Försättsblad till skriftlig tentamen vid Linköpings Universitet

(fylls i av ansvarig)

Datum för tentamen	201-01-07
Sal	TER4
Tid	08-12
Kurskod	TDDD65
Provkod	TEN1
Kursnamn/benämning	Introduction to the Theory of Computation
Institution	IDA
Antal uppgifter som ingår i tentamen	7
Antal sidor på tentamen (inkl. försättsbladet)	4
Jour/Kursansvarig	Tommy Färnqvist
Telefon under skrivtid	0704 547668
Besöker salen ca kl.	09:30
Kursadministratör (namn + tfnnr + mailadress)	Madeleine Häger Dahlqvist, 282360, madha@ida.liu.se
Tillåtna hjälpmedel	Ordbok (från engelska till valfritt språk)
Övrigt (exempel när resultat kan ses på webben, betygsgränser, visning, övriga salar tentan går i m.m.)	

Linköpings Tekniska Högskola
Institutionen för Datavetenskap
Gustav Nordh

2013-01-07

TDDD65 Introduction to the Theory of Computation
Examination, Monday, 2013-01-07

Material allowed: An English dictionary (to any language) is allowed. Other material (like books, lecture notes, own notes etc.) and electronic equipment (computers, calculators, mobile phones etc.) is **not allowed**.

Questions: Tommy Färnqvist, 0704 547668, will appear in the examination room around 1.5 hours after the start of the exam

Grading There are 7 problems giving max 20 points. To pass you need 10 points. The lower bounds of points for the grades 3,4,5 are as follows: 3:10, 4:14, 5:17.

Results An announcement will be posted at the course homepage http://www.ida.liu.se/~TDDD65 approx. one week after the exam with information on where you can look at your graded exam and discuss the result with the examiner.

Please observe the following:

- Solutions to different problems should be placed one-sided on separate page(s).
- Justify your answers properly: missing or insufficient explanations will result in reduction of points.
- Be sure that your answers are readable.
- Leave space for comments.

Good luck!

1. Recall that kSAT is the problem of checking the satisfiability of kCNF-formulas, i.e., checking the satisfiability of conjunctions of clauses with (at most) k literals. For example, (5 p)

$$(x_1 \vee x_1 \vee x_2) \wedge (\overline{x_1} \vee \overline{x_2} \vee \overline{x_2}) \wedge (\overline{x_1} \vee x_2 \vee x_2)$$

is a satisfiable 3CNF-formula, and

$$(x_1 \vee x_2) \wedge (\overline{x_1} \vee \overline{x_2}) \wedge (\overline{x_1} \vee x_2) \wedge (x_1 \vee \overline{x_2})$$

is an unsatisfiable 2CNF-formula.

   (a) Briefly explain why 3SAT is in NP. (1)

   (b) Give a polynomial-time mapping reduction from 4SAT to 3SAT. (4)

2. Provide a regular expression for the language over $\{0, 1\}$ consisting of all strings that are the binary representation of even natural numbers. (2 p)

3. Invent a simple context-free grammar that is ambiguous and prove that it is indeed ambiguous. (2 p)

4. Consider the language L (over the alphabet $\Sigma = \{a, b, c\}$) defined as $\{cccca^{2n}b^n acc \mid n \geq 0\}$. (4 p)

   Use the pumping lemma to prove that L is nonregular.

5. Consider the languages A, B, and C, where A is a regular language, B is not Turing recognizable, and C is Turing recognizable but not decidable. Given the following mapping reductions: (3 p)

   - $A \leq_m F$,
   - $F \leq_m B$,
   - $B \leq_m D$,
   - $C \leq_m B$,
   - $E \leq_m C$, and
   - $E \leq_m A$,

   what can you conclude about the decidability of the languages D, E, and F? More specifically for each of D, E, and F answer whether it is decidable, undecidable, or whether the information given is not enough to draw a conclusion.

6. The NFAϵ $N = (Q, \Sigma, \Delta, S, F)$ is defined as follows: (2 p)

$$Q = \{1, 2, 3, 4, 5\} \qquad \Sigma = \{a, b\} \qquad S = \{1\} \qquad F = \{5\}$$

   with the transition function Δ given by

	ϵ	a	b
$\rightarrow 1$	$\emptyset$	$\{3\}$	$\{1, 2, 3\}$
2	$\emptyset$	$\{3\}$	$\{5\}$
3	$\{4\}$	$\emptyset$	$\emptyset$
4	$\emptyset$	$\{3\}$	$\{2\}$
5 F	$\emptyset$	$\{3, 4\}$	$\{5\}$

   Using the standard method, construct an equivalent DFA M.

7. (2 p)

(a) Assume that a proof of P = NP is discovered. Give one likely important consequence of such a proof that has an impact on the everyday life of people. (1)

(b) Assume that a proof of P $\neq$ NP is discovered. Give one likely important consequence of such a proof that has an impact on the everyday life of people. (1)