1. Let \( \Omega \) be an uncountable set. Show that

\[
\mathcal{A} := \{ A \subseteq \Omega : A \text{ countable or } A \text{ co-countable} \}
\]

is a \( \sigma \)-algebra.

2. Let \( \mathcal{C} \subseteq \mathcal{P}(\Omega), \sigma(\mathcal{C}) := \bigcap\{ \mathcal{A} \subseteq \mathcal{P}(\Omega) : \mathcal{C} \subseteq \mathcal{A}, \mathcal{A} \text{ a } \sigma-\text{algebra} \} \). Prove that \( \sigma(\mathcal{C}) \) is the smallest \( \sigma \)-algebra containing \( \mathcal{C} \). (Note that you need to prove the implicit statement that \( \sigma(\mathcal{C}) \) is a \( \sigma \)-algebra.)

3. E1.1 from the text.

4. If \( \mathcal{C} \) is a \( \pi \)-system, \( \Gamma \) a \( d \)-system, and \( \mathcal{C} \subseteq \Gamma \), then there is an algebra \( \overline{\mathcal{C}} \) such that \( \mathcal{C} \subseteq \overline{\mathcal{C}} \subseteq \Gamma \).