# CSE 4373/5373: General Purpose GPU Programming

Spring 2024

## Instructor Information

### Instructor(s)

Dr. Alex Dillhoff

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### Faculty Profile [Alex Dillhoff](https://www.uta.edu/academics/faculty/profile?username=dillhoffaj) (<https://www.uta.edu/academics/faculty/profile?username=dillhoffaj>)

**Course Website**

<https://ajdillhoff.github.io/courses/>

### Office Hours

MoWeFr 12PM – 1PM

TuTh 1PM – 2PM

## Course Information

### Section Information

CSE 4373/5373

### Time and Place of Class Meetings

MoWeFr 10AM – 10:50AM NH 112

### Description of Course Content

Study of general purpose computation on a GPU. Topics include GPU architectures, stream processing, and programming languages such as OpenCL and CUDA that realize data-parallel, high-throughput compute kernels on GPU architectures. Prerequisite: [CSE 3320](https://catalog.uta.edu/search/?P=CSE 3320) or consent of instructor.

### Student Learning Outcomes

* Explain CUDA/OpenCL programming models and mapping to hardware
* Apply common data-parallel programming patterns used in GPU computing
* Utilize GPU libraries like cuBLAS and cuDNN
* Develop proficiency in software development processes for GPU programming
* Analyze performance of GPU code and propose optimizations
* Assess applicability of GPU acceleration for computational problems

### Required Textbooks and Other Course Materials

* CUDA C++ Programming Guide. <https://docs.nvidia.com/cuda/cuda-c-programming-guide/index.html>
* CUDA C++ Best Practices Guide. <https://docs.nvidia.com/cuda/cuda-c-best-practices-guide/index.html>
* CUDA By Example: An Introduction to General-Purpose GPU. Jason Sanders and Edward Kandrot. <https://developer.nvidia.com/cuda-example>
* Programming Massively Parallel Processors: A Hands-on Approach. 4th ed. Wen-mei W. Hwu, David B. Kirk, Izzat El Hajj.

### Descriptions of major assignments and examinations

* 6 programming labs covering the topics taught throughout the course.
* 6 quizzes that serve to reinforce concepts and practical skills.
* 1 major project to apply learned concepts for a significant application.

In addition to these, regular in-class exercises and problems will be issues to reinforce the material.

### Technology Requirements

You should have access to a computer with an internet connection. There will be lab machines available for those wanting to test their programs on campus. If you have a CUDA or OpenCL-compatible video card, you are encouraged to use that instead of the machines on campus. Note that CUDA is a proprietary technology from NVIDIA, so you will not be able to run any CUDA code on AMD devices.

## Grading Information

* Assignments 40%
* Quizzes 40%
* Project 20%

While I do encourage students to study together and share resources for learning, I expect

every student to do their own work and turn in their own code. Assignments requiring code will

be automatically checked for similarity with other student submissions as well as online sources.

I am required to report any suspicion of academic dishonesty to the Office of Student Conduct.

Any student who is found guilty of violating any part of the UTA Honor Code will receive a 0

on the assignment or exam in question. Additionally, your final grade will be dropped to the next lowest letter grade. A second violation will result in an F for the class.

Information on UTA’s Honor Code can be found at https://www.uta.edu/student-affairs/community-standards/academic-integrity

Final grades are converted to letter grades based on the following:

* A: x >= 89.5%
* B: 89.5% > x >= 79.5%
* C: 79.5% > x >= 69.5%
* D: 69.5% > x >= 59.5%
* F: x < 59.5%

## Course Schedule

This schedule is tentative and subject to change. **Please refer to the course website for the most up-to-date information along with extra recommended resources.**

|  |  |  |
| --- | --- | --- |
| Date | Topic | Notes |
| January 17 | **L1** Introduction to Parallel Programming |  |
| January 19 | **L2** Heterogeneous Data Parallel Computing |  |
| January 22 | Environment Setup (Meet in Lab) | Lab 0 Out |
| January 24 | **L2** Cont., **L3** Multidimensional Grids and Data | Quiz 0 Due |
| January 26 | **L3** Cont., Recitation | Lab 0 Due, Lab 1 Out |
| January 29 | **L4** Compute Architecture and Scheduling |  |
| January 31 | **L4** Cont., **L5** Memory Architecture and Data Locality |  |
| February 2 | **L5** Cont., Recitation |  |
| February 5 | **L6** Performance Considerations | Lab 1 Due, Lab 2 Out |
| February 7 | **L6** Cont., **L7** Convolutions |  |
| February 9 | **L7** Cont., Recitation |  |
| February 12 | **L8** Profiling Code |  |
| February 14 | **L9** Stencil |  |
| February 16 | **L9** Cont., Recitation | Lab 2 Due, Lab 3 Out |
| February 19 | **L10** Parallel Histogram |  |
| February 21 | **L10** Cont., **L11** Prefix Sum |  |
| February 23 | **L11** Cont., Recitation | Project Proposals Due |
| February 26 | **L12** Merge |  |
| February 28 | **L12** Cont. |  |
| March 1 | Recitation | Lab 3 Due, Lab 4 Out |
| March 4 | **L13** Sparse Matrix Computation |  |
| March 6 | **L13** Cont., **L14** Graph Traversal |  |
| March 8 | **L14** Cont. |  |
| March 18 | **L15** Deep Learning | Lab 4 Due, Lab 5 Out |
| March 20 | **L15** Cont. |  |
| March 22 | Recitation |  |
| March 25 | **L16** MRI Reconstruction |  |
| March 27 | **L16** Cont., **L17** Electrostatic Potential Map |  |
| March 29 | **L17** Cont. | Lab 5 Due, Lab 6 Out |
| April 1 | **L18** Parallel Histogram |  |
| April 3 | **L18** Cont., **L19** Dynamic Parallelism |  |
| April 5 | **L19** Cont. |  |
| April 8 | **L20** Heterogeneous Computing Clusters |  |
| April 10 | **L20** Cont., **L21** Computational Thinking |  |
| April 12 | **L21** Cont. | Lab 6 Due |
| April 15 | **L22** Advanced Practices |  |
| April 17 | **L22** Cont. |  |
| April 19 | Recitation |  |
| April 22 |  |  |
| April 24 |  |  |
| April 26 |  |  |
| April 29 |  |  |

## Institutional Information

UTA students are encouraged to review the below institutional policies and informational sections and reach out to the specific office with any questions. To view this institutional information, please visit the [Institutional Information](https://resources.uta.edu/provost/course-related-info/institutional-policies.php) page (https://resources.uta.edu/provost/course-related-info/institutional-policies.php) which includes the following policies among others:

* Drop Policy
* Disability Accommodations
* Title IX Policy
* Academic Integrity
* Student Feedback Survey
* Final Exam Schedule

## Additional Information

### Face Covering Policy

Face masks or face coverings for all employees, students, visitors, and vendors are encouraged while in campus buildings and elsewhere on campus where social distancing measures are difficult to maintain (e.g., student shuttle buses, well-attended outdoor events, etc.). Cloth face masks will also be made available to individual employees and/or students at the University Center Campus Information Desk, the Main Library, and at The Commons Information Desk.

*N95 masks are more effective at filtering aerosols than surgical or cloth masks. More information can be found here:* [*https://www.projectn95.org/*](https://www.projectn95.org/)

### Attendance

At The University of Texas at Arlington, taking attendance is not required but attendance is a critical indicator of student success. Each faculty member is free to develop his or her own methods of evaluating students’ academic performance, which includes establishing course-specific policies on attendance.

I do not require attendance. Attendance is usually implicitly determined by student outcomes on assignments and exams. I will typically try and reach out to those that are waning in performance to see what we can do to stay on track.

However, while UT Arlington does not require instructors to take attendance in their courses, the U.S. Department of Education requires that the University have a mechanism in place to mark when Federal Student Aid recipients “begin attendance in a course.” UT Arlington instructors will report when students begin attendance in a course as part of the final grading process. Specifically, when assigning a student a grade of F, faculty report must the last date a student attended their class based on evidence such as a test, participation in a class project or presentation, or an engagement online via Canvas. This date is reported to the Department of Education for federal financial aid recipients.

### Emergency Exit Procedures

Should we experience an emergency event that requires evacuation of the building, students should exit the room and move toward the nearest exit, which is located out of the door and to the left. When exiting the building during an emergency, do not take an elevator but use the stairwells instead. Faculty members and instructional staff will assist students in selecting the safest route for evacuation and will make arrangements to assist individuals with disabilities.

An evacuation map for this room can be found here: <https://www.uta.edu/campus-ops/ehs/fire/Evac_Maps_All/Evac_NH/Evac_NH_108.pdf>

### Academic Success Center

The Academic Success Center (ASC) includes a variety of resources and services to help you maximize your learning and succeed as a student at the University of Texas at Arlington. ASC services include supplemental instruction, peer-led team learning, tutoring, mentoring and TRIO SSS. Academic Success Center services are provided at no additional cost to UTA students. For additional information visit: [Academic Success Center](https://www.uta.edu/student-success/course-assistance) (https://www.uta.edu/student-success/course-assistance). To request disability accommodations for tutoring, please complete this [form](https://www.uta.edu/student-success/course-assistance/tutoring/request) (https://www.uta.edu/student-success/course-assistance/tutoring/request).

**▲ The** [**IDEAS Center**](https://www.uta.edu/ideas/) (https://www.uta.edu/ideas/) **(**2nd Floor of Central Library) offers **FREE** [tutoring](https://www.uta.edu/ideas/services/tutoring/index.php) and [mentoring](https://www.uta.edu/ideas/services/mentoring/index.php) to all students with a focus on transfer students, sophomores, veterans and others undergoing a transition to UT Arlington. Students can drop in or check the schedule of available peer tutors at www.uta.edu/IDEAS, or call (817) 272-6593.

**Counseling and Psychological Services**

Physical and mental wellness are an important part of learning. UTA offers counseling and psychiatry to all students enrolled in campus-based classes. For more information, go to https://www.uta.edu/caps/. This is an amazing resource to have as a student!

## Emergency Phone Numbers

**▲** In case of an on-campus emergency, call the UT Arlington Police Department at **817-272-3003** (non-campus phone), **2-3003** (campus phone). You may also dial 911. Non-emergency number 817-272-3381