CSC 435 / S10  
High Performance Scientific Computing

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Office Hours: MW 2:00-3:00 p.m. (WSC 332), T 2:00-3:00 p.m. (CSB 201C) (or by appointment)

I feel the need, the need for speed. – Maverick and Goose, “Top Gun”

CSC 435 is a course to introduce students the foundational principles of High Performance Scientific Computing. Students in CSC 435 will be exposed to the fundamentals of single machine code optimization, as well as techniques for parallel programming. Much of the course will focus on parallel programming strategies for large scale numerical problems encountered in the sciences. The use of public domain libraries and packages for message passing and numerical computation will be demonstrated. Commercial symbolic algebra packages like Maple, MuPad, and Mathematica will also be used in the class to develop parallel numerical algorithms.

Students taking CSC 435 are expected to have a working knowledge of a high level programming language such as C, C++, Fortran, or JAVA. All parallel coding will be done in either C/C++ or Fortran. Strategies for high performance code development and project management with these languages will be discussed during the course. Students in CSC 435 are expected to read at the college level and also have a working knowledge of differential and integral calculus. Topics from multivariable calculus, linear algebra, and differential equations will be introduced as needed.

Class Meeting Times and Locations  
Lecture: TR 3:05 – 4:20 p.m., Room 306 CSB.

Course Materials  
REQUiRED: Fundamentals of Parallel Processing, Jordan and Alaghband  
RECOMMENDED: Pthreads Programming, Buttla, Ferrill, and Nichols  
RECOMMENDED: Fortran 95/2003 for Scientists & Engineers, Chapman  
Scientific Calculator  
Reference Material from Class Webpage (http://theochem.mercer.edu/csc435)

Course Structure  
Topics from eleven chapters of the text will be covered during the semester in the order listed on the class schedule. The lecture time will be used to expound on and augment the text, discuss problem solving strategies, and demonstrate algorithms. A significant amount of the class period will be devoted to actually utilizing the parallel computing cluster. Students are responsible for all material covered in class as well as the material from the textual sections listed in the class schedule. Four small exercises and four semester-long projects will be submitted for grading. The details of each project and the description of the deliverables for each project will be provided to the students in writing. A midterm and a final exam will be administered per the class schedule.

Grading  
Reading Quizzes (4 @ 25 pts) 100 pts  
Programming Exercises (4 @ 25 pts) 100 pts  
Programming Projects (4 @ 150 pts) 600 pts  
Midterm Exam 100 pts  
Final Exam 100 pts  

Total Possible 1000 pts
The following grading scale is assured but may be slightly lowered based on test results.

- **A** ≥ 900 pts
- **B** ≥ 800 pts
- **C** ≥ 700 pts
- **D** ≥ 600 pts
- **F** < 600 pts

**General Information**

**Honor Code:** All students in CSC 435 are expected to adhere to the Mercer University Honor Code. Any suspected violations will be reported to the Honor Council for further investigation.

Many students have difficulty in determining how to apply the Mercer honor code to Computer Science courses. A few general guidelines should help you in deciding whether you are violating the honor code or not.

1. You are allowed to receive help on your programs from other students, provided the purpose of the help is to help you understand your own program better, not to write your program for you.
2. You are NOT allowed to use copies of programs written by other students, or copies of programs from published sources, even if you plan to modify them extensively.
3. You are NOT allowed to give copies of your programs, or parts of your programs, to other students in any form.
4. In short – YOU MUST WRITE YOUR OWN CODE. DO NOT COPY PROGRAMS OR PARTS OF PROGRAMS FROM ANY SOURCE UNLESS I TELL YOU TO DO SO. If you have any questions about using a published resource, just ask me.
5. Any attempt to gain unauthorized access to the computing systems or to in any way damage the parallel computing systems and job schedulers so as to hinder the work of others will not only result in an honor code violation but will infringe upon intellectual property rights and result in criminal prosecution.

Any violation of the above policies will be treated as academic dishonesty and a violation of the Mercer Honor Code.

**Attendance:** Attendance will be taken randomly during the semester. The attendance grade will be based on the percentage of absences on the randomly chosen days. For each 10 percentage points below 100%, the students final letter grade will drop one letter grade. At a minimum, attendance will be taken on ten days of class. Students are still accountable for all material covered in class as well as any announcements made during the lecture period.

**Missed Exams:** Anyone missing an exam for any reason (personal illness, death in the immediate family, or other emergency) must notify Dr. Pounds in advance. The absence will be considered unexcused otherwise. Make-up exams will be individually scheduled.

**Partial Credit:** Partial credit will not be awarded on any exam unless individuals show their work and clearly delineate how they arrived at their answers.

**Re-grading Policy:** If a student suspects that an error was made in the grading of a submitted work, they may return the paper for re-grading with the understanding that the entire work will be re-graded and not only the portion in question.

**Posting of Grades:** Grades will not be posted. If you are curious about your cumulative grade, see Dr. Pounds.

**American Disability Act:** “If you believe that you possess a disability for which reasonable accommodation must be made, you must consult with the instructor at the close of the initial class meeting. The instructor will refer you to the Office of the Dean of Students for evaluation, documentation of your disability, and a recommendation as to the accommodation, if any, to be provided. If you do not consult with the instructor and follow up with the Office of the Dean of Students, as instructed above, you will thereby waive any claim to a disability and the right to any accommodation pertaining thereto.”

**Electronic Submission of Materials:** “Students bear sole responsibility for ensuring that papers or assignments submitted electronically to a professor are received in a timely manner and in the electronic format(s) specified by the professor. Students are therefore obliged to have their e-mail client issue a receipt verifying that the document has been received. Students are also strongly advised to retain a copy of the dated submission on a separate disk. Faculty members are encouraged, but not required, to acknowledge receipt of the assignment.”
<table>
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<tr>
<th>Week Starting</th>
<th>Chapter</th>
<th>Lecture Topics</th>
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| January 12th  | Chapters 1 and 2 | Introduction  
                The Dusty Deck  
                Code Timing                                                 |
| January 19th  |                  | Single Processor Tuning  
                Performance Tuning Tools  
                Amdahl’s Law                                                   |
| January 26th  |                  | Cache and Memory Optimization  
                Loop Optimization  
                Numerical Libraries  
                Interlanguage Communication  
                A review of *makefiles*                                        |
| February 2nd  | Chapter 3        | Vector Computers  
                SIMD Computes  
                The Pipeline                                                   |
| February 9th  | Chapter 4        | Introduction to *pThreads*  
                Introduction to *OpenMP*  
                Embarassingly Parallel Computations  
                Monte Carlo Integration                                         |
| February 16th |                  | Data Dependencies  
                Loop Transformations                                           |
|               |                  | *(MIDTERM EXAM – 2/18/07)*                                  |
| February 23rd | Chapter 5        | Introduction to MPI  
                Preparations for Parallel Cluster Work                        |
| March 2nd     | Chapter 6        | Network Mapping  
                Network Characteristics                                         |
| March 9th     |                  | **SPRING BREAK**                                               |
| March 16th    | Chapter 7        | MORE Data Dependence  
                Work and Data Decomposition  
                Locating Parallel Regions                                      |
| March 23th    |                  | Performance Tuning Tools  
                Parallel Debugging                                              |
| March 30th    | Chapter 8        | Revisiting Data Dependencies  
                Network Mapping and Data Flow  
                Barrier Synchronization                                          |
| April 6th     | Special Topic    | Linear System  
                Gaussian Elimination  
                Non-linear Systems  
                The Jacobi Method                                               |
| April 13th    | Chapter 9        | Parallel Processor Performance                                 |
| April 20th    |                  | N-Body Problems and Particle Dynamics  
                Pairwise Interactions  
                Strategies for Breaking Dependencies  
                Parallel Interaction Tables                                    |
| April 27th    | Chapter 11       | Parallel I/O  
                Presentations                                                    |
| April 29th    |                  | **FINAL EXAM, 5/4/10, 2 p.m.**  
                *(Tuesday)*                                                      |

I reserve the right to modify this schedule as situations warrant.