

Combinatorics Problems, Part 1

1. Show that $\binom{r}{r} + \binom{r+1}{r} + \dots + \binom{n}{r} = \binom{n}{r+1}$.
2. Find a nice formulation for the sum $\binom{n}{0}^2 + \binom{n}{1}^2 + \dots + \binom{n}{n}^2$.
3. Let $S_n = \binom{n}{0} + \binom{n-1}{1} + \dots + \binom{n-2}{\lfloor \frac{n}{2} \rfloor}$. Show that $S_n = F_n$.
4. Given $S = \{1, 2, \dots, n\}$, How many unordered pairs $\{A, B\}$ are there where A and B are nonempty subsets of S with $A \cap B = \emptyset$.
5. Do there exist 10,000 10-digit numbers which are all divisible by 7 and are all rearrangements of the same digits.
6. A person has a coat of area 1 composed of five possibly overlapping patches. The area of each patch is at least $\frac{1}{5}$. Prove that there are two patches whose overlap has area of at least $\frac{1}{5}$.
7. A permutation of n elements is a one-to-one function $\pi: \{1, 2, \dots, k\} \rightarrow \{1, 2, \dots, k\}$. A permutation π of $\{1, 2, 3, \dots, 2n\}$ has property P if $|\pi(i) - \pi(i+1)| = n$ for at least one i . Show that for any $n \in \mathbb{Z}$, there are more permutations with property P than without it.
8. Let M be a set of $n \geq 4$ points in the plane, no three of which are collinear. Initially these points are connected with n segments so that each point in M is the endpoint of exactly two segments. Then, we perform moves where we choose two segments AB and CD that intersect and replace them by the segments AC and BD if none of them is present.

Prove that it is impossible to perform $\frac{n^2}{4}$ moves.

Combinatorics Problems And Solutions

Ying-Ying Zheng



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