CS 430 Problem Set #6

Date assigned: Monday, November 10, 2008.
Date due: Monday, November 24, 2008 @ 11:45am.
Points: 60 pts.

1. (8 pts) For the following problems, consider the following scenario:

   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. (4 pts) 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. (4 pts) 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. (12 pts) CPI stands for clock cycles per instruction and is the number of cycles needed to execute a particular instruction.
   a. (4 pts) If we reduce the clock cycle time in a particular processor from C to 0.8C and each instruction takes the same number of cycles, what is the speedup?
   b. (4 pts) If we reduce the clock cycle time from C to 0.8C and 20% of the instructions need an extra cycle, what is the speedup?
   c. (4 pts) If we leave the clock cycle time the same, but change the average CPI for 40% of the instructions from 5 to 4, (leaving the average CPI for the remaining instructions at 5), what is the speedup?

3. (12 pts) Let's assume that there is a machine with a 100MHz clock. A program that I executed on this machine executed 198,000 instructions in 2.97 ms (milliseconds). An optimized version of this same program executed 66,000 instructions in 1.32 ms.
   a. (4 pts) Calculate the CPI (clock cycles per instruction) for the unoptimized code.
   b. (4 pts) Calculate the CPI for the optimized code.
   c. (4 pts) What is the speedup of the optimized code compared to the unoptimized code?

4. (8 pts) Work problem 12.9 on p. 457

5. (20 pts) You are to write an assembly language program for the winMIPS64 machine that sorts a list of N signed numbers in increasing order where N is specified as the first word in a list of numbers followed by the numbers to be sorted. Your program is to be completely documented with the file documentation consisting of:

```
;*************************************************************
; Filename:
; Author:
; Date:
; Class:
; Assignment:
; Purpose:
; Algorithm:
;*************************************************************
```

Further, each line of assembly is to be documented. As for the numbers to be sorted, the list will look like the following which can be easily expanded.

```
            .data

values:     .word 10,5,20,100,-5,30,45,-15,-10,25,20
```

Note: The first word specifies the number of words to follow.

On the day this assignment is due, each of you will demo your solutions. I will provide a set of values for each of you to use in your program.

You may submit this assignment in one of two way: (1) a Google document shared with ShereenKhoja@gmail.com, (2) a Word document attached to an email sent to ShereenKhoja@gmail.com. Do not submit a hard copy. Name your document “06PSPUNet”, i.e. mine would be called “06PSkhoj0332”.