1. Finish the following truth table. Is the last expression a tautology, contradiction or neither?

| $P$ | $Q$ | $\sim Q$ | $P \Rightarrow Q$ | $P \vee \sim Q$ | $(P \Rightarrow Q) \wedge (P \vee \sim Q)$ |
|---|---|---|---|---|---|
| T | T | | | | |
| T | F | | | | |
| F | T | | | | |
| F | F | | | | |

2. Suppose that $P$ is false and $Q$ is true. Find whether each of these statements is true (T) or false (F).

   - $(P \Rightarrow \sim Q) \Rightarrow Q$

   - $(P \wedge (Q \Longleftrightarrow (\sim P))) \vee Q$

   - Repeat the above problems with the alternate given information that $Q \Rightarrow P$ is false. (Recall that this information means we know the values of $P$ and $Q$!)

3. Given the statement of implication "($x \in \mathcal{S}$ and $x \leq 5$) implies that ($x > 2$ or $x = -10$.)"
   - Find its converse; write it without the word "not" and without the symbol "$\sim$."

   - Find its negation; write it without the word "not" and without the symbol "$\sim$."

   - Find its contrapositive; write it without the word "not" and without the symbol "$\sim$."

   - Find its inverse; write it without the word "not" and without the symbol "$\sim$."

- If $\mathcal{S} = \{3, 4, 7, 11\}$, is the statement true or false for all $x \in \mathcal{S}$?

4. Given the statement: $\forall x \in \mathbb{Z}, (x \text{ even or } x|18) \Rightarrow ((x+1) \text{ is odd and } x^2 > 3)$.
   - Find its negation; write it without the symbol "$\sim$."

   - Find a counterexample which proves the original statement is false.

5. Given the statement: $\forall x \in \mathbb{R}, \exists y \in \mathbb{N}$ s.t. $yx \leq (yx + x)$.
   - Find its negation; write it without the symbol "$\sim$."

6. Given the statement: If you have a french-apple pie then you have raisins, cherries and a glazed crust.
   - Find its contrapositive; write it without the symbol "$\sim$."

   - Find its converse; write it without the symbol "$\sim$."

   - Rewrite the statement using the words "only if."

   - Rewrite the statement using the word "necessary."

   - Rewrite the statement using the word "sufficient."

7. All quiz problems are good to study from! Homework problems too!