Problem 1

Examples of blackboard and calligraphic letters: \( \mathbb{R}^d \supseteq \mathbb{S}^{d-1}, \mathcal{C} \subset \mathcal{B} \). Examples of bold-faced letters (perhaps suitable for matrix and vectors):

\[
L(x, \lambda) = f(x) - \langle \lambda, Ax - b \rangle. \tag{1}
\]

Example of a custom-defined math operator:

\[
\text{var}(X) = \mathbb{E}X^2 - (\mathbb{E}X)^2.
\]

Example of references: the Lagrangian is given in Eq. (1), and Theorem 1 is interesting.

Example of adaptively-sized parentheses:

\[
\left( \prod_{i=1}^{n} x_i \right)^{1/n} + \left( \prod_{i=1}^{n} y_i \right)^{1/n} \leq \left( \prod_{i=1}^{n} (x_i + y_i) \right)^{1/n}.
\]

Example of aligned equations:

\[
\Pr(X = 1 \mid Y = 1) = \frac{\Pr(X = 1 \land Y = 1)}{\Pr(Y = 1)} = \frac{\Pr(Y = 1 \mid X = 1) \cdot \Pr(X = 1)}{\Pr(Y = 1)} \quad . \tag{2}
\]

Example of a theorem:

**Theorem 1** (Euclid). There are infinitely many primes.

*Euclid’s proof.* There is at least one prime, namely 2. Now pick any finite list of primes \( p_1, p_2, \ldots, p_n \). It suffices to show that there is another prime not on the list. Let \( p := \prod_{i=1}^{n} p_i + 1 \), which is not any of the primes on the list. If \( p \) is prime, then we’re done. So suppose instead that \( p \) is not prime. Then there is prime \( q \) which divides \( p \). If \( q \) is one of the primes on the list, then it would divide \( p - \prod_{i=1}^{n} p_i = 1 \), which is impossible. Therefore \( q \) is not one of the \( n \) primes in the list, so we’re done. \( \square \)
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Problem 2
Problem 3
Problem 4
Problem 5