

CS 2130 Exam 1

Name _____

You **MUST** write your e-mail ID on **EACH** page and put your name on the top of this page, too.

If you are still writing when “pens down” is called, your exam will not be graded – even if you are still writing the honor pledge. So please do that first. Sorry to have to be strict on this!

There are 6 pages to this exam. Once the exam starts, please make sure you have all the pages. Questions are worth different amounts of points, so be sure to look over all the questions and plan your time accordingly.

This exam is **CLOSED** text book, closed-notes, closed-cell phone, closed-smart watch, closed-computer, closed-neighbor, etc. You may **not** discuss this exam with anyone until after all the exam times have ended. Please write and sign the honor pledge below.

I am just a child who has never grown up. I still keep asking these ‘how’ and ‘why’ questions. Occasionally, I find an answer.

–Stephen Hawking

Page 2: Binary

1. [6 points] What is $0x25$ in decimal?

Answer

2. [6 points] What is $0b011010111101$ in hexadecimal?

Answer

3. [14 points] Answer the following questions assuming 8-bit two's-complement numbers.

A. Compute the following sum, showing your work (such as carry bits, etc).

$$\begin{array}{r} 1\ 0\ 1\ 1\ 0\ 0\ 1\ 1 \\ +\ 1\ 1\ 0\ 0\ 0\ 1\ 1\ 1 \\ \hline \end{array}$$

B. Is your result a positive or negative number? (circle one)

Positive

Negative

Page 3: Logic and FP

4. [11 points] Write the following binary number as an 8-bit floating point number assuming a 4-bit exponent value.

-10111.01100

Answer

5. [14 points] Assume x and y are 8-bit two's complement integers. For each of the following pairs of expressions, if the two expressions are equivalent for all x and y , write "same"; otherwise, write an example x (and y if used in the expressions) in binary for which the two are different.

A. $(x \gg 5) \ll 4$ and $(x \ll 4) \gg 5$

B. $\sim(x \wedge y)$ and $(x \& y) \mid (\sim x \& \sim y)$

6. [6 points] Assume 32-bit signed integers. Which of the following are 1 if and only if x is negative? (Fill in the bubble for each that applies.)

$x \gg 31$

$(x \gg 31) \& 0x1$

$!(x \gg 31)$

$x \& 0x80000000$

$(x \& 0x80000000) \mid 0x1$

$!((\sim x) \& 0x80000000)$

Page 4: Programming our Computer

Suppose we extended the ISA simulator you wrote in Lab 4 with the following code:

```
if (reserved == 1 && icode == 4) {  
    R[a] = R[b] & M[oldPC + 1];  
    return oldPC + ____;  
}
```

7. [4 points] What is the value that we will need to increment the oldPC? (Fill in the blank below.)

```
return oldPC + _____;
```

8. [15 points] Using the new instruction above at least once, write a program that determines if the contents of register 2 is a negative number in two's complement and stores the result in register 0. That is, if the high order bit of register 2's value is a 1, your program should store a 0×01 in register 0. Answer in hexadecimal bytes, separated by spaces. *Hint: you may need to write additional instructions.*

Answer: _____

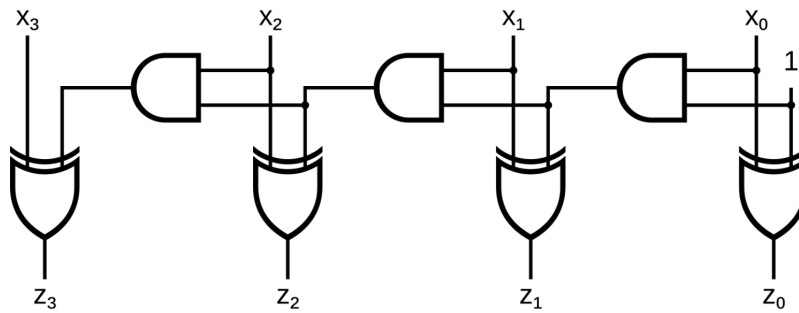
9. [8 points] Complete the table below listing all the register values as hex digits after the following code executes. Assume that all registers start with value 0×00 .

```
6c 20 60 ff 2c 04 54 19
```

Register	Value
0	
1	
2	
3	

Page 5: Circuits

10. [16 points] In class, we discussed a 4-bit increment circuit below that added 1 to the input.



How can we change this circuit to instead increment by 2, i.e., $x += 2$? Draw the new circuit below. *Note: you should not use more gates than the original circuit.*

Page 6: Scratch Paper

Our Example ISA. This is the ISA described in class and used in Lab 4 and Homework 3. Each instruction is one (or two) bytes, defined as:



If the reserved bit (bit 7) in our instruction is 0, the following table defines our instruction encoding.

icode	b	behavior
0		$rA = rB$
1		$rA += rB$
2		$rA \&= rB$
3		$rA = \text{read from memory at address } rB$
4		write rA to memory at address rB
5	0	$rA = \sim rA$
	1	$rA = -rA$
	2	$rA = !rA$
	3	$rA = pc$
6	0	$rA = \text{read from memory at } pc + 1$
	1	$rA += \text{read from memory at } pc + 1$
	2	$rA \&= \text{read from memory at } pc + 1$
	3	$rA = \text{read from memory at the address stored at } pc + 1$
		For icode 6, increase pc by 2 at end of instruction
7		Compare rA as 8-bit two's-complement to 0 if $rA \leq 0$ set $pc = rB$ else increment pc as normal

Nothing on this page will be graded.