Tik-79.148 **Spring 2001**
Introduction to Theoretical Computer Science
Tutorial 9
Exercises

Ordinary Exercises:

1. Construct Turing machines that *decide* the following languages. Give the answers as machine schemas. (The alphabet is $\{a, b\}$ in all cases):

   a) $\emptyset$ b) $\{e\}$ c) $a^* \cup b^*$

2. Construct a Turing machine that accepts the language ab^*b. Give both transition function and machine schema.

3. Construct a Turing machine that computes the function:

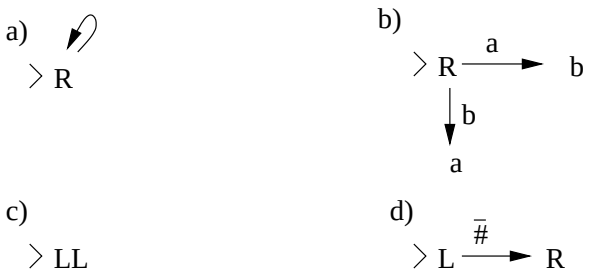
$$\begin{aligned} f : \mathbb{Z}_{2^n} &\rightarrow \mathbb{Z}_{2^n} \\ x &\mapsto x - 1 \pmod{2^n}. \end{aligned}$$

   The input and output are n-length words of the alphabet $\{0, 1\}$.

   An example computation with $n = 3$: $(s, \triangleright \sqcup 010\underline{\sqcup}) \vdash_M^* (h, \triangleright \sqcup 001\underline{\sqcup})$.

Demonstration exercises:

4. What do the following Turing machines do:



5. a) Construct a Turing machine that accepts the language a^*ba^*b.

   b) Construct a Turing machine that decides the language $\{ww^R \mid w \in \{a, b\}^*\}$.

   c) Construct a Turing machine that computes the function $f(n, m) = n + m$, where $n, m \in \mathbb{N}$.

6. *difficult* Construct a 3-tape Turing machine that computes the product of two