## **Computer Sciences Department**

## **University of Wisconsin-Madison**

## **CS/ECE 552 – Introduction to Computer Architecture**

## **In-Class Exercise (04/16)**

**Answers to all questions should be uploaded on Canvas.**

1. [1 point] (Twist on Check Yourself 6.1) From the textbook: True or False: To benefit from a multiprocessor, an application must be concurrent.

Given that the answer is false, what is one example type of application that is not concurrent but does benefit from multiprocessors.

2. [4 points] Consider the following piece of sequential C code.

char a[128], b[128]; /\* each char is 1 byte (8 bits) in size \*/

for (int i = 0; i < 48; i++) { **// LOOP 1**

if ((a[i] % 7) == 0) {

b[i] += a[i] + ‘A’;

}

b[i] += a[i] + ‘B’;

}

for (int i = 0; i < 49; i++) { **// LOOP 2**

b[i] += a[i] + ‘C’;

}

Consider running the above code on a machine with SIMD instructions with 128-bit wide registers, datapath, and ALUs capable of processing 16 8-bit packed operands in a cycle.

1. [2 points] Will LOOP1 running on the above machine see a 15X speedup over a sequential (non-SIMD) machine? If yes, explain why. If no, explain the key impediments to achieving the speedup.
2. [2 points] Will LOOP2 running on the above machine see a 15X speedup over a sequential (non-SIMD) machine? If yes, explain why. If no, explain the key impediments to achieving the speedup.

3. [6 points] Consider your program running on a parallel processor.

1. [2 points] Applying Amdahl's Law, you estimate that when executing on two cores, the speedup of your entire program is 1.5x. What is the fraction of your program that can be parallelized?
2. [2 points] You decide to switch to a new parallel processor equipped with six general-purpose cores and an accelerator that can speed up half of the sequential (i.e., non-parallel) portion of your program by 3x. What is the speedup of your entire program on this new processor?
3. [2 points] If you did not have this accelerator and you only had the option to add more general-purpose cores, how many cores would you need to add (on top of the six that you already have) to achieve at least 98% of the speedup in Q2b above?