ITCS 4/5145 Parallel Computing
Test 2 5:00 pm - 6:15 pm, Wednesday April 13th, 2016

Name: .....

Answer questions in space provided below questions. Use additional paper if necessary but make sure your name is on additional sheets. *Clearly show how you obtained your answers. (No points for simply writing a numeric answer without showing how you got the answer, even if correct.)* This is a closed book test. Do not refer to any materials except those supplied for the test. Supplied: *"Brief Summary of CUDA"*

Total /40
6 pages

Qu. 1 Answer each of the following briefly:

(a) In Assignment 4 (Monte Carlo π calculation using MPI with a workpool), how do the slaves know when to terminate?

2

(b) What does the Suzaku routine **SZ_Scatter(A,A1) do**? How is the size of data transfer determined?

4

(c) In the command mpicc, what does the -c option specify (as used in Assignment 5 on Suzaku)?

2

(d) In the Seeds framework, there is a variable called “segment” that is an input parameter in the DiffuseData method. What is the name of the corresponding variable in the Suzaku framework and what does it specify?

2

(e) What is the sequential time complexity of the “brute force” algorithm used for the gravitational *N*-body problem (as used in Assignment 5) given *N* bodies and *t* iterations? When parallelized using a master-slave pattern, what is the parallel time complexity (not given in the slides but can be inferred if each process handles one body at the same time)?

4

(f) Very briefly describe how to solve a general system of linear equations ***by iteration***.

2

(g) In a pipeline executing more than one instance of a complete problem, the speedup is given by:

$$S(m) = p \times m/(p + m - 1)$$

where there are m instances of the problem and p pipeline stages. Briefly explain how this equation is derived? 2

(h) What is the best possible sequential time complexity (lower bound) for a compare and exchange sorting algorithm that does not use any special properties of the numbers if there are N numbers? (Sufficient to state without proof.)

2

Hence what is best possible parallel time complexity (lower bound) for a compare and exchange sorting algorithm that does not use any special properties of the numbers if there are N numbers and N parallel processes?

2

(i) Show the steps to sort the following four numbers using odd-even transposition sort. It will take four steps for four numbers generally and show all four steps even if sorted before that. 4

7 4 8 3

(j) Is the following a Bitonic sequence? Explain your answer. 2

3 4 5 3 4 5

(k) In CUDA, what does **threadId.y** indicate? 2

Qu. 2 Write a CUDA program that copies the values from a 1-dimensional array of integers, A[N], into a second array B[N] but in reverse order, e.g. if the array A[N] has the values:

A[0]	A[1]	A[2]	…	A[N-3]	A[N-2]	A[N-1]
4	6	5	…	3	1	9

afterwards the array B[N] has the values:

B[0]	B[1]	B[2]	…	B[N-3]	B[N-2]	B[N-1]
9	1	3	…	5	6	4

Use one CUDA thread to copy one element in the array. Organize the kernel structure as a 1-D grid of 1-D blocks with 16 threads in each block and the minimum number of blocks necessary given N as a defined constant. For example if N = 30, you would need two blocks. Your code must take into account any value for N. You may assume that the program has code to store initial values in the array A[N]. Declare all variables and arrays needed. Provide comments in your code to help the grader! ***If I do not understand the code, I will assume it is incorrect.***

Note: The C library function **double ceil(double x)** returns the smallest integer value greater than or equal to **x**. Use this to round a number up.

10

Intentionally blank to continue your answer for question 2 if needed.