2023-1 Computer Architecture Homework #1

Due: 3/31 (Fri) 11:59 p.m.

1.7 Consider two different implementations of the same instruction set architecture. The instructions can be divided into four classes according to their CPI (class A, B, C, and D). P1 with a clock rate of 2.5 GHz and CPIs of 1, 2, 3, and 3, and P2 with a clock rate of 3 GHz and CPIs of 2, 2, 2, and 2.

1.7.1 [10] <§1.6> Given a program with a dynamic instruction count of 1.0E6 instructions divided into classes as follows: 10% class A, 20% class B, 50% class C, and 20% class D, which is faster: P1 or P2?

1.7.2 [5] <§1.6> What is the global CPI for each implementation?

1.7.3 [5] <§1.6> Find the clock cycles required in both cases.

1.9 The Pentium 4 Prescott processor, released in 2004, had a clock rate of 3.6 GHz and voltage of 1.25 V. Assume that, on average, it consumed 10 W of static power and 90 W of dynamic power.

The Core i5 Ivy Bridge, released in 2012, had a clock rate of 3.4 GHz and voltage of 0.9 V. Assume that, on average, it consumed 30 W of static power and 40 W of dynamic power.

1.9.1 [5] <§1.7> For each processor find the average capacitive loads.

1.9.2 [5] <§1.7> Find the percentage of the total dissipated power comprised by static power and the ratio of static power to dynamic power for each technology.

1.11 Assume a 15 cm diameter wafer has a cost of 12, contains 84 dies, and has 0.020 defects/cm^2. Assume a 20 cm diameter wafer has a cost of 15, contains 100 dies, and has 0.031 defects/cm^2.

1.11.1 [5] <§1.5> Find the yield for both wafers.

1.11.2 [5] <§1.5> Find the cost per die for both wafers.

1.12 The results of the SPEC CPU2006 bzip2 benchmark running on an AMD Barcelona has an instruction count of 2.389E12, an execution time of 750 s, and a reference time of 9650 s.

1.12.1 [5] <§§1.6, 1.9> Find the CPI if the clock cycle time is 0.333 ns.

1.12.2 [5] <§1.9> Find the SPECratio.

1.12.3 [5] <§§1.6, 1.9> Find the increase in CPU time if the number of instructions of the benchmark is increased by 10% without affecting the CPI.

1.12.4 [5] <§§1.6, 1.9> Find the increase in CPU time if the number of instructions of the benchmark is increased by 10% and the CPI is increased by 5%.

1.12.5 [5] <§§1.6, 1.9> Find the change in the SPECratio for this change.

1.12.6 [10] <§1.6> Suppose that we are developing a new version of the AMD Barcelona processor with a 4 GHz clock rate. We have added some additional instructions to the instruction set in such a way that the number of instructions has been reduced by 15%. The execution time is reduced to 700 s and the new SPECratio is 13.7. Find the new CPI.

1.14 Another pitfall cited in Section 1.11 is expecting to improve the overall performance of a computer by improving only one aspect of the computer. Consider a computer running a program that requires 250 s, with 70 s spent executing FP instructions, 85 s executed L/S instructions, and 40 s spent executing branch instructions.

1.14.1 [5] <§1.11> By how much is the total time reduced if the time for FP operations is reduced by 20%?

1.14.2 [5] <§1.11> By how much is the time for INT operations reduced if the total time is reduced by 20%?

1.14.3 [5] <§1.11> Can the total time can be reduced by 20% by reducing only the time for branch instructions?