

Logic, Proofs and Discrete Math: math test, College – download the PDF

Suggested time: 45 minutes. Out of 20 points. Calculator allowed only when the problem says so.

1 Logic

/ 3 pts

(a) Using a truth table, show that $\neg(p \Rightarrow q)$ and $p \wedge \neg q$ are equivalent. (b) Write the negation of “For every real number x there is an integer n with $n > x$.”

2 A proof

/ 3 pts

Prove that if n is an integer and n^2 is odd, then n is odd. (Hint: use the contrapositive.)

3 Induction

/ 4 pts

Prove by induction that $1^2 + 2^2 + \dots + n^2 = \frac{n(n+1)(2n+1)}{6}$ for all $n \geq 1$.

4 Sets and functions

/ 3 pts

(a) How many integers from 1 to 12 are divisible by 2 or by 3? (b) How many functions are there from $\{1, 2, 3\}$ to $\{a, b, c, d\}$? (c) How many of them are injective?

5 Counting and graphs

/ 4 pts

A club has 9 members. (a) In how many ways can it choose a president, a vice president and a treasurer? (b) In how many ways can it choose a 4-person committee? (c) How many edges does the complete graph K_6 have? (d) A graph has 6 vertices with degrees 3, 3, 3, 3, 2, 2. How many edges does it have?

6 A recurrence

/ 3 pts

Let $a_0 = 1$ and $a_n = 2a_{n-1} + 3$. (a) Compute a_1, a_2, a_3 . (b) Prove by induction that $a_n = 2^{n+2} - 3$.



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