CS3339

Homework 1

Fall 2018

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SHOW YOUR WORK

SHOW UNITS

Instructions: Print the homework out and answer the problems, SHOWING YOUR WORK, in the space provided. Use the back of page if you run out of room but be sure to say " continued on back". Put your name below, staple all pages together and turn in at the beginning of class on the due date.

NAME:_____

1.(20 points) Consider three different processors P1, P2, P3 executing the same instruction set. P1 has a clock rate of 3 GHz and a CPI of 1.5, P2 has a clock rate of 4 GHz and a CPI of 1.7, and P3 has a clock rate of 6.0 GHz and a CPI of 6.2.

a. Which processor has the highest performance expressed in instructions per second?

b. If the processors each execute a program in 15 seconds, find the number of cycles and the number of instructions.

c. We are trying to reduce the execution time of P2 by 25 percent but this leads to an increase in the CPI of 35 percent. What clock rate should we have to get this reduction?

2.(20 points) Consider two different implementations of the same instruction set architecture (ISA). The instructions in each ISA can be divided into four classes according to their CPI (Class A,B,C,D). P1 has a clock rate of 2.5 GHZ and CPIs of 3,2,1,3 and P2 has a clock rate of 3 GHz and CPIs of 1,4,2,3.

a. Given a program with an instruction count of 1.0E6 instructions, where the instructions can be divided into classes as follows: 15 percent class A, 20 percent class B, 25 percent class C, and 40 percent class D, which is the fastest implementation?

b. What is the effective CPI for each implementation?

c. What is the required number of clock cycles to execute the program for each implementation?

3.(20 points) Compilers can have a profound impact on the performance of an application. Assume that for a particular program, compiler A results in an instruction count of 1.0E9 and has an execution time of 2.0 seconds while compiler 2 results in an instruction count of 1.5 E9 instructions and an execution time of 1.6 seconds.

a. Find the average CPI for each program given that the processor has a clock cycle time of 1 nanosecond.

b. A new compiler is developed that generates only 8.0E8 instructions and has an effective CPI of 1.2. What is the speedup of using this new compiler versus using compiler A or B?

4.(15 points) Add the following binary numbers: (assume unsigned ints)

// uh oh they are different lengths

110110 + 0110 =

// uh oh this one is really interesting

11111 + 1 =

// Uh Oh be careful

1001001 + 110110 =

5 .(5 points) Convert the following binary numbers to hexadecimal (suggest NOT using programming calculator)

11100011001101

10000011100001001100

6.(20 points) Assume for arithmetic, load/store, and branch instructions, a processor core has CPIs of 1,12 and 5 respectively. Also assume that on a single processor core a program requires the execution of 2.56E9 arithmetic instructions, 1.28E9 load/store instructions, and 256.0E6 branch instructions. Assume all processor cores run at 2 GigaHertz.

Assume that, as the program is parallelized to run over multiple processor cores, the number of load/store instructions per processor core is divided by .5 times p for all number of cores greater then 1, where p is the number of cores. Assume that the number of arithmetic and branch instructions per core stays the same.

a. Find the total execution time for the program on 1,2,4 cores

b. Find the relative speed up on 2,4 cores compared to one core