# CMPUT 101 - Solutions
# Quiz 2 (50 minutes)
# August 8, 2001
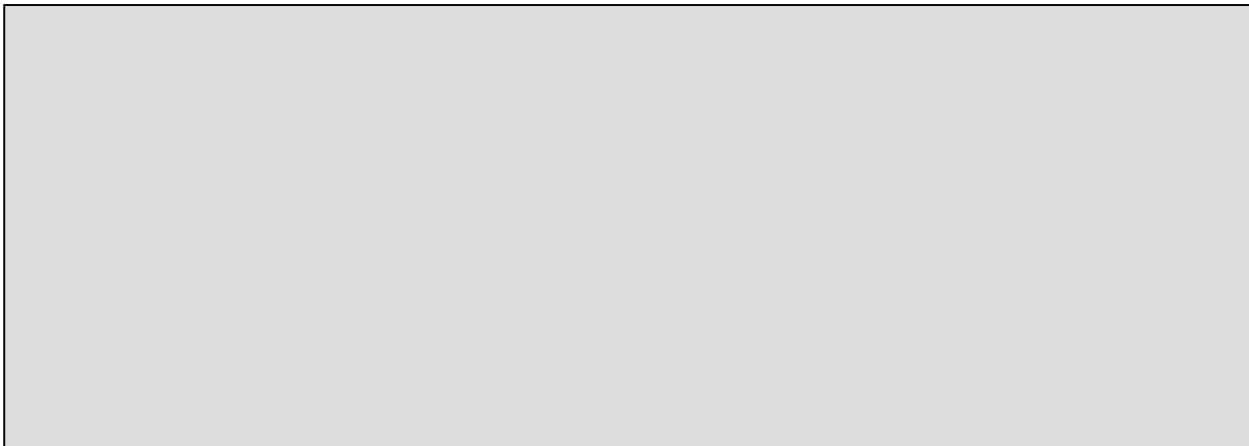
Last Name:  _____

First Name:  _____

Section:  B1

Instructor:  I. E. Leonard

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. **Turn 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 turn 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 ALL that apply.**

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

   **(a) memory**
   (b) system software
   (c) cache
   **(d) Input/Output units**
   **(e) ALU**
   (f) Windows 2000

2. (2 marks) Prior to being decoded, a machine language instruction must be stored in the:

   **(a) IR**
   (b) ALU
   (c) MAR
   (d) hard-drive
   (e) cache
   (f) R0

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

   **(a) each memory cell has a unique address**
   (b) the first bit in a memory cell always represents the sign of the number stored
   **(c) the time it takes to fetch or store a memory cell is the same for all cells**
   (d) a part of a memory cell can be fetched or stored
   (e) the time it takes to fetch a value from a memory cell is called seek time
   (f) information can only be fetched, not stored

4. (2 marks) The task of the control unit is to

   (a) perform mathematical and logical operations
   (b) store nonvolatile data
   **(c) fetch from memory the next instruction to be executed**
   (d) control where information are stored on the hard-drive
   **(e) decode and execute machine language instructions**

5. (2 marks) A decoder with N input lines has how many output lines?

   (a) 1
   (b) N
   (c) $2^N-1$
   **(d) $2^N$**
   (e) $N^2-1$
   (f) $N^2$

## Part II: Circuits

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



$x = \_\_\_\_\_ \overline{(a \bullet b)} + (b \bullet c) _____$

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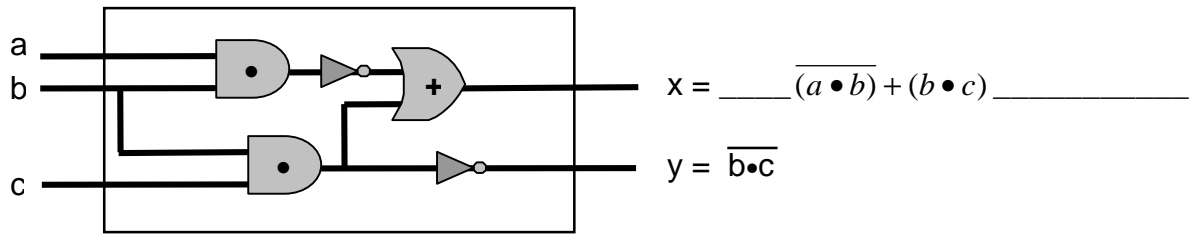
(a) The Boolean expression that describes the output value of *y* is shown above. Similarly, write above the expression that describes the output value of *x*.

(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 | 1 |
| 1 | 1 | 1 | 1 | 0 |

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.
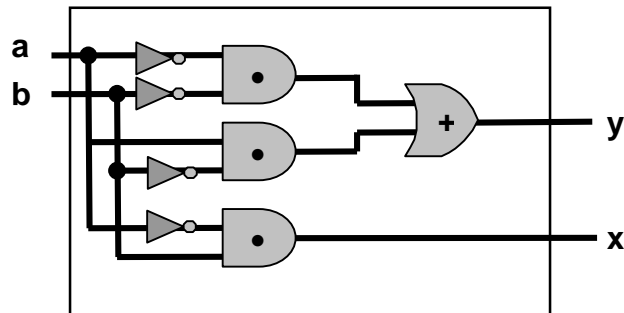
| Input | | Output | |
|---|---|---|---|
| a | b | x | y |
| 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 0 |

(a) Write the expressions that describe the outputs:

$x = \_\_\_\_ \overline{a} \bullet b _____$

$y = \_\_\_\_ (\overline{a} \bullet \overline{b}) + (a \bullet \overline{b}) _____$

(b) Draw the circuit diagram.

3. (4 marks) Design a circuit that has 2 inputs and 3 outputs. The input lines represent a two-digit binary number in the range 0-3.  Each output is connected to a separate light bulb that illuminates when the output signal is on (1).  The input value dictates how many of the lights will turn on.  For example, when the input is 2 ($x_1 x_0 = 1\ 0$) then two of the light bulbs should lit (which two doesn't really matter, you can choose). Fill in the truth table (there is <u>no</u> need to show the Boolean expressions or draw the circuit diagram).

| Input | | Output | | |
|---|---|---|---|---|
| $x_1$ | $x_0$ | $B_1$ | $B_2$ | $B_3$ |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 |

# Part III: Von Neumann Architecture

1. (2 marks) Fill in the blanks.

   Disc access time consists of several components.  The _____**seek time**_____ is the time

   needed to position the read/write head over the correct track, whereas ___**latency**___ is the

   time for the beginning of the desired sector to rotate under the read/write head.

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

| | |
|---|---|
| Number of sectors per track | 10 |
| Number of tracks per surface | 50 |
| Number of surfaces | 1 |
| 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 50 x 1 = 50,000 bytes**

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

   **60 rev/min → 1 rev/sec. → each revolution takes 1 second.**
   **10 sectors each track → 1/10 sec. read/write a  single sector.**
   **Worst/best/average transfer time the same or, 0.1 sec (100 msec.)**

3. (2 marks) The following actions show what happens when a particular machine instruction is being executed:  $IR_{addr}$ → MAR
                            FETCH
                            MDR → R
   Which machine instruction is being executed:      __**LOAD**_____

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.
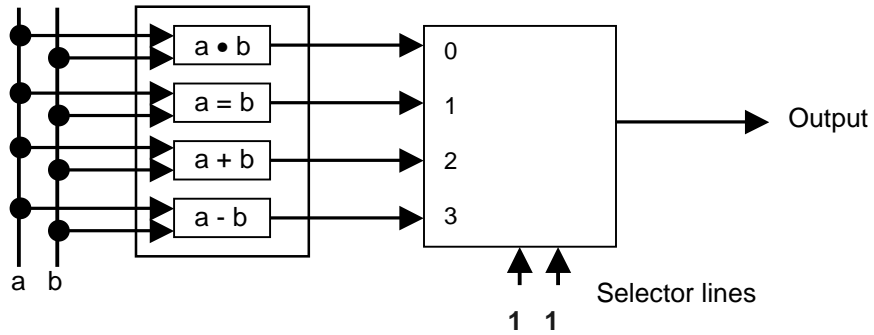


(a) What kind of a control circuit is used to select the output? ____**Multiplexor**____
(b) In the blanks below the selector lines, write down the signals (0 or 1) that make the result of the subtraction circuit become the output.

# 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 contain the values 3 and 5 respectively, what values will they and the register R contain after the following assembly program fragment is executed?

|   | | |
|---|---|---|
| | LOAD | X |
| | ADD | Y |
| | STORE | Y |
| | DECREMENT | X |

Answer: X = _**2**_    Y = _**8**_   R = _**8**_

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

|   | | |
|---|---|---|
| | .BEGIN | |
| | LOAD | A |
| | ADD | Two |
| | STORE | A |
| | COMPARE | B |
| | JUMPGT | Over |
| | INCREMENT | B |
| Over: | INCREMENT | B |
| | OUT | A |
| | OUT | B |
| | HALT | |
| Two: | .DATA | 2 |
| A: | .DATA | 1 |
| B: | .DATA | 3 |
| | .END | |

Answer: __**3**__     __**5**__

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

Get value for N, M
Set Count to 0
While N ≥ M do
    Increase Count by 1
    Decrease N by 3
End loop
Print Count
Stop

|  |  |  |
|---|---|---|
|  | .BEGIN |  |
|  | IN | N |
|  | IN | M |
|  | CLEAR | Count |
| Startloop: | LOAD | M |
|  | COMPARE | N |
|  | JUMPLT | Endloop |
|  | INCREMENT | Count |
|  | LOAD | N |
|  | SUBTRACT | Three |
|  | STORE | N |
|  | JUMP | Startloop |
| Endloop: | OUT | Count |
|  | HALT |  |
| Three: | .DATA | 3 |
| N: | .DATA | 0 |
| M: | .DATA | 0 |
| Count: | .DATA | 0 |
|  | .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)<br>If CON(X) = R then EQ = 1 (GT=0, LT=0)<br>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. |