

Computer Science 695
**Introduction to High Performance
Computing**

3 Credits, Fall 2007

Tues, Thurs 3:00–4:15 P.M. Room: ECSB 2120

Prof. Alex Pothen
pothen@cs.odu.edu
(757) 683-6391
2122 ECSB, Old Dominion University

Syllabus

The U.S. federal government plans to invest heavily in high performance computing resources (both hardware and software) for solving the challenging problems in science, engineering, and business that impact on our economic well-being. The U.S. Department of Energy has a multi-billion dollar effort called SciDAC (Scientific Discovery through Advanced Computing) for developing massively parallel computers and parallel algorithms for solving computational science problems. Our research group leads an Institute, called CSCAPES, (Combinatorial Algorithms for Petascale Simulations), funded by the Office of Science of the Department of Energy for the next five years to develop scalable tera-scale and peta-scale algorithms and software for problems in combinatorial scientific computing.

Simultaneously, microprocessors are going parallel, with many cores on a single chip to utilize the increasing number of transistors that can be fabricated on a chip while keeping power requirements low. Some computer architects such as David Patterson at Berkeley believe that this marks an inflection point in the history of computing. Realizing high single chip performance will require much rethinking of conventional wisdom. Thus these are exciting times to learn and do research in parallel computing.

CS 695 is designed to train students to take advantage of the opportunities for “Parallel computing in the 21st century” by providing an introduction to the solution of computational problems on parallel computers.

The tentative syllabus of the course will include:

A look at parallel computing in the 21st century
Models of parallel computers and machine organizations
Measurement of parallel algorithm performance

Basic parallel algorithmic techniques: balanced binary tree computations, pointer jumping, divide and conquer, partitioning, pipelining

Communication operations: broadcast, reduction

Graph algorithms: graph partitioning, Load balancing, graph coloring, graph matching.

Solution of dense and sparse systems of linear equations by iterative methods and factorization methods.

Software libraries

Students will have the opportunity to write parallel programs using the MPI (Message Passing Interface) library on small parallel machines and workstation clusters. CS 695 is open to graduate students. The intended audience includes both CS students, and students from engineering and science departments with computational aptitude and prior programming experience.

Grading

Students will be expected to do regular Homework problems, which will involve both programming and assignments. There will be a final examination that all students are required to take. Graduate students requiring 700/800 level credit can be accommodated.

Prerequisites

Students will be expected to have knowledge of algorithms and data structures, and linear algebra at an undergraduate level. Students are expected to be proficient in either C or C++, and to be familiar with the Unix environment.

Textbooks

The textbook for the course is “Introduction to Parallel Computing,” Second Edition, by Ananth Grama et al., Addison Wesley Publishing Company, 2003. The book “Parallel Programming with MPI” by Peter Pacheco, Morgan Kaufmann Publishers, 1997 (ISBN 1-55860-339-5), or another book on MPI will help you with parallel programming; but you do not need to purchase it.

I will make course material including syllabus, homework, solutions, and any announcements available at www.cs.odu.edu/~pothen/Courses/CS695. The website already has two documents for you to read: “The Landscape of Parallel Computing Research: The View from Berkeley”, and “Cyberinfrastructure vision for the 21st century”, a report from the National Science Foundation.