Midterm Exam
General CS 2 (320102)

March 23, 2009

NAME:

MATRICULATION NUMBER:

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

You can reach 26 points if you solve all problems. You will only need 23 points for a perfect score, i.e. three 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	1.2	2.1	2.2	3.1	3.2	Sum	grade
total	2	4	4	6	6	4	26	
reached								

1 Graphs

Problem 1.1 (Planar Graphs) 6pt 10min

A graph G is called planar if G can be drawn in the plane in such a manner that edges do not cross elsewhere than vertices. The geometric realization of a planar graph gives rise to regions in the plane called faces; if G is a finite planar graph, there will be one unbounded (i.e. infinite) face, and all other faces (if there are any) will be bounded. Given a planar realization of the graph G, let $v = |V|$, $e = |E|$, and let f be the number of faces (including the unbounded face) of G's realization.

Prove that the Euler formula, $v - e + f = 2$, must hold for a connected planar graph.

2 Combinatorial Circuits

Problem 2.1 (Two's complement conversion) 4pt 12min

Let $A = 27C$ and $B = -71$ be base 13 numbers.

1. Convert the numbers into n-bit TCN. What is the minimum n for A and B?
2. Perform the binary operations $A + B$ and $A - B$ on the TCN numbers.

Problem 2.2 (Number comparator) 4pt 12min

Design a combinatorial circuit which takes as input two n-bit numbers $(a_0, a_1, \cdots, a_n)$ and $(b_0, b_1, \cdots, b_n)$ and outputs also 2 n-bit numbers $(g_0, g_1, \cdots, g_n)$ and $(s_0, s_1, \cdots, s_n)$ representing which one is greater and which one is smaller.

3 Machine Programming

Problem 3.1 (Binary to decimal) 6pt 8min

Let $D(0) = n$ contain the number of bits of a binary number stored in $D(2)...D(2 + n - 1)$. Each memory cell represents one bit of the number where $D(2)$ is the least significant bit and $D(2 + n - 1)$ is the most significant bit. Write a program that stores the corresponding decimal number in $D(1)$.

4 Memory

Problem 4.1 (Reading from and writing to memory) 6pt 8min

Suppose you have a 2-bit addressed memory of 4 bits managed by 4 D-Flipflops aligned as shown in the figure. The input of the circuit consists of a total of 4 bits. 2 of the bits

(a_0 and a_1) provide a 2-bit address. In addition there is a data bit D and a write bit W. Design a circuit which output should be the data memorized in the D-Flipflop addressed by $\langle\langle a_1 a_0 \rangle\rangle$. In addition if the write bit W is 1, your circuit should write the data from the data bit D to the same D-Flipflop addressed by $\langle\langle a_1 a_0 \rangle\rangle$