

Question 1 (25 points): Provide a brief answer for each of the questions below.

1. **(5 points)** In Chapter 1 of the textbook we studied that the execution time of a computer program in a given machine can be computed by the following expression:

$$\text{CPU Time} = \frac{\text{Instructions}}{\text{Program}} \times \frac{\text{Clock cycles}}{\text{Instruction}} \times \frac{\text{Seconds}}{\text{Clock Cycle}} \quad (1)$$

This expression can be simplified to:

$$\text{CPU Time} = \text{IC} \times \text{CPI} \times \frac{1}{\text{Frequency}} \quad (2)$$

where IC is the Instruction Count and CPI is the average number of Clock Per Instruction. Explain which of the three components of the execution time (IC, CPI and frequency) are affected by the choice of algorithm, the choice of programming language, the compiler, and the instruction set architecture.

2. **(5 points)** Now that you have completed CMPUT229 you should be aware of some shortcomings of a performance analysis that uses the expression above for modern microprocessors. What are these shortcomings?
3. **(5 points)** What is the role of a sticky bit in a floating-point unit? How does this bit affect the rounding process.

4. (**5 points**) Explain how increasing the associativity of a cache memory may improve the performance of the system.
5. (**5 points**) Two basic approaches to generate code to traverse an array are: (i) an index-based loop where an index variable is incremented in each iteration of the loop and used to access array elements; (ii) a pointer-based loop where a pointer is used to access array elements and the pointer is incremented in each iteration of the loop. What are the advantages/disadvantages of each of these approaches?