

## CS 6245 Syllabus: Parallelizing Compilers, 3 credits, 3:30 pm - 4:45 pm, MW, Hybrid Delivery

### Instructor Information

Instructor	Email	Office Hours & Meeting Link
Vivek Sarkar	vsarkar@gatech.edu	2pm – 3pm, Mondays,
Teaching Assistant	Email	Office Hours & Meeting Link
Sana Damani	sdamani@gatech.edu	TBD

### General Information

#### Description

Are you curious about how a compiler generates parallel code for modern computers with vector, multicore and GPU processors? What program properties enable or prevent an application from executing efficiently on these processors? These questions have taken on new importance as parallelism is now ubiquitous in hardware with the end of Dennard Scaling and Moore's Law, and has become critical for newer application domains including machine learning. To answer these question, this course will cover the foundations of advanced compilation techniques for parallel computer systems, including the analysis of program dependence, program transformations to enhance parallelism, compiler management of the memory hierarchy, and inter-procedural data flow analysis. By the end of this course, students will be knowledgeable about the strengths and limitations of state-of-the-art compilers, both from the viewpoint of the compiler user as well as of the compiler developer. The techniques taught in the course should be relevant to anyone interested in enabling software to execute efficiently on parallel computers, whether by hand or through the use of compilers.

#### Pre-Requisites

Students should have taken an undergraduate class on compilers, such as CS 4240: Compilers and Interpreters at Georgia Tech or equivalent. If in doubt, please contact the instructor.

#### Course Goals and Learning Outcomes

Upon successful completion of this course, you should be able to:

- Understand the capabilities and limitations of different array dependence analysis techniques
- Understand the capabilities and limitations of different loop transformations for locality and parallelism (distribution, fusion, interchange, skewing, tiling, polyhedral)
- Design compiler extensions to perform automatic parallelization, and related high level code optimizations

- Through your project, learn about the state of the art in current research on a topic of your choice related to parallelizing compilers.

### Course Modality

This course will be taught in hybrid mode with remote online lectures and in-person touchpoint meetings between the instructor and individual project teams (each team will consist of 1 or 2 students). All homeworks, exams, etc will be administered online. Any accommodation requests for fully-remote class participation, (i.e., for also making your touchpoint meetings online), will be given full consideration. Please email the instructor if you have any questions.

### Course Requirements & Grading

The table below summarizes all course assignments that contribute to course assessment, and the percentage of the overall

Assignment	Percentage of course grade
3 written homeworks	30%
Midterm Exam (given online during class on 10/7/20)	15%
Class Participation	5%
Final Exam (Dec 2, 2:40 PM - 5:30 PM)	30%
Class Project (teams of 1 or 2 people)	20%

### Final Exam

Wednesday, Dec 2, 2:40 PM - 5:30 PM (published in registrar's [Fall 2020 Final Exam Matrix](#))

### Grading Scale

The default plan is to assign your final letter grade according to the standard scale below. However, the cutoffs for certain letter grades may be lowered based on the instructor's discretion. For example, if your total course grade is 90% or higher, you are guaranteed to receive an A. And if the cutoff is lowered to 88%, all students who received course grades of 88% or higher will receive an A. However, no cutoff will be raised relative to the standard scale below.

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

### Course Text

R. Allen and K. Kennedy, *Optimizing Compilers for Modern Architectures*, Morgan-Kaufmann, Second Printing, 2005.

### **Course Expectations & Guidelines**

- Lectures – Even though the lectures will be conducted online, we will make our best effort to make it an interactive experience for all. Feel free to use BlueJeans chat to ask and answer questions during the lecture, or to unmute your microphone when you'd like to ask or answer a question orally.
- Open-book homeworks and exams – The three written homeworks and two exams will be “open book”. They are designed to be completed using material from the textbook and the course Piazza site. They must be completed individually with no help from anyone else. If any other external material is used, it must be explicitly acknowledged. The midterm exam will cover topics from the first half of the semester, and the final exam will cover all topics discussed in the course.
- Class Project -- The goal of the class project is to perform an in-depth study of a research problem related to the course material. It should include a theoretical focus with a written project report (with references to recent related work). Practicality can be demonstrated using hand-implemented code transformations, or using a tool to perform code transformations. The project should be done individually or in groups of 2, and project groups should be finalized by the end of the first week of class. The project scope will depend on whether it is being undertaken individually or in pairs.
- Class Participation will be assessed based on your level of participation in lectures, worksheets, office hours and on Piazza.

### **Health-Related Considerations**

Effective July 15, 2020, University System of Georgia (USG) institutions require all faculty, staff, students, and visitors to wear an appropriate face covering while inside campus facilities/buildings. All members of the campus community will be provided reusable cloth face coverings.

Face covering use will be in addition to and is **not** a substitute for social distancing. Anyone not using a face covering when required will be asked to wear one or must leave the area. Refusal to comply with the requirement may result in discipline through the applicable conduct code for faculty, staff or students.

There are a few exemptions. Reasonable accommodations may also be made for those who are unable to wear a face covering for documented health reasons.

For more information about face masks and coverings, review the [guidelines from Human Resources](#).

### **Academic Integrity**

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit <http://www.catalog.gatech.edu/policies/honor-code/> or <http://www.catalog.gatech.edu/rules/18/>.

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

### **Collaboration & Group Work**

Students are expected to complete all coursework independently, except for in-class worksheets which are encouraged to be done collaboratively and will not be graded (other than that worksheet submissions, regardless of whether they are correct or wrong, will count towards class participation). While students are of course welcome to discuss the course material outside of class, solutions to homework and exam problems should not be discussed with others. References to any materials used beyond the textbook and course material on the Piazza site must be explicitly cited.

### **Accommodations for Students with Disabilities**

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or <http://disabilityservices.gatech.edu/>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail the instructor as soon as possible in order to set up a time to discuss your learning needs.

Also, as mentioned earlier, all accommodation requests for fully-remote class participation, (i.e., for also making your touchpoint meetings online), will be given full consideration. Please email the instructor if you have any questions.

### **Class Participation**

Students are encouraged to pursue an active learning approach in this class during lectures, worksheets, office hours and on Piazza. This includes asking questions and contributing to answers to questions by other students. No strict guidelines will be enforced regarding whether students attend class. However, not attending class may reduce your opportunity to contribute to the Participation component of your grade (5%).

Please also [see this catalog page](#) for more information about institute expectations and restrictions around attendance, including information about excused absences.

**Extensions, Late Assignments, & Re-Scheduled/Missed Exams**

There will be an automatic penalty-free 48-hour extension given for all homework and project submissions. If an accommodation is needed for a further extension, please contact the instructor as soon as possible in advance of the deadline.

Exams will be held at the scheduled times listed at the start of the syllabus. Please inform the instructor ahead of time if you need an accommodation to take the exam at a different time.

**Student-Faculty Expectations Agreement**

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See [this catalog page](#) for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.