

**Helsinki University of Technology**  
**Laboratory for Theoretical Computer Science**  
Timo Latvala (tel 2895). Tommi Syrjänen (tel 5082)

**T-79.148 Introduction to Theoretical Computer Science (2 cr)**  
**Exam Mon 22 August, 12-15 p.m.**

Write down on each answer sheet:

- Your name, degree program, and study book number
- The text: "T-79.148 Introduction to Theoretical Computer Science 22.8.2005"
- The total number of answer sheets you are submitting for grading

1. Regular languages.

Find the minimal (deterministic) finite automaton, describing the language  $\{w \in \{a, b\}^* \mid |w| > 2 \text{ and the second last character is an } a\}$ .

15 p.

2. Give a context-free grammar that produces the language  $\{a^n ccb^m \mid m = n + 2\}$ . Show a parse tree of your grammar for the sentence *accbbb*.

15 p.

3. Present a push-down automaton for the language in assignment 2. Describe your automaton using state charts.

10 p.

4. The language class  $\mathcal{C}$  is closed w.r.t. complementation if for every  $L \in \mathcal{C}$  we have that  $\bar{L} \in \mathcal{C}$ .

(a) Show that the class of regular languages is closed w.r.t. complementation.

5 p.

(b) Show that the class of recursive languages is closed w.r.t. complementation.

5 p.

(c) Show that the class of context-free languages is not closed w.r.t. complementation. *Hint: the language  $L = \{a^n b^n c^n \mid n \geq 0\}$  is not context-free.*

5 p.

(d) Give a regular expression for the complement of the language given by the regular expression  $(a \cup b)(a \cup b)^*$ .

5 p.

Total 60 p.