

Examination
Formal Languages and Automata Theory
TDDD14 & TDDD85

(Formella Språk och Automatateori)

2015-06-03, 8.00 – 12.00

1. **NOT ALL PROBLEMS ARE FOR BOTH COURSES.**

Pay attention to “only” comments.

2. Allowed help materials

- A sheet of notes - 2 sided A5 or 1 sided A4.
The contents is up to you.
The notes should be signed in the same way as the exam sheets and returned together with the exam.
- English dictionary

Tillåtna hjälpmedel:

- Ett papper med valfria anteckningar - 2 sidor A5 eller 1 sida A4.
Anteckningarna ska signeras på samma sätt som tentamensarken och bifogas tentamen vid inlämnandet.
- Engelsk ordbok

3. You may answer in Swedish or English.

4. Total number of credits is 33. Limits:

3: 16 p, 4: 22 p, 5: 28 p.

5. *Jour* (person on duty): Johannes Schmidt, tel. 07 25 72 18 03

GOOD LUCK !

4. (5p) For each of the following languages answer whether it is regular, context-free but not regular, or not context-free. (Here a brief explanation is sufficient).
- (a) The set of the strings over $\{a, b, c\}$ with even number of b 's, not containing a substring abc and with each a immediately preceded by b .
 - (b) $\{xyx \mid x, y \in \{a, b\}^*, |y| = 2\}$
 - (c) $\{0^j 1^k 0w \mid w \in \{0, 1\}^*, 0 \leq j < |w| - k\}$
 - (d) $\{0^j 2^k w \mid w \in \{0, 1\}^*, j > k > |w| > 0\}$
 - (e) The image of the latter language under the homomorphism h given by $h(0) = a, h(1) = b, h(2) = a$.
5. (5p) Which of the following statements are true, which are false? Why?
- (a) There is a recursive language whose complement is not recursive.
 - (b) There is a recursively enumerable language whose complement is recursive.
 - (c) There exist deterministic finite automata M_1, M_2 such that $L(M_1) \cup L(M_2) \neq L(R)$, for any regular expression R .
 - (d) If a language is generated by an unambiguous context-free grammar then it is accepted by a deterministic pushdown automaton.
 - (e) There exists a universal Turing Machine which halts on every input.
6. (3p) **Only TDDD14**
 Explain the notions of a recursive language and a recursively enumerable language. Show that the intersection of two recursively enumerable languages is recursively enumerable.
7. (3p) **Only TDDD85**
 Explain what it means that a context-free grammar is in Chomsky Normal Form. Write a context-free grammar in Chomsky Normal Form for the language from 1b.