Försättsblad till skriftlig tentamen vid Linköpings universitet

(fylls i av ansvarig)

Datum för tentamen	2014-01-09
Sal	TER2
Tid	14-18
Kurskod	TDDD65
Provkod	TEN1
Kursnamn/benämning	Introduction to the Theory of Computing
Institution	*IDA*
Antal uppgifter som ingår i tentamen	5
Antal sidor på tentamen (inkl. försättsbladet)	3
Jour/Kursansvarig	Christer Bäckström
Telefon under skrivtid	0705-840889
Besöker salen ca kl.	c:a kl. 15
Kursadministratör (namn + tfnnr + mailadress)	Liselotte Lundberg, 281278 liselotte.lundberg@liu.se
Tillåtna hjälpmedel	Lexikon från engelska till valfritt annat språk. Inga övriga hjälpmedel.
Övrigt (exempel när resultat kan ses på webben, betygsgränser, visning, övriga salar tentan går i m.m.)	
Vilken typ av papper ska användas, rutigt eller linjerat	
Antal exemplar i påsen	

TDDD65 Introduction to the Theory of Computation

2014-01-09, kl. 14–18, Room TER2

Materials allowed: A dictionary from English to any other language is allowed. No other books, notes etc. are allowed and no electronic equipment (calculators, computer, mobile phones etc.) are allowed.

Questions: Christer Bäckström will show up after approx one hour and is otherwise available on phone 0705-840889

Grading: The maximum number of points is 30 and 15 points are required to pass the examination. At least 15 p is required for grade 3, at least 20 p is required for grade 4 and at least 25 p is required for grade 5.

Results: When the exams are graded there will be an opportunity to see the exams and discuss the result with the examiner (this is called a *tentavisning* in swedish). When and where this will happen will be announced on the course homepage as soon as the grading is finished.

Please observe the following:

- Use only one side of each paper.
- Each problem must be solved on a separate paper (or several papers, if necessary. Subproblems of a problem (a, b, c etc.) may be solved on the same page.
- Properly justify all your answers. If you give only an answer without justification, you may get zero points even if the answer is correct.
- Make sure your answers are readable.
- Try to leave space for comments on every page.

Good luck!

Problems

1. Assume the alphabet $\Sigma = \{0, 1\}$. (6 p)

   (a) Draw the state transition diagram for an NFA that accepts exactly those strings over Σ^* that end with at least three 1's. For example, it should accept 0110010111 and 111111 but not 111011.

   (b) Convert this NFA to a DFA using the standard method.

2. Consider a language L defined by the following CFG. (6 p)

$$S \leftarrow A|B|0|1$$
$$A \leftarrow 0A|1A|0$$
$$B \leftarrow 0B|1B|1$$

   (a) Prove or disprove that this grammar is ambiguous.
   (b) Define L with a regular expression or prove that L is not regular.

3. For every positive integer k, define the language (6 p)

$$L_k = \{0^n 1 0^n \mid n \leq k\}.$$

   Also define the language

$$L_\infty = \bigcup_{k=1}^{\infty} L_k.$$

   (a) Prove that L_k is regular for every constant value k.
   (b) Prove that L_∞ is not regular.

4. Assume some alphabet Σ and two languages $A, B \subseteq \Sigma^*$. Define the language $A \setminus B = \{x \in \Sigma^* \mid xy \in A \text{ for some } y \in B\}$. Prove that if both A and B are Turing recognizable, then also $A \setminus B$ is Turing recognizable. (4 p)

5. For each of the following 3 problems, prove that the problem is in NP or explain why this cannot be proven (with our current knowledge). For problems in NP, also prove that they are NP-complete, if possible. (8 p)

   (a) ANDSAT
   Input: Two 3CNF formulae φ and ψ.
   Question: Are both φ and ψ satisfiable?
   (b) ORSAT
   Input: Two 3CNF formulae φ and ψ.
   Question: Is at least one of φ and ψ satisfiable?
   (c) XORSAT
   Input: Two 3CNF formulae φ and ψ.
   Question: Is exactly one of φ and ψ satisfiable?