

Helsinki University of Technology
Laboratory for Theoretical Computer Science
Pekka Orponen (tel. 5246), Tommi Syrjänen (tel. 5082)

T-79.1002 Introduction to Theoretical Computer Science Y (2 ECTS)
Exam Thu 27 Oct 2005, 9–12 a.m.

Write down on each answer sheet:

- Your name, department, and study book number
- The text: “T-79.1002 Introduction to Theoretical Computer Science Y 27.10.2005”
- The total number of answer sheets you are submitting for grading

Note that you CANNOT use this exam to compensate for course T-79.148 in the pre-2005 study requirements!!!

1. Which of the following claims are true (T) and which false (F):

- (a) All languages described by regular expressions are context-free. 2p.
- (b) Nondeterministic finite automata can recognise (decide) more languages than deterministic ones. 2p.
- (c) All context-free languages are regular. 2p.
- (d) All languages recognised (decided) by nondeterministic finite automata can be generated by context-free grammars. 2p.

2. Describe the following languages **both** in terms of regular expressions **and** in terms of deterministic finite automata:

- (a) $\{w \in \{0,1\}^* \mid w \text{ contains either } 010 \text{ or } 110 \text{ (or both) as a substring}\}$, 5p.
- (b) $\{w \in \{0,1\}^* \mid w \text{ contains neither } 010 \text{ nor } 110 \text{ as a substring}\}$. 5p.

3. (a) Describe verbally the language generated by the following context-free grammar:

$$\begin{aligned} S &\rightarrow ASb \mid \epsilon \\ A &\rightarrow aA \mid a \end{aligned}$$

5p.

- (b) Show that the grammar in part (a) is ambiguous. 5p.
- (c) Design an unambiguous context-free grammar that generates the same language as the grammar in part (a). 5p.

4. Design a context-free grammar that generates the language

$$L = \{a^m b^n \mid n \geq 0 \text{ and } m = n \text{ or } m = 2n\}.$$

7p.

Total 40p.