T-79.1001/2 **Autumn 2006**

Introduction to Theoretical Computer Science T/Y
Tutorial 2, 25 to 27 September
Problems

Remember to enroll for the course using the TOPI registration system by 27 September. For bookkeeping reasons, registration is **compulsory***, even if you were not intending to attend the lectures or the tutorial sessions.*

Homework problems:

1. Design finite automata that recognise the following languages:

   (a) $\{w \in \{0,1\}^* \mid w \text{ contains 00 as a substring}\}$;

   (b) $\{w \in \{0,1\}^* \mid \text{00 occurs exactly once in } w \text{ as a substring}\}$.

2. Design a finite automaton (state machine) that models the behaviour of a simple TV set. The TV can be on or off, and when it is on, the channel selector of the TV has three positions (1/2/3), while the volume control has two (lo/hi). At the beginning the TV is off, but the automaton does not need to have any final states.

3. Design finite automata that recognise the following languages:

   (a) $\{w \in \{a,b\}^* \mid w \text{ starts with the substring } aba\}$;

   (b) $\{w \in \{a,b\}^* \mid w \text{ ends with the substring } aba\}$;

   (c) $\{w \in \{a,b\}^* \mid w \text{ contains } aba \text{ as a substring}\}$.

Demonstration problems:

4. Formulate the model of a simple coffee machine presented in class (lecture notes p. 17) precisely according to the mathematical definition of a finite automaton (Definition 2.1). What is the formal language recognised by this automaton?

5. Design finite automata that recognise the following languages:

   (a) $\{a^m b^n \mid m = n \mod 3\}$;

   (b) $\{w \in \{a,b\}^* \mid w \text{ contains equally many } a\text{'s and } b\text{'s, modulo } 3\}$.

   (The notation "$m = n \mod 3$" means that the numbers m and n yield the same remainder when divided by three.)

6. Design a finite automaton that recognises sequences of integers separated by plus and minus signs (e.g. 11+20-9, -5+8). Implement your automaton as a computer program that also calculates the numerical value of the input expression.