CSE 311: Foundations of Computing I

Section: Gates and Equivalences

Binary Addition

Just as a quick recall of binary, do the following operations. Then, convert your answers to base-10.

(a) $(101011)_2 + (1111)_2$

(b) $(101011)_2 \oplus (1111)_2$

(c) $(101011)_2 * (1111)_2$

Equivalences

Prove that each of the following pairs of propositional formulae are equivalent using propositional equivalences.

(a) $p \leftrightarrow q$ $\qquad\qquad$ $(p \wedge q) \vee (\neg p \wedge \neg q)$

(b) $\neg p \rightarrow (q \rightarrow r)$ $\qquad\qquad$ $q \rightarrow (p \vee r)$

Tautologies

Prove that each of the following propositional formulae are tautologies by showing they are equivalent to T.

(a) $((p \rightarrow q) \wedge (q \rightarrow r)) \rightarrow (p \rightarrow r)$

(b) $(p \wedge q) \vee (p \wedge r) \rightarrow (q \vee r)$

(c) $(p \wedge q) \vee (\neg p \wedge q) \vee \neg q$

Non-equivalence

Prove that each of the following pairs of propositional formulae are not equivalent by finding an input they differ on.

(a) $p \to q$ $\qquad\qquad$ $q \to p$

(b) $(p \to q) \to r$ $\qquad\qquad$ $p \to (q \to r)$

Convert To A Circuit

(a) $\neg((p \vee q) \wedge (p \vee r)) \vee (q \vee r)$

Boolean Algebra

For each of the following parts, write the logical expression using boolean algebra operators. Then, simplify it using axioms and laws of boolean algebra.

(a) $\neg p \vee (\neg q \vee (p \wedge q))$

(b) $\neg(p \vee (q \wedge p))$