Proposition: Let $A_1, A_2, ..., A_n$ be sets in universe U, where $n \geq 2$. Then $S_n : \overline{A_1 \cup A_2 \cup ... \cup A_n} = \overline{A_1} \cap \overline{A_2} \cap ... \cap \overline{A_n}$.

Proof. (Strong induction).
Basis step. Suppose $n = 2$. Observe that

$$\begin{aligned}
\overline{A_1 \cup A_2} &= \{x : x \in U \land x \notin (A_1 \cup A_2)\} && \text{(Def. of set complement)} \quad (1)\\
&= \{x : x \in U \land \neg(x \in (A_1 \cup A_2))\} && (2)\\
&= \{x : x \in U \land \neg(x \in A_1 \lor x \in A_2)\} && \text{(Def. of set union)} \quad (3)\\
&= \{x : x \in U \land (x \notin A_1 \land x \notin A_2)\} && \text{(DeMorgan's law)} \quad (4)\\
&= \{x : (x \in U \land x \notin A_1) \land (x \in U \land x \notin A_2)\} && \text{(Distributive property)} \quad (5)\\
&= \{x : x \in U \land x \notin A_1\} \cap \{x : x \in U \land x \notin A_2\} && \text{(Def. of set intersection)} \quad (6)\\
&= \overline{A_1} \cap \overline{A_2}. && (7)
\end{aligned}$$

Thus S_2.
Inductive step. Suppose S_m for all $m, n \in \mathbb{N}$ where $2 \leq m \leq n$.
We now show S_m implies S_{n+1}. Observe that

$$\begin{aligned}
\overline{A_1} \cap \overline{A_2} \cap ... \cap \overline{A_n} \cap \overline{A_{n+1}} &= (\overline{A_1} \cap \overline{A_2} \cap ... \cap \overline{A_n}) \cap \overline{A_{n+1}} && (8)\\
&= (\overline{A_1 \cup A_2 \cup ... \cup A_n}) \cap (\overline{A_{n+1}}) && \text{(Inductive hypothesis)} \quad (9)\\
&= \overline{A_1 \cup A_2 \cup ... \cup A_n \cup A_{n+1}}. && (10)
\end{aligned}$$

Thus S_{n+1}.
It follows by mathematical induction that S_n for all sets $A_1, A_2, ..., A_n$ in universe U, where $n \geq 2$. ■