Problem 1

Examples of blackboard and calligraphic letters: $\mathbb{R}^d \supset S^{d-1}$, $C \subset \mathcal{B}$. We usually reserve $\mathbb{R}$ for the real numbers, $\mathbb{N}$ for the natural numbers, $\mathbb{Z}$ for the integers, etc. These are defined through macros \bbR, \bbS, \cC, \cB, etc.

Examples of bold-faced letters, perhaps suitable for matrix and vectors:

$$L(x, \lambda) = f(x) - \langle \lambda, Ax - b \rangle.$$  \hfill (1)

These are defined through macros \bfx, \bflambda, \bfA, \bfb, etc. The inner product uses the \dotp macro.

Example of a math operator:

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

The \texttt{var} macro is defined using \texttt{DeclareMathOperator}.

Example of references: the Lagrangian is given in Eq. (1), and Theorem 1 is interesting. If the references show up as question marks, check that the reference is valid, and then also just try running the \LaTeX compiler once or twice more.

Example of adaptively-sized parentheses: using the \texttt{Parens} macro,

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

(also have macros for \texttt{Braces, Brackets, Norm, etc.}).

Example of aligned equations:

$$\Pr(X = 1 \mid Y = 1) = \frac{\Pr(X = 1 \land Y = 1)}{\Pr(Y = 1)} = \frac{\Pr(Y = 1 \mid X = 1) \cdot \Pr(X = 1)}{\Pr(Y = 1)}.$$  \hfill (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.

Here is a centered table:

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td>1</td>
<td>entries</td>
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<td>2</td>
<td>more entries</td>
<td>more entries</td>
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</tr>
</tbody>
</table>

Here is an unordered list:

- An item
- Another item

Here is an ordered list:

1. First item
2. Second item

Problem 2

Problem 3

Problem 4

Problem 5