Problem 1

Examples of blackboard and calligraphic letters: $\mathbb{R}^d \supset \mathbb{S}^{d-1}, \mathcal{C} \subset \mathcal{B}$. 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 $\textbf{bbR}, \textbf{bbS}, \textbf{cC}, \textbf{cB}$, etc.

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

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

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

Example of a math operator:

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

The $\text{var}$ macro is defined using $\textbf{DeclareMathOperator}$.

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 $\textbf{Parens}$ 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 $\textbf{Braces}, \textbf{Brackets}, \textbf{Norm}$, etc.).

Example of aligned equations:

$$
\Pr(X = 1 \mid Y = 1) = \frac{\Pr(X = 1 \land Y = 1)}{\Pr(Y = 1)}
= \frac{\Pr(Y = 1 \mid X = 1) \cdot \Pr(X = 1)}{\Pr(Y = 1)} \cdot
\text{Usual expression for Bayes’ rule}. \label{eq:2}
$$

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>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>entries</td>
<td>in</td>
<td>a</td>
<td>table</td>
</tr>
<tr>
<td>2</td>
<td>more</td>
<td>entries</td>
<td>more</td>
<td>entries</td>
</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