Automi, Linguaggi e Traduttori. 18 February 2009.

Precision and clarity are important. The PARSER exercise is compulsory. Use comments to document your program of the PARSER exercise. Motivate your constructions and answers.

• PARSER [5]. Write a C++ or Java program whose time complexity is at most $O(n)$, for testing whether or not a word in $\{a, b\}^*$ of length n (≥ 0) is generated by the grammar with axiom S and the following productions:

$\quad S \to a \mid S\,A \qquad\qquad A \to a\,A \mid A\,a\,b \mid \epsilon$

• REGULAR EXPRESSIONS [3]. Show that the regular expresions $a(ba)^*$ and $(ab)^*a$ denote the same subsets of $\{a, b\}^*$.

• CONTEXT-SENSITIVE [2]. Give a context-sensitive grammar which generates the language

$\quad L = \{a^n b^n c^n \mid n \geq 1\}$ and show that L is not context-free.

• GREIBACH [3]. Compute the Greibach normal form of the following grammar:

$\quad S \to S\,A \mid a \qquad\qquad A \to S \mid A\,S \mid a \mid \varepsilon$

• LALR [3]. Construct an $LALR(1)$ parser, if any, for the context-free grammar G with axiom S and the following productions:

$\quad S \to a\,A \mid b\,B \qquad\qquad A \to \varepsilon \mid c\,A\,d \qquad\qquad B \to \varepsilon$

• DECIDABILITY [3]. Show that the set of all pairs $\langle$Java program P, $n\rangle$ such that P halts for the input n, is not decidable, but it is semidecidable.

• CORRECTNESS [3]. Let x^n be defined as follows: **if** $n = 0$ **then** 1 **else if** $odd(n)$ **then** $x\,(x^{n-1})$ **else** $(x^{n/2})^2$. Show the total correctness of the following program:

$\qquad \{n \geq 0\}$
$\quad k := n; \quad y := 1; \quad z := x;$
$\quad$ **while** $k \neq 0$ **do** **if** $odd(k)$ **then** **begin** $k := k-1; \quad y := y\,z;$ **end**;
$\qquad\qquad\qquad\qquad k := k$ div $2; \quad z := z\,z;$
$\qquad\qquad$ **od**
$\qquad \{y = x^n\}$

Nota. Tra parentesi quadre sono indicati i punti per ogni esercizio. Le due prove in itinere valgono, di norma, 4+4 punti. Per la prova orale, si presenti: (i) il programma, *fatto da solo/a*, dell'Esercizio del PARSER con alcune prove di esecuzione, (ii) un elaborato con la soluzione degli altri esercizi *fatto da solo/a* e (iii) si venga, se possibile, con un computer portatile ove siano istallati e pronti per l'esecuzione i programmi relativi alle due prove in itinere.