CS430 Problem Set #6

Date assigned: Wednesday, April 15, 2015
Date due: Monday, April 27, 2015
Points: 50

1) (8 pts) You have been hired as a consultant by Micro Devices because they are considering incorporating a new microprocessor with a hardware floating-point functional unit (FPU) into one of their embedded devices. For floating-point computations, the hardware floating-point unit will be 50 times faster than the software routines otherwise used.

a) To compute the speedup of a program on the new processor, we find the percent of the execution time that would be improved by the new feature. This is called the "percent enhanced" of the execution time. In our case, this is the percent of the time spent executing the software floating-point routines on the old processor. If a job spends half of its time in the software floating-point routines, what is the maximum speedup that an infinitely fast hardware FPU could achieve?
b) After benchmarking the new microprocessor with the hardware FPU, the program takes 10 seconds, but the FPU is used only 10% of that time. Is it worth buying a new machine for a device that is used only 10% of the time? To justify your argument, compute the speedup of the new microprocessor over the old on this job and use this in your explanation.

2) (6 pts) Work problem 14.5 on p. 528. In answering parts a) and b) compute the speedup and give your answer as a % faster.

3) (8 pts) Work problem 14.9 on p. 528.

4) (28 pts) Consider the following poorly written assembly language program for a winMIPS64 processor.

```
.data
        ; 64-bit integers
values: .word 10, 12345, 6459832, 2397458, 9934851, 45900345
        .word 540598349, 44423945, 32338854, 2121, 10000043
result: .space 8

.text
main:   daddi r16,r0,2      ; r16 is a value of 2
        ld r8,values(r0)    ; get number of values in the array
        slti r2,r8,1        ; test if # values < 1 (i.e. array is empty)
        bnez r2,l3          ; if empty, branch to l3
        daddi r2,r0,8       ; set r2 to first element
        dadd r3,r0,r0       ; set r3 to 0

l1:     slti r6,r8,1
        bnez r6,l3
        ld r4,values(r2)
```

```
        dadd r5,r4,r0
        ddivu r17,r4,r16
        dmulu r17,r17,r16
        dsub r17,r17,r5
        bnez r17,l2
        daddi r3,r3,1
l2:     daddi r2,r2,8
        daddi r8,r8,-1
        j l1

l3:     sd r3,result(r0)    ; save result
        halt                ;the end
```

a) Give a general English description of what this program does. Do not describe each statement one at a time for your English description. That is, in general, what is the program doing?

b) Run this program through the WinMIPS64 simulator and report on: a) the number of cycles this program takes to run and b) the CPI for this program

c) What is the machine language for the statement **`bnez r6,l3`**?

d) There are three different pieces of information for the machine language statement in c). Number and describe each of these pieces of information.

e) The MIPS branch instruction behaves differently than the x86 branch instruction. Using the machine language for the statement **`bnez r6,l3`**, explain how this instruction works. Further, how far forward and backward can this instruction branch? Give your answer in bytes.

f) You must modify the above program to run at least 200% faster on the WinMIPS64 simulator without changing any of the simulator default settings or changing any of the program logic. That is, your solution must be logically equivalent. Paste your solution into the final Word document.

Extra Credit (3 pts)

You can receive 3 points of extra credit if your solution executes in 155 cycles or less for the above data set.

Note1: Please make sure your problem sets are typed, answered in order, and stapled together.

Note2: A hard copy of your Problem Set Solution is due on the instructor's desk by 11:45am on the day the assignment is due. Create a folder 06PUNetID and place a copy of your solution 06PUNetID.doc (or .pdf) and a fully documented copy of the assembly language program from 4 f) 06PUNetID.s into the folder. Then place the folder 06PUNetID in the CS430 Drop Box by 11:45am on the day in which the assignment is due.