



CS 677: Parallel Programming for Many-core Processors
School of Engineering and Science
Spring 2019

Meeting Times: Wednesday 6:15-8:45 PM
Classroom Location: North 101
Instructor: Philippos Mordohai
Contact Info: North 209, Philippos.Mordohai@stevens.edu, 201 216 5611
Office Hours: Tuesday 5:00-6:00 PM and by appointment
Course Web Address: http://www.cs.stevens.edu/~mordohai/classes/cs677_s19.html
Prerequisite(s): CS 537 or CS 511 or CS 631
Corequisite(s): N/A
Cross-listed with: N/A

COURSE DESCRIPTION

The objective of the course is to provide the students with knowledge of the state-of-the art hardware architectures and programming philosophies for gaming, machine learning, scientific computation, simulation, and visualization. The emphasis will be on the NVIDIA's CUDA, which currently is the most widely used parallel computing architecture.

LEARNING OBJECTIVES

After successful completion of this course, students will be able to...

- Memory Types - Select the appropriate memory types for a multicore application to minimize latency.
- Divergence - Identify and describe divergence in SIMD/SIMT programs.
- Resources - Design algorithms taking into account system resources such as memory, register availability, and maximum number of cores/active threads.
- Occupancy - Estimate the occupancy of the multicore architecture and identify bottlenecks. (MS - GDSP C expertise)

FORMAT AND STRUCTURE

This course is comprised of weekly three-hour lectures.

COURSE MATERIALS

Textbook(s): Programming Massively Parallel Processors: A Hands-on Approach
by David Kirk and Wen-mei Hwu, Morgan Kaufmann, 2016 (3rd edition)

Other Readings: Available on course web page

Materials: None

COURSE REQUIREMENTS

- Attendance** Attendance is not mandatory, but there will be regular quizzes during the semester.
- Participation** Participation is strongly encouraged.
- Homework** There will be four homework assignments, which will be tentatively assigned in Weeks 3, 4, 6 and 7 and will be due one week later.
- Quizzes** There will be several quizzes during the semester, at the beginning of each lecture.
- Project** Each student will select a project, which has to be approved by me regarding relevance and feasibility. I will also provide suggestions for potential projects and pointers to relevant material. Students actively involved in research can select a project related to their research, but new work has to be done during the semester. Large projects can be performed by groups of two students. Each student will briefly present a proposal of his or her project, **which will have to be approved by Week 8, in Week 9.** Longer status updates will be given three weeks later and the final presentations will be given in the last week of classes. The written reports will be due on the date of the (non-existent) final exam.
- Exams** The midterm is scheduled for Week 8.

GRADING PROCEDURES

Grades will be based on:

Homework	(40%)
Quizzes	(10%)
Final Project	(35%)
Midterm Exam	(15%)

ACADEMIC INTEGRITY

Graduate Student Code of Academic Integrity

All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

All graduate students are bound by the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at www.stevens.edu/provost/graduate-academics.

Special Provisions for Undergraduate Students in 500-level Courses

The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described

in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Dean of Graduate Academics or to the Honor Board, who will refer the report to the Dean. The Honor Board Chairman will give the Dean of Graduate Academics weekly updates on the progress of any casework relating to 500-level courses. For more information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the [Bylaws of the Honor System](#) document, located on the Honor Board website.

EXAM ROOM CONDITIONS

The following procedures apply to quizzes and exams for this course. As the instructor, I reserve the right to modify any conditions set forth below by printing revised Exam Room Conditions on the quiz or exam.

1. Students may use the following devices during quizzes and exams. Any electronic devices that are not mentioned in the list below are not permitted.

Device	Permitted?	
	Yes	No
Laptops		X
Cell Phones		X
Tablets		X
Smart Watches		X
Google Glass		X
Other		X

2. Students may use the following materials during quizzes, marked with Q, and exams, marked with E. Any materials that are not mentioned in the list below are not permitted.

Material	Permitted?	
	Yes	No
Handwritten Notes <i>Conditions:</i>		EQ
Typed Notes <i>Conditions:</i>		EQ
Textbooks <i>Conditions:</i>		EQ
Readings <i>Conditions:</i>		EQ
Other (specify)		

3. Students are not allowed to work with or talk to other students during quizzes and exams.

LEARNING ACCOMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. Student Counseling and Disability Services works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, and psychiatric disorders in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to

encourage independence and self-advocacy with support from SCDS staff. The SCDS staff will facilitate the provision of accommodations on a case-by-case basis. These academic accommodations are provided at no cost to the student.

Disability Services Confidentiality Policy

Student Disability Files are kept separate from academic files and are stored in a secure location within the office of Student Counseling, Psychological & Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

For more information about Disability Services and the process to receive accommodations, visit <https://www.stevens.edu/sit/counseling/disability-services>. If you have any questions please contact: Lauren Poleyeff, Psy.M., LCSW - Disability Services Coordinator and Staff Clinician in Student Counseling and Disability Services at Stevens Institute of Technology at lpoleyef@stevens.edu or by phone (201) 216-8728.

INCLUSIVITY STATEMENT

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in education and innovation. Our community represents a rich variety of backgrounds, experiences, demographics and perspectives and Stevens is committed to fostering a learning environment where every individual is respected and engaged. To facilitate a dynamic and inclusive educational experience, we ask all members of the community to:

- be open to the perspectives of others
- appreciate the uniqueness their colleagues
- take advantage of the opportunity to learn from each other
- exchange experiences, values and beliefs
- communicate in a respectful manner
- be aware of individuals who are marginalized and involve them
- keep confidential discussions private

TENTATIVE COURSE SCHEDULE

Week Starting	Topic(s)	Readings	Assignment
January 23	Introduction to massively parallel programming and CUDA	Kirk & Hwu Ch. 1, 2 and 3	
January 30	CUDA threads and atomics; CUDA memories	Kirk & Hwu Ch. 4 and 5	
February 6	Performance considerations	Kirk & Hwu Ch. 6	Homework 1
February 13	More performance considerations and floating point representation	Kirk & Hwu Ch. 6 and 7	Homework 2

February 20	Project ideas; Case study: MRI reconstruction	Kirk & Hwu Ch. 11	
February 27	Convolution, constant memory and cache, reduction trees, parallel patterns: prefix sum	Kirk & Hwu Ch. 8 and 9	Homework 3
March 6	Case study: Electrostatic Potential Calculation; input binning; Sparse matrix and vector operations; summed area tables	Kirk & Hwu Ch. 10, 12, 13 and notes	Homework 4
March 13	Midterm Exam		Project Proposals
March 27	Computational thinking and CUDA Streams	Kirk & Hwu Ch. 13	
April 3	Thurst; more libraries	Notes	
April 10	OpenCL	Kirk & Hwu Ch. 14 and notes	Project status reports (due 4/17)
April 17	Project mid-point reports; more OpenCL.	Notes	
April 24	Latest GPU and CUDA features; OpenACC, OpenMP	Notes	
May 1	Project Presentations		
May 15			Final Project report due on projected day of final exam