

CS 442/542 Introduction to Parallel Processing

BASIC COURSE INFORMATION

Instructor/Class Information

- Instructor: Prof. Patrick Bridges
- Course Time: M/W/F 11:00am-12:00pm CEC 1026\

Instructor Office Hours

- Farris Engineering Center #2370, M/W/F 1:00pm-2:30pm or by appointment
- Office Phone Number: 505-277-3032

Course Description: CS442/542 is a senior/graduate-level class in parallel programming systems, including programming and systems issues of shared memory machines, distributed memory machines (e.g. clusters), co-processor systems (GPUs), and Big Data systems. In particular, the class focuses on understanding, reasoning about, and optimizing how parallel and big data programs map to the underlying computing systems.

The class covers a range of topics including:

- Parallel architectures/classifications
- Parallel performance models and laws
- Parallel toolchains and runtime systems
- Parallel programming motifs and patterns
- Parallel Programming Paradigms
 - Threads-based parallelism (OpenMP) on Modern CPUs
 - Message/Process-based parallelism (MPI) on Clusters
 - SIMD Programming (CUDA/OpenCL) on GPUs
 - Big Data Programming (Spark) on Clusters/Cloud systems
- Tools for analyzing program and system performance

The majority of the problems we will discuss will be scientific computing problems. The class will also expose students to more recent parallel informatics and data processing techniques/systems when possible.

The class has 3 weekly lectures; attendance at lectures is optional, but *students are responsible for all content presented at lectures, even if it is not in the book!* Note that in some cases, one of the weekly lectures will be replaced with a lab section.

Course Grading:

Course assessment is through the following instruments, broken down as listed:

- 2 midterm exams (10% of grade each)
- Programming assignments (25% of final grade)
- Homework assignments (25% of final grade)
- Group final project (30% of final grade)

Final course grades are determined on a standard 10-point scale (90.0-100 A, 80.0-89.9 B, etc.). Individual assignments will not be curved, though I may lower cutoffs for final grades at my discretion.

REQUIRED BACKGROUND, MATERIALS, AND SYSTEMS

Prerequisites: Students in this class are expected to have a widely varied background, with varying levels of knowledge of computer architecture, parallel programming, numerical algorithms, and related topics. However, each student is expected to have experience in at least *one* of the following areas at the level provided by a junior/senior level class:

- Computer organization and architecture, including cache memory systems (e.g. UNM CS341)
- Scientific computing, including basic parallel programming in MPI and/or OpenMP (e.g. UNM Math 471)
- Big data computing, including basic data-centric programming in Spark and/or Hadoop (e.g. UNM CS567)

At a minimum, students should be competent programmers in a modern programming language, ideally C, C++, Fortran or perhaps Java. Knowledge of scripting languages like Python and/or shell scripting is also useful. Finally, students should be comfortable writing, compiling, debugging, and running substantial programs on UNIX systems. A simple assignment at the start of the semester will be given to help students refresh their knowledge of these areas.

Formal Course Materials: We will use multiple reference materials over the course of the semester, including the following two books provided to students by UNM Learn Inclusive Access through the "Course Materials" section to the left. Your UNM account will be billed for these two text directly at a rate less than the cost of purchasing the books directly from the publisher following the UNM drop date for this course.

Title	Author
High Performance Spark	Holden Karau; Rachel Warren
Parallel Programming for Modern High Performance Computing Systems	Pawel Czarnul

In addition, we will also use a pre-print of the book *Parallel and High Performance Computing* by Robey and Zamora, which is available online at from [Manning Publications](#). You can receive half off the price of this publication from manning.com using the code "phpcomp50".

Additional Course Background Readings: Two other very high quality references are also available in this area for free online, or for a modest fee in print, and I highly recommend that students use them. We will reference the second (the Foster book) in class with some regularity.

- [Introduction to High Performance Parallel Computing](#) by Eijkhout
- [Designing and Building Parallel Programs](#) by Foster

Computer Systems: Course programming and homework assignments will be graded on UNM Department of Computer Science Linux servers and UNM Center for Advanced Research Computing high-performance computing systems. Every student should have an account on the CS systems so that they can test their programs on the machine where I will test them prior to turning them in. Students will be provided accounts on Center for Advanced Research Computing systems to run course assignments in the second week of the semester.

ADDITIONAL INFORMATION

Late Assignments: In general, I do *not* accept late assignments. Late assignments will, without prior arrangement or *documented* extraordinary circumstances that make prior arrangement impossible, be given the grade of 0. If you know that you will be unable to make a turn-in date due to illness, death in the family, or other reason, please make arrangements with me either in person, by email, or by phone as soon as possible for an extension. If you miss a turn-in date due to unforeseeable extraordinary circumstances, bring documentation of the situation and we will work something out. In general, I will do my best to announce the dates of the exams and the due dates for assignments as soon as possible. One final note:

Regrading Requests: Requests for regrades of assignments or exams must be

made within two weeks from when the assignment is returned. Assignments will not be regraded after that point.

Academic Honesty: The university policy on academic honesty is contained in the Pathfinder; you should review this policy if you are unfamiliar with it. Cheating will result in an automatic F for the entire semester and the student will be reported to the UNM Dean of Students for further disciplinary action. There will be no second chances. Any work you hand in for this class must be your own, personal original work.

Do not, under any circumstances, share source code or writings with your peers without my explicit prior approval. Students can, however, verbally discuss assigned readings and programming problems outside of class. Feel free to describe verbally how you attacked a particular problem in a programming assignment, for example. The following, however, are clearly not acceptable and will be considered cheating: copying another person's code; co-developing code with someone else; mailing your code to another person; using the Internet to find a solution to the problem; making your files readable so another person can copy them; reading another person's files; using another person's listing (taken from the trash, for example); or having another person write a portion of your code for you.

You may use ancillary libraries to aid the development of your programs only with prior written (e.g. email) permission of the instructor.

Accessibility: In accordance with University Policy 2310 and the Americans with Disabilities Act (ADA), academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as I am not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow. Contact Accessibility Resource Center at 277-3506 for additional information.

If you need an accommodation based on how course requirement interact with the impact of a disability, you should contact me to arrange an appointment as soon as possible. At the appointment we can discuss the course format and requirements, anticipate the need for adjustments and explore potential accommodations. I rely on the Disability Services Office for assistance in developing strategies and verifying accommodation needs. If you have not previously contacted them I encourage you to do so.

Sexual Harassment and Title IX Reporting: Our classroom and our university should always be spaces of mutual respect, kindness, and support, without fear of discrimination, harassment, or violence. Should you ever need assistance or have concerns about incidents that violate this principle, please access the resources available to you on campus, especially the LoboRESPECT Advocacy Center and the support services listed on its website (<http://loborespect.unm.edu/>).

Please note that, because UNM faculty, TAs, and GAs are considered "responsible employees" by the Department of Education, any disclosure of gender discrimination (including sexual harassment, sexual misconduct, and sexual violence) made to a faculty member, TA, or GA must be reported by that faculty member, TA, or GA to the university's Title IX coordinator. For more information on the campus policy regarding sexual misconduct, please see: <https://policy.unm.edu/university-policies/2000/2740.html>.