

CSc 746 High-performance Computing

Catalog Description: Principles and current practices in High-performance Computing. Basics of multiprocessor systems such as clusters and graphics processors. Message-passing and shared memory-based software development. Cloud computing.

Prerequisites: grade of B or better in CSc 656 or consent of instructor

Texts: *Programming Massively Parallel Processing: A Hands-on Approach*, by Kirk and Hwu, Morgan Kaufmann
MPI tutorials at <http://citutor.org>
CSc 746 lecture slides (available on iLearn)

References: *Computer Architecture -- a Quantitative Approach* by Hennessy and Patterson, 4th edition (Morgan-Kaufmann)
Parallel Programming with MPI by Peter Pacheco (Morgan Kaufmann)
Parallel computer architecture by David Culler et al. (Morgan Kaufmann)
journals and conference proceedings to be announced in class

Topics: Performance and Cost
Processor architecture overview
Multiprocessor systems
GPUs and CUDA
Message-based parallel programming
Shared memory-based parallel programming
Cloud computing

Grading: Prerequisite quiz
Midterm
Final
3-6 projects and presentations
in-class and iLearn forum participation

Detailed Topics:

Performance and cost (1 week)

Processor architecture overview (1 week)

- Processor pipelines

- Multiple-issue processors

- Memory hierarchy concepts

Multiprocessor concepts (1 week)

- Parallel computation basics

- Shared memory systems

- Message passing systems

POSIX threads (1 week)

- Thread creation and termination

- Synchronization

- Mutual exclusion

Introduction to parallel algorithms (1 week)

- Trapezoidal rule

- Matrix multiply

- Jacobi relaxation

- Parallel merge-sort

Message Passing Interface (4 weeks)

- MPI processes

- Message handling

- Collective communications

- Virtual topologies

- Dijkstra's algorithm

- K-means clustering

GPU programming with CUDA (4 weeks)

- Threads, blocks, and grids

- Memory hierarchy

- Matrix multiply

Cloud computing (1-2 weeks)

Projects: Projects in Fall 2011 covered the following technologies:

P1 POSIX threads

P2 to P4 Message Passing Interface (MPI)

P5 to P6 CUDA (GPU programming)