Problem 1

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

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

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

These are defined through macros $\textbackslash \text{bfX}$, $\textbackslash \text{bfLambda}$, $\textbackslash \text{bfA}$, $\textbackslash \text{bfB}$, etc. The inner product uses the $\textbackslash \text{dotp}$ macro.

Example of a math operator:

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

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

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 $\text{LATEX}$ compiler once or twice more.

Example of adaptively-sized parentheses: using the $\textbackslash \text{ParenX}$ 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 $\textbackslash \text{Braces}$, $\textbackslash \text{Brackets}$, $\textbackslash \text{Norm}$, etc.).

Example of aligned equations:

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

(Usual expression for Bayes’ rule)

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. \hfill $\square$

**Here is a centered table:**

\[
\begin{array}{|c|c|c|c|}
\hline
& A & B & C & D \\
\hline
1 & entries & in & a & table \\
\hline
2 & more & entries & more & entries \\
\hline
\end{array}
\]

**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**