January 8, 2009

COMPUTER ENGINEERING DEPARTMENT

ICS 233

COMPUTER ARCHITECTURE & ASSEMBLY LANGUAGE

Major Exam II

First Semester (081)

Time: 1:00-3:30 PM

Student Name : _____

Student ID. : _____

Question	Max Points	Score
Q1	20	
Q2	16	
Q3	16	
Q4	16	
Q5	8	
Q6	8	
Q7	16	
Total	100	

Dr. Aiman El-Maleh

[20 Points]

(Q1) Given below a summary of syscall services:

Service	$v0	Arguments / Result
Print Integer	1	$a0 = integer value to print
Read Integer	5	$v0 = integer read
Exit Program	10	

(i) Determine the output produced by the following program given that the program inputs are 7 and 4.

```
        .text
        .globl main
main:
        li $v0, 5
        syscall
        move $t0, $v0
        li $v0, 5
        syscall
        move $a1, $v0
        move $a0, $t0
        jal Proc1
        move $a0, $v0
        li $v0, 1
        syscall
        li $v0, 10
        syscall
Proc1:
        bne $a0, $a1, Skip
        move $v0, $a0
        jr $ra
Skip:
        addi $sp, $sp, -8
        sw $a0, ($sp)
        sw $ra, 4($sp)
        addi $a0, $a0, -1
        jal Proc1
        lw $t0, ($sp)
        lw $ra, 4($sp)
        addi $sp, $sp, 8
        mul $v0, $v0, $t0
        jr $ra
```

(ii) Determine the output produced by the following program given that the program input is 987.

```
        .text
        .globl main
main:
        li $v0, 5
        syscall
        move $a0, $v0
        jal Proc2
        move $a0, $v0
        li $v0, 1
        syscall
        li $v0, 10
        syscall

Proc2:
        li $t0, 10
        move $t1, $a0
Next:
        xor $t3, $t3, $t3
Again:
        divu $t1, $t0
        mflo $t1
        mfhi $t2
        addu $t3, $t3, $t2
        bnez $t1, Again
        move $t1, $t3
        bge $t1, $t0, Next
        move $v0, $t1
        jr $ra
```

[16 Points]

(Q2) Given that **Multiplicand=1010** and **Multiplier=1111**.

(i) Using the **refined unsigned multiplication** hardware, show the **unsigned** multiplication of **Multiplicand** by **Multiplier**. The result of the multiplication should be an 8 bit **unsigned** number in HI and LO registers. Show the steps of your work.

(ii) Using the **refined signed multiplication** hardware, show the **signed** multiplication of **Multiplicand** by **Multiplier**. The result of the multiplication should be an 8 bit **signed** number in HI and LO registers. Show the steps of your work.

[16 Points]

(Q3) Given that **Dividend=1001** and **Divisor=0101**.

(i) Using the **refined unsigned division** hardware, show the **unsigned** division of **Dividend** by **Divisor**. The result of division should be stored in the Remainder and Quotient registers. Show the steps of your work.

(ii) Using the **refined unsigned division** hardware, show the **signed** division of **Dividend** by **Divisor**. The result of division should be stored in the Remainder and Quotient registers. Show the steps of your work.

[16 Points]

(Q4)

(i) What is the decimal value of the following single-precision floating-point number?

`0100 0011 0110 1001 1000 0100 0000 0000`.

(ii) Show the single-precision floating-point binary representation for: **555.9375**.

(iii) Perform the following floating-point operation rounding the result to the **nearest even**. Perform the operation using **guard**, **round** and **sticky** bits.

```
      1100 1110 0000 0000 0000 0000 0100 0000
+     0101 0010 0000 0000 1000 0000 0000 0000
```

[8 Points]

(Q5)

(i) Fill the following table by placing a check mark (✓) indicating the impact of each listed factor on the Instruction Count (I-Count), CPI and Cycle time.

	I-Count	CPI	Cycle
Compiler			
Instruction Set Architecture (ISA)			
Organization			
Technology			

(ii) List three problems in using MIPS as a performance metric.

[8 Points]

(Q6) Suppose that a program runs in 150 seconds on a machine, with ALU operations responsible for 40 seconds of this time, multiply operations responsible for 50 seconds of this time and divide operations responsible for 40 seconds of this time. The remaining time is taken by the remaining operations. Suppose that a new implementation of the machine has improved the execution time of the ALU by a factor of 2, the multiplier by a factor of 1.5 and the divider by a factor of 1.6. Determine the new execution time and the speedup of the program based on the new implementation.

[16 Points]

(Q7) Given the following instruction mix of a program on a RISC processor:

Class	CPI	Frequency
ALU	2	40%
Branch	2	25%
Jump	1	15%
Load	4	10%
Store	3	10%

(i) What is the average CPI?

(ii) Assuming that the processor has a clock rate of 2 GHz, determine MIPS.

(iii) What is the percent of time used by each instruction class?

(iv) How much faster would the program run if load time is reduced to 3 cycles, and two ALU instructions could be executed at once, assuming that the cycle time has increased by 5% and the instruction count has increased by 10%?