Name: **Id#**

COE 301/ICS 233, Term 161

Computer Architecture & Assembly Language

Quiz# 5 Solution

Date: Tuesday, Dec. 25, 2016

Q1. A benchmark program runs for 100 seconds. We want to improve the speedup of the benchmark by a factor of 3. We enhance the floating-point hardware to make floating point instructions run 5 times faster. How much of the initial execution time would floating-point instructions have to account for to show an overall speedup of 3 on this benchmark?

Speedup = 1 / (f/s + (1-f) => 3 = 1 / (f/5+(1-f) => f/5 + 1-f = 1/3 => f + 5 – 5f = 5/3 => 4f = 3.33 => f =0.833
Thus, floating-point instructions must account for 83.3% of the initial execution time to show an overall speedup of 3 on this benchmark.

Q2. 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