at least one of p or q must be true.
4. **Exclusive-or ($\oplus$):** the exclusive-or of p and q is the statement "p XOR q." For the statement to be true, exactly one of p and q must be true.
5. **Conditional statement ($\rightarrow$):** "If p, then q." Written $p \rightarrow q$. This is false when p is true and q is false, and true in every other instance.
6. **Converse:** $q \rightarrow p$.
7. **Inverse:** $\neg p \rightarrow \neg q$.
8. **Contrapositive:** $\neg q \rightarrow \neg p$ (logically equivalent to the given conditional).
9. **Bi-conditional statement ($\leftrightarrow$):** "p if and only if q." One cannot exist without the other. Statement is true when both statements are true or both statements are false. q is sufficient for p and p is sufficient for q.
10. **Definition of Biconditional:**
$$p \leftrightarrow q \equiv (p \rightarrow q) \wedge (q \rightarrow p)$$
11. **Tautology:** a compound proposition that is always true. Examples: $p \rightarrow p, p \vee \neg p$.
12. **Contradiction:** a compound proposition that is always false. Example: $\neg p \wedge p$.
13. **Contingency:** a compound proposition that is neither a tautology nor a contradiction. Most statements are contingencies. Example: $p \wedge q$.
14. **Logical Equivalence:** Two compound propositions p and q are logically equivalent if $p \leftrightarrow q$ is a tautology. Notation: $p \equiv q$.

2 Laws & Axioms

- **De Morgan's Laws:**
  1. $\neg(p \land q) \equiv \neg p \lor \neg q$
  2. $\neg(p \lor q) \equiv \neg p \land \neg q$
- **Conditional Disjunction Equivalence (CDE):** $p \to q \equiv \neg p \lor q$.

Table 1: **Only equivalences and rules of inference present on this table will be accepted.**

Equivalence	***Name***
$p \to q \equiv \neg p \lor q$	Conditional Disjunction Equivalence
$p \to q \equiv \neg q \to \neg p$	Contrapositive Law
$p \leftrightarrow q \equiv (p \to q) \land (q \to p)$	Definition of Biconditional
$\neg(\neg p) \equiv p$	Double Negation Law
$p \land \mathbf{T} \equiv p$ $p \lor \mathbf{F} \equiv p$	Identity Laws
$p \lor \mathbf{T} \equiv \mathbf{T}$ $p \land \mathbf{F} \equiv \mathbf{F}$	Domination Laws
$p \lor p \equiv p$ $p \land p \equiv p$	Idempotent Laws
$p \lor q \equiv q \lor p$ $p \land q \equiv q \land p$	Commutative Laws
$(p \lor q) \lor r \equiv p \lor (q \lor r)$ $(p \land q) \land r \equiv p \land (q \land r)$	Associative Laws
$p \lor (q \land r) \equiv (p \lor q) \land (p \lor r)$ $p \land (q \lor r) \equiv (p \land q) \lor (p \land r)$	Distributive Laws
$\neg(p \land q) \equiv \neg p \lor \neg q$ $\neg(p \lor q) \equiv \neg p \land \neg q$	De Morgan's Laws
$p \lor (p \land q) \equiv p$ $p \land (p \lor q) \equiv p$	Absorption Laws
$p \lor \neg p \equiv \mathbf{T}$ $p \land \neg p \equiv \mathbf{F}$	Negation Laws