ITCS 4145/5145 Parallel Programming
Final exam
Tuesday December 14th, 2010, 5:00 pm - 7:30pm

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 /60

Do not refer to any materials for this part

Qu. 1   Answer each of the following <u>briefly</u>:

(a)   What is a "Grand Challenge" problem?   2

(b)   Derive Amdahl's law.   2

Suggest under what practical situations can the speedup be less that 1? Explain.   1

(c)   Often in MPI, one uses static process creatation rather than dynamic process creation. Explain static process and dynamic process creation and suggest one reason dynamic process creation might be needed.

2

(d)   What is an MPI communicator?

2

(e)   In the MPI send and receive routines, one parameter specifies the data being sent as a pointer and one argument specifies the datatype of each item being sent and received. Suppose the data is held in an array declared as:

char message[20];

What are the actual arguments to specify the data being sent and the datatype in the send and receive routines?

2

(f)   In the mpicc command, what does the -o option specify?   2

(g)   In a MPI collective routine, what does "root" specify?

(h)   What the sequential time complexity of Bucketsort (Explain how you got your answer.) How can Bucketsort be parallelised?   3

(i)   What is the prefix sum calculation?   2

(j)   What is a thread-safe routine? Is printf() thread-safe?   3

(k)   What is a critical section? How can it be implemented?   3

(l)   In Java threads, what does the keyword **Synchronized** specify? Give an illustrative example.   3

(m)   In OpenMP, what does the **sections** directive specify? Give an illustrative example.   3

(n)   State Berstein's conditions for parallelism.   2

(o)   Suppose the following statements are in a C program:

```
main() {
    int x,y,z;

    ...              // computation with x, y ,and z

    #pragma omp parallel
    {

    ...              // threads

    }

}
```

where **x** is acessed only in thread 1, **y** is accessed only in thread 2, and **z** is only accessed in thread 3. Suppose the compiler places **x, y,** and **z** next to each other in memory. Suggest one reason for reduced performance for such a layout.

2

(p)   In OpenMP, what does the following do:

```
sum = 0
#pragma omp parallel for reduction(+:sum)
for (k = 0; k < 100; k++ ) {
    sum = sum + funct(k);
}
```

2

(q) Is following a Bitonic sequence:

$$4\ 6\ 9\ 7\ 4\ 2\ 3$$

Explain your answer. 2

(r) In CUDA, what does the construct:

myKernel<<< n, m >>>(arg1);

do?

4

(s) In the CUDA assignment (Assignment 6), what does "make run" do?

2

Qu. 2   Write a *complete* C program that uses both MPI and OpenMP to find the first zero in a list of integers stored in an array that holds 50,000 integers. Share the work across 10 MPI processes where each process has 50 OpenMP threads again sharing the work.

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.

Qu 3   Write a _complete_ CUDA program to multiple two matrices, A and B. Each matrix has 10000 elements. Use one thread to multiple one row in A with one column in B.

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.