CMPUT 101 with Solutions
Quiz 2 (50 minutes)
November 16, 2000
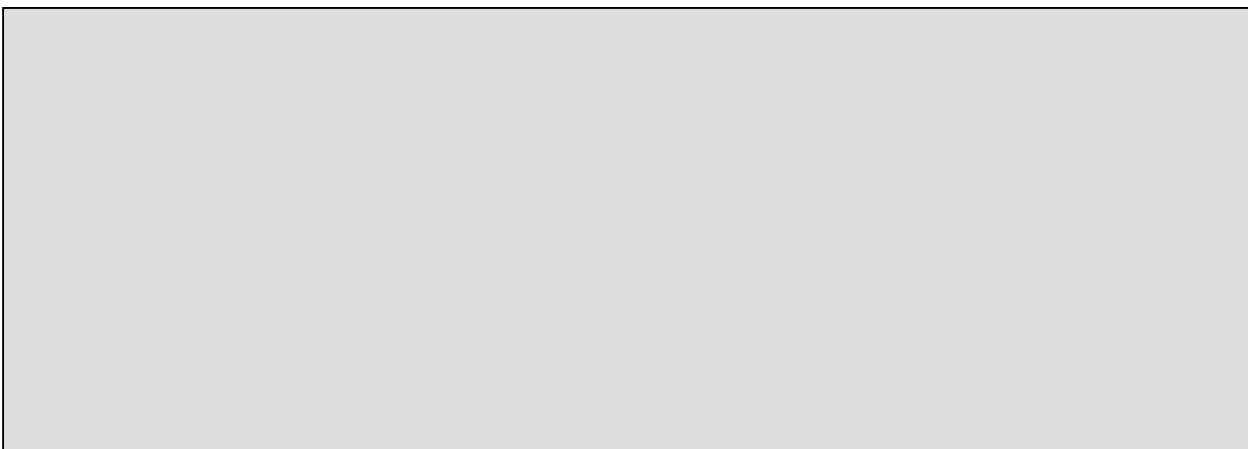
Last Name: _____

First Name: _____

Section: A6

Instructor: Yngvi Bjornsson

Instructions: Read carefully before proceeding.

No calculators, books or other aids are permitted for this test.

1. Print your name in the space provided above.

2. **Flip to the next page**.

Instructions (continued): Read carefully before proceeding.

3. Print your name and student ID in the space provided below (**yes, your name again**!).

4. Read the instructions below, and then wait until you are told to start working on the test (**don't flip the pages yet**).

5. Once you are told to start, write your ID number on top of all remaining pages in the test, only then start answering the questions. Put all your answers on the test paper, no additional sheets of papers can be handed it. You can use the back of the pages for your scratch notes and calculations.

6. When you are told that the time is up, stop working on the test.

   Good luck!

Last Name: _____

First Name: _____

Student ID: _____

Marks: (don't write anything below)

1	2	3	4	Total
10	15	10	15	50

Part I (Multiple choice) **There can be more than one correct choice for each question, circle <u>ALL</u> that apply.**

1. (2 marks) Which of the following are considered main subsystems in the *Von Neumann architecture*?

    (a) <u>memory</u>
    (b) system software
    (c) cache
    (d) <u>control unit</u>
    (e) <u>ALU</u>
    (f) Windows 2000

2. (2 marks) In most modern computers the main *processor* (CPU) contains a

    (a) I/O Controller
    (b) <u>control unit</u>
    (c) <u>ALU</u>
    (d) magnetic surface
   (e) read/write head
    (f) <u>cache</u>

3. (2 marks) The following properties are true for *random access memory* (RAM):

    (a) <u>each memory cell has a unique address</u>
    (b) <u>the time it takes to fetch or store a memory cell is the same for all cells</u>
    (c) the first bit always represents the sign of the number stored
    (d) <u>a complete cell (all bits) must always be fetched or stored</u>
    (e) information can only be fetched, not stored

4. (2 marks) An unspecified machine language instruction set uses 16 bits to represent memory addresses. Each instruction can have maximum of two address fields. What is the maximum memory size a computer using this instruction set can use?

    (a) 16
    (b) $2^{16} - 1$
    (c) <u>2^{16}</u>
    (d) 2×2^{16}
    (e) $2 \times (2^{16} - 1)$
    (f) 16 megabytes

5. (2 marks) Which of the following are considered to be *system software*:

    (a) <u>compilers</u>
    (b) web browsers
    (c) <u>file systems</u>
    (d) <u>assemblers</u>
    (e) computer games
    (f) hard-drives

Part II: Circuits

1. (4 Marks) The following circuit is given:

$x = \underline{\quad} \overline{(a \bullet b) + (\overline{b} \bullet c)} \underline{\quad}$

$y = \overline{b} \bullet c$
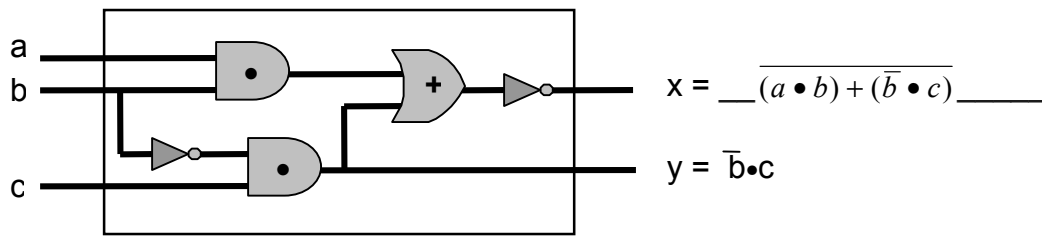
(a) The Boolean expression that describes the output value of y is shown above. Similarly, write above the expression that describes the output value of x.

(b) For the two rows shown in the truth-table below, fill in the correct output values for x and y:

Input			Output	
a	b	c	x	y
0	0	0	1	0
1	0	1	0	1

2. (7 Marks) Use the **sum-of-products** circuit construction algorithm to design a circuit using AND, OR, and NOT gates that implements the following truth table.

Input		Output	
a	b	x	y
0	0	1	0
0	1	0	0
1	0	0	1
1	1	1	0

(a) Write the expressions that describe the outputs:

$x = \underline{\qquad} (\overline{a} \bullet \overline{b}) + (a \bullet b) \underline{\qquad}$

$y = \underline{\qquad} (a \bullet \overline{b}) \underline{\qquad}$

(b) Draw the circuit diagram.
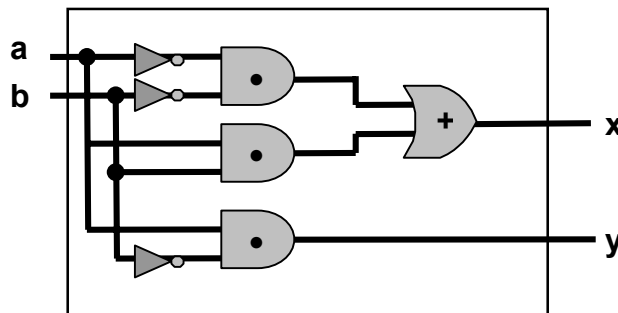
3. (4 marks) Design a circuit that has 3 inputs and 2 outputs. The circuit should output the number of inputs set to 1. You only need to fill in the truth table for the circuit, there is no need to show the Boolean expressions or draw the circuit diagram. Hint: Think of the outputs $x_1 x_0$ as a two bit binary number, e.g. when a b c = 1 0 1 the number of '1's is 2 and, thus, $x_1 x_0$ = 1 0.

Input			Output	
a	b	c	x_1	x_0
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

Part III: Von Neumann Architecture

1. (2 marks) The following actions show what happens when a particular machine instruction is being executed: $IR_{addr} \rightarrow$ MAR
   FETCH
   MDR $\rightarrow$ R
   Which machine instruction is being executed: _____**LOAD**_____

2. (4 marks) Assume a disk with the following characteristics:

Number of sectors per track	10
Number of tracks per surface	20
Number of surfaces	2
Number of bytes per sector	100
Arm movement time	1 msec to move 1 track
Number of tracks read/write head moves of average	10
Rotation speed	60 rev/min

(a) How many bytes can be stored on this disk (show your work)?

   100 x 10 x 20 x 2 = 40,000 bytes

(b) What are the worst- and average-case latency for this disk (show your work)?

   60 rev/min => 1 sec each rev.   worst case (wait one rev.)   = 1 sec.
   **average case(wait half rev.) = 0.5 sec.**

3. (2 marks) Fill the blanks below with the appropriate register names.

   The _____**PC**_____ holds the address of the next instruction to be fetched.

   Prior to being decoded an instruction must be stored in the _____**IR**_____.

4. (2 marks) The following figure shows one possible implementation of the ALU circuit. All the arithmetic/logic operations are done in parallel but then the result of only one of the operations is selected to be the output.
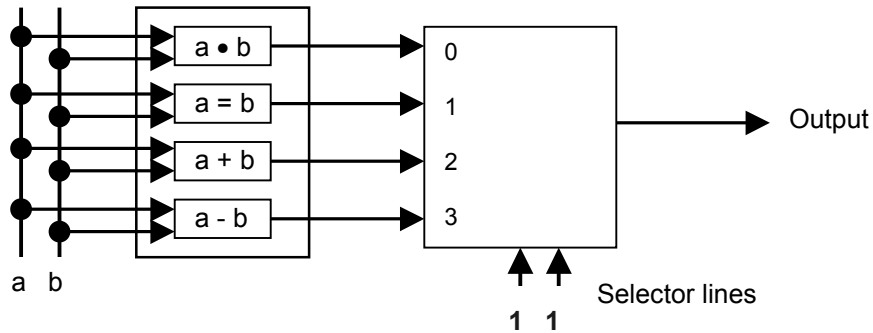
(a) What kind of a control circuit is used to select the output? __ **Multiplexor** ___
(b) In the blanks below the selector lines, write down the signals (0 or 1) that make the result of the subtraction circuit become the output.

Part IV: Assembly language

Note: *A table describing the syntax and semantics of the assembly language instructions is provided in the appendix (at the bottom of the last page).*

1. (3 marks) Assuming that memory locations X and Y store the values 2 and 3 respectively, what values will they and the register R store after the following assembly program fragment is executed?

	DECREMENT	X
	LOAD	Y
	ADD	X
	STORE	Y

Answer: X = _1_   Y = _4_ R = _4_

2. (4 marks) What does the following assembly program output when executed?

	.BEGIN	
	LOAD	N
	ADD	M
	STORE	N
	LOAD	Three
	COMPARE	N
	JUMPLT	Output
	INCREMENT	M
Output:	OUT	N
	OUT	M
	HALT	
N:	.DATA	2
M:	.DATA	3
Three:	.DATA	3
	.END	

Answer: ___5___   ___4____

3. (8 marks) Write an assembly program that implements the following algorithm.

Get value for N
While N ≥ 1 do
    Print the value of N
    Decrease N by 10
End loop
Stop

	.BEGIN	
	IN N	
Startloop:	LOAD	One
	COMPARE	N
	JUMPLT	Endloop
	OUT	N
	LOAD	N
	SUBTRACT	Ten
	STORE	N
	JUMP	Startloop
Endloop:	HALT	
N	.DATA	0
One:	.DATA	1
Ten:	.DATA	10
	.END	

Appendix: Assembly Language Instructions

INSTRUCTION		MEANING
LOAD	X	CON(X) → R
STORE	X	R → CON(X)
CLEAR	X	0 → CON(X)
ADD	X	R + CON(X) → R
INCREMENT	X	CON(X) + 1 → CON(X)
SUBTRACT	X	R – CON(X) → R
DECREMENT	X	CON(X) – 1 → CON(X)
COMPARE	X	If CON(X) > R then GT = 1 (EQ=0, LT=0) If CON(X) = R then EQ = 1 (GT=0, LT=0) If CON(X) < R then LT = 1 (GT=0, EQ=0)
JUMP	X	Transfer to memory location X
JUMPGT	X	Transfer to location X if GT = 1
JUMPEQ	X	Transfer to location X if EQ = 1
JUMPLT	X	Transfer to location X if LT = 1
JUMPNEQ	X	Transfer to location X if EQ = 0
IN	X	Input an integer value from the standard input device and store it in memory cell X.
OUT	X	Output, in decimal notation, the value stored in memory cell X.
HALT		Stop program execution.