Name: _____
CSE ID: _____ Student Number: _____ **ID: B**

Midterm Test - CSE 2021 - Fall 2011

Instructions

- This is a closed book, 80 minutes test.
- The MIPS reference sheet may be used as an aid for this test.
- An 8.5" x 11" "Cheat Sheet" may also be used as an aid for this test. MUST be original handwriting.
- This is a question/answer booklet: Write your answers in the space provided and as indicated in each question. Use the backside for scratch work. *Do not* hand in anything other than this booklet.
- Fill in your personal data in the box below *before the start of the test*. *Do not* turn this page over until the instructor has announced that you may do so.
- Keep your York photo ID (or any other acceptable photo ID) on the desk in front of you so that the instructor may inspect it without disturbing you.
- You may use ONLY those instructions that appear in the MIPS sheet. Whenever needed, assume that **the machine is little endian.**
- No questions during the exam. Write your final answer with a pen.

LAST NAME: _____

FIRST NAME: _____

STUDENT NUMBER: _____

PRISM LOGIN: _____

Question	Points	Mark
1	6	
2	4	
3	10	
4	6	
5	14	
TOTAL	**40**	

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1.
```
main:  la   $t0, array
       addi $t1, $0, 12
       lw   $t2, array($t1)
       add  $t3, $t1, $t2
       .data
array: .word 10, 27, 36, 57
```

$t2 (in decimal) =

$t3 (in decimal) =

2. Translate the number below into a radix of 16. Also assuming IEEE 754 format, what decimal number is represented by:

   0 01111010 00000000000000000000000

Number (in hex) =

Number (in decimal) =

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Problem

3. Consider two different implementations, M1 and M2, of the same instruction set. There are three classes of instructions (A, B, and C) in the instruction set. M1 has a clock rate of 80 MHz and M2 has a clock rate of 100 MHz. The average number of cycles for each instruction class and their frequencies (for a typical program) are as follows:

Instruction Class	M1 - Cycles/Instruction	M2 - Cycles/Instruction	Instruction Frequency
A	1	2	60%
B	2	3	30%
C	4	4	10%

(a) [4 points] Calculate the average CPI for each machine, M1, and M2.

(b) [4 points] Calculate the average MIPS ratings for each machine, M1 and M2.

(c) [2 points] Which machine has a smaller MIPS rating ? Which individual instruction class CPI do you need to change, and by how much, to have this machine have the same or better performance as the machine with the higher MIPS rating (you can only change the CPI for one of the instruction classes on the slower machine)?

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4. Fig. 1 shows the schematic diagram of a NOR gate

Fig.1: Schematic diagram of the NOR gate

which has the following truth table

a	*b*	*c* = *a* NOR *b*
0	0	1
0	1	0
1	0	0
1	1	0

A NOR gate is a universal gate because any digital component can be implemented using NOR gates only. Implement [2 points each] (a) a NOT gate, (b) an AND gate and (c) an OR gate using only NOR gates. You may use more than one NOR gate but no other type of gate may be used.

5. "Binary-Coded Decimal" (BCD) is a system for representing decimal numbers in binary. Each digit of a decimal number is represented by the corresponding 4-bit binary number. For example the decimal number 33_{ten} would be represented as 0011 0011 or 0x33 or 64_{ten} would be represented by 0110 0100 or 0x64.

   A digital circuit for converting a 4-bit binary number into BCD is required. The circuit has a 4-bit input representing the binary number and a total of 8 BCD bits giving the corresponding BCD representation of the number. An example is provided below:
   Inputs:

w	x	y	z
1	1	1	1

   Outputs:

a	b	c	d	e	f	g	h
0	0	0	1	0	1	0	1

   (a) [4 points]Provide the truth table for this circuit. The columns labelled w, x, y, z represent the 4 input bits and a, b, c, d, e, f, g, h represent the 8 BCD output bits

Inputs				Outputs							
w	x	y	z	a	b	c	d	e	f	g	h

   (b) [6 points] Derive simplified logical expressions for the 8 BCD output bits

   a =

   b =

c =

d =

e =

f =

g =

h =

(c) [4 points] Using AND, OR and NOT gates draw the circuit diagrams for each of the outputs

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Answer Section

SHORT ANSWER

1. ANS:

```
$t2 (in decimal) = 57

$t3 (in decimal) = 69
```

   PTS: 1 OBJ: Section A

2. ANS:
   Hex number:

   0011 1101 0000 0000 0000 0000 0000 0000
   3 D 0 0 0 0 0 0

   The decimal number

   = (-1)^0* $(1.000)_2$*(2^(122-127))
   = (1)*(1.0)*(0.03125)
   = 0.03125

   PTS: 1

PROBLEM

3. ANS:
(a) Calculate the average CPI for each machine, M1, and M2.
For Machine M1:
Clocks per Instruction = (60/100)* 1 + (30/100)*2 + (10/100)*4 = 1.6
For Machine M2:
Clocks per Instruction = (60/100)*2 + (30/100)*3 + (10/100)*4 = 2.5

(b) Calculate the average MIPS ratings for each machine, M1 and M2.
For Machine M1:
Average MIPS rating = Clock Rate/(CPI * 10^6) = (80 * 10^6) / (1.6*10^6) = 50.0

For Machine M2:
Average MIPS rating = Clock Rate/(CPI * 10^6) = (100 * 10^6) / (2.5*10^6) = 40.0

(c) Which machine has a smaller MIPS rating ? Which individual instruction class CPI do you need to change, and by how much, to have this machine have the same or better performance as the machine with the higher MIPS rating (you can only change the CPI for one of the instruction classes on the slower machine)?

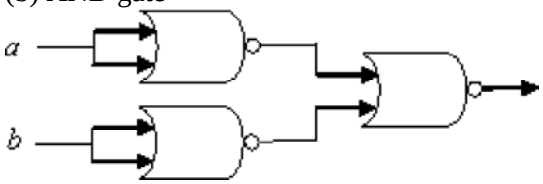
Machine M2 has a smaller MIPS rating.

If we change the CPI of instruction class A for Machine M2 to 1, we can have a better MIPS rating than M1 as follows:
Clocks per Instruction = (60/100)*1 + (30/100)*3 + (10/100)*4 = 1.9
Average MIPS rating = Clock Rate/(CPI * 10^6) = (100 * 10^6) / (1.9*10^6) = 52.6

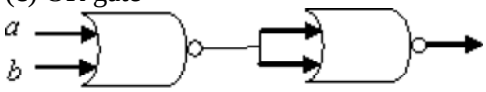
PTS: 1

4. ANS:
(a) NOT gate

(b) AND gate



(c) OR gate



PTS: 1

5. ANS:

(a)

w	x	y	z	a	b	c	d	e	f	g	h
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	0	1	0
0	0	1	1	0	0	0	0	0	0	1	1
0	1	0	0	0	0	0	0	0	1	0	0
0	1	0	1	0	0	0	0	0	1	0	1
0	1	1	0	0	0	0	0	0	1	1	0
0	1	1	1	0	0	0	0	0	1	1	1
1	0	0	0	0	0	0	0	1	0	0	0
1	0	0	1	0	0	0	0	1	0	0	1
1	0	1	0	0	0	0	1	0	0	0	0
1	0	1	1	0	0	0	1	0	0	0	1
1	1	0	0	0	0	0	1	0	0	1	0
1	1	0	1	0	0	0	1	0	0	1	1
1	1	1	0	0	0	0	1	0	1	0	0
1	1	1	1	0	0	0	1	0	1	0	1

(b)

a = b = c = FALSE (or 0)

d = w · (x + y)

e = w · x’ · y’

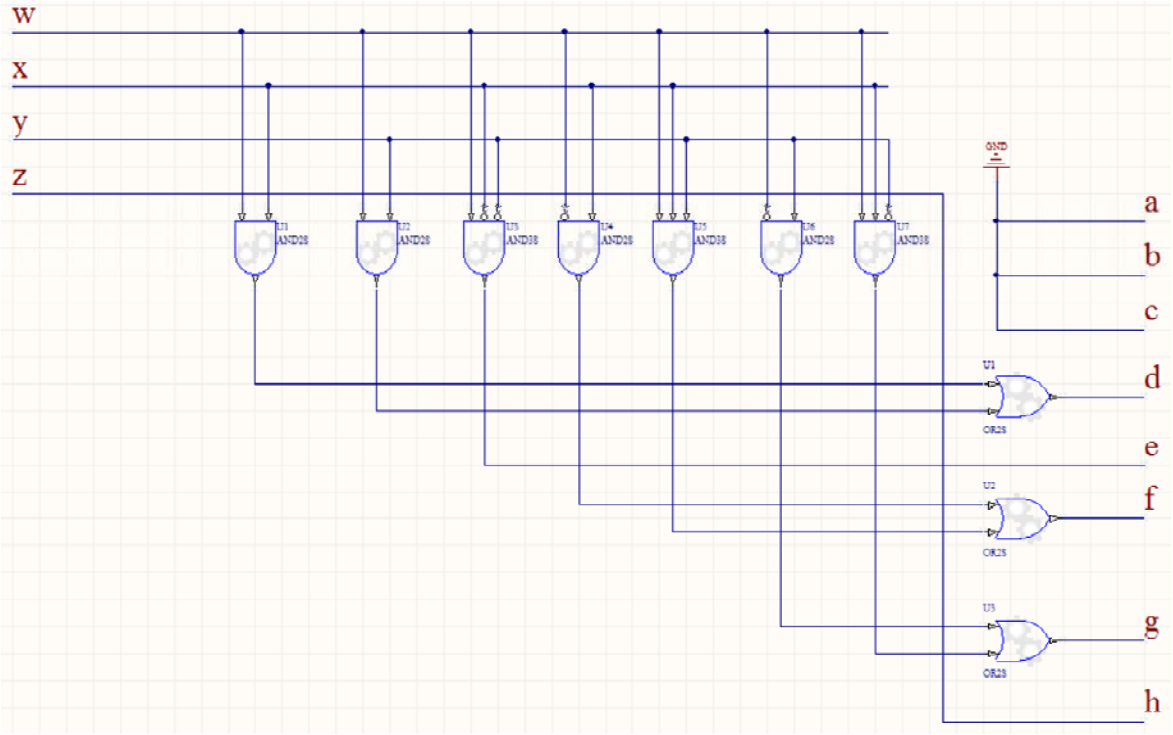
f = w’· x + w · x · y

g = w’ · y + w · x · y’

h = z

(c)

A drawing of the logic equations from part b is:



PTS: 1