CS 5802 - Introduction to Parallel Programming and Algorithms

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Office Hours: posted on the instructor’s homepage

**If the instructor is late for the class, students are expected to wait ~5 minutes before they leave the classroom.

Textbook (Recommended): Parallel Programming; B. Wilkinson and M. Allen, Prentice Hall, 2005

**Required background:** Algorithms, complexity theory, operating sys, Linux, and C/C++

**Objectives:**
- Learn how to write parallel programs using Message Passing Interface (MPI)
- Study parallel algorithms and their complexities related to broadcasting, routing, sorting, image processing, graphs, and numerical computation.
- Study the issues that influence the speedup and efficiency of parallel programs
- Study popular parallel architectures and network topologies
- Study pipelining, message passing, process communication/synchronization, process level parallelism, data parallelism, task partitioning and load balancing.

**Project Presentations:**
During the semester, students will complete a semester project which will consist of:
(i) selecting a research topic and collecting and reading papers related to the project (a list of potential projects are provided) and, (ii) giving two presentations in class throughout the semester.

Since this is a senior/graduate level class, participation is very important. Sometimes, the decision to adjust a grade is made partially on the basis of attendance and classroom participation. You are encouraged to exchange information regarding the term projects, and the assignments. However, the final work, programs, and report must be your own work. Cheating and plagiarism will not be tolerated. Page 30 of the S & T Student Academic Regulations handbook (http://registrar.mst.edu/academicregs/index.html) describes the student standard of conduct relative to the System’s Collected Rules and Regulations section 200.010, and offers descriptions of academic dishonesty including cheating, plagiarism or sabotage.

Any student inquiring about academic accommodations because of a disability will be referred to Disability Support Services (http://dss.mst.edu/) so that appropriate and reasonable accommodative services can be determined and recommended.

**Grading:**
Tests (2 x 225 points), Term Project (2 presentations: 125 + 125 + 50)

Letter grades will be assigned as follows:
A (≥86%), B (≥70%), C (≥55%), D (≥40%), F (<40%)
COURSE SCHEDULE

CHAPTER 1: PARALLEL COMPUTERS
parallel computers/programming, Shared/distributed memory, message-passing, MIMD/SIMD paradigms, Embedding, Granularity, Speedup/Efficiency, Amdahl’s Law, processor-time product (cost), Scalability

CHAPTER 2: MESSAGE PASSING & MPI PROGRAMMING
MPI for parallel programming on a cluster, modeling communication, comm. latency, time complexity of parallel alg.s, broadcasting/routing on networks

CHAPTERS 3 & 4:
Embarrassingly parallel applications, Divide-and-conquer, partitioning data, work pool approach, Monte Carlo methods bucket sort, and numerical integration

CHAPTER 5: PIPELINED COMPUTATIONS
The pipeline concept, application areas and analysis Examples: Insertion sort, prime number generation, and solving an upper triangular system of linear equations.

CHAPTERS 6 & 7 (briefly):
Global and local barriers, Data parallel computations, Synchronous iterations, Examples: prefix sum, iterative solution of equations, cellular automata, parallel MST (Prim’s) and SSSP (Dijkstra’s), Distributed termination detection

*** REVIEW - Question/Answer Pool for TEST I (in class) ***
*** MIDTERM EXAM (in class) and Solutions ***

*** Project Presentations I ***

CHAPTER 10: SORTING ALGORITHMS
Bubble sort, odd-even transposition sort, quicksort on a hypercube, bitonic sort

CHAPTER 11: NUMERICAL ALGORITHMS
Parallel matrix multiplication, Gaussian elimination, Jacobi, and Gauss Seidel

*** REVIEW and TEST II ***

Project Presentations II