1. Prove the **Space Hierarchy Theorem** (Problem 7.4.9 in the textbook), and use it to show that L $\subsetneq$ PSPACE.

2. Prove that P, NP, co-NP, L, NL, PSPACE, and EXP are all closed under $O(log(n))$ space reductions (Proposition 8.3, and Problem 8.4.3, in the textbook).

3. Show that P and NP are closed under the following operations: union, intersection, and *Kleene star* which is defined as follows: given a language L, its Kleene star, denoted L^*, is the language $L^* = \{x_1x_2 \ldots x_k | k \geq 0, x_i \in L\}$. (Problems 7.4.5 and 7.4.6 in the textbook).

4. Let $\mathcal{C}$ be a class of languages defined as follows: $L \in \mathcal{C}$ iff there exists a family of circuits $\{C_n\}$ such that $x \in L \cap \{0,1\}^n \iff C_n(x) = 1$, and furthermore, each C_n can be constructed in time polynomial in n (i.e., there exists a TM which on input x outputs $C_{|x|}$ in time bounded by a fixed polynomial $p(|x|)$). Show that $\mathcal{C} = $ P.