Assignment 1

Due: 9:00am, Thu Jan 18th, 2018

Note: Make reasonable assumptions where necessary and clearly state them. Feel free to discuss problems with classmates, but the only written material that you may consult while writing your solutions are the textbook and lecture slides/videos. Solutions should be uploaded as a single pdf file on Canvas. **Show your solution steps** so you receive partial credit for incorrect answers and we know you have understood the material. Don't just show us the final answer.

1. Processor performance improves by a significant amount every year. What are three contributing factors to this steady improvement? (5 points)
2. What are the two primary reasons why this improvement has somewhat stagnated in the last decade? (5 points)
3. System A takes 5 seconds to run a program. The same program takes 4 seconds to run on a new system B. What is the speedup provided by B over A? What is the performance improvement of B over A? (5 points)
4. A popular app takes 10 seconds to execute on a 10 watt smartphone A, and it takes 9 seconds to execute on a 12 watt smartphone B. The app is a bigger drain on the battery on which smartphone? (10 points)
5. A processor running at 2.5 GHz consumes 60 W of dynamic power and 15 W of leakage power. It briefly enters Turbo-boost mode and operates at a frequency of 3.0 GHz. How much dynamic power and leakage power does the processor consume in Turbo-boost mode? (15 points)
6. System A has two processors. Program X takes 10 seconds to execute on one of the processors. Program Y takes 10 seconds to execute in parallel on the other processor. System B has a single processor that can execute only one program at a time. Program X takes 6 seconds to execute on this processor. Program Y takes 6 seconds to execute on this processor. Which system would you pick if you cared about overall system throughput? (15 points)
7. A program executes 100 billion instructions. It executes on an IBM processor that has an average CPI of 1.1 and a clock frequency of 4.0 GHz. How many seconds does the program take to execute? What is the cycle time of this IBM processor? Assume that an ARM processor takes 30 seconds to execute the program. What is the speedup provided by the IBM processor, relative to the ARM processor? (15 points)
8. Ben builds a 1 GHz processor where two important programs, A and B, take one second each to execute. Each program has a CPI of 2. Elaine is tasked with designing the company's next-generation processor. She comes up with an idea that improves the CPI of A to 1.5 and the CPI of B to 1.8. But the idea is so complex that the processor can only be implemented with a cycle time of 1.2 ns. Does Elaine's new processor out-perform Ben's processor on program A? How about on program B? (15 points)
9. In a server, the processor accounts for 50% of total server power, the memory system accounts for 30%, the disk accounts for 10%, and miscellaneous components account for the remaining 10%. You have a $500 budget to upgrade your server to make it more power-efficient. You plan to either replace your memory module with a new memory module or your disk with a new disk. With that budget, you can either

purchase a new memory module that consumes 20% less power than your old memory module, or a new disk that consumes 40% less power than your old disk. Which of the two will you purchase if you were only concerned with reducing your server's power consumption? (15 points)
