Helsinki University of Technology
Laboratory for Theoretical Computer Science
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T-79.148 Introduction to Theoretical Computer Science (2 cr)
Exam Tue 17 May, 3-6 p.m.

Write down on each answer sheet:
- Your name, degree programme, and study book number
- The text: "T-79.148 Introduction to Theoretical Computer Science 17.5.2005"
- The total number of answer sheets you are submitting for grading

1. Let L be the language defined by the regular expression $(a \cup \epsilon)(ab \cup b)^*$.

   (a) Give a non-deterministic finite automaton that recognises the language L.
   7 p.

   (b) Give a minimal deterministic finite automaton that recognises the language L.
   8 p.

2. Consider the following grammar that produces parenthesis expressions.

$$S \rightarrow (S) \mid SS \mid \epsilon$$

   (a) Give a parse tree of the grammar for the string $(()()())$. *4 p.*

   (b) Show that the grammar is ambiguous. *4 p.*

   (c) Show (precisely!) that the language defined by the grammar is not regular.
   7 p.

3. Design a deterministic and single-tape Turing machine that recognises the language $L = \{w \in \{a, b\}^* \mid w = w^R\}$. Present your Turing machine as a state diagram. Show the accepting computation sequence of your machine on input aba and the rejecting computation sequence on input aab.
   15 p.

4. Are the following claims *true* or *false*. **Motivate** your answer.

   (a) All recursive languages are finite (contain a finite number of strings). *3 p.*

   (b) The regular languages are closed with respect to complementation (i.e. if L is a regular language, then $\bar{L}$ is also a regular language).
   4 p.

   (c) All languages recognised by a deterministic Turing machine are recursive.
   4 p.

   (d) The language $L = \{a^k c^i b^k \mid i, k \geq 0\}$ is context-free. *4 p.*

Total 60 p.

If you complete the feedback form of the course at `http://www.cs.hut.fi/Opinnot/Palaute/kurssipalaute-en.html` by May 20, 2005, you will be awarded one bonus exam point.