(1) Write the contrapositive of the following proposition. If $ab \neq 0$ then $a = 0$ or $b = 0$.

(2) Write in symbols the converse, the contrapositive and the negation of the statement $P \Rightarrow (Q \wedge R)$.

(3) Consider the following statement. $x^2 + y^2 + z^2$ cannot be of the form $8k + 7$ when x, y and z are odd.

(a) Write this statement in the propositional calculus. Use variables and quantifiers.

(b) Write the negation of this statement. Simplify it as much as possible and translate it into simple mathematical English.

(4) Use truth tables to determine if

$$(P \Leftrightarrow Q) \Rightarrow R$$

is equivalent to

$$P \Leftrightarrow (Q \Rightarrow R)$$

(5) Give a careful proof of the following set theoretic identity.

$$C \setminus (B \setminus A) = (A \cap C) \cup (C \setminus B)$$

Do not use Venn diagrams.

(6) Give a careful proof of the following number theoretic proposition.

Let n and m be integers. If nm is odd then $n + m$ is even.

(7) Let A and C be sets and let $f : A \to C$ and $g : C \to A$ be functions. True or false: if $f \circ g$ and $g \circ f$ are both bijective, then f is bijective. If its true, prove it. If its false, give a counterexample.

(8) Fix an integer $k \geq 2$. Prove that $k - 1$ divides $k^n - 1$ for all integers $n \geq 1$.