1 Information

1. The assignment is worth 100 points.

2. Individual work.

3. Due at 12:00 on 3/16, i.e., Thursday noon.

4. When asked, use a scientific notation, i.e., show a value in the form $m \times 10^n$, where $1 \le |m| < 10$ and n is an integer.

5. If any fractional part, round to the second decimal place.

6. Submit the assignment to the course website.

7. Write the assignment in English or Chinese MS Word or PDF format.

2 Contents

1. Sometimes software optimization can dramatically improve the performance of a computer system. Assume that a CPU can perform a multiplication operation in 15 ns, and an addition operation in 2 ns.

    (a) (15 points) How long will it take for the CPU to calculate the result of $d = a \times b + a \times c$?

    (b) (15 points) Could you optimize the equation so that it will take less time?

2. (15 points) A computer has 3 instruction classes. They are A, B and C. The A instruction class is 1 CP1 (clock cycles per instruction), the B instruction is 2 CPI and the C instruction is 3 CPI. A program code has 5 millions of the A instruction class, 2 millions of the B instruction class and 3 millions of the C instruction class. Assume that the clock rate of the computer is 100 MHz. What is the execution time of the program code?

3. (15 points) A program runs in 10 seconds on computer X, which has a 5 GHz clock. You are trying by increasing the clock rate to build a computer Y that will run the program in 6 seconds. However, the increase will cause the computer Y to require 1.2 times as many clock cycles as computer X. What clock rate should you design?

   (a) 10 GHz

   (b) 9 GHz

   (c) 8 GHz

   (d) 7 GHz

4. Suppose CPI for instrcction class A, B, C are 1, 2, 3, respectively. We measure the code for the same program from two different compilers and obtain the following data:

Code from	Instruction counts (in billions) for each instruction class		
	A	B	C
Compiler 1	5	1	1
Compiler 2	10	1	1

   Assume that the computer's clock rate is 4 GHz.

   (a) (15 points) Which code sequence will execute faster according to execution time?

   (b) (15 points) Which code sequence will execute faster according to MIPS?

5. (10 points) Suppose that FPSQR instructions are improved with speedup=10. FPSQR instructions are responsible for 20% of the execution time. What is the overall speedup?

   (a) 1.08

   (b) 1.22

   (c) 1.35

   (d) 1.55