

**ITCS 4145/5145 Parallel Programming**  
**Final exam**  
**Tuesday May 5th, 2009, 3:00 pm - 6:00 pm**

Name: .....

This is a closed book test. Do not refer to any materials except those supplied for the test.

Supplied: “*Summary of OpenMP 3.0 C/C++ Syntax.*”

Answer questions in space provided below questions. Use additional paper if necessary but make sure your name is on every sheet.

Total /50

Do not refer to any materials for this part

Qu. 1 Answer each of the following briefly:

- (a) Using the derivation of Amdahl’s law as a basis, derive a formula for speed-up factor given that there are  $p$  processors,  $f$  is the fraction of the computation that must be done *in parallel*, and the parallelizable part of the program can be divided into  $s$  parallel parts, where  $s < p$ . *Clearly show how you go your answer.* 3

What would the speedup be if  $s > p$ ? *Clearly show how you go your answer.*

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(b) What is the difference between a blocking MPI routine and non-blocking MPI routine? 2

(c) What is the purpose of a message tag in MPI and why can it be insufficient? What feature does MPI add? 4

(d) What does the MPI routine **MPI\_sendrecv()** do? 2

(e) What is a detached thread in Pthreads? 2

(f) What is the prefix sum calculation? 2

(g) Suppose one wishes to compute  $1 - \pi/4$  using a Monte Carlo method. Suggest one way this could be done without computing  $\pi/4$  first. 2

(h) Is following a Bitonic sequence:

4 6 9 7 4 2 3

Explain your answer. 2

(i) Show the steps in sorting the following sequence using *odd-even transposition sort* (a parallel variation of bubble sort):

4, 2, 7, 8, 5, 1, 3, 6

4

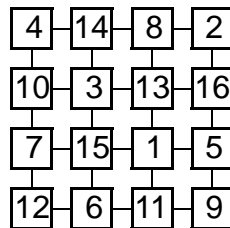
(j) Why is the Gauss-Seidel relaxation method of solving Laplace's equation by iteration not suitable for parallelization? 2

(k) Explain why the following program segments will not work for computing the sum of the elements of an array **A**:

```
forall (i = 0; i < n; i++)  
    sum = sum + A[i];
```

2

(l) Show the steps to sort the following numbers using Shearsort: 4



Qu. 2 Write a parallel program in MPI to solve the one-dimensional problem based upon finite difference equation:

$$x_i = \frac{x_{i-1} + 2x_i + x_{i+1}}{2}$$

for  $1 \leq i < 10$ . The unknown points to solve are  $x_1$  to  $x_9$  inclusive.  $x_0$  and  $x_{10}$  have fixed values, which are given. Using 9 processes, one for each unknown.

***Provide very clear explanation of how the program works and comments in your code. If I do not understand the code, I will assume it is incorrect.***

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Qu. 3 Write a parallel program using Java threads to find the first zero in a list of integers stored in an array. There are 500 integers. Use 5 threads.

***Provide very clear explanation of how the program works, and comments in your code. If I do not understand the code, I will assume it is incorrect.***

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