

# CPSC 479 Homework 1: Introduction to HPC

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**Submission:** Upload the answers on Canvas. In case of uploading multiple files, clearly labeling each file.

**Problem 1. [10 points]** Consider the following instructions of a sequential program:

I1 :  $z = (b * d) / (b + d)$

I2 :  $x = z * z + (c * a)$

I3 :  $y = (e + a) * d$

I4:  $z = x + d / (b + c)$

(a) Which pairs of instructions (I1-I2, I1-I3, I1-I4, I2-I3, I2-I4, I3-I4) can be parallelized? Use the data dependency conditions to decide which instructions can be executed in parallel.

Show your complete work otherwise points will be deducted. [1.5 points each]

(b) Can all four I1-I2-I3-I4 be parallelized? Justify a NO or YES answer. [1 point]

Show your work.

**Problem 2. [ 2 points]** Consider the following sequential program:

$x[0] = 1$

$x[1] = x[0] + 2$

$x[2] = x[1] + 3$

$x[3] = 3$

$x[4] = x[2] + 3$

$x[5] = x[1] + 2$

The fastest execution time of this portion of the program can be obtained by executing this code in parallel. What is the number of processors that can be used to execute this code in parallel and obtain the minimum execution time? You do not need to use Amdahl's law. Show your complete work to justify your answer otherwise points will be deducted. [2 points]

**Problem 3.[2 points]** Amdahl's law computes the speedup in execution time for a program executed on P processors with fixed input size. If the input size increases proportionally to the number of processors, then Gustafson law is used to calculate the speedup. Give two real-world examples of problems and/or situations in which Gustafson law should be applied instead of Amdahl's law. Justify your answer otherwise points will be deducted. [2 points]