CSC 258 midterm

27 February 2004

Name (underline surname):

Student number:

Tutorial section:

No aids permitted, but there is a list of algebraic identities attached.
Total: 35 marks.
Time allotted: 45 minutes.

Since time is short, be careful not to get stuck on one question to the exclusion of others. The amount of marks or answer-space allotted does not indicate how long it will take you to complete the question, nor does the size of the answer-space indicate the size of the correct answer.

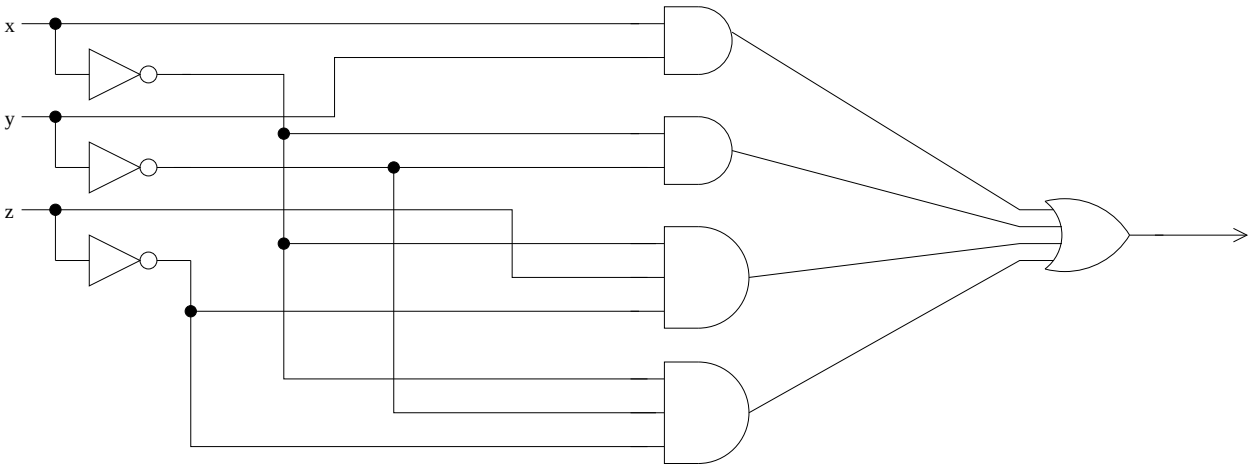
Answer *all* questions. Answer questions in the space provided.

Do not open this booklet until you are instructed to.

Do not write anything in the following table:

	value	mark
1	10	
2	10	
3	10	
4	5	
total	35	

1. [10 marks]
a) What function does the following logic gate diagram compute?



b) Simplify this formula (using any appropriate technique).

c) Draw a logic gate diagram for your simplified formula.

2. [10 marks]
Draw a sequential circuit with three outputs and one input line in addition to the clock.
While the data input is 0, your circuit functions as a three-bit counter (counting clock pulses).
While the data input is 1, your circuit skips the value 010 (it goes from 001 to 011, but all other transitions are the same). When the data input goes back to 0, the count continues (it doesn't jump back for a missed 010 or anything like that).

3. [10 marks]
Using four-bit numbers, show how the addition of 3+(−2) in the signed representation is the same as adding 3+14 in the unsigned representation. What is the value of the result?

4. [5 marks]
Write machine-language (assembly language) instructions to assign z to be $(x - y)^2$, if x is in register R0, y is in register R1, and z is in register R2. (To square an integer, you can just multiply it by itself, of course.)

Some Boolean algebra identities

identity laws:

$$a \cdot 1 = a$$
$$a + 0 = a$$

base laws:

$$a \cdot 0 = 0$$
$$a + 1 = 1$$

idempotence:

$$aa = a$$
$$a + a = a$$

excluded middle:

$$a + \bar{a} = 1$$

non-contradiction:

$$a \cdot \bar{a} = 0$$

double-negation:

$$\bar{\bar{a}} = a$$

exclusive-or definition:

$$a \oplus b = a\bar{b} + \bar{a}b$$

commutative:

$$ab = ba$$
$$a + b = b + a$$
$$a \oplus b = b \oplus a$$

associative:

$$(ab)c = a(bc)$$
$$(a + b) + c = a + (b + c)$$
$$(a \oplus b) \oplus c = a \oplus (b \oplus c)$$

distributive:

$$a(b + c) = ab + ac$$
$$a + bc = (a + b)(a + c)$$

de Morgan's laws:

$$\overline{a + b} = \bar{a}\bar{b}$$
$$\overline{(ab)} = \bar{a} + \bar{b}$$
etc

absorption:

$$a(a + b) = a$$
$$a + ab = a$$
$$a + \bar{a}b = a + b$$

no name:

$$ab + a\bar{b} = a$$