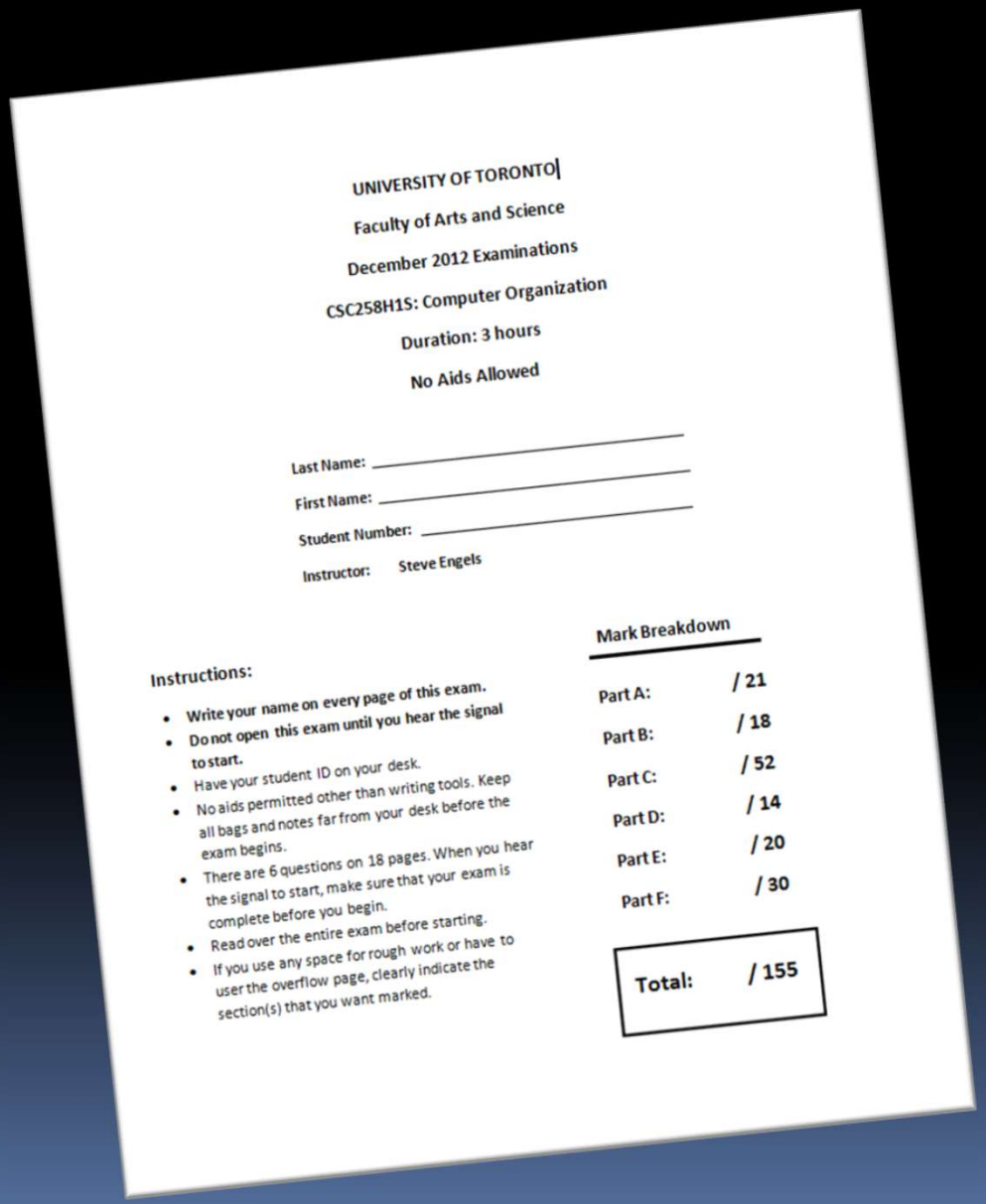
Week 12 Review

Final Exam Review!



UNIVERSITY OF TORONTO

Faculty of Arts and Science

December 2012 Examinations

CSC258H1S: Computer Organization

Duration: 3 hours

No Aids Allowed

Last Name: _____

First Name: _____

Student Number: _____

Instructor: Steve Engels

Instructions:

- Write your name on every page of this exam.
- Do not open this exam until you hear the signal to start.
- Have your student ID on your desk.
- No aids permitted other than writing tools. Keep all bags and notes far from your desk before the exam begins.
- There are 6 questions on 18 pages. When you hear the signal to start, make sure that your exam is complete before you begin.
- Read over the entire exam before starting.
- If you use any space for rough work or have to user the overflow page, clearly indicate the section(s) that you want marked.

Mark Breakdown

Part A:	/ 21
Part B:	/ 18
Part C:	/ 52
Part D:	/ 14
Part E:	/ 20
Part F:	/ 30
Total:	/ 155

Exam Details

- Similar to past (pre-pandemic) final exams:
  - 3 hour final exam
  - Aids: one highlighter
- Exam content:
  - Most questions focus on post-midterm material
    - Maybe ¼ of the final refers to pre-midterm material.
  - Questions are drawn from lecture slides, labs and tutorials.
- Differences to recent final assessments:
  - During pandemic, final assessments were take-home finals (there was no midterm).

Sample Questions

1. How many integers can be stored in a memory unit that uses 12 address bits with a 32-bit architecture? **(3 marks)**

2. How many address bits are needed to specify a location in byte-addressable memory, given a 2048 bit memory unit and a 64-bit architecture? **(3 marks)**

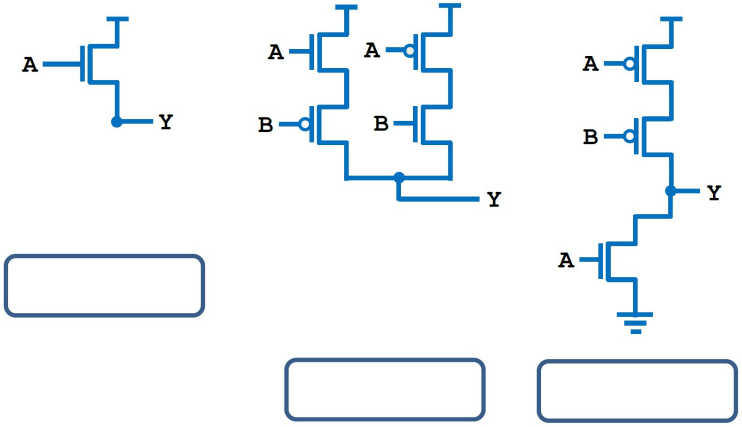
3. True or False? Multiplication with Booth's Algorithm uses the same number of clock cycles as multiplication with an accumulator circuit. **(1 mark)**

4. What colour appears on the RGB Video display when the Data In 888 RGB is `0xFFFF00`? **(2 marks)**

5. True or False? As the stack increases in size, the value in `$sp` decreases. **(1 mark)**

Part B: Transistors (14 marks)

The following transistor diagrams are attempting to implement various logic gates from Week 2 of the course, but part of each transistor circuit is missing. In the diagrams below, complete the missing parts of each circuit and fill in the name of the completed gate in the space provided below the circuit.



Part C: Circuit Design (20 marks)

A vending machine that dispenses tea has four buttons: H (hot), L (lemon), M (milk) and S (sugar). Create the logic for the signal that will dispense a stirring stick, based on the following rules:

1. If the `Hot` button is left unpressed, then the machine will dispense cold tea.
2. The machine will not allow lemon and milk to be selected at the same time. If you don't already know why, look this up and never, ever serve tea this way.
3. If the tea is cold, you need to provide the user with a stirring stick to mix in lemon or sugar.
4. Also provide a stirring stick when hot tea is selected with lemon but no milk and no sugar.

Stick	$\overline{M}\,\overline{S}$	$\overline{M}\,S$	$M\,S$	$M\,\overline{S}$
$\overline{H}\,\overline{L}$				
$\overline{H}\,L$				
$H\,L$				
$H\,\overline{L}$				

In the Karnaugh map provided here, fill in the values that indicate whether to dispense a stirring stick (`1`) or not to dispense a stick (`0`). **(8 marks)**

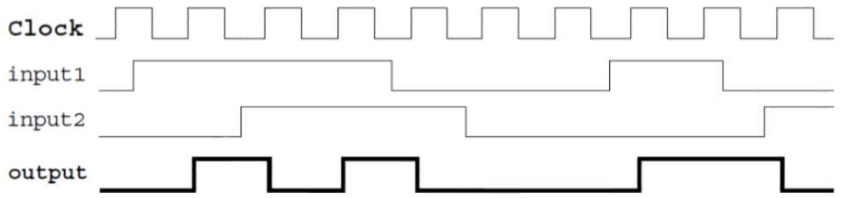
Once you've filled in these values, group the values that would create the most efficient/reduced implementation of this circuit. **(4 marks)**

In the space below, indicate what the Boolean expression is for this circuit in terms of inputs H, L, M and S. **(3 marks)**

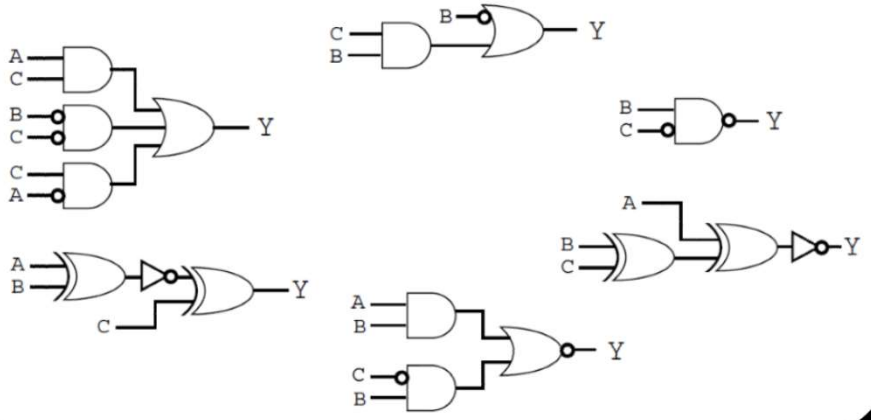
`Stick` = _____

In the space below, draw the circuit diagram for the output `Stick`. For full marks, your diagram should be drawn entirely with only NAND gates. **(5 marks)**

1. In the space below, draw a circuit whose behaviour matches the following waveform. **(4 marks)**

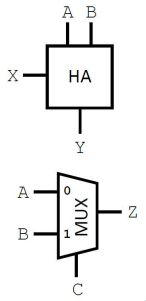


2. Which of the circuits below have equivalent behaviour? Draw lines that connect any circuits that match. **(6 marks)**



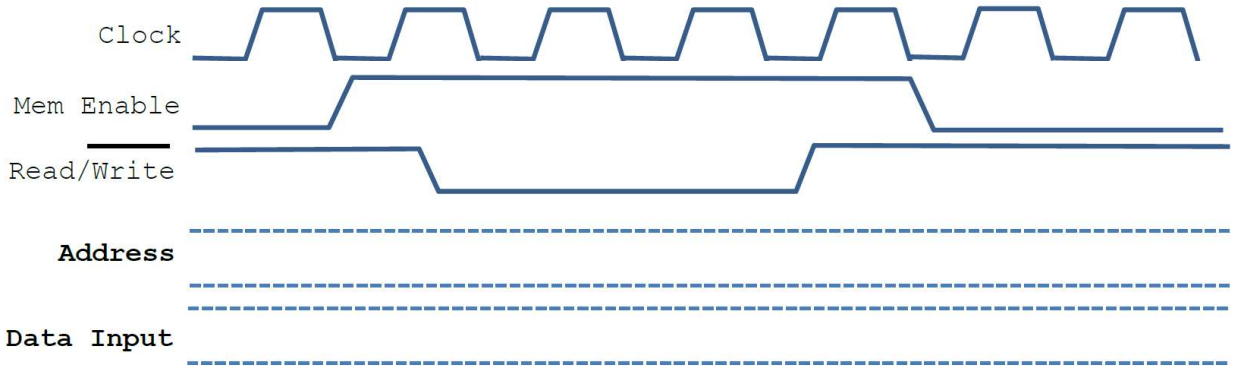
Part D: Logical Devices (10 marks)

1. Consider the half adder and the multiplexer on the right. In the space below, draw a diagram that implements the half adder behaviour using only multiplexers and NOT gates. For full marks, use the fewest multiplexers and gates possible. **(5 marks)**



Part G: Processors, part 1 (11 marks)

1. In the memory write diagram below, label the regions in the address and data input where those signals have valid values **(4 marks)**. On the same diagram, label the Setup Address Time and the Hold Data Time, and describe the reasons for these delays in the spaces provided. **(4 marks)**

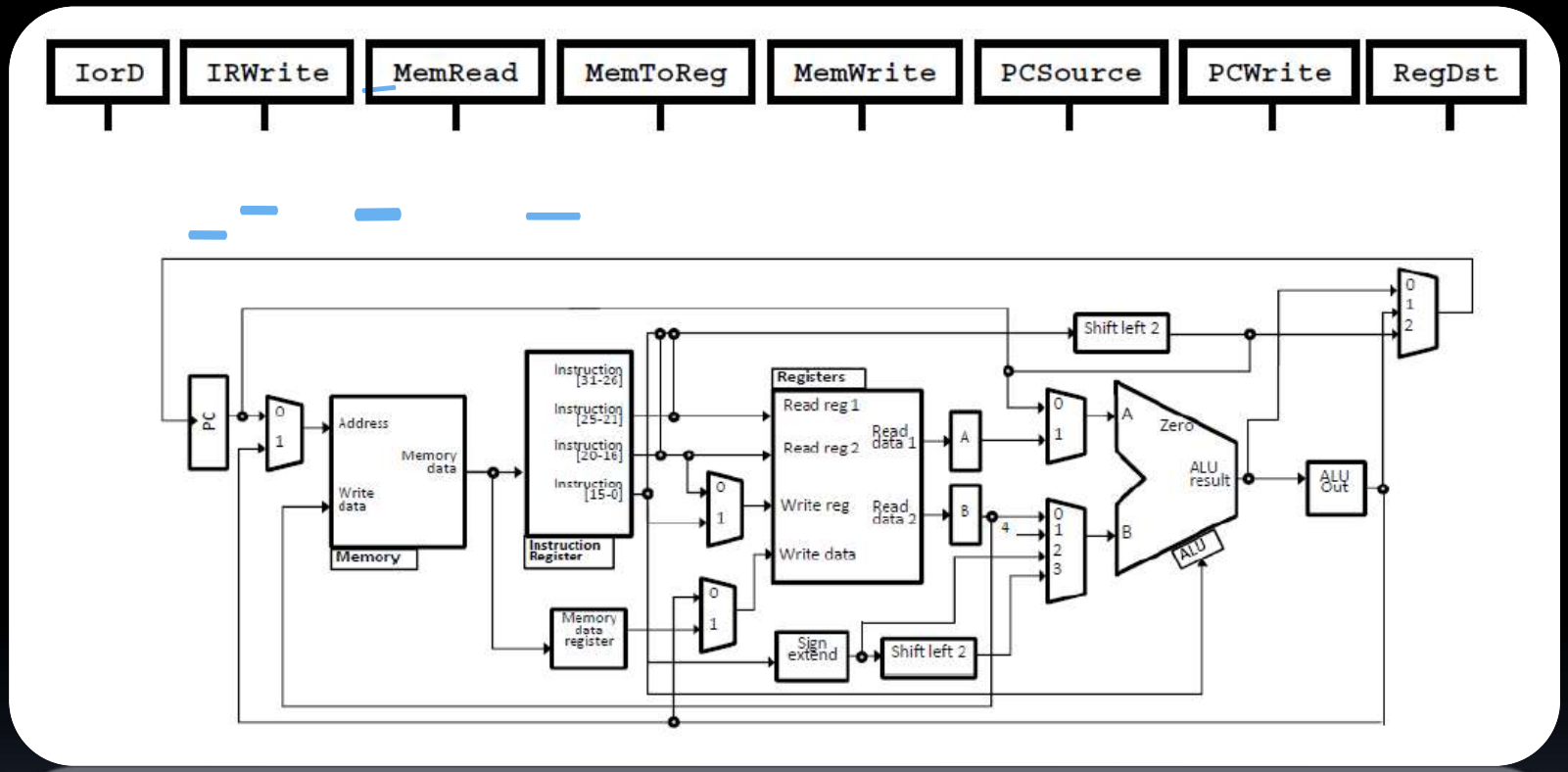


Define these and label on the diagram

Setup Address Time _____

Hold Data Time _____

2. In the diagram below, fill in the circuitry for an 8-bit shift-by-two circuit, similar to those found in the processor datapath. Assume that the A pins represent the inputs and the Y pins represent the outputs. For full marks, use the fewest gates possible. **(3 marks)**


IorD
IRWrite
MemRead
MemToReg
MemWrite
PCSource
PCWrite
RegDst
PC
Address
Memory data
Write data
Memory
Instruction [31-26]
Instruction [25-21]
Instruction [20-16]
Instruction [15-0]
Instruction Register
Memory data register
Registers
Read reg 1
Read reg 2
Write reg
Write data
Read data 1
Read data 2
A
B
4
Shift left 2
Sign extend
Shift left 2
A
B
Zero
ALU
ALU result
ALU Out

5. For the following assembly language instructions, write the equivalent machine code instruction in the space provided. You might find the reference information in the appendix helpful for this question. **(10 marks)**

a) `addu $t2, $t0, $t1`

b) `lw $t0, 20($s0)`

c) `jal top` (where top is at hexadecimal address 0xFF00)

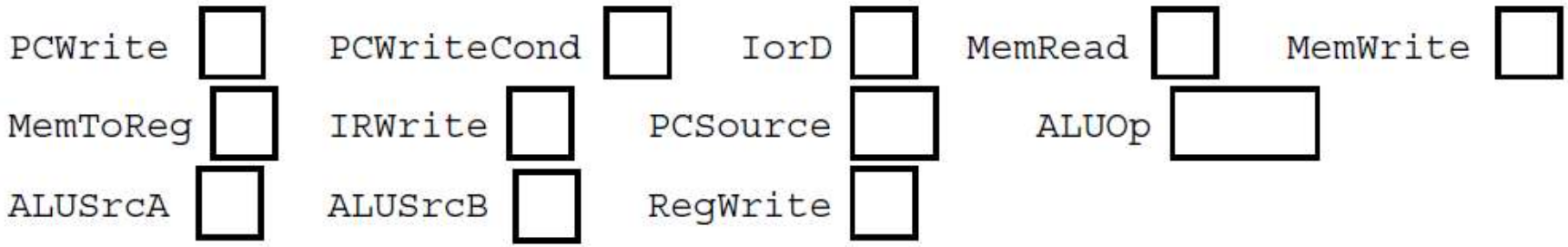
6. For the following machine code instructions, provide the equivalent assembly language instruction in the space provided. **(6 marks)**

a) `00111001000001000000000011111111`

7. For each of the processor tasks below, indicate what the values of the following control unit signals will be by filling in the boxes next to each signal with the signal values. **(12 marks)**

- If a control signal doesn't affect the operation, fill in its value with an X.
- For ALUOp, if you don't know the values, just write what kind of operation is taking place.

Reduce the program counter by the value stored in $t0.



Part J: Assembly Language, part 1 (12 marks)

In the spaces provided below, write the assembly language instruction(s) that perform the following tasks. Full marks will only be given for one-instruction answers.

a) Set the value stored in `$s0` to one eighth of its original value. **(3 marks)**

b) Set `$a1` to the 1's complement of the value stored in `$a0`. **(3 marks)**

5. In the space below, write a short assembly language program that is a translation of the program on the right. You can assume that `i` has been placed on the top of the stack, and should be replaced by the return value before returning to the calling program. Make sure that you comment your code so that we understand what you're doing. **(8 marks)**

```
int make_even (int i) {
   if (i % 2 == 1)
      return i-1;
   else
      return i;
```

Final Exam Tips

- Preparing for the exam:
  - Look over the midterm, figure out what you knew and didn't know and why.
  - Look over past final exams.
    - Ignore Verilog questions.
- During the exam:
  - Read over everything first.
  - Don't do the questions in order.
  - Instruction details are important!
  - What concept is this question testing?

Final Administrative Items

- Check your marks on Quercus
  - Verify that they match what you expect!
- Please fill out the course evaluations ☺
- Make sure to thank your TAs!

Some Final Thoughts

The End