Comp 411 Computer Organization
Fall 2010

Problem Set #6
Issued Monday 29 March; Due Monday 12 April

Homework Information: Some of the problems are probably too time consuming to be done the night before the due date, so plan accordingly. Late homework will not be accepted. Feel free to get help from others, but the work you hand in should be your own.

Problem 1. "Bits of Floating-Point"

Represent the following in single-precision IEEE floating point. Give your answers in hexadecimal:

a) 308.0
b) 15.0625
c) $(2^{19} - 1)$

Convert the following single-precision floating point number (given in hexadecimal) to decimal:

d) 0x338c1000

Problem 2. "Floating-Point Arithmetic"

Given the following two single-precision IEEE floating-point numbers:

x = 0x35850000 and y = 0xabd10000

Compute the following showing all work:

a) $x + y$
b) $x \times y$

Problem 3.
We wish to compare the performance of two different computers: M1 and M2. The following measurements have been made on these computers.

Program	Time on M1	Time on M2
1	2.0 seconds	1.5 seconds
2	5.0 seconds	10.0 seconds

Which computer is faster for each program, and how many times as fast is it?

Problem 4.
Suppose that M1 in problem 3 costs $500 and M2 costs $800. If you needed to run program 1 a large number of times, which computer would you buy in large quantities? Why?

Problem 5.
Suppose you wish to run a program P with 7.5 billion instructions on a 5GHz machine with a CPI of 0.8. What is the expected CPU time? When you run P, it takes 3 seconds of wall clock time to complete. What is the percentage of CPU time P received?

Problem 6.
Consider two different implementations, I1 and I2, of the same instruction set. There are three classes of instructions (A, B, and C) in the instruction set. I1 has a clock rate of 6GHz, and I2 has a clock rate of 3GHz. The average number of cycles for each instruction class on I1 and I2 is given in the following table:

Class	CPI on M1	CPI on M2	C1 Usage	C2 Usage	C3 Usage
A	2	1	40%	40%	50%
B	3	2	40%	20%	25%
C	5	2	20%	40%	25%

The table also contains a summary of average proportion of instruction classes generated by three different compilers. C1 is a compiler produced by the makers of I1, C2 is produced by the makers of I2, and the other compiler is a third-party product. Assume that each compiler uses the same number of instructions for a given program but that the instruction mix is as described in the table. Using C1 on both I1 and I2, how much faster can the makers of I1 claim I1 is compared to I2? Using C2, how much faster can the makers of I2 claim that I2 is compared to I1? If you purchase I1, which compiler would you use? If you purchased I2, which compiler would you use? Which computer and compiler would you purchase if all other criteria are identical including cost?

Problem 7.
Consider program P, which runs on a 1GHz machine M in 10 seconds. An optimization is made to P, replacing all instances of multiplying a value by 4 (mult X, X, 4) with two instructions that set x to x+x twice (add x,x,x; add x,x,x). Call this new optimized program P'. The CPI of a multiply instruction is 4, and the CPI of an add is 1. After recompiling, the program now runs in 9 seconds on machine M. How many multiplies were replaced by the new compiler?