CSE340: Computer Architecture

Assignment 1

Chapter 1 (Computer Abstractions and Technology)
Total Marks: 15 (Marks are indicated in third brackets after each question)

Question 1 [Marks: 7]

Suppose gaming consoles PlayStation 5 and Xbox Series X use different implementations of AMD's Zen 2 architecture. The instructions they support can be divided into four classes according to their CPI (class A, B, C, and D).

PlayStation has a clock rate of 2.7 GHz and the instruction classes have CPIs of 7, 2, 3 and 6 respectively whereas Xbox has a clock rate of 3.0 GHz and the instruction classes have CPIs of 5, 4, 2 and 1 respectively.

Now suppose, a program has a instruction count of $1.0 * 10^6$ and the instructions are divided into classes as follows:
30% class A,
50% class B,
10% class C, and
10% class D.

Now answer the following questions:
1. **Calculate** how many more clock cycles per instruction on average does the PlayStation take compared to the Xbox? **[2 Marks]**
2. **Calculate** the difference between the execution time in these two consoles in milliseconds **[2 Marks]**
3. If the program runs on a reference PC with an execution time of 120 milliseconds, **calculate the** SPECRatio for the Playstation **[1 Mark]**
4. **Explain** how the performance is affected by Algorithm, Compiler and ISA. **[2 Marks]**

Question 2 [Marks: 3]

Suppose you are calculating the performance of a program in your PC using the SPEC CPU2006 hjig benchmark program. Your pc is running on an intel Core i9 and it takes 540s to execute the program which has an instruction count of $1.35 * 10^{12}$. The reference time which is provided is 1394 s.

1. **Calculate** the CPI if the clock cycle time is 0.22 ns. **[1.5 Marks]**
2. If the number of instructions of the program is increased by 12%, the CPI is increased by 6% and the clock cycle time is 0.22 ns, then **calculate** the new SPECRatio for this change. **[1.5 Marks]**

Question 3 [Marks: 5]

Suppose, you are a developer of a software company named 'HackerMan'. Your supervisor asked you to develop a password generator program, for MIPS architecture, that can not only generate passwords but also break them. After building the program, you observed that the program was taking 2100 seconds to execute and the password generation was taking 90% of the total run time.

After reporting to your boss fearfully, he said it was unacceptable and threatened to fire you unless you can increase the whole program's performance by a factor of 5 by optimizing the password generation.

Now, your job's future rests in your optimization skills and the results of your analysis. Let's start with the analysis.

1. You need to improve the password generation operation by a factor of what, to meet the requirements? **[2.5 Marks]**
2. **Compute** the new time of the program (in seconds) taken by the generation operation. **[2.5 Marks]**