York University
Lassonde School of Engineering
Dept. of Electrical Engineering and Computer Science
Fall 2015

EECS2021 **Midterm** **Computer Organization**

Wednesday, Oct. 21st, 2015 5:30 – 6:45

Last Name |__|__|__|__|__|__|__|__|__|__| First name| __|__|__|__|__|__|__|__|__|__|

ID _____ Solution

A

Instructions to students:

Answer all questions.
Marks are shown in front of each question number.
Show your work
Be neat and clean while drawing your logic, block, or state diagrams.

This examination consists of **FIVE** questions

Problem	Points	problem	Points
1	/8	2	/6
3	/4	4	/5
5	/8	6	/4
Total	**/35**		

Problem 1 (8 points)

Answer each of the following questions:

(a) What is the minimum two's complement number that can be represented in six bits?

100000 : -32

(b) What is the maximum two's complement number that can be represented in six bits?

011111 : 31

(c) What does 11110001 represent in unsigned format?

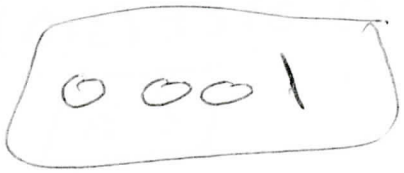
$2^0 + 2^4 + 2^5 + 2^6 + 2^7 = 241$

(d) What does 11110001 represent in 2's complement format

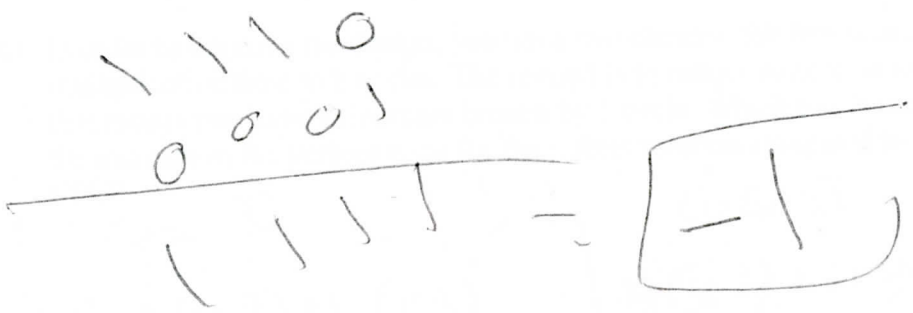
$2^0 + 2^4 + 2^5 + 2^6 - 2^7 =$ ~~121~~ -15

(e) Represent the number -2 in 4 bits using 2's complement format

(f) represent the number 1 in 4 bits using two's complement format



(g) Add the numbers in (e) and (f) using 2's complement, show the actual addition and what is the result?



Problem 2 (6 points)

Instruction	Cycles	percentage
load	4	20%
store	3	20%
add/sub	1	30%
multiply	10	10%
branch	3	20%

a) What is the average CPI?

$4(0.2)+3(0.2)+1(0.3)+10(0.1)+3(0.2)$

3.3

1pt

b) A program executes 10 billion instructions, and a clock rate of 500MHz, how long to execute this program on the above machine?

2pt.

$\frac{10\times10^9\times3.3}{500\times10^6} = 66$ sec

OR $10^{10}(4\times0.2+3\times0.2+\ldots)/500\times10^6 = 66$ sec

c) In order to improve the design, you have two choices; the first is to reduce multiplication time to 8 cycles. The second is to reduce store time to 1 cycle, but that means you have to increase branch by 1 cycle. Which one is faster? What is the increase in the performance for the fastest solution compared to the original CPU?

3pt.

Case I

$4(0.2)+3(0.2)+1(0.3)+8(0.1)+3(0.2)$

3.1

Case II

$4(0.2)+3(0.1)+1(0.3)+10(0.1)+3(0.2)$

2.8

Case II faster by

$\frac{3.3}{2.8} = 1.18$ 18%

$4(0.2)+1(0.2)+1(0.3)+10(0.1)+4(0.2)$

3.1

Problem 3 (4 points)

A given application is written in Java runs 10 seconds on a desktop processor. A new Java compiler is released that requires only 0.5 as many instructions as the old compiler. Unfortunately, it increases the CPI by 20%. What is the percentage performance increase of this application using this new compiler?

$T_{before} = 10 = IC \times CPI \times T_c$ 2pts

$T_{after} = = 0.5IC \times 1.2 CPI \times T_c$

$= 0.6(IC \times CPI \times T_c)$

$= 0.6 \times 10 = 6$ 2pts

improved by $\frac{10}{6} = 1.66$ or 66%

Problem 4 (5 points)

Consider the following piece of code.

```
addi  $s0, $zero, 6
addi  $v0, $zero, -3
add   $s1, $s0, $v0
beq   $s1, $v0, Skip
sll   $s2, $s1, 1
Skip
or $v0, $v0, $s2
```

$s0 = 6
$v0 = -3
$s1 = 3
not taken
$s2 = 6

Register $s0 = 6

Register $v0 = -1

Register $s1 = 3

Register $s2 = 6

1 pt. each + 1

$v0 : $v0 OR $s2

$v0 : -3 = 2's Comp of 000...011

11...1111101

OR 6 : $s2 0000110

11111111

= -1

Problem 5 (8 points)

Given the following code

Memory Address	Data Value
0x23180000	0x00000000
0x23180004	0x00000010
0x23180008	0x00001000
0x2318000C	0x00010000
0x23180010	0x00100000

Write the contents of the registers mentioned after the '#' **after the execution of the instruction to the left**

```
main:
lui   $a0, 0x2318          #$a0= 0x23180000
ori   $a0, $a0, 0x0000     #$a0= 0x23180000
lw    $t0, 8($a0)          #t0= 0x00001000
addi  $sp, $sp, -4
sw    $t0, 0($sp)          #$t0= 0x00001000
lw    $t1, 0($a0)          #$t1= 0x00000000
or    $t3, $t0, $t1        #$t3= 0x00001000
sw    $t3, 0($a0)          #$t3=
addi  $sp, $sp, -4
sw    $t1, 0($sp)
lw    $t3, 0($sp)          #$t3= 0x00000000
addi  $sp, $sp, 4
lw    $t4, 0($sp)          #$t4= 0x00001000
```

00001000
00000000

Fill in the contents of the memory after the completion of the above code

Memory Address	Data Value
0x23180000	0x00001000
0x23180004	0x
0x23180008	0x
0x2318000C	0x
0x23180010	0x

→ 1 pt

no change 1 pt.

Problem 6 (4 points)

- In MIPS, there are many branch instructions `beq bne, br, jr`
  Which of these branches has the largest reach (can jump further away than any other branch)? Briefly explain

Jr uses 32-bit register

- Name 2 different special purpose registers in MIPS and mention their use

sp stack pointer

gp frame pointer

at Compiler

ra return address

any 2 will do