

CS 581 – Spring 2025

High Performance Computing: Tools and Applications

General Information

Please note:

1. The information in this syllabus is subject to change at any point in the semester, as deemed necessary by the instructor. ¹ Any changes will be communicated to the students both in class and via email in a timely fashion. For the latest version of this document, please check the course page on Canvas or on class webpage.
2. This course provides an introduction to parallel computing, covering both parallel architectures, parallel algorithms, and their implementation. The programming language used in this course will mainly be C / C++ with pthreads, OpenMP, MPI, and CUDA. We will cover topics in traditional parallel architectures and quantum computing.
3. The prerequisite is CS 350 or equivalent transfer credit.
 - **Instructor:** Tianshi Xu <txu41@emory.edu>.
 - **Class Schedule:** TTh 8:30 – 9:45 AM
 - **Instruction Method:** In person, unless there are special circumstances.
 - **Office Hours:** Tuesday 10:00 – 12:00. All instructor's office hours will be held in a hybrid format, allowing you to attend in person or join via Zoom.

Materials and Tools

- **Canvas Page:** <https://canvas.emory.edu/courses/142951> It is your responsibility to visit the website periodically.
- **Textbook:** Most of the material covered in the course can be found in the following books:
 - “Programming Massively Parallel Processors: A Hands-on Approach”, 4th Edition, by David B. Kirk and Wen-mei W. Hwu, Paperback ISBN: 9780323912310, eBook ISBN: 9780323984638

¹Last Updated: April 3, 2025

- “Introduction to Parallel Computing”, 2nd edition, by V. Kumar, A. Grama, A. Gupta, and G. Karypis. ISBN-13: 978-0201648652; ISBN-10: 0201648652
- “Introduction to Parallel Programming”, by Peter S. Patcheco, ISBN-13: 9780080921440, ISBN-10: 0080921442

Our official textbook is the first one, but textbooks are not required.

- **Lecture Notes:** Lecture notes will be posted to the Canvas page after class.
- **Tech Requirements:** It is recommended that you have access to the following equipment:
 - A computer with reliable internet access. You should be able to access the Canvas site.
 - A scanner or smartphone for taking photos to upload online.

No calculators or calculating devices are allowed during the midterms and the final.

Grading Information

- **Grade Distribution:**

Homework	40 %
Exams	60 %
Total	100 %

- **Grading Scale:** Your final grade will be decided based on the following scale:

	B+: [87,90)	C+: [77,80)	D+: [67,70)		
A: [93,100]	B: [83,87)	C: [73,77)	D: [60,67)	F: [0,60]	
A-: [90,93)	B-: [80,83)	C-: [70,73)			

The class may be curved in the end at the discretion of the instructor. However, your final course grade will be no worse than your actual grade. That is, we will never “curve down”. Besides, each exam may be “curved up”. As a result, the course grade will not be rounded up. For example, a course grade of 92.99% is strictly 92.99% (and hence an A-).

- **Honor Code:** Students are required to follow the Emory University Honor Code throughout the semester. Details can be found at [Emory Honor Code](#).
- **Attendance:** Attendance is not required but strongly recommended. Please maintain a respectful and professional demeanor if you come to class.
- **Homework:** There will be four homework assignments (please see the tentative schedule section for the schedule). To accommodate late submissions, we have a policy that

allows for late assignments with a deduction of 15% per day, for up to two days. Assignments submitted later than two days will receive no credit.

- **Exams:** There will be four exams (including final). Please see the tentative schedule section for the schedule of the exams. The lowest exam will be dropped. All exams will be held in person. Final is on 05/06/25, 8:00 – 10:30 AM. Location TBD. Makeup exams will be given only with adequate excuses. The exam may be curved at the discretion of the instructor. However, your grades will be no worse than your actual grades. That is, we will never “curve down”.

Student Success Resources

- **Tech Support:** For technical assistance, refer to [Emory IT Services](#).
- **Undergraduate Education Resources:** The Office of Undergraduate Education offers various student support services including academic advice, peer tutoring, and guidelines for missed exams. More information is available at [OUE Emory](#).
- **Accessibility Services:** Students with documented disabilities or who suspect they may have a disability should reach out to the Office of Accessibility Services for accommodation support and resources. Confidentiality regarding any disability-related information is assured. Further details can be found at [Office of Accessibility Services Emory](#).
- **Academic and Religious Observance Calendar:** Please familiarize yourself with the [Academic Calendar](#) for crucial academic dates.
- **Health and Wellness Resources for Students:** Achieving academic success is closely linked to maintaining a healthy lifestyle, both mentally and physically. Emory University offers several no-cost resources to support student well-being:
 - Emory HelpLine: For non-critical mental health needs, students can reach out to the Emory HelpLine at 404-727-4357. This confidential, peer-run phone counseling service operates every evening from 8:30 pm to 1:00 am.
 - For immediate mental health concerns, the Student Counseling Center is available at 404-727-7450.
 - This program supports students dealing with sexual assault, relationship violence, or stalking. Confidential consultations, crisis intervention, and referrals are provided. Contact them at 404-727-1514.
 - Offering a broad range of services including primary care, physical exams, dietary and substance abuse counseling, Emory Student Health is committed to supporting students’ physical health.
- **Policy on Harassment:** As per [Emory Equal Opportunity and Discriminatory Harassment Policy](#), Emory University strictly prohibits any form of discriminatory harassment. This includes sexual harassment and harassment based on race, color, religion,

ethnic or national origin, gender, genetic information, age, disability, sexual orientation, gender identity, gender expression, veteran status, or any other category protected under applicable law. This policy applies to faculty, staff, administration, students, vendors, contractors, guests, and patrons on campus.

Tentative Topics

Week	Topic
Week 1	Introduction, parallel computing platforms
Week 2	Basic memory organization, Pthreads, and OpenMP
Week 3	Introduction to distributed memory system, network topologies
Week 4	Introduction to message passing and Programming with MPI
Week 5	More on MPI
Week 6	Principle of parallel algorithm design
Week 7	Introduction to GPU Programming with CUDA
Week 8	Quantum computing basics
Week 9	Spring break
Week 10	Quantum algorithms
Week 11	Matrix algorithms
Week 12	More on matrix algorithms

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Week	Topic
Week 13	Endless lectures on matrix algorithms
Week 14	Parallel sorting and graph algorithms
Week 15	Sparse matrix algorithms

Tentative Schedule

Red: Exam or Holiday

Blue: Potential Remote Class

Orange: Homework out

Purple: Homework due

Week	Tuesday	Thursday
Week 1	Lecture 1: 01/14/25	Lecture 2: 01/16/25
Week 2	Lecture 3: 01/21/25	Lecture 4: 01/23/25 HW1 out
Week 3	Lecture 5: 01/28/25	Lecture 6: 01/30/25
Week 4	Lecture 7: 02/04/25	Lecture 8: 02/06/25 HW1 due

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Week	Tuesday	Thursday
Week 5	Lecture 9: 02/11/25 Exam1	Lecture 10: 02/13/25 HW2 out
Week 6	Lecture 11: 02/18/25	Lecture 12: 02/20/25
Week 7	Lecture 13: 02/25/25	Lecture 14: 02/27/25 HW2 due
Week 8	Lecture 15: 03/04/25 Exam2	Lecture 16: 03/06/25 Potential Remote Class HW3 out
Week 9	No Class: 03/11/25 Spring Break No Class	No Class: 03/13/25 Spring Break No Class
Week 10	Lecture 17: 03/18/25	Lecture 18: 03/20/25
Week 11	Lecture 19: 03/25/25	Lecture 20: 03/27/25 HW3 due
Week 12	Lecture 21: 04/01/25	Lecture 22: 04/03/25 HW4 out
Week 13	Lecture 23: 04/08/25 Exam3	Lecture 24: 04/10/25

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Week	Tuesday	Thursday
Week 14	Lecture 25: 04/15/25	Lecture 26: 04/17/25 HW4 due
Week 15	Lecture 27: 04/22/25	Lecture 28: 04/24/25