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T-79.1002 Introduction to Theoretical Computer Science Y (2 ECTS)
Exam Thu 9 Mar 2006, 4–7 p.m.

Write down on each answer sheet:
- Your name, department, and student id
- The text: "T-79.1002 Introduction to Theoretical Computer Science Y 9.3.2006"
- 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!!! If you want to take an exam for this course, or the post-2005 two-period course T-79.1001, please ask for another exam sheet!!!

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

   (a) Any language recognised (decided) by a nondeterministic finite automaton can be described by a context-free grammar. *2p.*

   (b) The intersection of any two context-free languages is regular. *2p.*

   (c) The complement of any regular language is context-free. *2p.*

   (d) The union of any two regular languages can be recognised (decided) by a deterministic finite automaton. *2p.*

2. Show that each of the following languages is regular, by describing it either in terms of a regular expression or in terms of a finite automaton:

   (a) $\{w \in \{0,1\}^* \mid$ each two 1's in w are separated by an even number of 0's (possibly none)$\}$, *5p.*

   (b) $\{w \in \{0,1\}^* \mid w$ contains substring 11 exactly once$\}$, *5p.*

   (c) $\{w \in \{0,1\}^* \mid w$ does not contain substring 111$\}$. *5p.*

3. (a) Show that the following context-free grammar is ambiguous:

   $$S \to aSb \mid aSbb \mid \varepsilon.$$

   5 p.

   (b) Design an unambiguous grammar generating the same language as the grammar in part (a). *5 p.*

4. (a) Justify the claim: if language A over the alphabet $\Sigma = \{0,1\}$ is regular, then so is the language $A^R = \{w^R \mid w \in A\}$. (Notation w^R denotes the reverse of string w, i.e. the string with the symbols of w written in the opposite order.) *4p.*

   (b) As part (a), but for context-free languages: if language $A \subseteq \{0,1\}^*$ is context-free, then so is the language A^R. *3p.*

Total 40p.