1. Consider the conditional $E = "p \land \sim q \rightarrow \sim r"$.

Use de Morgan’s laws to write simplified versions of the following:

- The negation of $E$:

- The inverse of $E$:

- The converse of $E$:

- The contrapositive of $E$:

2. Fill in the truth table below.

<table>
<thead>
<tr>
<th>$p$</th>
<th>$q$</th>
<th>$r$</th>
<th>$p \rightarrow \sim q \land r$</th>
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10 points
3. Determine if the following argument is valid. Justify your answer.

\[ r \rightarrow p \lor q \]
\[ \sim p \land \sim q \]
Therefore, \( r \)

4. (a) Convert 1101 1011 0001\(_2\) to \textit{decimal}.

(b) The value of 2797\(_{10}\) in binary is 1010 111\( \_x\) \_y\(_{10}\). Find the values of the unknown digits \( x \) and \( y \).
(c) Convert $2BFEC_{16}$ to binary.

(d) The value of an integer $x = 2F37D_{16}$. What is the value of $\frac{x - 13}{16}$ in hexadecimal?

5. Write the truth set for the predicate $P(n) = \"n^2 < 169\"$, with domain:

(a) the set of real numbers, $\mathbb{R}$

(b) the set of natural numbers, $\mathbb{N}$
6. Consider the statement "All mathematics teachers hate computer science".

   (a) Using the domain \( D = \) all people, and predicates \( M(x) = \) "\( x \) is a mathematics teacher", and \( C(y) = \) "\( y \) hates computer science", write this statement symbolically.

   (b) Write a simplified symbolic negation of your statement.

   (c) Express your negation in English.

7. Draw a diagram of validity for the following syllogism, and determine if the argument is valid. If so, state whether it is direct (Modus Ponens), indirect (Modus Tollens), or other. If it is not valid, describe the error.

   \( D = \) all dogs

   "All young greyhounds run quickly".

   "Whimsy does not run quickly".

   "Therefore, Whimsy is not a greyhound".