CPS 303 High Performance Computing

Fall 2008

MWF: 10:45 – 11:45 am (Smith G0038)

Instructor: Wensheng Shen
Department of Computational Science
130 Smith Hall
Phone: (585) 395-5182
Email: wshen@brockport.edu
Web: http://www.cps.brockport.edu/~shen

Office hour: TR 1:00 – 3:00 or by appointment

Prerequisite: basic calculus, programming in C or Fortran, the UNIX operating system, linear algebra

Textbook: Parallel Programming with MPI
Author: Peter Pacheco
Pulisher: Morgan Kaufmann
ISBN:

References: MPI - The Complete Reference
Authors: Steven Huss-Lederman, William Gropp
Pulisher: MIT Press

Description: High-performance computing involves the use of advanced computer technology and techniques to analyze models in fields such as mathematics, engineering, business and sciences. Successful implementation of these models invariably requires the knowledge of mathematics. Frequently, the models generated can be prohibitively large (in terms of the required computational resources). Such situations require the use of parallel programming approaches. This course includes various topics in high performance computing, such as computer architectures, basic topics of parallelism, parallel computing, and understanding benchmarks, numerical integration, differentiation, linear systems and matrix-vector operations.

Objectives: This course presents principles, algorithms, and strategies in high performance computing. Outcome of a successful completion of the course include: (1) to understand basic principals of parallelism, (2) to translate mathematical descriptions into models suitable for investigation via a high-level language such as variants of Fortran and C, (3) to identify the numerical techniques necessary to solve a given model, (4) to understand how to extract parallelism from numerical algorithms, (5) to implement computational algorithms using both serial and parallel

programming techniques, (6) to gain experience in the use of message passing software (MPI), (7) to understand how to compare and evaluate the computational characteristics of computers through the use of benchmarks.

Topics: The topics include Discretization of Models, Numerical Algorithms, Parallel Architectures, Concepts, Parallel Extraction, The Message Passing Interface (MPI), Benchmark Evaluation.

Grading: Homework assignments (50%)
Projects (30%)
Midterm (10%)
Final exam (10%)

Average	100 – 90.0	87.0 – 89.9	83.0 – 86.9	80.0 – 82.9	77.0 – 79.9	73.0 – 76.9
Grade	A	A-	B+	B	B-	C+
Average	70.0 – 72.9	67.0 – 69.9	63.0 – 66.9	60.0 – 62.9	57.0 – 59.9	<57.0
Grade	C	C-	D+	D	D-	E

Note: extra credits may be given in home and project assignments as well as tests. Final exam may be replaced by a project.

Assignment policy: Homework assignments given in class will be due in two weeks and project assignments given in class will be due in four weeks after they are assigned. Late assignments can be accepted with a penalty at a rate of 10% per day. ***No makeup tests and no incompletes. A missed test will receive 0 points.*** Exceptions to these rules, at instructor's discretion, apply to cases of illness, personal tragedy, or extraordinary circumstances beyond a student's control, if it is documented to instructor's satisfaction. Arrangement for such an exception needs to be discussed with the instructor.

Attendance: Students are expected to attend all classes. Some of the material may not be contained in the textbook. If a student misses a class, it is his/her responsibility to get class notes and handouts. Absences will be excused for documented illness, official representation of the College, an unfortunate death of a close relative, religious holiday, and other circumstances beyond student's control.

Authorship: Students are allowed to discuss ideas and help others by explaining concepts and possible solutions. All the work that is submitted, however, must be performed by individual students independently. Students must provide appropriate citations for any text fragments in books, journals, conference proceedings, web-based resources, etc. that have been used in their assignments. Students also need to acknowledge any help from

others. A student is considered cheating if he/she submits materials as his/her own work that is not entirely his/her own work, or if he/she intentionally provides an answer to another person. If cheating has been detected, the student will receive a zero grade for that assignment. Further disciplinary procedures may also be considered.

Policies: Students with documented disabilities may be entitled to specific accommodations. SUNY Brockport's Office for Students with Disabilities makes this determination. Please contact the Office for Students with Disabilities at 395-5409 to inquire about obtaining an official letter to the course instructor detailing approved accommodations. The student is responsible for providing the course instructor with the official letter. Faculty and staff work as a team with the Office for Students with Disabilities to meet the needs of students with disabilities

Weekly Schedule

Week 1	Aug. 25	Class begin, syllabus, introduction
	Aug. 27	Chapter 1: Introduction to HPC
	Aug. 29	Chapter 1: Introduction to HPC
Week 2	Sept. 1	Labor day
	Sept. 3	Chapter 2: Architecture of Parallel Computers
	Sept. 5	Chapter 2: Architecture of Parallel Computers
Week 3	Sept. 8	Chapter 3: Architecture of Parallel Computers
	Sept. 10	Chapter 3: Basic MPI
	Sept. 12	Chapter 3: Basic MPI
Week 4	Sept. 15	Chapter 3: Basic MPI
	Sept. 17	Chapter 4: An application --- numerical integration
	Sept. 19	Computer lab: Basic MPI
Week 5	Sept. 22	Chapter 4: An application --- numerical integration
	Sept. 24	Chapter 4: An application --- numerical integration
	Sept. 26	Computer lab: Numerical integration
Week 6	Sept. 29	Chapter 5: Collective communication
	Oct. 1	Chapter 5: Collective communication
	Oct. 3	Computer lab: Collective communication
Week 7	Oct. 6	Chapter 5: Collective communication
	Oct. 8	Chapter 6: Grouping Data for Communication
	Oct. 10	**Midterm exam**
Week 8	Oct. 13	Fall break
	Oct. 15	Chapter 6: Grouping Data for Communication
	Oct. 17	Computer lab: Grouping Data for Communication
Week 9	Oct. 20	Chapter 7: Communicators and topologies
	Oct. 22	Chapter 7: Communicators and topologies
	Oct. 24	Computer lab: Communicators and topologies
Week 10	Oct. 27	Chapter 7: Communicators and topologies
	Oct. 29	Chapter 8: Debugging
	Oct. 31	Computer lab: Communicators and topologies
Week 11	Nov. 3	Chapter 9: Design and Coding of Parallel Programs
	Nov. 5	Chapter 9: Design and Coding of Parallel Programs
	Nov. 7	Computer lab: Design and Coding of Parallel Programs
Week 12	Nov. 10	Chapter 9: Design and Coding of Parallel Programs
	Nov. 12	Chapter 10: Performance
	Nov. 14	Computer lab: Design and Coding of Parallel Programs
Week 13	Nov. 17	Chapter 10: Performance
	Nov. 19	Chapter 10: Performance
	Nov. 21	Computer lab: Performance
Week 14	Nov. 24	Chapter 11: More on Performance
	Nov. 26 -28	Thanksgiving break
Week 15	Dec. 1	Chapter 11: More on Performance
	Dec. 3	Class Review
	Dec. 5	Computer lab: More on Performance