Midterm Exam
General CS 2 (320102)
April 4. 2006

NAME:

MATRICULATION NUMBER:

You have one hour (sharp) for the test;
Write the solutions to the sheet.

You can reach 29 points if you solve all problems. You will only need 27 points for a perfect score, i.e. two points are bonus points.

You have ample time, so take it slow and avoid rushing to mistakes!

Different problems test different skills and knowledge, so do not get stuck on one problem.

To be used for grading, do not write into this box								
prob.	1.1	2.1	2.2	3.1	3.2	3.3	Sum	grade
total	5	5	3	6	6	4	29	
reached								

1 Resolution Calculus

5pt

Problem 1.1 (Resolution Calculus with Nand Connective) 10min

Develop a variant $\mathcal{CNF}^{\uparrow}$ of the CNF transformation calculus presented in class that transforms propositional formulae expressed with *NAND* (denoted by $\uparrow$) as the only logical connective. To do so just complete the scheme of inference rules given here:

$$\frac{\mathbf{C} \vee \mathbf{A} \uparrow \mathbf{B}^{\mathsf{T}}}{?} \qquad \frac{\mathbf{C} \vee \mathbf{A} \uparrow \mathbf{B}^{\mathsf{F}}}{?}$$

With this variant $\mathcal{CNF}^{\uparrow}$ together with the usual inference rule from resolution calculus conduct a resolution proof to verify the formula $(A \uparrow A) \uparrow ((A \uparrow B) \uparrow (A \uparrow B))$

2 Combinatorial Circuits

5pt

Problem 2.1 (Combinatorial Circuit for Shift) 10min

Design an explicit 3-bit shifter (using only *NOT*, *AND* and *OR* gates) that shifts its input to the left by one, iff the control bit is 1 and leaves it as it is otherwise. Formally, design a circuit that corresponds to $f_{shift}\colon \mathbb{B}^3 \times \mathbb{B} \to \mathbb{B}^3$ with

$$f_{shift}(\langle a2, a1, a0\rangle, c) \begin{cases} \langle a1, a0, 0\rangle & if\ c = 1 \\ \langle a2, a1, a0\rangle & if\ c = 0 \end{cases}$$

3pt

Problem 2.2 (TCN Substraction) 6min

Let $A = 576$ and $B = 9$.

1. convert the numbers into an n-bit TCN system. What is the minimal n in order to encode A as well as B?
2. perform a binary subtraction $A - B$ and check the result by converting back to the decimal system.

3 Machine Programming

6pt

Problem 3.1 (Discrete Integration) 10min

Given is $N \geq 1$ stored in $D(0)$ and N numbers stored in $D(1) \ldots D(N)$. Write an assembler program that performs a sum of the array and stores the result finally in $D(1)$. Write comments to each line of your code (like in the example codes from the slides).

6pt

10min

Problem 3.2 (While Loop in $\mathcal{L}(\texttt{VM})$)

Write a program in the Simple While language that takes two numbers A and B, given at the memory addresses 1 and 2, and returns $(A + B)^{42}$. Show how the compiled version of it looks like in the Virtual Machine Language $\mathcal{L}(\texttt{VM})$ (concrete, not abstract syntax). 4pt

Problem 3.3 (Turing Machine) 8min

Given a tape arbitrarily filled with ones and zeros. Define a transition table such that the machine reads the tape from left to right as long as the entries are alternating between ones and zeros and terminates otherwise.