Name: KEY **Id#**

ICS 233, Term 142

Computer Architecture & Assembly Language

Quiz# 5

Date: Thursday, April 29, 2015

Q1. Consider the following fragment of MIPS code. Assume that **a** and **b** are arrays of words and the base address of **a** is in **$a0** and the base address of **b** is in **$a1**. How many instructions are executed during the running of this code? If ALU instructions (**addu** and **addiu**) take 1 cycle to execute, load/store (**lw** and **sw)** take 5 cycles to execute, and the branch (**bne**) instruction takes 3 cycles to execute, how many cycles are needed to execute the following code (all iterations). What is the average CPI?

```
        addu $t0, $zero, $zero   # i = 0
        addu $t1, $a0, $zero     # $t1 = address of a[i]
        addu $t2, $a1, $zero     # $t2 = address of b[i]
        addiu $t3, $zero, 101    # $t3 = 101 (max i)
loop:   lw $t4, 0($t2)           # $t4 = b[i]
        addu $t5, $t4, $s0       # $t5 = b[i] + c
        sw $t5, 0($t1)           # a[i] = b[i] + c
        addiu $t0, $t0, 1        # i++
        addiu $t1, $t1, 4        # address of next a[i]
        addiu $t2, $t2, 4        # address of next b[i]
        bne $t0, $t3, loop       # loop if (i != 101)
```

.

The loop body will be executed 101 times. Thus, the total number of instructions executed per class is:

Class	Instruction Count
addu and **addiu**	4 + 101x4 = 408
lw and **sw**	101x2=202
Bne	101

Thus, the total number of instruction executed = 408 + 202 + 101 = 711 instruction.

Total number of cycles needed to execute the code = 408x1+202x5+101x3=1721 cycle.

The average CPI = 1721/711 = 2.42

Q2. 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.

Execution time of new implementation = 40/2 + 50/1.5 + 40/1.6 + 20 =20+33.33+25+20=98.33 seconds

Speedup = 150/98.33 = 1.525