Problem 1. Let $ABCD$ be a quadrilateral with $\angle DAB = \angle ABC > 90^\circ$, and denote $\{X\} = AC \cap BD$. Let $PQ$ be the parallel line to $CD$ passing through $X$, where $P \in AD$ and $Q \in BC$. Show that

$$\frac{PX}{QX} = \frac{AD}{BC}.$$ 

Problem 2. Show that for positive integers $m \geq n$, the binomial coefficient

$$\binom{2m-1}{2n-1} = \frac{(2^m-1)!}{(2^n-1)!(2^m-2^n)!}$$

is odd.

Problem 3. Suppose that $n$ is a positive integer whose digits are all either 0 or 4. Show that one cannot write $n = a^4 + b^4 + c^4$ for any integers $a, b, c$. 