ENSC 254 Homework Assignment 1

Important Logistics:

- Some general grading logistics on homework assignments has been posted on our course website.
- Homework is for individual work; each student will be graded individually.
- Homework 1 weighs 2% of the final marks. It includes 12 points in total. If you get X points out of 12 points, it will be scaled as X/12 * 2% of the final marks.
- **Electronic submission:** You can type in the answers in Microsoft Word, or write on paper and then take a picture. For your final submission, please convert all your answers into **one PDF file**, and submit it electronically.
- **Formatting:** To avoid confusion for TAs during the marking, make sure to label the start of your answer to each (sub)question clearly, e.g., starting with "Answer to Q1.a): ". Otherwise, you will lose 10% of the total points of this homework. Moreover, please write down your answers clearly and make sure it's readable; illegible answers will get 0 points.
- Every 10 minutes late, you will lose 10% of the points; 100 minutes late, you will get zero mark for this homework.

1. [6 points] <Lecture 2, §1.6> Consider two different processor implementations (processors P1 and P2) of the same instruction set architecture. The instructions can be divided into four classes according to their CPI (classes A, B, C, and D). Assume processor P1 with a clock rate of 2.5 GHz and CPIs of 1, 2, 3, and 3 for instruction classes A, B, C, and D; and processor P2 with a clock rate of 3 GHz and CPIs of 2, 2, 2, and 2 for instruction classes A, B, C, and D.

   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. Reference for E notation: https://en.wikipedia.org/wiki/Scientific_notation

   a) [2 points] What are the clock cycles to execute this program on each processor?
   b) [2 points] What is the execution time of this program on each processor?
   c) [2 points] What is the global CPI for each processor?

   Note: detailed calculation steps must be included; otherwise, you will lose half of the points.

2. [6 points] <Lecture 2, §1.11> Assume a program requires the execution of 5.0E7 FP (floatingpoint) instructions, 1.1E8 INT (integer) instructions, 8.0E7 L/S (load/store) instructions, and 1.6E7 branch instructions. The CPI for each type of instruction is 1, 1, 4, and 2, respectively. Assume that the processor has a 2 GHz clock rate.

   a) [2 points] If we want the program to run two times faster and can only optimize the CPI of FP instructions, what should be the final optimized CPI of FP instructions?
   b) [2 points] If we want the program to run two times faster and can only optimize the CPI of L/S instructions, what should be the final optimized CPI of L/S instructions?

c) [2 points] If the CPI of INT and FP instructions is reduced by 40% and the CPI of L/S and Branch is reduced by 30%, how much speedup could the program gain?

Note: CPI could be smaller than one in a multi-issue processor, where multiple instructions are issued and executed per cycle.

Note: detailed calculation steps must be included; otherwise, you will lose half of the points.