UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING
MIDTERM EXAMINATION, MARCH 2013

ECE243H1 S – COMPUTER ORGANIZATION
Exam Type: D
Duration: 2 Hours

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This is a type D exam. You are allowed to use any printed material and a calculator as allowed by the University regulations.

PRINT IN ALL CAPS PLEASE:

Last Name: ___________________________

First Name: ___________________________

Student Number: ______________________

Instructor Session (where you'll pick up the midterm)

□ **Phil Anderson**

□ **Natalie Enright Jerger**

□ **Andreas Moshovos**

Please:
State your assumptions. Show your work. Comment your code. **Use your time wisely as not all questions will require the same amount of time.** If you think that assumptions must be made to answer a question, state them clearly. If there are multiple possibilities, comment that there are, explain why and then provide at least one possible answer and state the corresponding assumptions.

1. [20] Data Representation:

What is **`1010 1111`**?

a) **[3]** Written in hexadecimal?

b) **[3]**If interpreted as an unsigned number? _________ (in decimal please)

c) **[3]** If interpreted as a signed number in 2's complement? ________ (in decimal please)

e) **[4]** Interpret the following 32-bit quantity as a single-precision floating point number in IEEE format:

`0100 0011 0000 0001 1100 0000 0000 0000`

First write the following in binary:

Sign bit = ____

Exponent field = ___________________

Mantissa = ____

Then write the value in decimal:

Value in decimal = __________________________________

Contd…

f) **[7]** Write an assembly subroutine "floatX4" which takes as argument a 32-bit single-precision floating point number in IEEE format and returns the same number multiplied by 4. Assume no overflow in the exponent and that the function will be called only for regular numerical values and not for any of the special represented cases such as NaN, infinity, etc.

2. [20] Little vs. Big Endian: During the second month of a mission to Mars, the NIOS II equipped navigation computer was struck by a hefty dose of radiation and lost functionality of its STW and STH instructions. Fortunately, STB still works. Write an assembly subroutine “void doSTW(int *addr, int val)” that gets a memory address (addr) and a 32-bit value (val) as input arguments and stores the value at the specified memory address. Remember to only use STB to write to memory, and to check for proper alignment. If the address is not properly aligned the subroutine should not write anything to memory and just return.

3. [20] Sequencing:

3.a [12]: Write down the PCs of all the executed instructions in program order (i.e., as they execute) in hexadecimal. LABEL_X refers to address 0x100c, LABEL_Y refers to address 0x2000, and PC is initially 0x1004.

```
          add  r5, r0, r0
          addi r4, r0, 7
LABEL_X:
          ori  r5, r4, 8
          addi r4, r0, 8
          blt  r5, r4, LABEL_Y
          addi r4, r0, 0x1
          br   LABEL_Y
          ..other unknown code...
LABEL_Y:
          addi r4, r4, -1
          bgt  r4, r0, LABEL_X
          addi r4, r0, 8
```

`0x1004` continue the list below

3.b [8]: When the following code executes:

```
          addi r4, r0, 10
          beq  r4, r5, GT10
          ldw  r5, -8(r8)
          br   DONE
GT10:
          addi r5, r5, 10
          ldw  r6, 8(r8)
DONE:
          addi r4, r4, r4
```

you observe, using a digital analyzer attached to the memory address pins, that memory words are read from the following addresses in the following order :

0x1000
0x1004
0x1010
0x1014
0x2028
0x1018

i) [4] What is the value of r8? Explain why.

ii) [4] What is the value of r5 after the last instruction executes? Explain why.

4. [15] Data Structure Representation and Manipulation:

A data structure is declared as follows:

```
struct    lala_t {
               int a;
               int b;
               int c[100];
               } koko[1024];
```

a) [3] How many bytes are required to store one element of array koko? That is, what is the size of a “struct lala_t” data element?

b) [5] Which address of memory is koko[i].c[j] stored at? Express it as a function of koko, i, and j.

b) [7] If `i` is in `r8` and `j` in `r9` complete the code below that reads into **`r2`** the value of **`koko[i].c[j]`**:

```
          .text
          .align 2
          movia r10, koko
```

5. [20] Machine Code and Functions:

a) **[10]** Implement a function “`unsigned int modI(unsigned int a, unsigned int b)`“ that returns the remainder (a MOD b) of the integer division of a by b. Do not use a multiply or divide instruction. Explain your code.

```
     .text
modI:
```

b) **[10]** Implement this function in NIOS II assembly (assume int modI(int, int) is provided):

```
int isprime (int n)
{
   int i;

  if (n == 1) return 1;
  for (i = 2; i < n; i++)
     if (modI(n, i) == 0) return 0;
  return 1;
}
```

6. [15] Calling Conventions: Immediately after the following function gets called, and before any of its instructions execute:

```
int
zoom (int a, int b, int c, int d, int e, int f)
{
  return c + broom (blam(f, e), a, b + 3);
}
```

sp = 0x30000 and the memory contents, in words, starting at address 0x30000 are as follows:

0x30000	0x1234
0x30004	0xABCD
0x30008	0x14263748
0x3000c	0x1020

a) [4] What is the value of e and f?

e = ___________________

f = ___________________

b) [**11**] Which registers of r0-r31 will zoom() have to save on stack before calling any of the other functions? List each register and concisely explain why.

`Register       Reason why it needs to be saved`

7. [10] Interrupts:

A network adapter is connected to IRQ16 and is memory mapped starting at address 0x40000. The device's control register (CR) is at 0x40010. CR's bit 15 counting from zero, if set, enables interrupts. The rest of CR contains several other bits which should be left unchanged when writing bit 15. Reading the control register returns the current state of all bits. Assuming that initially all interrupts are disabled, provide a sequence of instructions that enable interrupts from this device. After your code, the processor should be accepting interrupt requests from this device only, and the device should be requesting them whenever a packet is received.

Last Name (in case pages get detached):___________________

	Marks	Max. Marks	Notes
1		20	
2		20	
3		20	
4		15	
5		20	
6		15	
7		10	
Total		120	