(1) Let $\Sigma = \{0, 1, \#\}$, and let $L$ be the language over $\Sigma$ given as

$$L = \{s\#s \mid s \in \{0, 1\}^*\};$$

for example, $\#$, $10\#10$, and $000\#000$ are elements of $L$, but $10\#0$, $\#\#$, and $110\#111$ are not. Give a 1-tape Turing machine that decides $L$, and explain how it works.

(2) Let $\Sigma, L$ be as in Problem 1. Give a 2-tape Turing machine that decides $L$ in linear time, i.e., that if given an input that is a string of length $n$, halts in time $O(n)$ (i.e., for sufficiently large $n$, halts in time at most $Cn$ for some constant $C$ independent of $n$). Explain how your machine works.

(3) Problem 3.11 of [Sip] (regarding doubly-infinite taped TM's).