
Homework 2 LOGICAL EQUIVALENCES

MA 240, Instructor: Jeffrey Horn, Fall 2019

NAME:

Assignment: Read Section 1.3 of our Rosen text, then answer these questions (4 questions total, three sides). Show work for possible partial credit but clearly separate your final answer from your “scratch” work!

Question 1

Use (that means “show”!) truth tables to determine the following:

(1a) Is $\bar{p} \rightarrow \bar{q}$ logically equivalent to $p \vee \bar{q}$?

(1b) Is $\bar{p} \leftrightarrow \bar{q}$ logically equivalent to $\overline{p \oplus q}$?

(1c) Can $(p \vee \bar{q}) \wedge \bar{q}$ be simplified to p ?

Question 2

Use (and show) truth tables to prove the following.

(2a) Either one of DeMorgan's Laws.

(2b) Prove that the converse and inverse (of $p \rightarrow q$) are logically equivalent.

Question 3

We know that $\{\neg, \wedge, \vee\}$ is a functionally complete set of logical operators. Show that just $\{\overline{\wedge}\}$ (i.e., logical NAND, the negation of AND) is enough (for functional completeness) by finding an expressions using only $\overline{\wedge}$ (and p , and q) that are logically equivalent to $p \wedge q$, $p \vee q$, and $\neg p$. Prove the logical equivalences with truth tables.

Question 4

Label the following compound expressions as one of *tautology*, *contingency*, or *contradiction*. You don't need to show any proofs (e.g., truth tables) but you should if you are the least bit unsure of your answer and want a chance at partial credit for an incorrect label!

(4a) $(p \wedge q) \vee (\neg q \wedge \neg p)$

(4b) $(p \wedge q) \vee (\neg q \vee \neg p)$

(4c) $(p \oplus q) \rightarrow (q \vee p)$

(4d) $(p \oplus q) \rightarrow (\neg q \vee \neg p)$

(4e) $(p \vee q \vee r) \vee (\bar{p} \vee \bar{q} \vee \bar{r})$

(4f) $(r \rightarrow (p \rightarrow q)) \leftrightarrow ((r \rightarrow p) \rightarrow q)$